EXHIBIT 1

US005493335A

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Parulski et al.

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[45] Date of Patent: Feb. 20, 1996

[54] **SINGLE SENSOR COLOR CAMERA WITH USER SELECTABLE IMAGE RECORD SIZE**

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[73] Assignee: **Eastman Kodak Company**, Rochester, N.Y.

[21] Appl. No.: **85,516**

[22] Filed: **Jun. 30, 1993**

[51] **Int. Cl.**[6] **H04N 5/76**

[52] **U.S. Cl.** **348/233**; 348/273; 358/906; 358/909.1

[58] **Field of Search** 358/209, 909, 358/906, 909.1; 348/207, 266, 272, 273, 233; H04N 5/30, 5/76

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,971,065	7/1976	Bayer	358/41
4,412,252	10/1983	Moore et al.	358/160
4,468,755	8/1984	Iida	364/900
4,541,010	9/1985	Alston	358/44
4,623,922	11/1986	Wischermann	358/160
4,779,135	10/1988	Judd	358/183
4,821,121	4/1989	Beaulier	358/160
4,876,590	10/1989	Parulski	358/41
5,016,107	5/1991	Sasson et al.	358/209
5,018,017	5/1991	Sasaki et al.	358/209
5,040,068	8/1991	Parulski et al.	358/209
5,097,518	3/1992	Scott et al.	382/47
5,138,459	8/1992	Roberts et al.	358/209
5,164,831	11/1992	Kuchta et al.	358/209

OTHER PUBLICATIONS

"Popular Science", Sep. 1992, p. 65.

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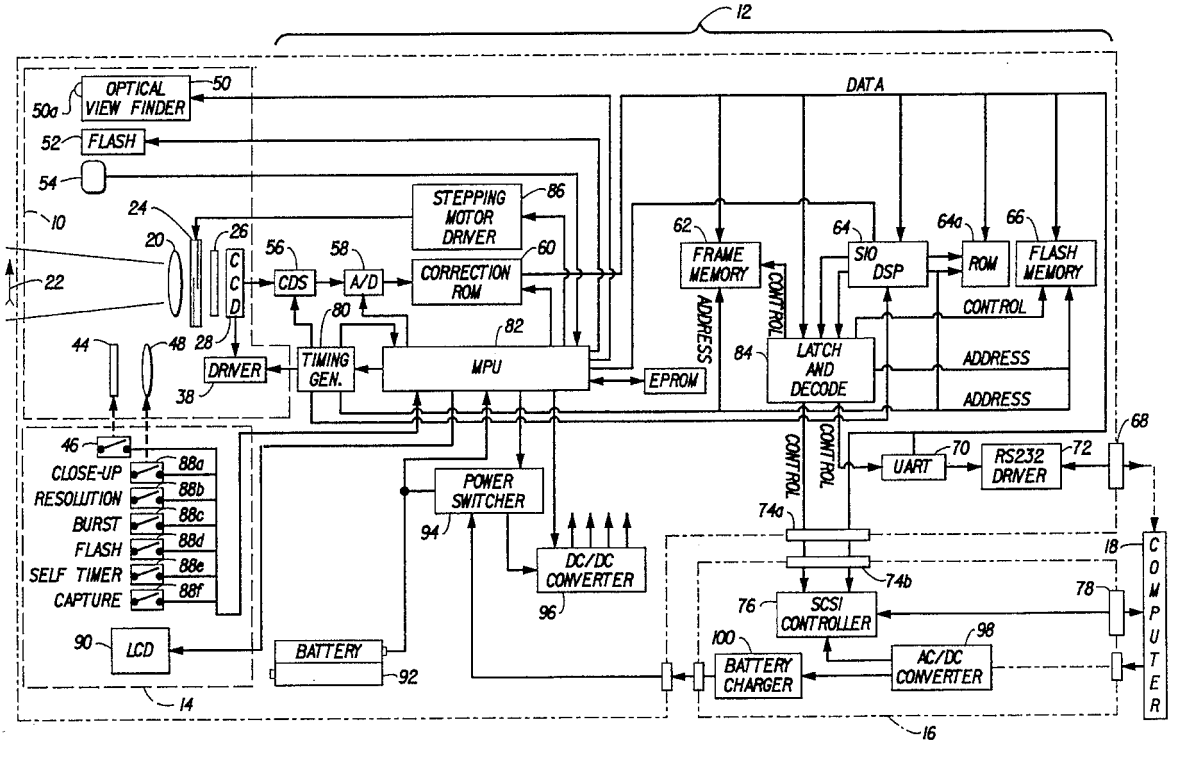
Assistant Examiner—Cheryl Cohen
Attorney, Agent, or Firm—David M. Woods

[57] **ABSTRACT**

An electronic camera is adapted for processing images of different resolution to provide a user selectable image record size. A buffer memory is provided for storing color image pixels from a sensor as baseband signals corresponding to at least one image. A timing controller responsive to a resolution mode switch controls the order in which color image pixels are selected for storage in both vertical and horizontal directions. The order selected by the resolution switch includes a full resolution mode, and at least one reduced resolution mode in which the color image pixels are subsampled such that each chrominance image pixel is selected to be spatially adjacent to a selected luminance image pixel. Additionally, the buffer memory can store a burst of low resolution images.

15 Claims, 5 Drawing Sheets



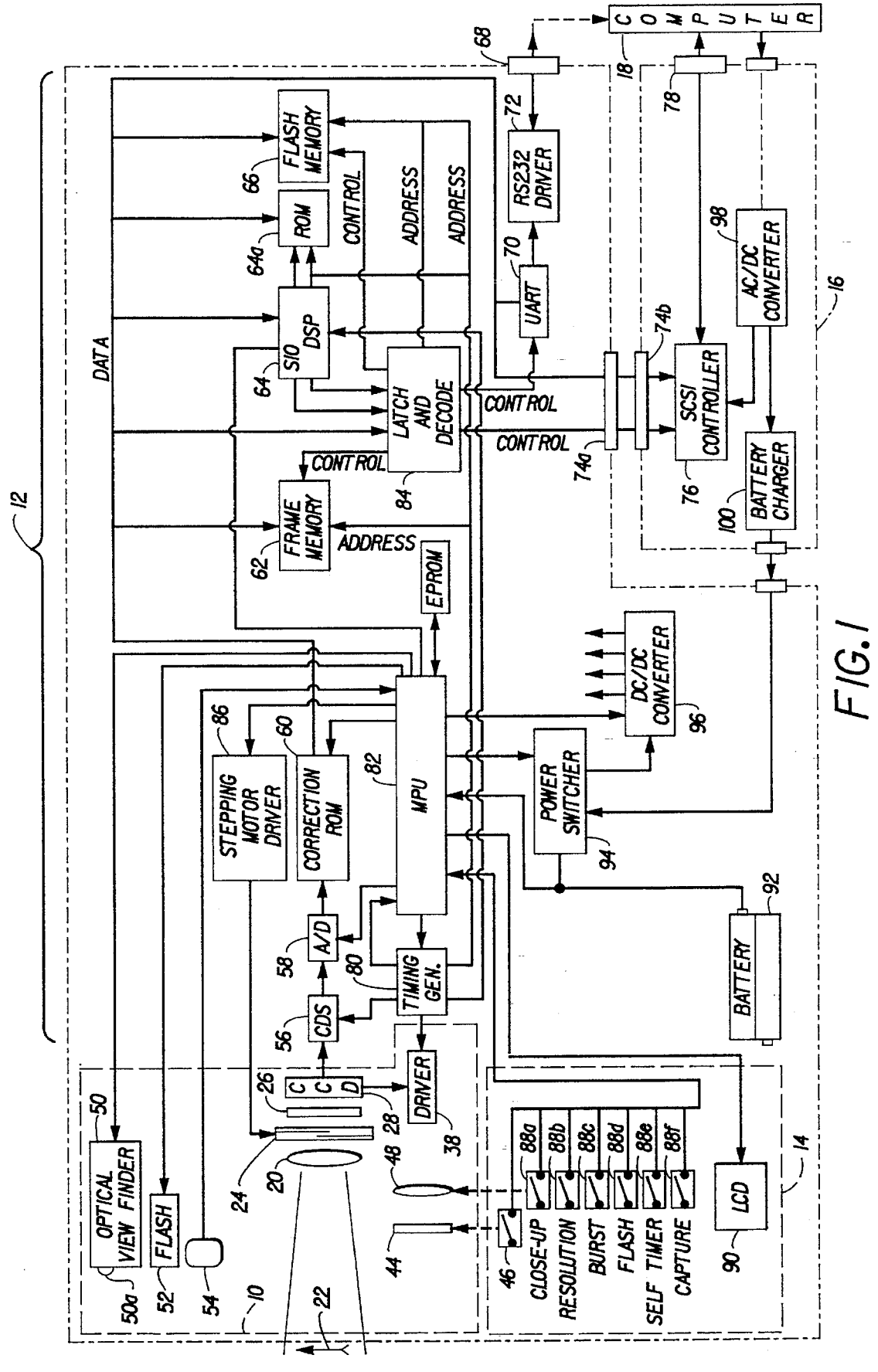

COMPUTER
18
68
72
RS232 DRIVER
70
UART
78
98
AC/DC CONVERTER
16
74b
SCSI CONTROLLER
76
BATTERY CHARGER
100
74a
FLASH MEMORY
66
ROM
64a
DSP
64
SIO
DATA
ADDRESS
ADDRESS
CONTROL
LATCH AND DECODE
84
CONTROL
CONTROL
FRAME MEMORY
62
ADDRESS
EPROM
12
DC/DC CONVERTER
96
STEPPING MOTOR DRIVER
86
CORRECTION ROM
60
MPU
82
POWER SWITCHER
94
BATTERY
92
A/D
58
TIMING GEN.
80
CDS
56
DRIVER
38
26
28
48
24
20
44
22
OPTICAL VIEW FINDER
50
50a
FLASH
52
54
10
46
88a
88b
88c
88d
88e
88f
CLOSE-UP
RESOLUTION
BURST
FLASH
SELF TIMER
CAPTURE
LCD
90
14

FIG. 1

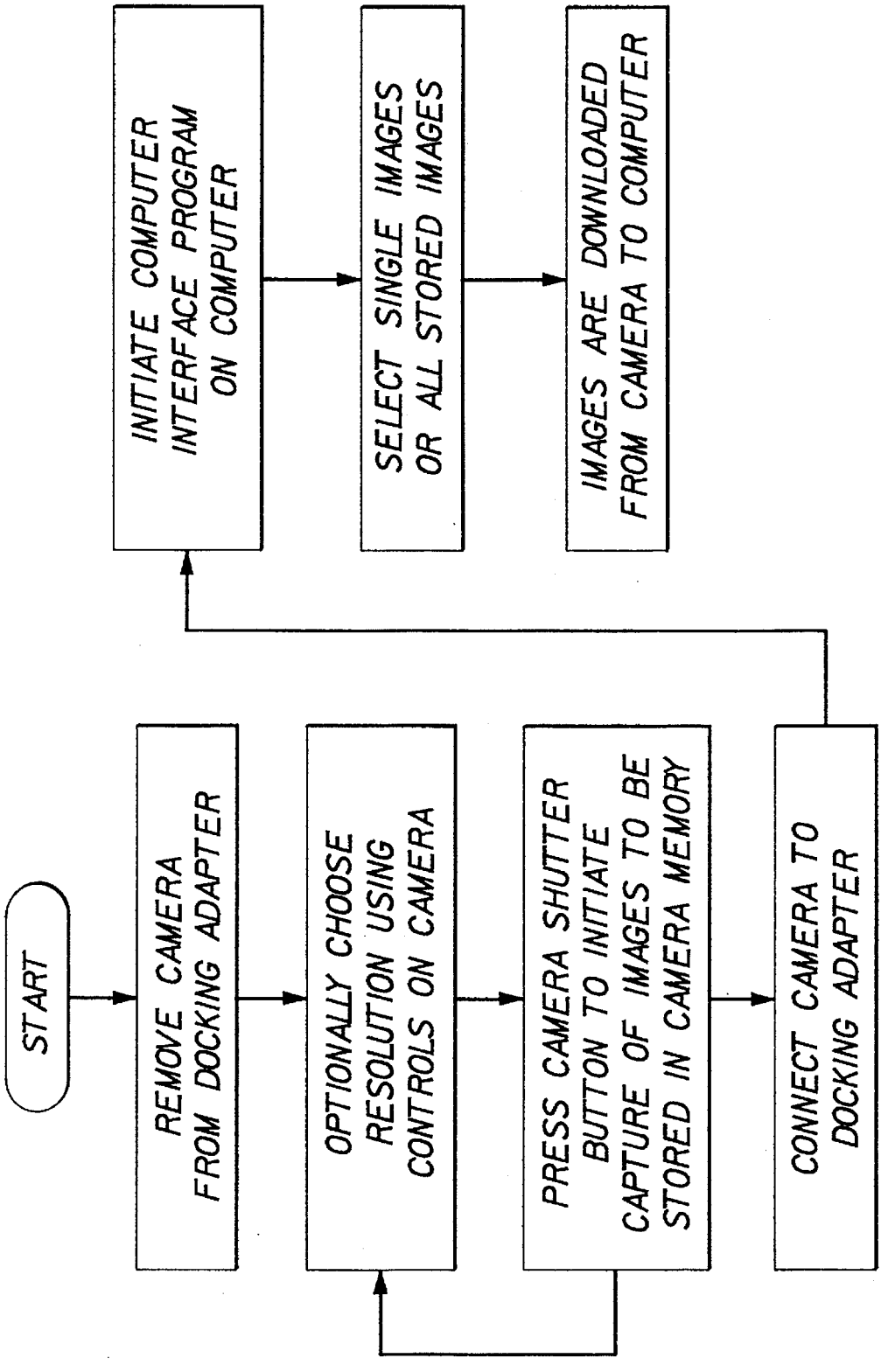

START
REMOVE CAMERA FROM DOCKING ADAPTER
OPTIONALLY CHOOSE RESOLUTION USING CONTROLS ON CAMERA
PRESS CAMERA SHUTTER BUTTON TO INITIATE CAPTURE OF IMAGES TO BE STORED IN CAMERA MEMORY
CONNECT CAMERA TO DOCKING ADAPTER
INITIATE COMPUTER INTERFACE PROGRAM ON COMPUTER
SELECT SINGLE IMAGES OR ALL STORED IMAGES
IMAGES ARE DOWNLOADED FROM CAMERA TO COMPUTER

FIG. 2

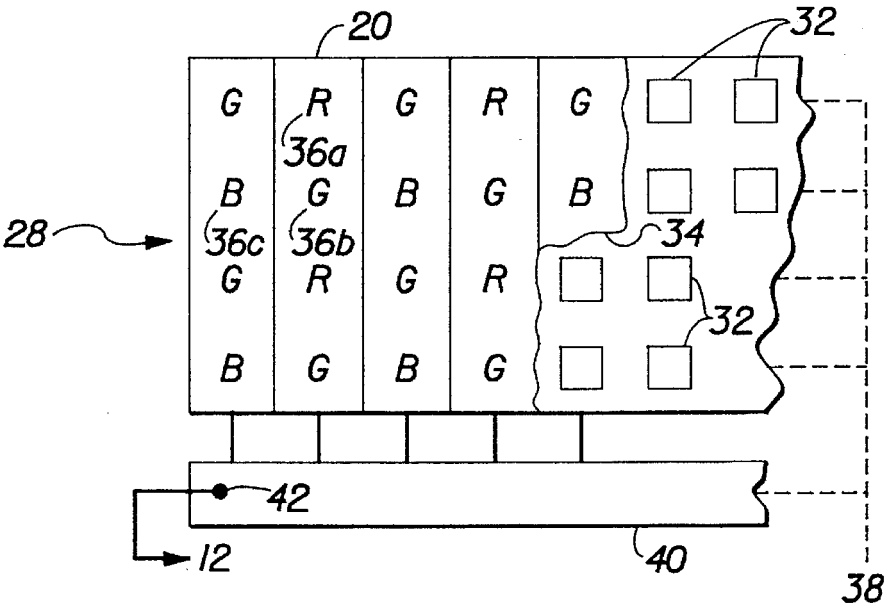
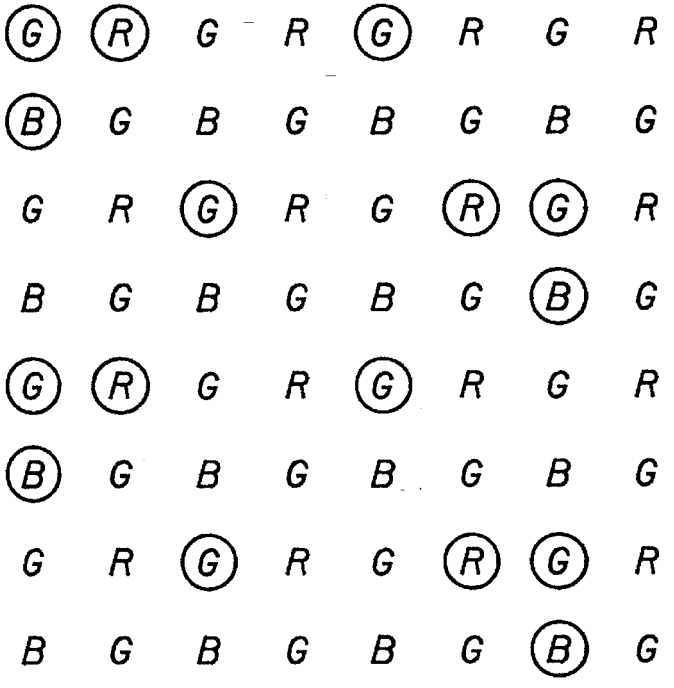

20
32
G
R
G
R
G
36a
B
G
B
G
B
28
36c
36b
34
G
R
G
R
32
B
G
B
G
42
12
40
38

FIG. 3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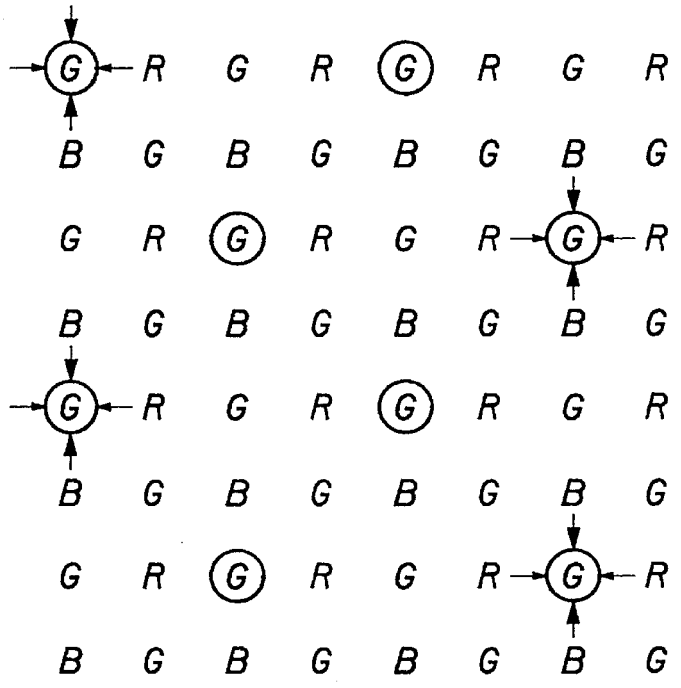
B G B G B G B G
G R G R G R G R
B G B G B G B G
G R G R G R G R
B G B G B G B G
G R G R G R G R
B G B G B G B G

FIG. 4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G R G R G R G R
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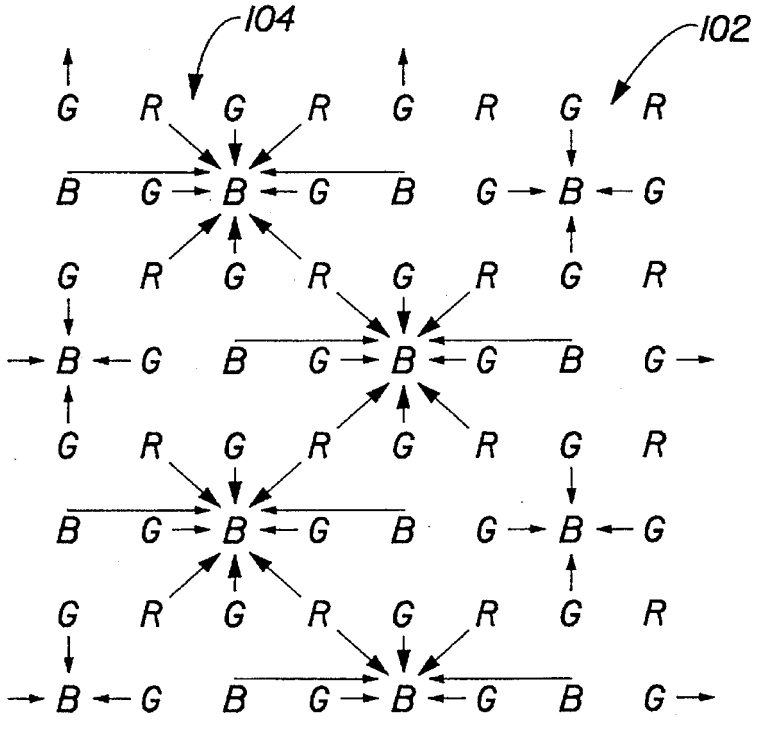
G R G R G R G R
B G B G B G B G
G R G R G R G R
B G B G B G B G

FIG. 5


104
102
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B G B G B G B G
G R G R G R G R
B G B G B G B G
G R G R G R G R
B G B G B G B G
G R G R G R G R
B G B G B G B G

FIG. 6

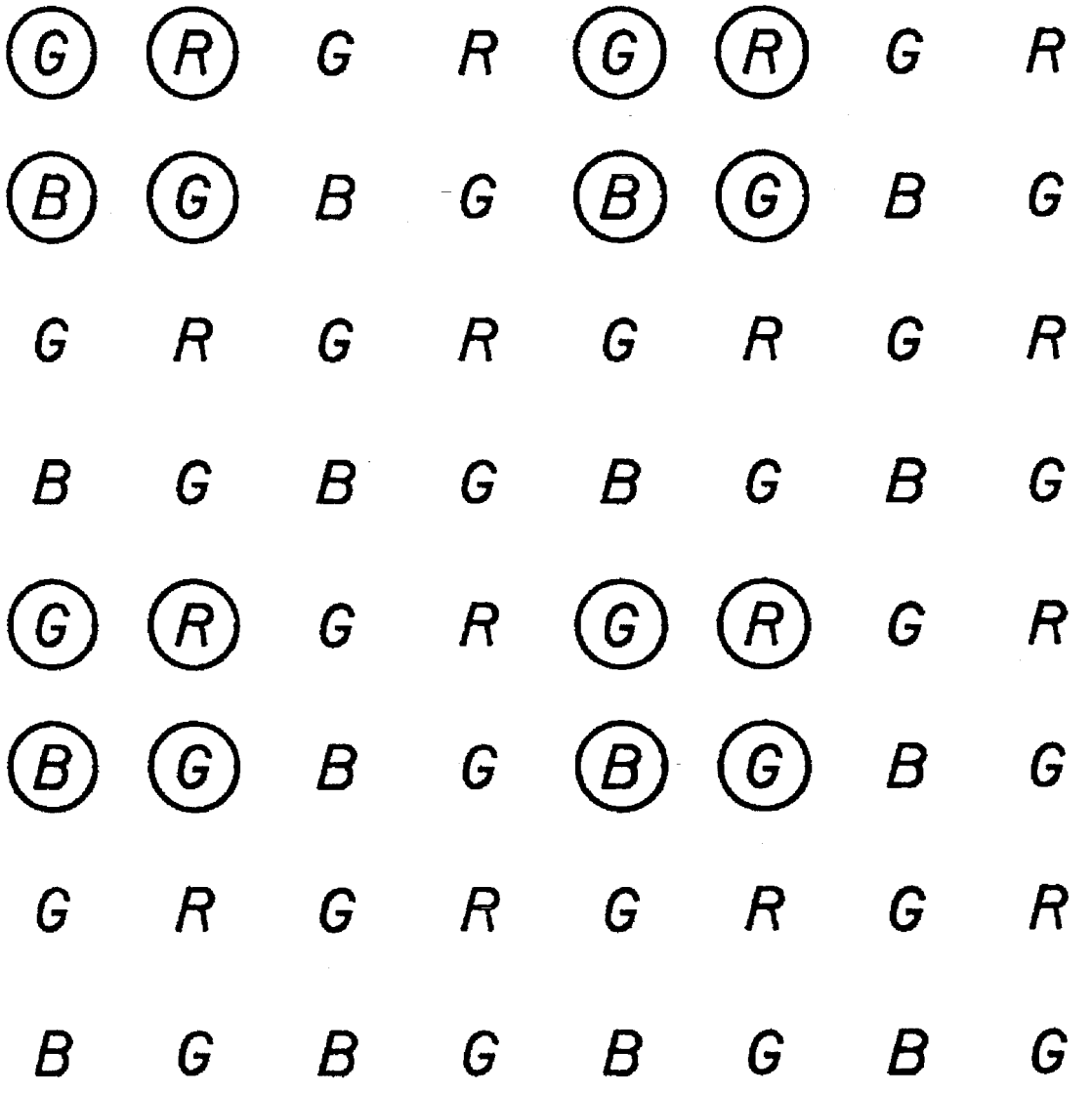

G R G R G R G R
B G B G B G B G
G R G R G R G R
B G B G B G B G
G R G R G R G R
B G B G B G B G
G R G R G R G R
B G B G B G B G

FIG.7

SINGLE SENSOR COLOR CAMERA WITH USER SELECTABLE IMAGE RECORD SIZE

FIELD OF THE INVENTION

This invention relates to the field of electronic imaging and, in particular, to electronic still imaging by means of an electronic still camera having a single color sensor and semiconductor memory.

BACKGROUND OF THE INVENTION

It is known in the prior art to provide an electronic camera with variable resolution modes by which the memory capacity required for recording an image can be changed as required, for example, to cope with limited residual memory in the recording medium.

U.S. Pat. No. 5,018,017 is representative of a camera utilizing such variability in resolution modes. The problem in the prior art, as set forth in this patent, is that provision of different resolution modes complicates the compatibility of removable memory used in electronic cameras. Whereas signal processing may be simple in construction when data corresponding to each picture element is simply recorded in the removable memory, any change in the number of filter elements or the arrangement of the color filter accordingly changes the arrangement of data recorded in the memory or the amount of data per image recorded in the memory. This means that the recorded memory cannot be interchangeably used with other camera systems having different sensor arrangements. While this problem is always a serious shortcoming, it becomes even more serious, and complicated, when several resolution modes are provided because each mode is likely to be dependent upon the particular color filter arrangement in use.

U.S. Pat. No. 5,018,017 solves this problem by preprocessing the baseband image data from the sensor, in this case to form luminance and color difference signals, before providing any change in resolution. This achieves a degree of uniformity, regardless of the sensor being used. Four resolution modes are provided, a full resolution mode and a lower resolution mode obtained by subsampling the full resolution signal, and two lesser resolution modes obtained by using progressively lower quantization levels in compressing the lower resolution image. In each case, the progressively lowered resolutions are derived from a color signal that is already preconverted into a standardized form. These reduced resolution modes offer more image storage for a given memory and open the possibility of continuously photographing, and recording, a series of images in memory that would, at full resolution, only store one, or a few, images. As noted in U.S. Pat. No. 5,018,017, the upper limit of the speed attained during such a burst mode is restricted by the time required for writing into the removable memory.

The principal shortcoming of known camera systems with several resolution modes is the amount of signal processing that is done between image capture and the point at which data reduction occurs. The more processing that occurs, the more chance for noise to enter the system before the new reduced resolution image is constructed. Moreover, a principal reason for going to reduced resolution in the first place is to free up memory storage for the taking, and storage, of more pictures. The camera is then able to load as many pictures as possible, and as quickly as possible, into the camera memory. However, the camera disclosed in this patent limits the attained speed to the access time to the removable memory, a circumstance that basically does not take full advantage of the reduced resolution modes. This is particularly the case where the removable memory is, as is usually the case, the slowest memory in the system.

Consequently, an object of the invention is to collapse the processing chain between image capture and resolution reduction so that problems caused by intervening processing are avoided.

Another object is to fully utilize the collapsed processing interval for continuous photography so that a subsequent circuit element, such as the removable memory, does not appreciably limit the attainable speed.

A further object is to permit the user to select an image record size in accordance with the need, whether for continuous photography or added storage for any other reason.

SUMMARY OF THE INVENTION

In accordance with the invention, the aforementioned problems are solved with an electronic camera for processing images of different resolution, as set forth in the description of the preferred embodiments. As claimed, the camera includes an image sensor for generating a baseband image signal representative of color image pixels arranged in vertical and horizontal directions as obtained from a two-dimensional array of photosites covered by a pattern of luminance and chrominance color filters. A buffer memory includes sufficient capacity for storing the color image pixels as baseband signals corresponding to at least one image. An output memory, connected subsequent to the buffer memory, includes capacity for storing processed image signals obtained from the buffer memory. A resolution mode switch selects the pixel resolution of the image by specifying the order in which the color image pixels are selected for storage in both vertical and horizontal directions, the order including a full resolution mode in which all color image pixels are selected and at least one reduced resolution mode in which a fewer number of color image pixels are selected. A timing controller responsive to the pixel resolution selected by a resolution mode switch accordingly changes the number of horizontal and vertical pixels that represent the image by effecting a subsampling of the color image pixels for the reduced resolution mode. Finally, the selected color image pixels are stored in the output memory, such that the output memory is able to store more images in the reduced resolution mode than in the full resolution mode.

Several advantageous technical effects flow from the invention. One advantage is that each reduced resolution image directly corresponds to the image pixel data on the sensor, thus being a truer representation with less contamination by processing noise. Another advantage is that the processing channel before subsampling can be much simpler than in the prior art, with the usual attendant advantages in cost and speed. A further advantage is that the system can be designed to maximize incoming throughput into fast buffer memory, thus enhancing the speed of continuous photography. Other advantages and effects will become apparent in the ensuing description of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in relation to the drawings, in which

FIG. 1 is a block diagram of a single sensor color camera with user selectable image record size in accordance with the invention;

FIG. **2** is a flowchart showing the operation of the camera shown in FIG. **1**;

FIG. **3** is a view of a portion of the sensor shown in FIG. **1**;

FIG. **4** is a view of the color pattern shown in FIG. **3** with an overlay of a first subsampling pattern;

FIG. **5** is a view of the color pattern shown in FIG. **3** with an overlay of a second subsampling pattern;

FIG. **6** is a view of the color pattern shown in FIG. **3** with an overlay of a third subsampling pattern; and

FIG. **7** is a view of the color pattern shown in FIG. **3** with an overlay of a fourth subsampling pattern.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Since electronic still cameras employing a single color sensing device are well known, the present description will be directed in particular to elements forming part of, or cooperating more directly with, apparatus in accordance with the present invention. Elements not specifically shown or described herein may be selected from those known in the art.

Referring initially to FIG. **1**, the elements of a single sensor electronic camera are shown in block form. The camera is divided generally into an input section **10** for receiving image light and capturing an image, a processing and storage section **12** for processing and storing captured images, a control and display section **14** for user interface with the camera, and a detachable docking unit **16** for transferring stored images from the processing and storage section **12** to a host computer **18**. The camera shown in FIG. **1** is sometimes referred to as a dockable electronic still camera, since it relates to the computer **16** generally through a docking unit **16** (although, as will be described, a serial port is provided on the camera body itself for direct connection with the computer **18**).

The operation of the camera is generally shown in FIG. **2**. With this type of imaging system, the camera is generally removed from the docking unit **16** and used at a location significantly remote from the computer **18**. The camera is periodically returned to the computer, and images are then downloaded through the docking unit **16** (or the serial port) to free up the camera memory for more photographs. Because it is often inconvenient for the user to return to the computer to download images, the invention provides the user with the option to store some, or all, of the images at less than the highest resolution level, so that more images may be stored in the camera memory before having to return to the computer **18** to download the images. After the images are captured, the camera is connected to the docking adapter and the interface is initiated through the computer **18** (by appropriate software, which is not part of this invention). The desired images are selected, and perhaps previewed, through the computer **18**, and accordingly downloaded to its resident memory.

The input section **10** includes a lens **20** for imaging light from an object **22** through a shutter and aperture control **24** and an optical low pass filter **26** upon a charge-coupled device (CCD) image sensor **28**. The sensor **28** is shown in further detail in FIG. **3** to include a color filter array **30** overlying an array of photosites **32** (shown for illustration through a cutaway portion **34** of the color filter array **30**. The color filter array **30** has a plurality of red, green, and blue elements **36***a*, **36***b*, and **36***c* arranged in the familiar "Bayer array" described in U.S. Pat. No. 3,971,065, which is incorporated herein by reference. A characteristic of one form of the "Bayer array" is that the luminance picture elements (pixels), i.e., corresponding to the green element **36***b*, are arranged horizontally and vertically in a checkerboard pattern, and the chrominance pixels, i.e., corresponding to the red and blue color elements **36***a* and **36***c*, are each vertically and horizontally adjacent to a luminance pixel. A driver **38** (shown in FIG. **1**) generates clocking signals for controlling the image integration time and the vertical transfer of image pixels to a high speed horizontal register **40** (shown in FIG. **3**). An output capacitive node **42** produces a signal which is amplified, processed, and stored in the processing and storage section **12**.

Referring again to FIG. **1**, the input section further includes a lens cap **44** connected to a main switch **46** that activates the camera when the cap **44** is moved to expose the lens **20** to image light, and a close-up lens **48** that can be optionally moved into the path of image light for close-up exposures. The input section also includes an optical viewfinder **50** for framing the object **22** in relation to the sensor **28**, a flash unit **52** for illuminating the object **22**, and a photocell **54** for converting image intensity information into an electrical signal that is used in the processing and storage section **12** to regulate the shutter and aperture control **24**.

The processing and storage section **12** includes a correlated double sampling circuit **56** for providing analog image samples to a 10 bit analog-to-digital (A/D) converter **58**. The 10 bit digitized signals are corrected for white balance, gamma, and other conventional distortions by a correction read-only memory (ROM) **60**, which provides 8 bit output signals that are applied to a frame buffer memory **62**, which is a 4 megabit dynamic random-access memory (RAM). The buffered image signals are processed, e.g., compressed, in a digital signal processor (DSP) **64** and then stored in an output memory, such as flash electrically programmable read-only memory (EPROM) **66**. When the camera is to send image data to the computer **18**, one of two data paths are used. A serial path from the flash EPROM memory **66** to a serial port **68** is provided through a universal synchronous/asynchronous receiver/transmitter (UART) **70** and an RS232 driver **72**. Alternatively, a faster parallel path is provided through connectors **74***a* and **74***b* via a small computer systems interface (SCSI) controller **76** in the docking unit **16** to a parallel port **78**.

A timing generator **80** provides timing signals to the aforementioned elements in the processing and storage section **12**, in particular providing timing input to an 8-bit microprocessor controller **82** and address timing to the frame buffer memory **62**, the DSP **64**, the flash EPROM memory **66**, and a latching and decoding circuit **84**. The microprocessor controller in turn controls the A/D converter **58**, the correction ROM **60**, the flash unit **52**, and a stepping motor driver **86**, which controls operation of the shutter and aperture control **24**. The microprocessor controller **82** also controls a display element **50***a* in the viewfinder **50** (for indicating flash ready, under/over exposure, and the like), and receives exposure data from the photocell **54**.

While the processing and storage section **12** automatically controls image exposure upon the CCD sensor **28** by means of data input from the photocell **54**, a plurality of switches are provided in the control and display section **14** for manually activating a variety of additional features. (Some switches directly activate the respective features, while other switches activate a menu of choices on a liquid crystal display (LCD) **90**.) For instance, a switch **88***a* moves the close-up lens **48** into position, a switch **88***b* allows the user

to select which of two (high or low) different resolution levels of sensor data are stored in the frame buffer memory **62**, a switch **88***c* activates a low resolution "burst" mode in which several pictures are rapidly taken, a switch **88***d* activates the flash unit **52**, and a switch **88***e* activates a self-timer delay mode. A capture switch **88***f* initiates each exposure. The liquid crystal display (LCD) **90** indicates the selected feature values. Depending upon the capabilities of the camera, further input may be provided, e.g., levels of compression (number of bits) may be selected, and the color mode (black/white or color) may be designated.

A battery **92** provides power to the camera through a power switcher **94** and a DC/DC converter **96** when the camera is disconnected from the docking unit **16**. When the docking unit **16** is connected between the computer **18** and the camera, the computer supplies power to an AC/DC converter **98** in the docking unit **16**, which in turns powers a battery charger **100** that connects to the camera and charges the battery **92**.

In using the camera according to the invention, activation of the capture switch **88***f* allows the camera to capture one or a plurality of images, which are then stored in the flash EPROM memory **66**, until they can be downloaded to the computer **18**. The image which is read out from the sensor **28** has, in one embodiment, a total of 512 lines and 768 pixels per line. Since the sensor **28** incorporates a "Bayer" color filter pattern, the digitized values from the A/D converter **58** correspond to values from the various color elements **36***a*, **36***b*, **36***c* on the sensor **28**. Eight bit digital pixel values are read from the CCD sensor **28** via ROM **60** at a **2** MHz readout rate and stored in the 4 megabit dynamic RAM frame buffer memory **62**. About 200 msec are required to read one image from the sensor **28**, and into the frame buffer memory **62**. The image signals are then read from the frame buffer memory **62** at a slower speed, compressed using a DPCM algorithm (which compresses the image from 8 bits per pixel to 2 bits per pixel) implemented in the DSP **64** pursuant to instructions stored in a program ROM **64***a*, and stored in the flash EPROM memory **66**, which can hold several compressed images. This process takes about 4 seconds, which means that full resolution images can only be stored in the flash EPROM memory **66** every 4 seconds. The use of the buffer memory **62** allows the DSP **64** to operate at a throughput rate different from the CCD sensor **28**, as described in U.S. Pat. No. 5,016,107, entitled, "Electronic Still Camera Utilizing Image Compression and Digital Storage", which is incorporated herein by reference. The aforementioned latching and decoding circuit **84** accomplishes this separation of throughput rates by coordinating the requirement of the DSP **64** with control of the frame buffer memory **62** and the flash EPROM memory **66**.

According to the invention, the camera includes the switch **88***b* which allows the user to select the image record size, that is, which of two different resolution levels of sensor data are stored in the frame buffer memory **62**. When the switch **88***b* activates the "low resolution" mode, the timing generator **80** changes the timing to the buffer memory **62** so that, in one embodiment, only a quarter of the pixels on the CCD sensor **28** are stored in the memory **62**. This quarter size image is then compressed by the DSP **64**, and stored in the flash EPROM memory **66**. It is thus possible to store four times as many low resolution images as high resolution images in the flash memory **66**. In addition, it is possible to store up to five low resolution images rapidly into the buffer memory **62**. Consequently, when the user holds down the capture switch **88***b*, with the burst mode enabled by actuation of the switch **88***c*, a burst of up to five low resolution images is taken in rapid succession. These images are then read out, one by one, compressed, and stored in the flash EPROM memory **66**.

In order to form the low resolution images, a suitable "subsampling" pattern is required. For example, if only every second pixel of every second line was selected for storage in the buffer memory, the image would contain only values of one of the three colors. To provide a color image, the color filter array pixels must be subsampled properly. This subsampling should be done in a manner that maintains good luminance resolution, without introducing false color "aliasing" artifacts. One subsampling pattern is shown in FIG. **4**, with a circle surrounding each sampled pixel. In this pattern, the green (luminance) elements are subsampled in a checkerboard type arrangement, by selecting every second green element of every second line, but staggering the sampling by one element to form a "subsampled Bayer type checkerboard". The red and blue elements near the selected green elements are chosen in order to provide color samples which are spatially adjacent with at least some of the luminance samples. This minimizes the false color edges which might otherwise occur.

In alternate subsampling patterns, the image is stored in the frame buffer memory **62** in the low resolution mode, and the DSP **64** processes the values from multiple pixels of the same color to form the color subsampled image, by averaging some of the pixels. One such pattern is shown in FIG. **5**, with the (unaveraged) pixels surrounded by a circle and the averaged pixels at the base of respective arrows. Here, the green pixel values are used directly, while the two horizontally adjacent red values are averaged (as schematically shown by arrows) to form a red pixel value at every second green location, and the two vertically adjacent blue values are averaged (as shown by the arrows) to from a blue pixel value at the same locations. Green is not averaged, in order to maintain higher resolution. Unfortunately, this arrangement can cause some luminance aliasing. A further pattern, shown in FIG. **6**, also averages the green values to eliminate this luminance aliasing. This averaging, however, also reduces the image sharpness. In FIG. **6**, the 4 nearest green pixels in a "cross" shaped pattern in a first group **102** are averaged (as shown by the arrows). For every second group **104** of four green pixels, the four nearest red pixels are averaged, and one-half the value of the center blue pixel is summed with one-half the average value of the two horizontally adjacent blue elements. In all cases (FIGS. **4–6**) the subsampling always maintains a ratio of two green pixel values, for every red or blue pixel value.

The subsampling illustrated by FIG. **4** is obtained by suitably programming the microprocessor controller **82** to instruct the timing generator **80** to produce address and control signals at the proper intervals so as to store only the values of the circled pixels of FIG. **4** into frame memory **62**. The values from the non-circled pixels are not stored. The subsampling patterns illustrated by FIG. **5** and **6** are obtained by suitably programming the microprocessor controller **82** to instruct the timing generator **80** to produce address and control signals so as to store the pixel values which are either circled or at the tails of the arrows, in the respective figures.

Because only a fraction of the pixel values on the sensor **28** are stored for any of the subsampling modes shown in FIGS. **4–6**, the frame memory **62** is sufficient to store multiple images. When the burst mode controlled by switch **88***c* is enabled, the microprocessor controller **82** instructs the timing generator to capture a burst of low resolution images and store the subsampled pixel values of each low resolution image in successive address areas of frame memory **62**.

Because the subsampling pattern shown in FIG. **4** allows a smaller number of pixels to be stored in frame memory **62**, it has, compared to the patterns shown in FIGS. **5–6**, the advantage of allowing bursts containing a larger number of low resolution images to be captured at a relatively fast rate (approximately two frames per second) instead of at the slow rate (approximately four seconds per frame) of the high resolution mode, which is limited by the speed of flash memory **66** and DSP processor **64**. In all cases, the requisite programming of the microprocessor controller **82** and the timing generator **80** is well within the talents of a programmer possessing the ordinary skills of this art. Other subsampling patterns may be useful; preferably these would also include chrominance elements (red or blue) spatially adjacent to luminance elements (green). Other filter arrays, and patterns, may be used, e.g., based on complementary colors (cyan, magenta, and yellow).

Sometimes a simplified version of the invention is preferred where the main advantage sought is the increased storage space, rather than a burst mode capability. A preferred "quarter size" subsampling pattern for such usage is shown in FIG. **7**, with a circle surrounding each sampled pixel. In this case, all of the digitized image is stored in the frame memory **62**. Clocking is thus simplified for the buffer memory **62** because only one clock, rather than two, is required. Then, the DSP **64** decimates the original pixels and generates a "quarter size" Bayer pattern image, as shown in FIG. **7**. Because the DSP **64** is designed to be programmable, it is less difficult to have the DSP **64** do the "subsampling" than to specially program the clock for the buffer memory **62** to do the same.

The invention has been described in detail with particular reference to a preferred embodiment thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention. For example, while two resolution modes are disclosed in connection with the camera of FIG. **1**, the same principles apply regardless of the number of modes. For instance, a third mode could further subsample the pattern of sampled elements shown in FIG. **4** to provide a yet lower resolution image.

PARTS LIST

10	INPUT SECTION
12	PROCESSING AND STORAGE SECTION
14	CONTROL AND DISPLAY SECTION
16	DETACHABLE DOCKING UNIT
18	HOST COMPUTER
20	LENS
22	OBJECT
24	SHUTTER AND APERTURE CONTROL
26	OPTICAL LOW PASS FILTER
28	CCD IMAGE SENSOR
30	COLOR FILTER ARRAY
32	PHOTOSITES
34	CUT-AWAY PORTION OF THE SENSOR
36A	RED COLOR ELEMENT
36B	GREEN COLOR ELEMENT
36C	BLUE COLOR ELEMENT
38	DRIVER
40	HORIZONTAL REGISTER
42	OUTPUT CAPACITATIVE NODE
44	LENS CAP
46	MAIN SWITCH
48	CLOSE-UP LENS
50	OPTICAL VIEWFINDER
52	FLASH UNIT
54	PHOTOCELL
56	CORRELATED DOUBLE SAMPLING CIRCUIT
58	A/D CONVERTER
60	CORRECTION ROM

-continued

PARTS LIST

62	FRAME BUFFER MEMORY
64	DSP
64A	PROGRAM ROM
66	FLASH EPROM MEMORY
68	SERIAL PORT
70	UART
72	RS232 DRIVER
74A	CONNECTOR
74B	CONNECTOR
76	SCSI CONTROLLER
78	PARALLEL PORT
80	TIMING GENERATOR
82	MICROPROCESSOR CONTROLLER
84	LATCHING AND DECODING CIRCUIT
86	STEPPING MOTOR DRIVER
88A	CLOSE-UP SWITCH
88B	RESOLUTION SWITCH
88C	BURST MODE SWITCH
88D	FLASH SWITCH
88E	SELF-TIMER SWITCH
88F	CAPTURE SWITCH
90	LCD
92	BATTERY
94	POWER SWITCHER
96	DC/DC CONVERTER
98	AC/DC CONVERTER
100	BATTERY CHARGER
102	FIRST GROUP
104	SECOND GROUP

What is claimed is:

1. An electronic camera adapted for processing images of different resolution, said camera comprising:

an image sensor for generating a baseband image signal representative of color image pixels arranged in vertical and horizontal directions as obtained from a two-dimensional array of photosites covered by a pattern of luminance and chrominance color filters;

a buffer memory having sufficient capacity for storing the color image pixels as baseband signals corresponding to at least one image;

an output memory, connected subsequent to the buffer memory, for storing processed image signals obtained from the buffer memory;

a resolution mode switch for selecting a pixel resolution of the image by specifying an order in which the color image pixels are selected for storage in both vertical and horizontal directions, said order including a full resolution mode in which all color image pixels are selected and at least one reduced resolution mode in which less than all color image pixels are selected;

a controller responsive to the pixel resolution selected by the resolution mode switch for accordingly changing the number of horizontal and vertical pixels that represent the image, said controller effecting a subsampling of the color image pixels for the reduced resolution mode; and

means for storing the selected color image pixels in said output memory, whereby said output memory is able to store more images in said reduced resolution mode than in said full resolution mode.

2. A camera as claimed in claim **1** in which said storing means stores a plurality of different resolution images in said output memory, depending on the resolution mode selected by said resolution mode switch for each image.

3. A camera as claimed in claim **1** in which said buffer memory is operable according to a timing signal that regulates the order in which the color image pixels are selected for storage in said buffer memory, and said controller

responsive to the selected pixel resolution generates the timing signal and accordingly effects the subsampling by selecting appropriate pixels for storage in said buffer memory.

4. A camera as claimed in claim **1** wherein said controller further enables a burst mode wherein a multiplicity of subsampled images are stored in said buffer memory, and wherein said storing means subsequently transfers said subsampled images to said output memory.

5. A camera as claimed in claim **1** wherein said buffer memory is operable to store all of the color image pixels from said image sensor as baseband signals, and wherein said controller effectuates the subsampling for the selected pixel resolution by accordingly selecting appropriate pixels from said buffer memory for storage in said output memory.

6. A camera as claimed in claim **4** wherein said controller further averages certain of the selected pixels before storage in said output memory.

7. An electronic camera adapted for processing images of different resolution, said camera comprising:

an image sensor for generating a baseband image signal representative of color image pixels arranged in vertical and horizontal directions as obtained from a two-dimensional array of photosites covered by a pattern of luminance and chrominance color filters;

a buffer member having sufficient capacity for storing the color image pixels as baseband signals corresponding to at least one image, said memory operable according to a timing signal that regulates the order in which the color image pixels are selected for storage in said buffer memory;

a resolution mode switch for selecting a pixel resolution of the stored image by specifying an order in which the color image pixels are selected for storage in both vertical and horizontal directions, said order including a full resolution mode in which all color image pixels are stored and at least one reduced resolution mode in which a fewer number of color image pixels are stored; and

a timing controller responsive to the pixel resolution selected by the resolution mode switch for generating the timing signal and accordingly changing the number of horizontal and vertical pixels that represent the image, said timing signal effecting a subsampling of the color image pixels for the reduced resolution mode wherein each chrominance image pixel is selected to be spatially adjacent to a selected luminance image pixel.

8. An electronic camera adapted for processing images of different resolution, said camera comprising:

an image sensor for generating a baseband image signal representative of color image pixels arranged in vertical and horizontal directions as obtained from a two-dimensional array of photosites covered by a pattern of luminance and chrominance color filters;

a buffer memory having sufficient capacity for storing the color image pixels as baseband signals corresponding to at least one image, said memory operable according to a timing signal that regulates the order in which the color image pixels are selected for storage in said buffer memory;

a resolution mode switch for selecting a pixel resolution of the stored image by specifying an order in which the color image pixels are selected for storage in both vertical and horizontal directions, said order including a full resolution mode in which all color image pixels are stored and at least one reduced resolution mode in which less than all color image pixels are stored; and

a timing controlling responsive to the pixel resolution selected by the resolution mode switch for generating the timing signal and accordingly changing the number of horizontal and vertical pixels that represent the image, said timing signal effecting a subsampling of the color image pixels for the reduced resolution mode wherein (a) the luminance image pixels are subsampled in a checkerboard-type arrangement and (b) the chrominance image pixels are subsampled so as to be spatially adjacent to a luminance image pixel.

9. An electronic camera adapted for processing images of different resolution, said camera comprising:

an image sensor for generating a baseband image signal representative of color image pixels arranged in vertical and horizontal directions as obtained from a two-dimensional array of photosites covered by a pattern of luminance and chrominance color filters;

a buffer memory having sufficient capacity for storing the color image pixels as baseband signals corresponding to at least one image, said buffer memory operable according to a timing signal that regulates the order in which the color image pixels are selected for storage in said buffer memory;

a resolution mode switch for selecting a pixel resolution of the stored image by specifying an order in which the color image pixels are selected for storage in both vertical and horizontal directions, said order including a full resolution mode in which all color image pixels are stored and at least one reduced resolution mode in which less than all color image pixels are stored;

a timing controller responsive to the pixel resolution selected by the resolution mode switch for generating the timing signal and accordingly changing the number of horizontal and vertical pixels that represent the image, said timing signal effecting a subsampling of the color image pixels for the reduced resolution mode wherein each chrominance image pixel is selected to be spatially adjacent to a luminance image pixel;

a signal processor for generating a processed image signal by compressing the baseband image signal stored in said buffer memory; and

an output memory having sufficient capacity for storing the processed image signal corresponding to at least one full resolution image, or to a greater number of reduced resolution images.

10. A camera as claimed in claim **9** in which said output memory stores a combination of said full resolution and reduced resolution images, depending on the resolution mode selected by said resolution mode switch for each image.

11. An electronic camera adapted for processing images of different resolution, said camera comprising:

an image sensor for generating a baseband image signal representative of color image pixels arranged in vertical and horizontal directions as obtained from a two-dimensional array of photosites covered by a pattern of luminance and chrominance color filters;

means for exposing said image sensor to image light from at least one image;

a buffer memory having sufficient capacity for storing the color image pixels as baseband signals corresponding to at least one image, said buffer memory operable according to a timing signal that regulates the order in which the color image pixels are selected for storage in said buffer memory;

a resolution mode switch for selecting a pixel resolution of the stored image by specifying an order in which the

color image pixels are selected for storage in both vertical and horizontal directions, said order including a full resolution mode in which all color image pixels are stored and at least one reduced resolution mode in which less than all color image pixels are stored;

a timing controller responsive to the pixel resolution selected by the resolution mode switch for generating the timing signal and accordingly changing the number of horizontal and vertical pixels that represent the image, said timing signal effecting a subsampling of the color image pixels for the reduced resolution mode wherein each chrominance image pixel is selected to be spatially adjacent to a luminance image pixel;

a signal processor for generating a processed image signal by compressing the baseband image signal stored in said buffer memory;

an output memory having sufficient capacity for storing the processed image signal corresponding to at least one full resolution image, or to a greater number of reduced resolution images; and

means responsive to the reduced resolution mode selected by said resolution mode switch for enabling said exposing means to continuously expose said sensor to a series of images, whereby a corresponding series of processed image signals are generated by said signal processor and stored in said output memory.

12. An electronic camera adapted for processing images of different resolution, said camera comprising:

an image sensor for generating a baseband image signal representative of color image pixels arranged in vertical and horizontal directions as obtained from a two-dimensional array of photosites covered by a checkerboard pattern of luminance and chrominance color filters in which each luminance image pixel is horizontally and vertically adjoined by a chrominance image pixel;

a buffer memory having sufficient capacity for storing the color image pixels as baseband signals corresponding to at least one image;

a signal processor for generating a processed image signal by compressing the baseband image signal stored in said buffer memory; and

a resolution mode switch for selecting a pixel resolution mode of the image selected for compression, said resolution modes including a full resolution mode in which all color image pixels are processed for compression and at least one reduced resolution mode in which less than all color image pixels are produced by averaging at least some of the color image pixels before compression.

13. A camera as claimed in claim **12** in which the fewer number of color image pixels produced in the reduced resolution mode include a subsampled array of luminance image pixels and averaged values of the chrominance image pixels horizontally and vertically adjacent to at least some of the subsampled luminance image pixels.

14. A camera as claimed in claim **12** in which the fewer number of color image pixels produced in the reduced resolution mode include averages of luminance image pixels both horizontally and vertically adjacent to an array of chrominance image pixels.

15. A camera as claimed in claim **12** in which the fewer number of color image pixels produced in the reduced resolution mode represent luminance and chrominance values that are averaged over an array of positions that are adjacent to an array of chrominance image pixels.

* * * * *

US005493335C1

(12) EX PARTE REEXAMINATION CERTIFICATE (8115th)

United States Patent

Parulski et al.

(10) Number: US 5,493,335 C1

(45) Certificate Issued: Mar. 29, 2011

(54) **SINGLE SENSOR COLOR CAMERA WITH USER SELECTABLE IMAGE RECORD SIZE**

(75) Inventors: **Kenneth A. Parulski**, Rochester, NY (US); **Richard M. Vogel**, Pittsford, NY (US); **Seishi Ohmori**, Tokyo (JP)

(73) Assignee: **Eastman Kodak Company**, Rochester, NY (US)

Reexamination Request:

No. 90/010,630, Jul. 31, 2009

No. 90/010,910, Apr. 12, 2010

Reexamination Certificate for:

Patent No.: **5,493,335**

Issued: **Feb. 20, 1996**

Appl. No.: **08/085,516**

Filed: **Jun. 30, 1993**

(51) **Int. Cl.**

H04N 9/04 (2006.01)

H04N 5/335 (2006.01)

(52) **U.S. Cl.** **348/231.6**; 348/273; 358/906; 358/909.1

(58) **Field of Classification Search** 348/233

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,971,065	A	7/1976	Bayer
4,131,919	A	12/1978	Lloyd et al.
4,213,145	A	7/1980	Nagumo
4,546,390	A	10/1985	Konishi et al.
4,597,005	A	6/1986	Baleshta et al.
4,730,222	A	3/1988	Schauffele
4,746,980	A	5/1988	Petersen
4,746,993	A	5/1988	Tada
4,758,883	A	7/1988	Kawahara et al.

(Continued)

FOREIGN PATENT DOCUMENTS

JP	63-064485	3/1988
JP	63-286078	11/1988
JP	H1-243686	9/1989
JP	H2-214271	8/1990
JP	H03-1681	1/1991
JP	3-284079	12/1991
JP	4-35181	1/1992
JP	4-35181	2/1992
JP	4-239279	8/1992
JP	4-319893	11/1992
JP	4-324778	11/1992

OTHER PUBLICATIONS

W. K. Pratt, Digital Image Processing, 1978, pp. 93–198, 307–377, 591–731,736–741, John Wiley & Sons, Inc.

M. Sasaki et al., Digital Electronic Still Camera System, ITEJ Technical Report, Mar. 1989, pp. 17–22, vol. 13, No. 22.

Fujimori et al., Digital Card Camera, ITEJ Technical Report, Jan. 18, 1990, pp. 7–12, vol. 14, No. 5.

F. Izawa et al., Digital Still Video Camera Using Semiconductor Memory Card, IEEE Transactions on Consumer Electronics, Feb. 1990, vol. 36 No. 1.

G. K. Wallace, Overview of the JPEG (ISO/CCITT) Still Image Compression Standard, SPIE, 1990, pp. 220–233, vol. 1244.

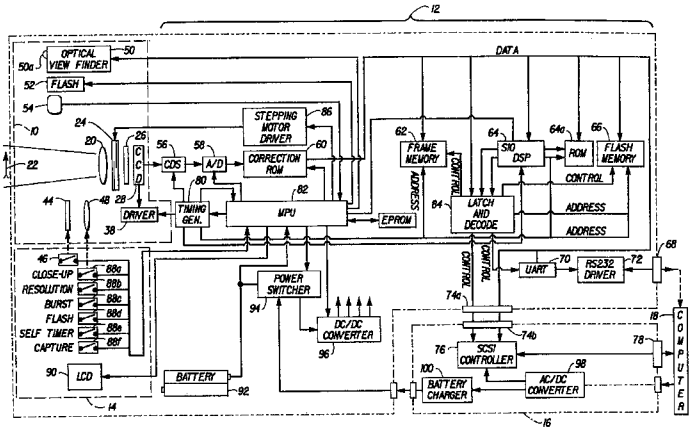
N. Watanabe et al., Bit Rate Controlled DCT Algorithm for Digital Camera, SPIE, 1990, pp. 234–239, vol. 1244.

(Continued)

Primary Examiner—Linh M. Nguyen

(57) **ABSTRACT**

An electronic camera is adapted for processing images of different resolution to provide a user selectable image record size. A buffer memory is provided for storing color image pixels from a sensor as baseband signals corresponding to at least one image. A timing controller responsive to a resolution mode switch controls the order in which color image pixels are selected for storage in both vertical and horizontal directions. The order selected by the resolution switch includes a full resolution mode, and at least one reduced resolution mode in which the color image pixels are subsampled such that each chrominance image pixel is selected to be spatially adjacent to a selected luminance image pixel. Additionally, the buffer memory can store a burst of low resolution images.



U.S. PATENT DOCUMENTS

4,764,805	A	8/1988	Rabbani et al.
4,774,562	A	9/1988	Chen et al.
4,837,628	A	6/1989	Sasaki
4,918,523	A	4/1990	Simon et al.
5,014,059	A	5/1991	Seckora
5,016,107	A	5/1991	Sasson et al.
5,018,017	A	5/1991	Sasaki et al.
5,027,214	A	6/1991	Fujimori
5,034,804	A	7/1991	Sasaki et al.
5,053,861	A	10/1991	Tsai et al.
5,067,019	A	11/1991	Juday et al.
5,097,518	A	3/1992	Scott et al.
5,128,776	A	7/1992	Scorse et al.
5,138,459	A	8/1992	Roberts et al.
5,153,730	A	10/1992	Nagasaki et al.
5,233,411	A	8/1993	Nam et al.
5,262,871	A	11/1993	Wilder et al.
5,280,343	A	1/1994	Sullivan
5,305,096	A	4/1994	Yamagami et al.
5,335,016	A	8/1994	Nakagawa
5,402,170	A	3/1995	Parulski et al.
6,084,633	A	7/2000	Gouhara et al.
6,518,999	B1	2/2003	Miyamoto

OTHER PUBLICATIONS

M. Sasaki, Signal Processing Technologies for a Digital Still Camera System, Toshiba Review, 1991, vol. 46 No. 2.

W. B. Pennebaker et al., JPEG: Still Image Data Compression Standard, 1993, pp. 1–27, 64–79, 252–259, 316–330.

R.A.F. Belfor et al., "Subsampling of Digital Image Sequences using Motion Information," Motion Analysis and Image Sequence Processing 189 (M. Ibrahim Sezan and Reginald L. Lagendijk eds., 1993).

EX PARTE REEXAMINATION CERTIFICATE ISSUED UNDER 35 U.S.C. 307

NO AMENDMENTS HAVE BEEN MADE TO THE PATENT

AS A RESULT OF REEXAMINATION, IT HAS BEEN DETERMINED THAT:

The patentability of claims **1**, **4** and **12** is confirmed.

Claims **2**, **3**, **5-11**, **13-15** were not reexamined.

* * * * *

EXHIBIT 2

US005828406A

United States Patent [19]

Parulski et al.

[11] **Patent Number: 5,828,406**

[45] **Date of Patent: Oct. 27, 1998**

[54] **ELECTRONIC CAMERA HAVING A PROCESSOR FOR MAPPING IMAGE PIXEL SIGNALS INTO COLOR DISPLAY PIXELS**

[75] Inventors: **Kenneth A. Parulski**, Rochester; **Timothy J. Tredwell**, Fairport, both of N.Y.

[73] Assignee: **Eastman Kodak Company**, Rochester, N.Y.

[21] Appl. No.: **367,399**

[22] Filed: **Dec. 30, 1994**

[51] **Int. Cl.**[6] **H04N 5/225**

[52] **U.S. Cl.** **348/220**; 348/333

[58] **Field of Search** 348/220, 222, 348/221, 333, 273, 391

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,541,010	9/1985	Alston	348/333
4,691,253	9/1987	Silver	360/33.1
4,714,963	12/1987	Vogel	348/220
4,876,590	10/1989	Parulski	348/333
4,928,137	5/1990	Kinoshita	348/333
5,418,565	5/1995	Smith	348/273
5,440,343	8/1995	Parulski et al.	348/220
5,444,483	8/1995	Maeda	348/220
5,943,335	2/1996	Parulski et al.	348/273

FOREIGN PATENT DOCUMENTS

0 405 491 A2	1/1991	European Pat. Off.	H04N 5/91
0 456 369 A2	11/1991	European Pat. Off.	H04N 5/14
0 533 107 A2	3/1993	European Pat. Off.	H04N 1/21
WO 89/12939	6/1989	WIPO	H04N 5/232

OTHER PUBLICATIONS

"A Multimedia Color Camera Providing Multi–Format Digital Images" by Takuya Imaide, Toshiro Kinugasa, Yoshimichi Kudo, and Naoki Yamamoto. From *IEEE Transactions on Consumer Electronics*, Aug. 1993, No. 3.

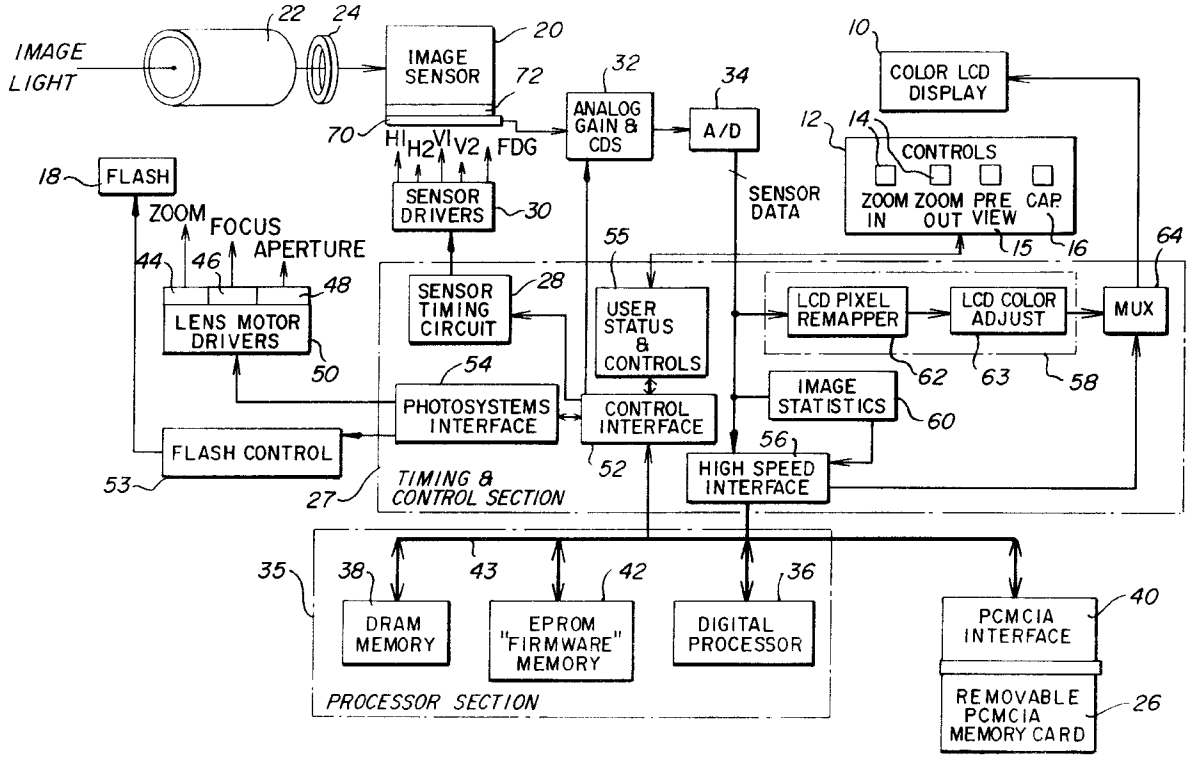
Primary Examiner—Wendy Garber

Attorney, Agent, or Firm—David M. Woods

[57] **ABSTRACT**

An electronic camera uses a relatively more complex digital image processing technique in a still image mode to produce high quality still images, and a relatively more simple image processing technique in a motion preview mode to produce preview images of acceptable quality prior to initiation of the still image mode. The more complex digital technique is done in software in a general purpose processor section **35**, while the more simple digital technique is implemented in a fixed digital circuit in an application specific integrated circuit **27**, which also implements timing and control functions. The motion preview mode uses a shorter image readout period than the still mode and further involves mapping image sensor pixels into a fewer number of color display pixels on a color LCD display **10**. The mapping further converts color pixel signals from a mosaic array into a different color pattern on the color LCD display **10**.

15 Claims, 10 Drawing Sheets



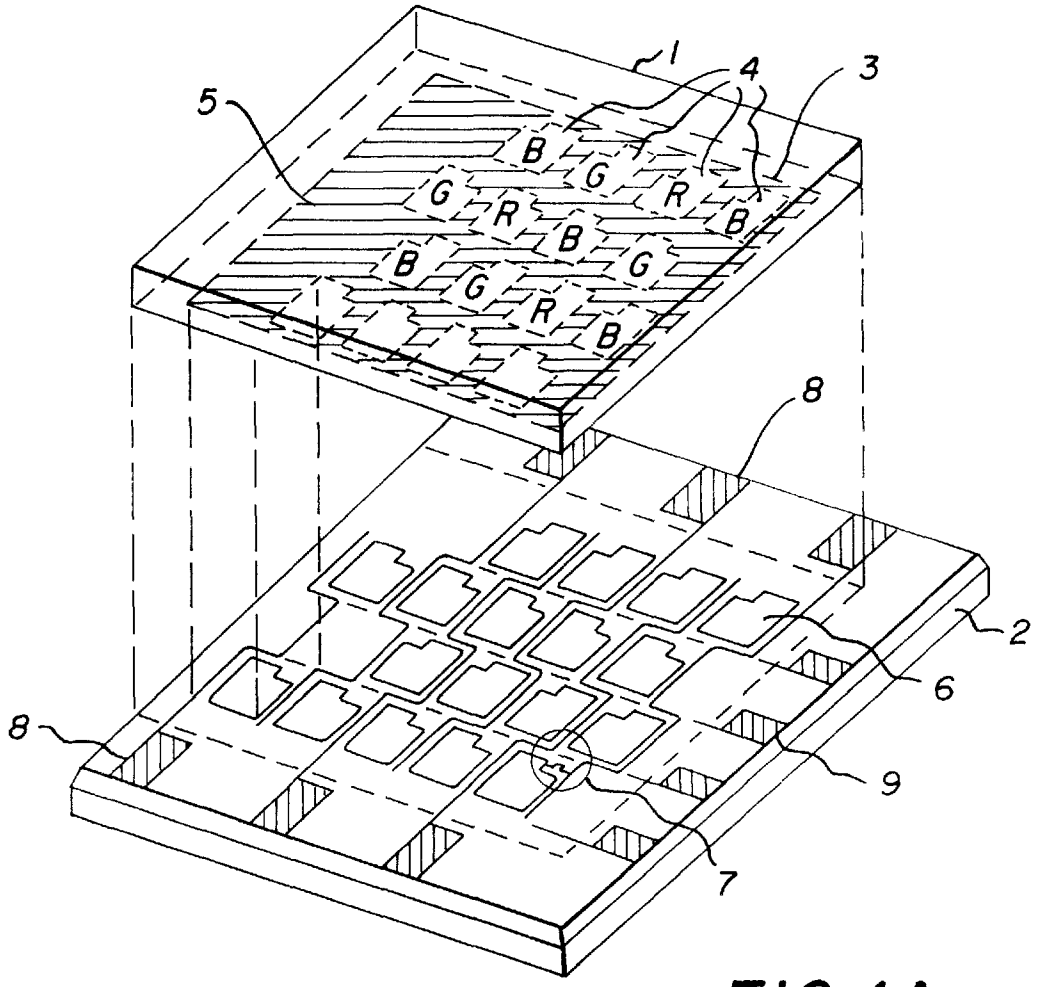


FIG. 1A

G	R	B	G	R	B	G	R
B	G	R	B	G	R	B	G
R	B	G	R	B	G	R	B
G	R	B	G	R	B	G	R

FIG. 1B

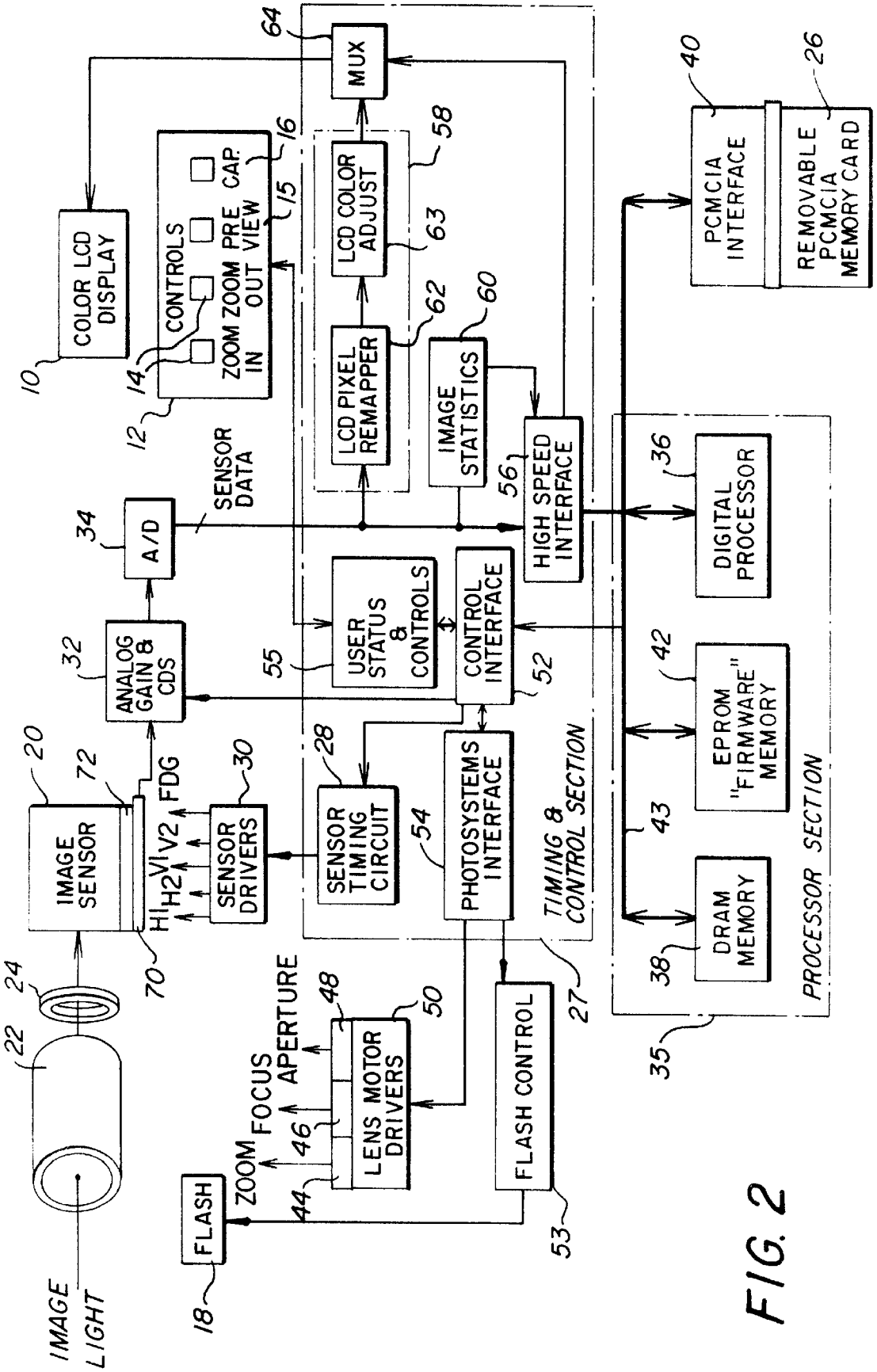


IMAGE LIGHT
22
24
20
IMAGE SENSOR
72
70
H1 H2 V1 V2 FDG
SENSOR DRIVERS
30
ANALOG GAIN & CDS
32
A/D
34
SENSOR DATA
SENSOR TIMING CIRCUIT
28
54
PHOTOSYSTEMS INTERFACE
TIMING & CONTROL SECTION
27
USER STATUS & CONTROLS
55
CONTROL INTERFACE
52
HIGH SPEED INTERFACE
56
LCD PIXEL REMAPPER
62
IMAGE STATISTICS
60
LCD COLOR ADJUST
63
58
MUX
64
COLOR LCD DISPLAY
10
CONTROLS
14
ZOOM IN
ZOOM OUT
PRE VIEW
15
CAP
16
12
FLASH
18
ZOOM
FOCUS
APERTURE
44
46
48
LENS MOTOR DRIVERS
50
FLASH CONTROL
53
DRAM MEMORY
38
EPROM "FIRMWARE" MEMORY
42
43
DIGITAL PROCESSOR
36
PCMCIA INTERFACE
40
REMOVABLE PCMCIA MEMORY CARD
26
PROCESSOR SECTION
35

FIG. 2

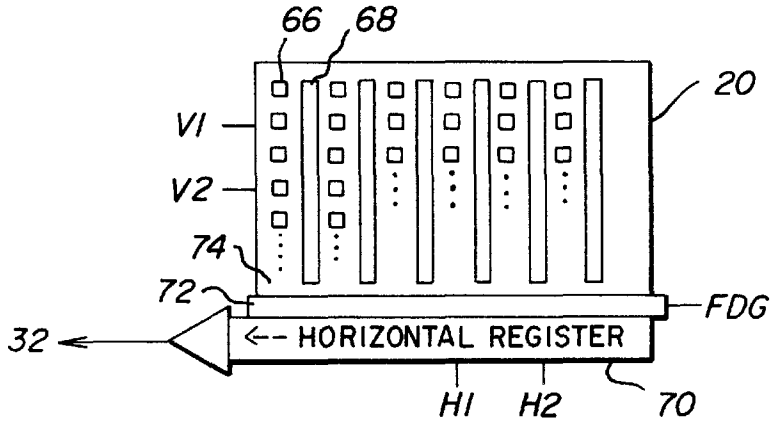
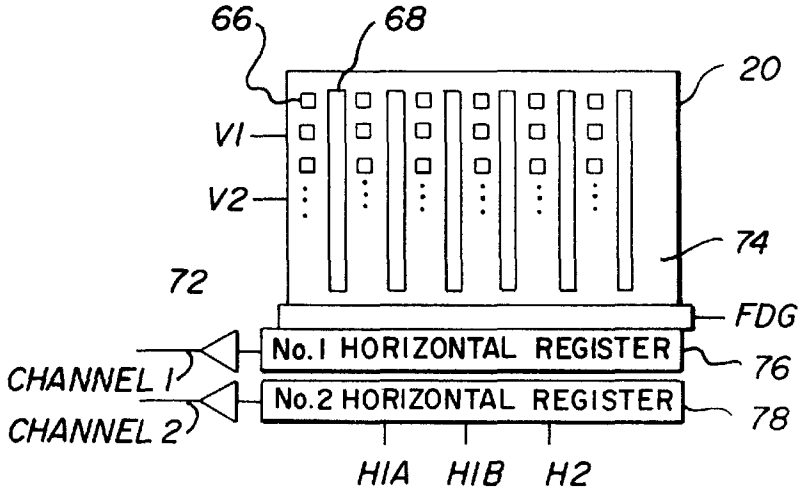


FIG. 3A

FIG. 3B



CCD LINES

LINE 1	G	R	G	R	G	R	G	R
LINE 2	B	G	B	G	B	G	B	G
LINE 3	G	R	G	R	G	R	G	R
LINE 4	B	G	B	G	B	G	B	G
LINE 5	G	R	G	R	G	R	G	R
LINE 6	B	G	B	G	B	G	B	G
LINE 7	G	R	G	R	G	R	G	R
LINE 8	B	G	B	G	B	G	B	G

FIG. 4

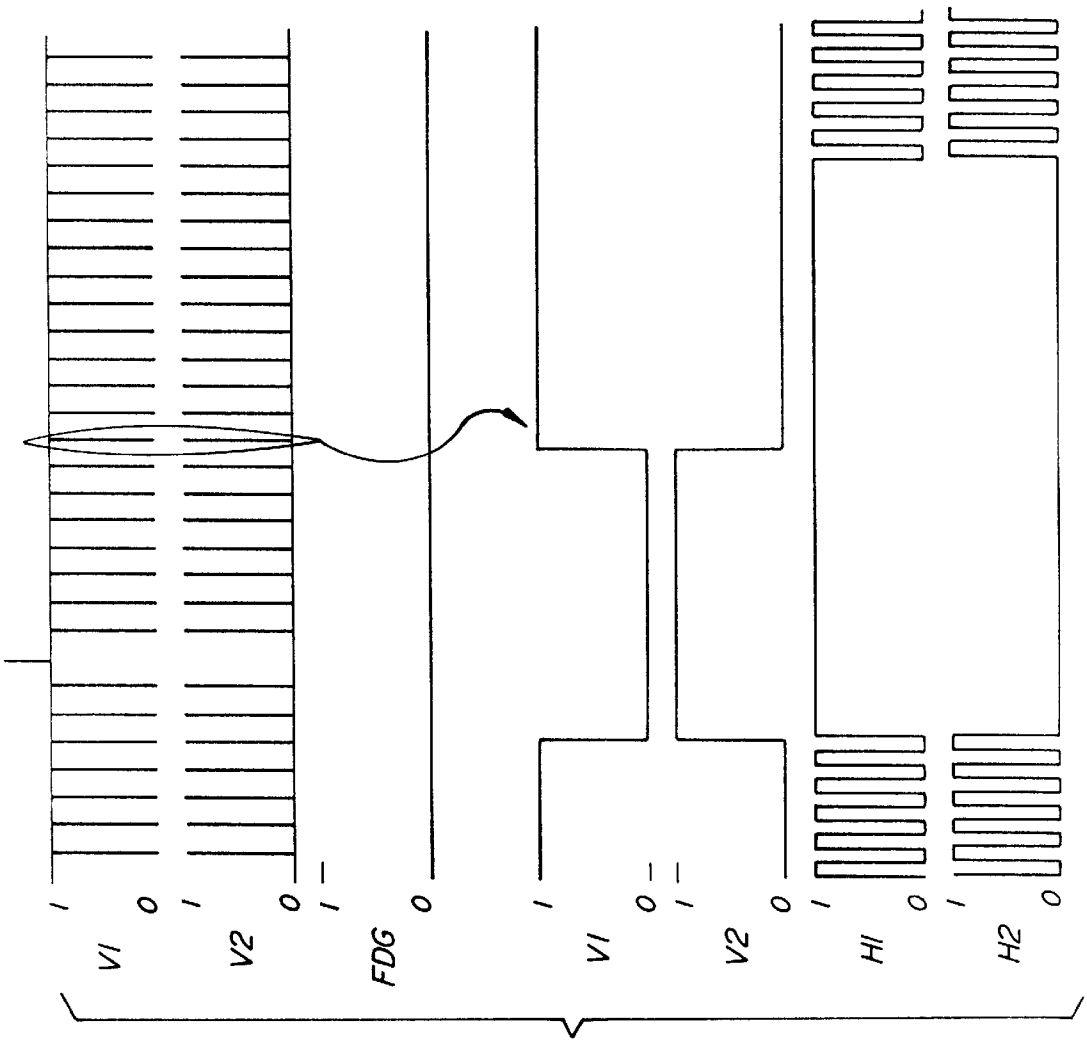


FIG.5

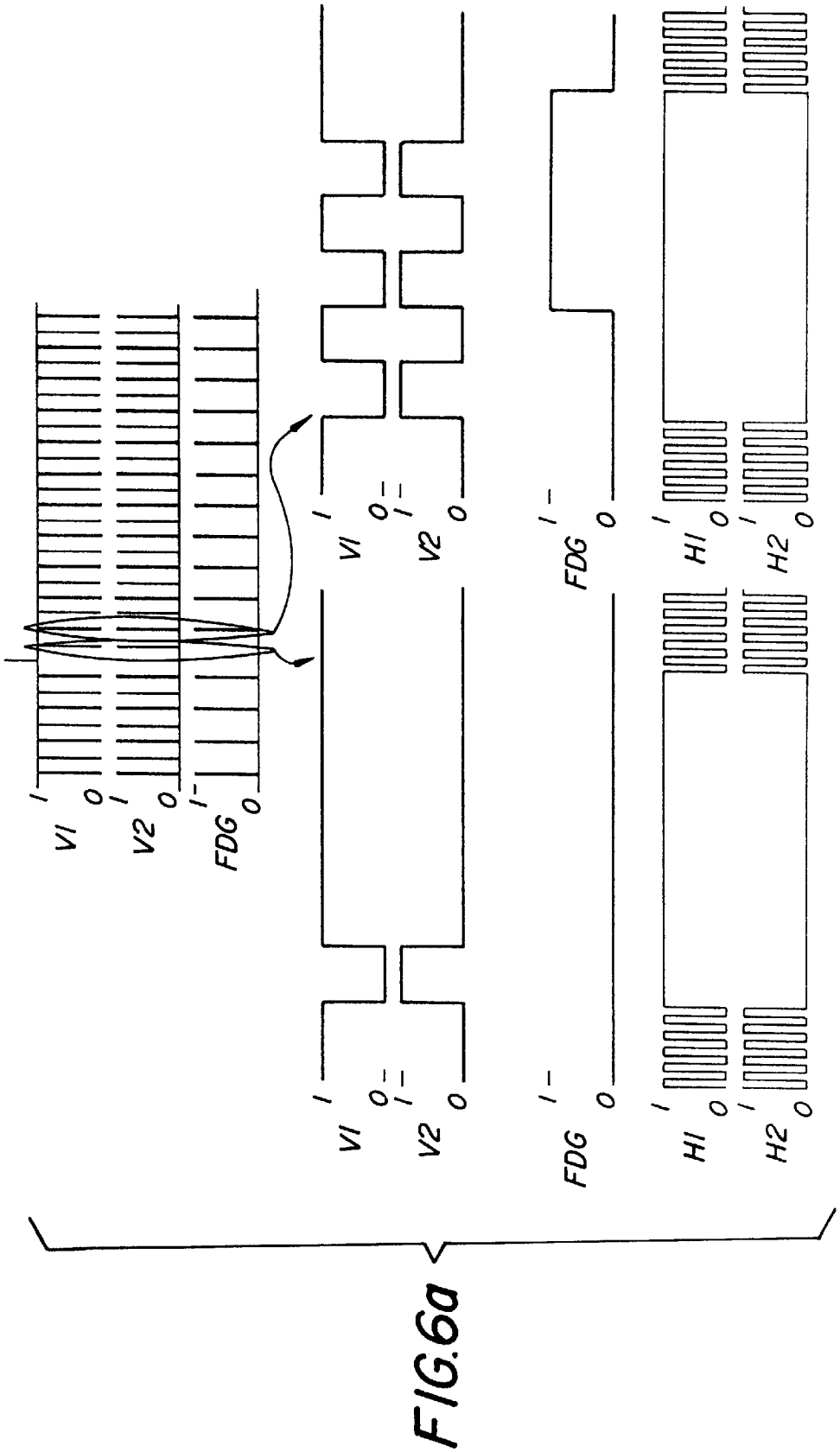


FIG.6a

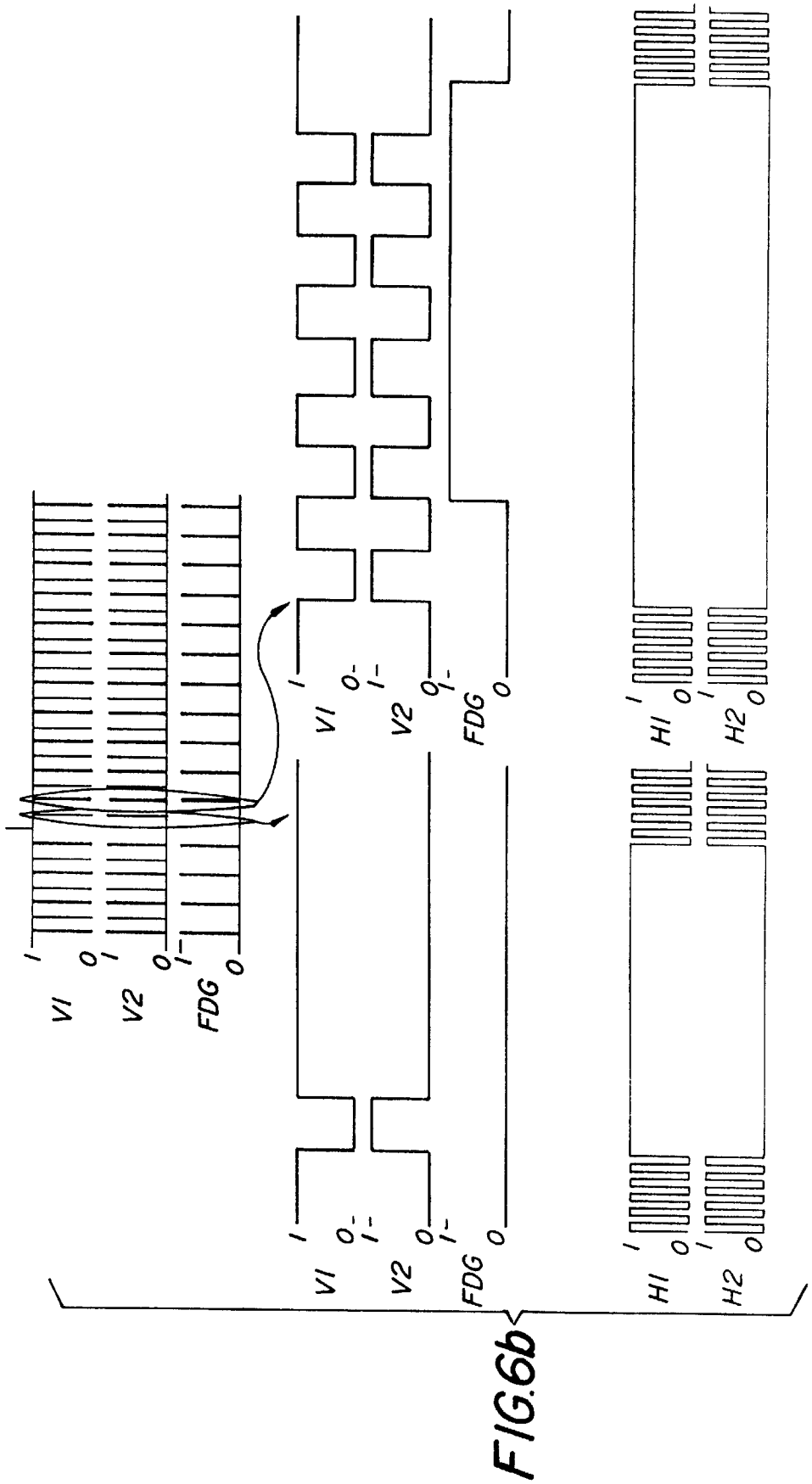


FIG.6b

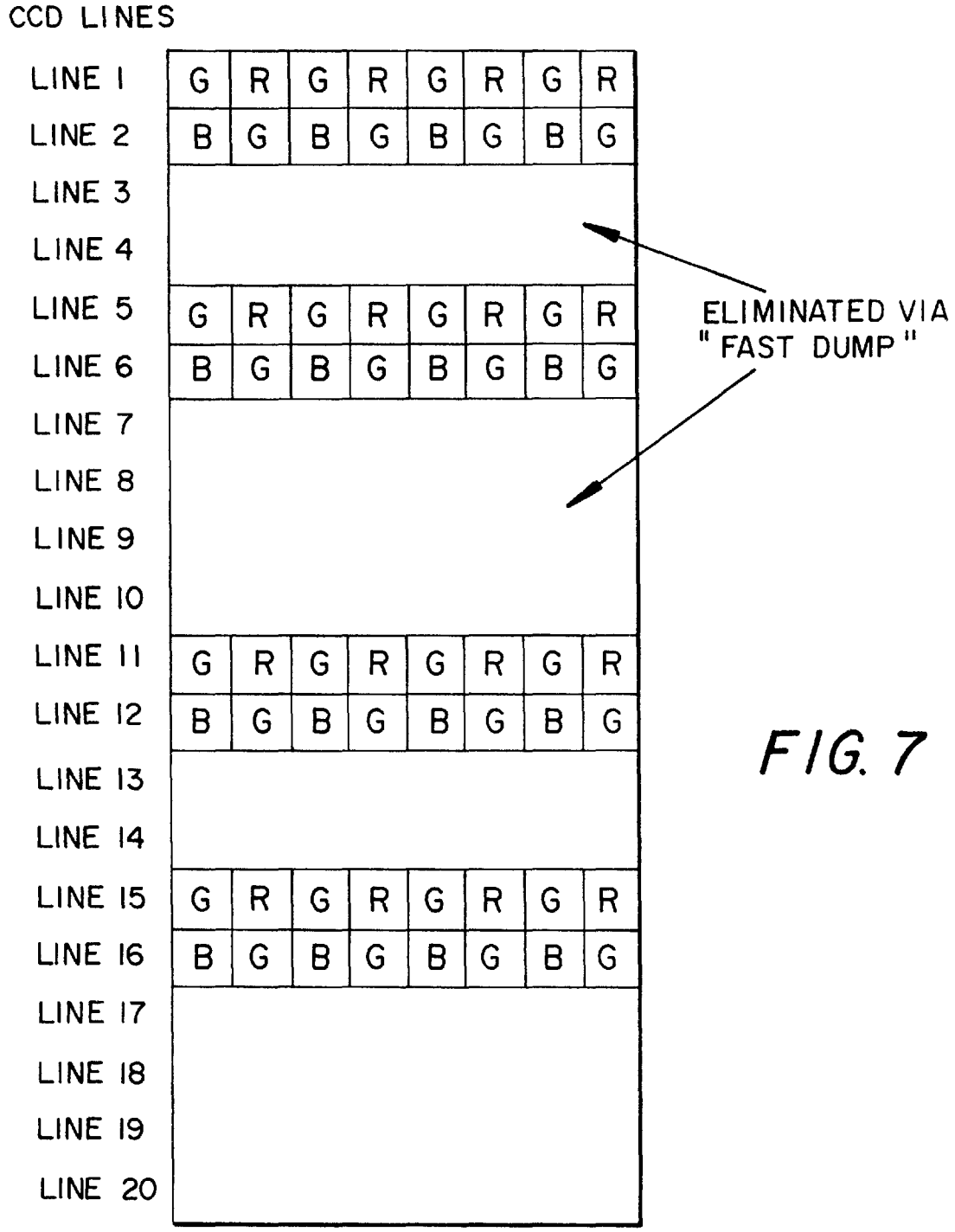

CCD LINES
LINE 1
LINE 2
LINE 3
LINE 4
LINE 5
LINE 6
LINE 7
LINE 8
LINE 9
LINE 10
LINE 11
LINE 12
LINE 13
LINE 14
LINE 15
LINE 16
LINE 17
LINE 18
LINE 19
LINE 20
G R G R G R G R
B G B G B G B G
ELIMINATED VIA
" FAST DUMP "

FIG. 7

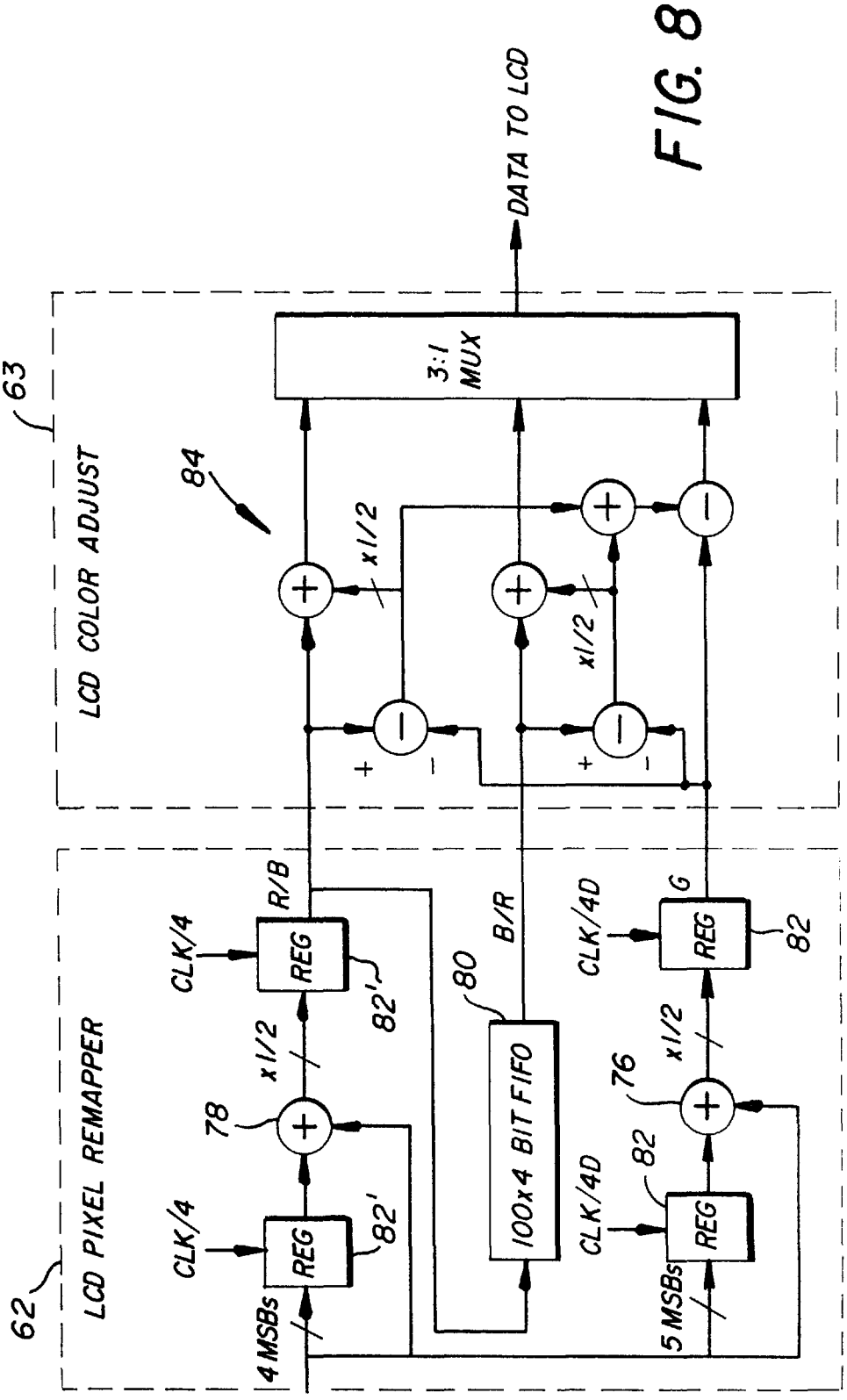

DATA TO LCD
63
LCD COLOR ADJUST
3:1 MUX
84
x1/2
x1/2
62
LCD PIXEL REMAPPER
CLK/4
R/B
REG
82'
x1/2
78
CLK/4
REG
82'
4 MSBs
80
B/R
100x4 BIT FIFO
CLK/4D
G
REG
82
x1/2
76
CLK/4D
82
REG
5 MSBs

FIG. 8

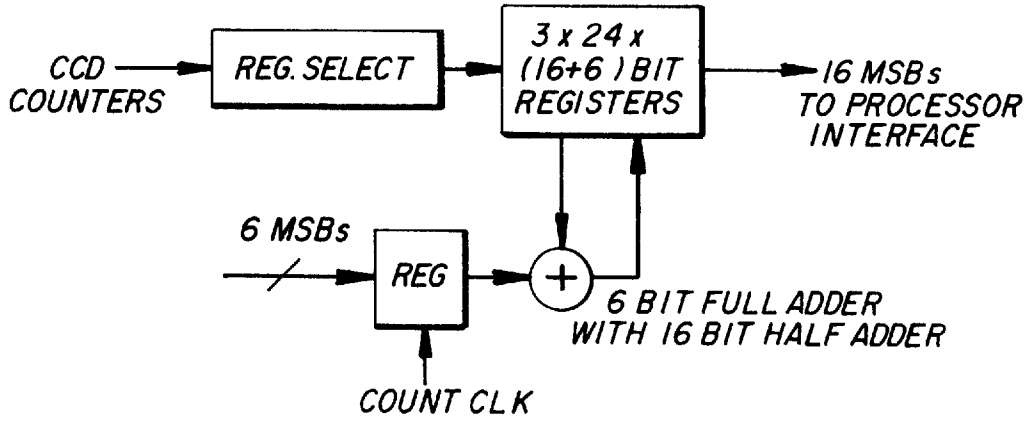

CCD COUNTERS
REG. SELECT
3 x 24 x (16+6) BIT REGISTERS
16 MSBs TO PROCESSOR INTERFACE
6 MSBs
REG
6 BIT FULL ADDER WITH 16 BIT HALF ADDER
COUNT CLK

FIG. 9A

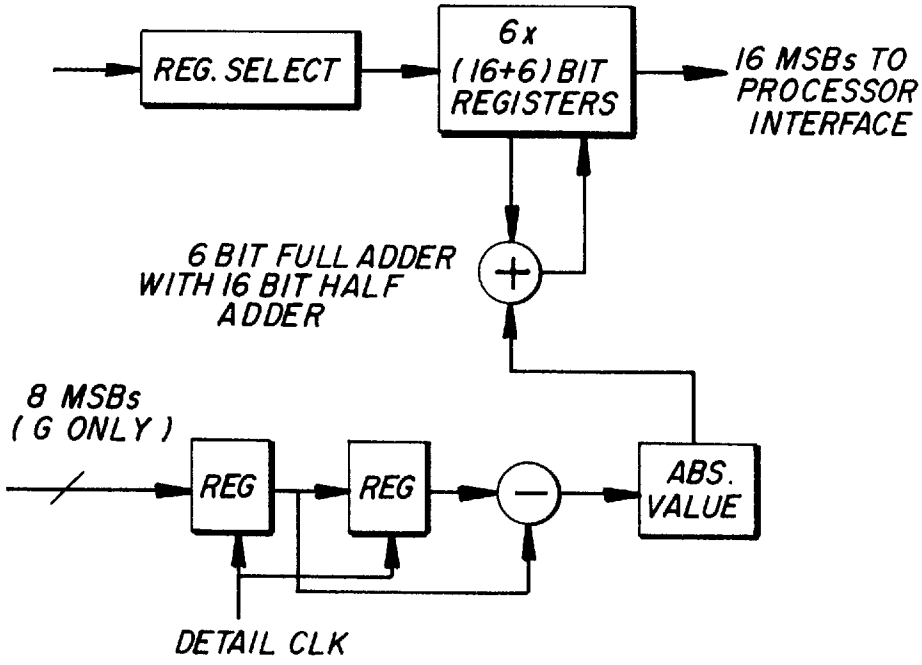

REG. SELECT
6x (16+6) BIT REGISTERS
16 MSBs TO PROCESSOR INTERFACE
6 BIT FULL ADDER WITH 16 BIT HALF ADDER
8 MSBs (G ONLY)
REG
REG
ABS. VALUE
DETAIL CLK

FIG. 9B

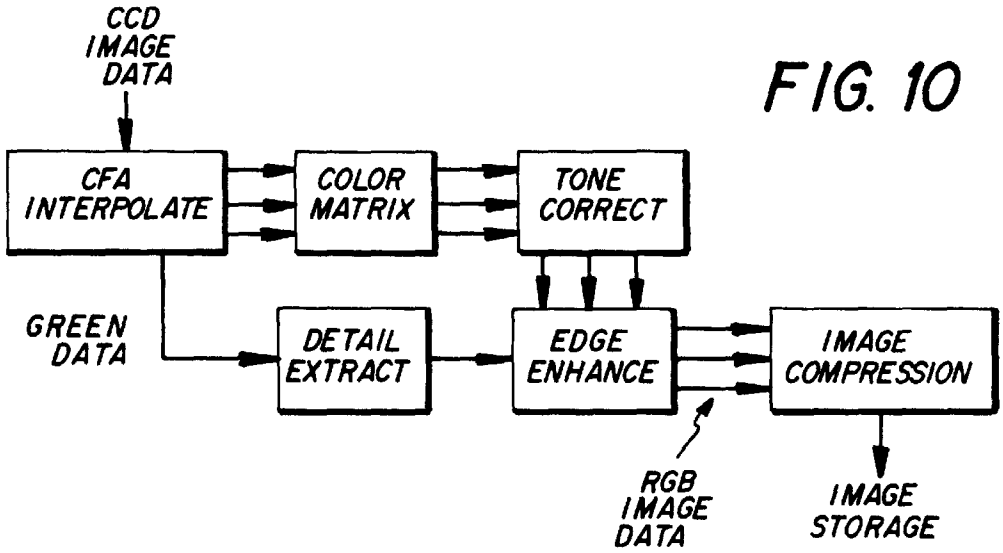


FIG. 10

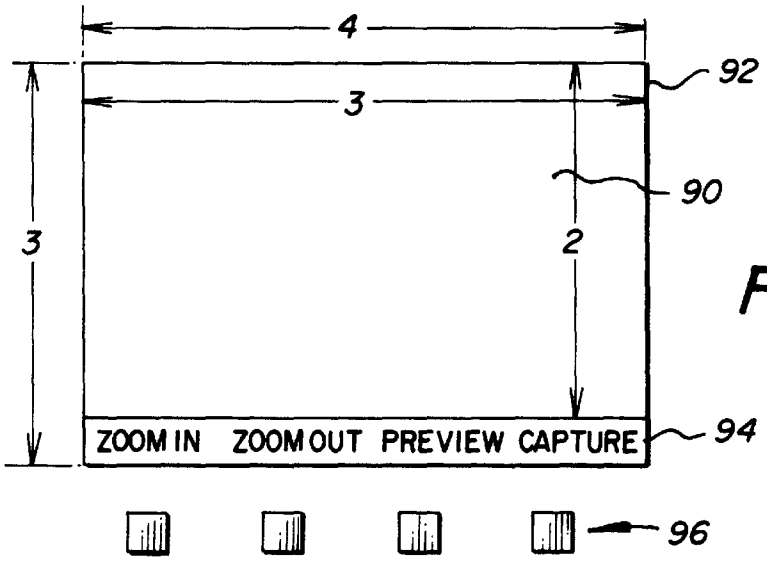


FIG. 11

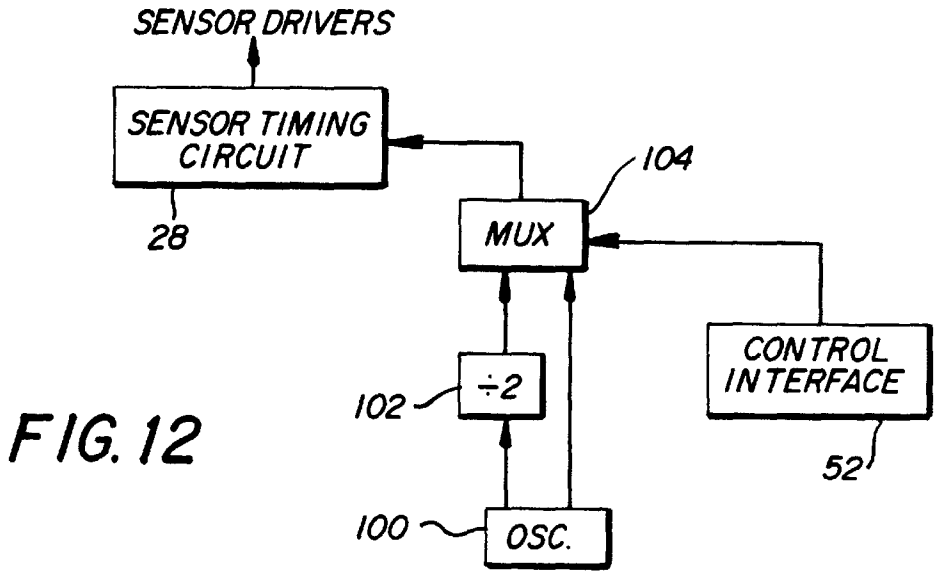


FIG. 12

ELECTRONIC CAMERA HAVING A PROCESSOR FOR MAPPING IMAGE PIXEL SIGNALS INTO COLOR DISPLAY PIXELS

FIELD OF THE INVENTION

The invention pertains to an electronic still camera for composing and capturing still images, and, more particularly, to an electronic camera having a "motion" mode for previewing a scene and a "still" mode for capturing a particular image in the scene.

BACKGROUND OF THE INVENTION

Consumer camcorders which include the capability of recording analog motion and/or still images on 8 mm or VHS videotape have been developed by a number of companies. Motion images are recorded in the same manner as in any standard camcorder. These cameras include a single chip charge coupled device (CCD) sensor having a color filter array that provides a spatially color-sampled image. To record still images, the user pushes a "still capture" button at the desired instant. The image obtained from the CCD sensor is temporarily stored in a digital memory. The image is then read from the memory and recorded onto the videotape. Some camcorders include color liquid crystal displays (LCD), which are also spatially color-sampled devices. Some are relatively large, for example, ranging from approximately 2.5" to 4" in diagonal. Such a display is used, instead of a normal eyepiece viewfinder, to allow the user to properly frame the subject and view the images as they are being recorded. It is also used to view the recorded images as the videotape is played back.

FIG. **1A** shows a typical color LCD display, in which the liquid crystal material is trapped between an upper glass plate **1** and a lower glass plate **2**. The upper plate **1** has a common transparent electrode **3** and an array **4** of color filters surrounded by a black mask **5**. The lower plate **2** includes an array **6** of transparent pixel electrodes juxtaposed underneath the array **4** of color filters. Individual pixel electrodes are activated via thin film transistors (TFT) **7** that are controlled from a video signal on the source lines **8** and a scanning signal on the gate line **9**. The LCD display includes the usual polarizer layers (not shown) on the glass plates **1** and **2**, such that activation of selected transparent pixel electrodes allows light to pass through the corresponding color filters and reflect to the viewer, thereby creating a color image. A typical LCD display such as the Epson LB 2F–BC00, manufactured by Seiko-Epson Company, Japan, has about 240 lines of pixels and about 300 pixels per line, with an image aspect ratio of 4:3. Such an aspect ratio allows the entire area of the image obtained from the 4:3 aspect ratio NTSC format CCD sensor to be displayed on the LCD screen, so that the LCD screen composition will be the same as the image that is recorded by the camcorder NTSC format recorder, for later display on an NTSC format television display. Note that because the LCD has only 240 lines of pixels, the interlaced NTSC signal is displayed using a "repeat field" technique, where both the odd and even fields from the NTSC format sensor are displayed using the same lines of pixels on the LCD. This LCD, like most commercially available LCDs, has "rectangular" pixels, rather than square pixels, where the distance between pixels in the horizontal direction is for example ⅔ the distance in the vertical direction. The LCD pixels are overlaid with a diagonal RGB stripe pattern as shown in FIG. **1B**.

In camcorders, the processing for both the still images and the motion images is identical. Such processing is normally implemented by hardwired analog integrated circuits, although camcorders which use digital image processing integrated circuits have been Such camcorders convert the signal from the CCD sensor into an NTSC composite or component format signal, which is provided to a video recording subsystem or a video output jack. The color LCD display includes circuitry to decode the NTSC composite or component signal back into spatially subsampled RGB signals to drive the individual RGB pixels on the LCD sensor.

In a system oriented toward still photography, and in particular a digital still system, it would be desirable to avoid the necessity of generating an NTSC format signal in order to reduce the complexity of the required circuitry. In a totally digital system, that is, both the recording and display channels are digital, it is further desirable to minimize incompatibility between the channels. The problem is to achieve these objective in an architecture that minimizes cost and complexity and maximizes user handling.

SUMMARY OF THE INVENTION

This problem is solved according to the invention by a number of features. In one aspect, the electronic camera is operable in a still image mode according to a relatively more complex digital image processing technique to produce high quality still images, and in a motion preview mode according to a relatively more simple digital image processing technique to produce a preview image of acceptable quality prior to initiation of the still image mode. Such an architecture is particularly adapted to mapping an array of color image pixels from a sensor into an array of color display pixels on an LCD display comprising discrete LCD display pixels fewer in number than image sensor pixels. In that case, a relatively simple digital processing technique combines same-colored image pixel signals into a fewer number of pixels that correspond to the arrangement of the color display pixels.

The advantage of the invention is that the two modes can be tailored for a relatively low quality "motion" mode and a much higher quality "still" mode. The motion mode images from the CCD sensor are processed by a hardwired digital signal processing circuit that generates low resolution, spatially subsampled digital image data which can directly drive the relatively low resolution LCD display. This reduces the complexity and clock frequency of the required circuitry, compared to generating an NTSC format signal, as is normally done in the prior art. The still mode image from the CCD sensor is processed by a general purpose processor (CPU) which executes an image processing software program in order to produce a high quality digital still image.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in relation to the drawings, whereon

FIGS. **1A** and **1B** show the structure and color filter pattern of a known color liquid crystal display (LCD);

FIG. **2** is a block diagram of an electronic camera incorporating dual modes for composing and capturing a still image according to the invention;

FIGS. **3A** and **3B** are diagrams of progressive scan image sensors useful with the camera of FIG. **2**;

FIG. **4** is a diagram of the Bayer color filter geometry for the sensor used with the camera of FIG. **1**;

FIG. **5** shows the line timing for the still mode of operation;

FIGS. 6A and 6B show the line timing for the preview mode of operation;

FIG. 7 shows the special line skipping pattern used in the preview mode;

FIG. 8 shows further detail of the preview mode processing circuit shown in FIG. 2;

FIGS. 9A and 9B show further detail of the image statistics processor shown in FIG. 2;

FIG. 10 shows one example of still mode image processing;

FIG. 11 shows the effect of pixel mapping from a sensor to an LCD display, each having different aspect ratios; and

FIG. 12 shows an enhancement to the block diagram of FIG. 2 in which a different sensor clock frequency is used in each of the dual modes.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A block diagram of a camera incorporating dual modes of processing according to the invention is shown in FIG. 2. The camera includes an electronic color display, for example, a color liquid crystal (LCD) display **10** of the type shown in FIG. 1A, and a user control section **12** having a number of user control buttons, including zoom buttons **14**, a preview button **15** and a capture button **16**. To take a still picture, the user turns on the camera (using a power switch (not shown), which may be automatically enabled when the user depresses the zoom buttons **14** or the preview button **15**, or partially depresses the capture button **16**). The user composes the picture by depressing the "zoom in" or "zoom out" buttons **14**, and by adjusting the position of the camera, while observing the display image. When the user is satisfied with the composition on the color LCD display **10**, the user depresses the capture button **16**. The camera then captures a single still image, firing a flash **18** if necessary when the ambient illumination level is low. The still image is focused upon an image sensor **20** by a motor driven zoom lens **22**. The intensity of the image light upon the sensor **20** is regulated by a motor-driven, variable, mechanical aperture **24**, while exposure time is regulated electronically by appropriate clocking of the sensor **20**. The still image from the image sensor **20** is processed and digitally stored on a removable memory card **26**.

Control of the sensor is provided by a timing and control section **27**, which is an application specific integrated circuit (ASIC) with processing and timing functions, for both capture and preview operating modes. For instance, the timing and control section **27** includes a sensor timing circuit **28** for controlling the image sensor functions. The sensor timing circuit **28** provides the signals to enable sensor drivers **30**, which provide horizontal clocks (H1, H2), vertical clocks (V1, V2), as well as a signal FDG for activating a drain structure on the sensor **20**. The output of the image sensor **20** is amplified and processed in an analog gain and sampling (correlated double sampling (CDS)) circuit **32**, and converted to digital form in A/D converter stage **34**. The A/D output signal is provided to a processor section **35**, which includes a digital processor **36** for temporarily storing the still images in a DRAM memory **38**. The digital processor **36** then performs image processing on the still images, and finally stores the processed images on the removable memory card **26** via a memory card interface circuit **40**, which may use the PCMCIA 2.0 standard interface. An EPROM memory **42** is used to store the firmware which operates the processor **36**. The components of the processor **35** are interconnected through a data bus **43**, which also connects to the timing and control section **27** and to the card interface **40**.

The motor-driven zoom lens **22** includes a zoom motor **44**, a focus motor **46**, and an aperture motor **48** (all controlled by lens motor drivers **50**). The timing and control section **27** further includes a control interface **52** connected to the lens motor drivers **50** and to a flash control circuit **53** via a photosystem interface block **54**, which controls the operation of the zoom lens **22** and the flash **18**. The lens zoom position is controlled by the photosystem interface block **54** based on position input from the zoom control buttons **14** through a user status and control section **55**. The focusing, exposure control, and white balance is done automatically, as is typically the case in consumer camcorders. This is done by computing "image statistics"in an image statistics processor **60** in the real-time ASIC (timing and control section **27**) as preview images are continuously read out of the image sensor **20**. The computed values are then used by a program implemented in the digital processor **36**, which decides how to adjust the focus motor, aperture, analog gain control, and analog white balance controls via the control interface **52** and the photosystems interface **54** on the ASIC timing and control section **27**. Although the digital processor **36** and the control interface **52** are shown as being within two separate sections, in some implementations the same component could be used to perform both of these functions (as well as other of the recited functions). Sensor image data is passed to the processor section **35** through a high speed interface **56** in the timing and control section **27**. The sensor image data is also directed to the color LCD display **10** through a preview mode processing circuit **58**.

The timing and control section (ASIC) **27** is operable in two modes, a relatively low quality "motion" mode and a much higher quality "still" mode. In the motion mode, images from the sensor **20** are processed by the preview mode processing circuit **58**; in the still mode, images from the sensor **20** are processed in the processor **35**. The processor **35** is a software–driven digital processing system that is slower than the ASIC **27**. The preview mode processing circuit **58** is a hardwired digital signal processing circuit (part of the ASIC **27**) that generates low resolution, spatially subsampled digital image data which can directly drive the relatively low resolution color LCD display **10**. This reduces the complexity and clock frequency of the required circuitry, compared to generating an NTSC format signal, as is normally done in the prior art. The preview mode processing circuit includes a pixel remapper **62** for mapping the greater number of image pixels from the sensor **20** into the lesser number of display pixels (i.e., corresponding to the array **6** of transparent pixel electrodes in FIG. **1**) in the color LCD display **10**. The color saturation of the remapped pixels is then adjusted in a color adjustment circuit **63** and its output is applied to a multiplexer **64**. The multiplexer **64** selects image data either from the preview mode processing circuit **58**, producing a preview image, or from the high speed interface **56**, which allows for suitably preprocessed viewing of stored images.

In this camera, the image processing used to create the preview mode is done in the timing and control ASIC **27**, since the processing must be done rapidly. About **60** images per second are processed in preview mode. However, since the image quality of the displayed image is limited by the resolution and color gamut of the LCD screen of the LCD color display **10**, there is no need for elaborate image processing. Therefore, simple "preview mode" image processing is performed in a fixed digital circuit embedded in the preview mode processing circuit **58** (which is part of the ASIC). The quality requirements for the still mode are much greater, since these images will be downloaded to a

computer, and may be displayed on a high resolution CRT display, or printed on a high quality thermal printer. Therefore, the digital image processing must be more elaborate. By using the processor **36** to implement software procedures stored in the firmware memory **42**, complex procedures can be implemented. These procedures can take several seconds to complete, since real-time operation is not required. Use of firmware-stored software allows the still mode image processing to be upgraded without requiring a new ASIC design. In effect, what happens is that a relatively less complex digital image processing technique is used in the motion preview mode, but at a higher data rate, and a relatively more complex digital image processing technique is used in the still mode, but at a slower data rate.

Since the update rate, that is, the number of images that need to be supplied per unit time, is different for the still mode than for the motion mode, it is beneficial to use different clock frequencies for the different modes of operation. For example, as shown in FIG. **12**, a system oscillator **100** produces a 12 mHz clock frequency for use in the motion mode to obtain more updates/second (e.g., 60 images per second), while a divider **102** divides by two to provide a 6 mHz clock frequency for the still mode. The lower frequency allows more time to accurately position the clamp and sample pulses so as to avoid CCD output signal transitions. This increases noise immunity in the still mode. A multiplexer **104** is enabled by the control interface **52** to determine which clock frequency is applied to the sensor timing circuit **28**. Though not specifically shown, the changed timing is also communicated to the A/D stage **34** and other timing and control circuits.

The sensor **20** is a progressive scan interline image sensor having a noninterlaced architecture, as shown in more detail in FIG. **3**A. The sensor comprises a two-dimensional array of photosites **66**, e.g. photodiodes, arranged in rows and columns of image pixels, a plurality of vertical registers **68** adjacent photosite columns for transferring rows of image pixel charge from the photosites **66** to a horizontal register **70** for readout responsive to clock signals from the sensor drivers **30**, and a charge drain (specifically, a fast dump structure **72**) interposed between the output of the vertical registers **68** and the horizontal register **70** for eliminating complete rows of image pixels at a time from the image sensor **20**. A preferred image sensor is the Kodak model CCD KAI-0400CM image sensor, which has approximately 512 active lines with approximately 768 active pixels per line and an image aspect ratio of 3:2. This sensor is described in a Performance Specification document available from Eastman Kodak Company, Rochester, N.Y. Each pixel is 9 microns "square", since both the vertical and horizontal distances between the centers of adjacent pixels are 9 microns. The 3:2 image aspect ratio of the CCD sensor, although wider than the 4:3 aspect ratio of the display, is considered to be a preferred aspect ratio for still photography, in that the standard 35 mm film format, and standard **4**R (4×6) prints also have a 3:2 image aspect ratio. The sensor uses a color filter array pattern known as the "Bayer checkerboard"pattern, described in U.S. Pat. No. 3,971,065, which is shown in FIG. **4**. Such a color filter array is characterized by a mosaic pattern in which the filter colors alternate in both line and column directions. In the normal operating mode, all of the image pixels on the sensor are transferred as color image pixels to the horizontal register **70**, which delivers a stream of color pixel signals to the analog gain and CDS circuit **32** (see FIG. **2**). The color pixel signals are subsequently converted to digital pixel signals in the A/D converter **34**.

The sensor **20** uses a progressive scan readout method, which allows the entire image to be read out in a single scan. The accumulated or integrated charge for the photodiodes comprising the pixels **66** is transported from the photosites to light protected vertical (parallel) registers **68** by applying a large positive voltage to the phase-one vertical clock (**V1**). This reads out every row, or line, into the vertical registers **68**. The image pixel charge is then transported from the vertical registers **68** to the horizontal register **70** by two-phase clocking of the vertical clocks (**V1**, **V2**). Between the vertical and horizontal registers is the fast dump structure **72**, which is further described in the Performance Specification document for the KAI-0400CM sensor. By setting a suitable positive potential on a fast dump gate line FDG, charge from the row of pixel values currently adjacent to the fast dump structure **72** is transferred from the CCD directly into the sensor substrate **74** rather than to the horizontal register **70**. This dump, or line clear, is accomplished during the vertical-to-horizontal transfer time. When properly controlled by the sensor timing circuit **28**, the fast dump structure **72** allows lines of charge to be eliminated.

The timing and control section **27** operates the electronic camera shown in FIG. **2** in the two aforementioned modes, including a first "still" mode wherein all rows of image pixel charge corresponding to each line are progressively read out through the horizontal register **70** during a single scan, and a second "motion" mode wherein some of the rows of image pixel charge corresponding to some lines are eliminated through the fast dump structure **72** prior to readout. As applied to the embodiment of FIG. **2**, the first mode corresponds to a high quality still imaging mode while the second mode corresponds to a special "line skipping" mode for driving the color LCD display **10**. In the second mode, the timing and control section **27** controls the fast dump structure **72** to eliminate two or more consecutive lines of image charge from the image sensor **20** for every one or more lines of image charge that are transferred to the horizontal register **70** for thereby generating a pattern of lines (shown in FIG. **7**) suitable for driving the LCD display in a "repeat field" mode. An appropriate video signal which displays the entire 3:2 aspect ratio sensor image on the 4:3 aspect ratio LCD, without introducing geometric distortion, is generated by alternately eliminating two or four consecutive lines of image charge for every pair of lines of image charge that are transferred to the horizontal register **70**.

The sensor timing circuit **28** is controlled by the control interface **52** to provide the clock signals V1, V2, H1, H2, and the gate signal FDG according to the two modes of operation. The timing signals for the first mode are shown in FIG. **5**; those for the second mode are shown in FIG. **6***a* and **6***b*. The two-phase cycling of signals V1 and V2 control the transfer of lines of image pixel charge from the vertical registers **68** to the horizontal register **70**. The two-phase cycling of signals H1 and H2 control the transfer of a stream of color pixel signals from the horizontal register **70** to subsequent circuits in the camera. The level of the signal FDG determines whether the image charge is dumped to the substrate **74** or transferred to the horizontal register **70**. When the sensor **20** is clocked using the first timing mode shown in FIG. **5** for all lines of the sensor, all lines of the sensor are clocked out, one after the other, through the horizontal register **70**, processed in subsequent camera circuitry, and stored in the removable memory **26**. This timing mode provides a high quality progressive scan still image, but may take 1/30 second or longer to read out the still image. Such timing, however, is acceptable for still mode usage, and, as mentioned before, does not require unusually

high speed components and, indeed, may benefit from a lower speed clock.

To provide an image to the color LCD display **10**, a lower resolution image is suitable, but the update rate must be sufficient to provide good motion rendition and eliminate display flicker. Moreover, the sensor **20** includes the aforementioned array of color filters arranged in a particular mosaic color pattern (e.g., the checkerboard Bayer pattern of FIG. **3**), and the lines of image charge that are transferred to the horizontal register **70** should preserve that particular color pattern in the pattern of lines that are generated for the line-skipping readout. To provide this kind of image, the sensor is read out in the second mode as shown in FIG. **7**, using the timing shown in FIGS. **6**A and **6**B. As shown in FIG. **6**A, first two lines (**1** and **2**) are read out as in the normal mode. These provide a green-red and a blue-green line. The next two lines (**3** and **4**) are eliminated by turning on the fast dump structure **72** during the time that these lines are transferred past the fast dump structure **72**. Next, as shown in FIG. **6**B, lines **5** and **6** are read out normally, and then lines **7**, **8**, **9**, and **10** are eliminated. Next, the FIG. **6**A timing is used to read out lines **11** and **12**, while eliminating lines **13** and **14**, and then the FIG. **6**B timing is used to read out lines **15** and **16**, while eliminating lines **17–20**. This process proceeds for the entire image readout period, during which **102** pairs of lines are read out, and **154** pairs of lines are eliminated.

This special "line skipping" readout mode, as shown in FIG. **7**, allows the sensor 3:2 aspect ratio image to be fully displayed on a 4:3 aspect ratio LCD without "geometric distortion", that is, without stretching the image vertically, and without cropping off the horizontal edges of the image from the image sensor. This allows the LCD to properly show the entire 3:2 aspect ratio image captured by the sensor, so that an image can be properly composed.

As the 512 lines of the CCD imager are read out using the special "line skipping" mode, they are displayed using only 204 out of the approximately 240 LCD lines of pixels. The remaining approximately 36 lines can either be masked behind a bezel, so that they are not visible, or preferably may be used to display status information, such as the time-of-day, image number, or a "push-button menu" for the user buttons. FIG. **11** shows a useful application of such conversions. A sensor having a 3:2 aspect ratio is shown mapped into an image area **90** of an LCD display screen **92** having a 4:3 aspect ratio. A proportional remapping leaves a status area **94** available for other purposes, specifically to show text indicating the function of a set of reconfigurable control buttons **96** in the control section **12**. The function of the buttons is specified by the user status and control section **55** (FIG. **2**). This status information graphics data can be supplied by the digital processor to the LCD **10** via high speed interface **56**, when the MUX **64** is controlled so as to use the digital data from interface **56**, rather than from circuit **58**, for supplying data to the final approximately 32 lines of the display **10**.

The "line skipping" readout causes some minor vertical sampling artifacts, but these are not noticeable in the small LCD displays. The pixels output for the sensor **20** in line skipping mode continue to have the Bayer-type color filter repeating pattern, so that they can be processed using processing techniques designed for the Bayer pattern.

The processing complexity of the camera of FIG. **2** is considerably simplified by directly mapping the RGB sensor pixels **66** to the RGB pixels of the display **10**. The easiest way to do this for the image sensor **20** (512 lines×768 pixels and 3:2 aspect ratio) is to have an LCD display with 512×768 pixels and the same aspect ratio and color filter pattern. However, this would be a custom, costly LCD. Instead, LCDs have fewer display pixels than image pixels on the image sensor, normally have a 4:3 image aspect ratio, and use the diagonally striped RGB pattern shown in FIG. **1**B. In this discussion, an LCD pixel array of about 240 lines×312 pixels per line is assumed.

Therefore, the sensor pixels are processed in a "pixel mapping circuit", such as the LCD pixel remapper **62**. A block diagram of this circuit is shown in FIG. **8**. Note that there are 768/2=384 green or red/blue pixels per line on the sensor (see FIG. **4**). There are about 300/3=100 green, red, or blue pixels per line on the LCD (see FIG. **1**B). Thus, there are approximately ¼ as many LCD pixels per line (per color) as there are sensor pixels per line. Therefore, the basic plan is to combine same-colored image pixels into a fewer number of intermediate, combination pixel signals that are then mapped into the color display pixels. For instance, a simple "pixel mapping" circuit maps four green sensor pixel signals into one green LCD pixel for one line by summing two green sensor values, spaced apart by 4 CCD pixel positions, in the green pixel summer **76** and dividing by two via bit-shift wiring. The necessary delay is provided by the registers **82** clocked at one fourth the pixel rate, further delayed by one pixel clock. It also maps four red sensor pixels into one LCD pixel in the same manner (using the red/blue summer **78**), and also stores this value in a 100 pixel FIFO **80**. The FIFO **80** compensates for the fact that the sensor has line sequential red and blue pixels, by supplying blue pixels on the red sensor lines, and red pixels on the blue sensor lines. Four pixel delays are provided by the registers **82'** clocked at one fourth pixel rate (CLK/4). The mapping process is basically, therefore, a process which, in its simplest form, involves averaging of signals to produce a smaller number of output color pixels than input color pixels. (The CFA interpolation algorithm discussed in reference to FIG. **10**, on the other hand, produces a larger number of "output" color pixels than input color pixels.) Alternate groups of 2 or 4 lines of sensor values are discarded during preview mode by using the fast dump gate shown in FIG. **3**A, as described in connection with the "line skipping" mode. This allows the sensor readout time to be decreased by more than ½ during the preview mode.

Another feature of the design is that by removing the NTSC rate driving circuitry from the color LCD display **10**, the active matrix LCD can be updated at a slower frequency than is normally used. This reduces the cost and power consumption of the LCD driver circuits (not shown). For example, the LCD can be updated at 30 Hz (provided the LCD active matrix display is designed so as not to exhibit noticeable flicker at this update rate), instead of 60 Hz.

Once the LCD pixel values are calculated, the LCD color adjust circuit **63** increases the color saturation of the image by forming R-G and B-G color difference signals, and adding or subtracting a fraction of these signals in an array **84** of adders and subtractors from the original RGB signals in order to increase the color saturation of the displayed image. This circuit performs a similar function as a 3×3 color matrix, but uses less hardware and provides less color accuracy. The color accuracy is not critical for the LCD display, however, due to the limited color reproduction quality of such displays. The color reproduction of the still image is much more important, and is done with a more complicated and precise color correction method with the stored firmware in EPROM **42**.

FIGS. **9**A and **9**B show the processing in the image statistics processor **60**, which computes real-time values for

both still and motion image capture, all during the preview mode. These values include **24** R, G, and B averages used to set white balance and exposure, and **6** average high frequency "detail" values used to set focus. The 24 RGB averages for white balance are calculated for a group of 4×6 rectangular image regions, for each of R, G, and B; a block diagram of the calculation in one color is shown in FIG. **9**A.

The **6** average "detail" values for focusing are calculated for green pixels only by accumulating the absolute value of the differences between nearby green values; a block diagram of this calculation is shown in FIG. **9**B. These values are computed for each preview image and downloaded to the processor **36**. The processor **36** implements a firmware stored procedure which determines the optimum exposure parameters (exposure time, f/stop, and analog gain), white balance settings, and lens focus setting. For the still mode, the processor **36** also decides, based on the last preview images, whether to fire the flash, and determines the optimum exposure parameters, white balance settings, and lens focus setting for the still **15** mode.

Once the still image is captured, the digital processor **36** implements the stored firmware procedures to process and store the still image. FIG. **10** shows a diagram of one possible still image processing method. The CFA interpolation diagram may include the green interpolation method described in U.S. patent application Ser. No. 085,520, filed Jun. 30, 1993, in the name of the same assignee as the present application, and the chrominance interpolation method described in U.S. Pat. No. 4,642,678, both of which are incorporated herein by reference. The color matrix, tone correction, and edge enhancement steps may be similar to those described in U.S. Pat. No. 5,189,511, also incorporated herein by reference. The image **30** compression method may be the JPEG standard compression technique.

The foregoing description envisions taking a single still picture following the motion preview mode.

The camera can also optionally capture "bursts" of high quality still images into the DRAM memory during the "still" mode, which are then processed as shown in FIG. **10**. Owing to the flash recharge time and other limitations of the "burst" mode, the "burst" mode could utilize different exposure parameters (exposure time, aperture, analog gain, flash, and digital processing) than either the motion or the single still mode.

The invention has been described with reference to a preferred embodiment. However, it will be appreciated that variations and modifications can be effected by a person of ordinary skill in the art without departing from the scope of the invention. For instance, FIG. **3**B shows a progressive scan sensor with two readout registers **86** and **88** (which corresponds to the Performance Specification document for the Kodak KAI-031CM image sensor; the preferred embodiment of FIG. **3**A simply uses but one register). The purpose is to eliminate the FIFO line delay **80** in the LCD pixel remapper **62**. The pairs of lines read out by the registers include both a green/red line and a blue/green line. Therefore, by adding an analog multiplexer between the outputs of the two channels and the analog gain and CDS block **32**, which is switched at ½ the sensor horizontal clock rate, it is possible to obtain a GRBG sequence of sensor data values at the output of the A/D stage **34**. The LCD pixel remapper **62** can then be designed to map from the CCD sensor color pixel pattern to the required RGBRGB LCD pixel pattern, without using a line delay. Since two CCD lines are read out in parallel, for each LCD line, fewer lines are eliminated via the fast dump gate than for the single-register sensor shown in FIG. **3**A.

In particular, if the dual register CCD in FIG. **3**B had 512×768 square pixels with a 3:2 aspect ratio, and the LCD had approximately **240** display lines and a 4:3 aspect ratio, the CCD readout would involve fast dumping one pair of lines for every four pairs of lines read out from the CCD sensor. The pixel readout procedure for the horizontal registers can then be varied depending on the mode of operation: both registers are used for the motion imaging mode and one register is used for the still imaging mode. Furthermore, although the Bayer pattern was described, other mosaic-type filter patterns could be used to advantage, for example, complementary patterns involving cyan, magenta, yellow and green filters. The processing for the LCD pixel remapper **62** and the LCD color adjust circuit **63** would be accordingly modified to account for the different color arrangement.

PARTS LIST

1 upper plate
2 lower plate
3 common transparent electrode
4 array of color filters
5 black mask
6 array of transparent pixel electrodes
7 thin film transistors
8 source lines
9 gate line
10 color LCD display
12 control section
14 zoom buttons
15 preview button
16 capture button
18 flash
20 progressive scan interline
22 zoom lens
24 mechanical aperture
25 memory card
27 timing and control section
28 sensor timing circuit
30 sensor drivers
32 analog gain and CDS
34 A/D converter
36 digital image processor
38 DRAM memory
40 card interface
42 EPROM memory
44 zoom motor
46 focus motor
48 variable aperture
50 lens motor drivers
52 control interface
53 flash control circuit
54 photosystems interface
55 user status and control section
56 high speed interface
58 preview mode processing circuit
60 image statistics processor
62 pixel remapper
63 color adjustment circuit
64 multiplexer
66 pixel
68 vertical readout register
70 horizontal register
72 fast dump structure
74 sensor substrate
76 green pixel summer
78 red/blue summer

80 fifo
82 two pixel delay registers
84 array
86 first readout register
88 second readout register
90 image area
92 LCD display screen
94 status area
96 reconfigurable buttons
100 oscillator
102 divider
104 multiplexer

We claim:

1. An electronic camera operable in a still image mode and in a motion preview mode, said electronic camera comprising:

an image sensor including a two-dimensional array of image pixels covered by a mosaic pattern of color filters, said image sensor providing a stream of color pixel signals at an output thereof suitable for still imaging;

an analog-to-digital stage for converting the color pixel signals to digital pixel signals;

a color display comprising a discrete two-dimensional arrangement of color display pixels, said color display having fewer color display pixels than the number of image pixels on the image sensor; and

a preview mode processor for mapping the digital image pixel signals into at least a viewable portion of the color display pixels by combining same-colored image pixels into a fewer number of same-colored intermediate pixels, each associated with a single color, that correspond to the color arrangement of the color display pixels.

2. An electronic camera as claimed in claim **1** wherein the mosaic pattern of color filters covering the image sensor is different than the arrangement of color display pixels.

3. An electronic camera as claimed in claim **2** wherein said mosaic pattern of color filters is the following pattern

R G R G
G B G B
R G R G
G B G B

and wherein the preview mode processor combines the digital pixel signals into a fewer number of RGB pixels by averaging two or more of the same-colored image pixels in each line to provide averaged display pixels.

4. An electronic camera as claimed in claim **3** wherein the preview mode processor further modifies the saturation of the display pixels by adding or subtracting portions of one or more of the other colors to each averaged display pixel.

5. An electronic camera as claimed in claim **1** wherein the image sensor and the viewable portion of the color display have the same aspect ratios such that the image pixel signals can be directly mapped into the color display pixels.

6. An electronic camera as claimed in claim **1** wherein the image sensor and the color display have different aspect ratios such that substantially all of the image pixel signals are mapped into the viewable portion of the color display pixels, leaving another portion of the color display pixels available for non-imaging use.

7. An electronic camera operable in a still image mode and in a motion preview mode, said electronic camera comprising:

an image sensor including a two-dimensional color filter array, a two-dimensional array of image pixels arranged in rows and columns with respect to the color filter array, and a horizontal register for outputting rows of color pixel signals;

an analog-to-digital stage for converting the color pixel signals to digital pixel signals;

a color display comprising a specific two-dimensional color pattern of display pixels arranged in rows and columns, having substantially fewer rows and fewer columns than the image sensor;

a still image processor for processing the digital pixel signals obtained during the still image mode, and

a preview mode processor for mapping the digital pixel signals obtained during the motion preview mode into the display pixels according to a procedure that digitally maps same-colored digital pixel signals corresponding to the color filter array of the sensor into a fewer number of same-colored display pixels, each associated with a single color, constituting the color pattern of the color display.

8. An electronic camera as claimed in claim **7** wherein the preview mode processor further modifies the saturation of the digital pixel signals.

9. An electronic camera as claimed in claim **7** wherein the still image processor utilizes a software procedure for processing the digital pixel signals and the preview mode processor includes a fixed digital circuit embedded in an application specific integrated circuit (ASIC) for processing the digital pixel signals.

10. An electronic camera as claimed in claim **9** wherein the ASIC processes the digital pixel signals more rapidly than the software procedure.

11. An electronic camera as claimed in claim **7** wherein the color filter array covering the image sensor is different than the color pattern of display pixels.

12. An electronic camera as claimed in claim **11** wherein said color filter array has the following pattern

R G R G
G B G B
R G R G
G B G B

and wherein the preview mode processor combines the digital pixel signals into a fewer number of RGB pixel signals by averaging two or more of the same-colored image pixel signals in each line to provide averaged RGB pixel signals.

13. An electronic camera operable in a still image mode and in a motion preview mode, said electronic camera comprising:

an image sensor comprising a two-dimensional color filter array, a two-dimensional array of image pixels arranged in rows and columns with respect to the color filter array, and a horizontal register for outputting rows of color pixel signals;

an analog-to-digital stage for converting the color pixel signals to digital pixel signals;

a color display comprising a specific two-dimensional color pattern of display pixels arranged in rows and columns, having substantially fewer rows and fewer columns than the image sensor;

a still image processor utilizing a software procedure for processing the digital pixel signals obtained during the still image mode, and

a preview mode processor including a fixed digital circuit embedded in an application specific integrated circuit for mapping same-colored digital pixel signals

obtained during the motion preview mode into a fewer number of same-colored display pixels, each associated with a single color, according to a procedure that digitally maps the digital pixel signals corresponding to the color filter array of the sensor into the color pattern of the color display.

14. An electronic camera as claimed in claim **13** wherein the ASIC processes the digital pixel signals more rapidly than the software procedure.

15. An electronic camera operable in a still image mode and in a motion preview mode, said electronic camera comprising:

an image sensor comprising a two-dimensional color filter array, a two-dimensional array of image pixels arranged in rows and columns with respect to the color filter array, and a horizontal register for outputting rows of color pixel signals;

an analog-to-digital stage for converting the color pixel signals to digital pixel signals;

a color display comprising a specific two-dimensional color pattern of display pixels arranged in rows and columns, having substantially fewer rows and fewer columns than the image sensor; and

a preview mode processor for mapping the digital pixel signals obtained during the motion preview mode into the display pixels according to a procedure that digitally maps same-colored digital pixel signals corresponding to the color filter array of the sensor into a fewer number of same-colored display pixels, each associated with a single color, constituting the color pattern of the color display.

* * * * *

EXHIBIT 3

US006147703A

United States Patent [19]

Miller et al.

[11] **Patent Number: 6,147,703**

[45] **Date of Patent: *Nov. 14, 2000**

[54] **ELECTRONIC CAMERA WITH IMAGE REVIEW**

[75] Inventors: **Michael Eugene Miller**, Rochester; **Richard William Lourette**, Fairport, both of N.Y.

[73] Assignee: **Eastman Kodak Company**, Rochester, N.Y.

[*] Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

[21] Appl. No.: **08/769,573**

[22] Filed: **Dec. 19, 1996**

[51] **Int. Cl.**[7] **H04N 5/225**; H04N 5/76; H04N 5/262

[52] **U.S. Cl.** **348/220**; 340/239; 340/552; 340/231

[58] **Field of Search** 348/333, 334, 348/252, 239, 373, 375, 376, 552, 220, 231, 221

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,302,776	11/1981	Taylor et al.	358/160
4,587,633	5/1986	Wang et al.	364/900
4,656,525	4/1987	Norris	358/280
4,689,696	8/1987	Plummer	358/333
4,691,253	9/1987	Silver	360/33.1
4,698,672	10/1987	Chen et al.	358/136
4,730,222	3/1988	Schauffele	358/310
4,742,369	5/1988	Ishii et al.	354/441
4,763,208	8/1988	Kawamura et al.	360/33.1
4,774,600	9/1988	Baumeister	560/14.1
4,777,525	10/1988	Preston, Jr.	358/102
4,782,399	11/1988	Sato	358/280
4,802,019	1/1989	Harada et al.	358/335
4,827,347	5/1989	Bell	358/224
4,890,168	12/1989	Inoue et al.	358/335
4,905,077	2/1990	Ishii	358/22
4,930,007	5/1990	Sugiura et al.	358/75
4,930,014	5/1990	Maeda et al.	358/209
4,999,715	3/1991	Porcellio et al.	358/433
5,014,134	5/1991	Lawton et al.	358/261.3
5,016,107	5/1991	Sasson et al.	358/209
5,018,017	5/1991	Sasaki et al.	358/209
5,027,214	6/1991	Fujimori et al.	358/209
5,027,221	6/1991	Hisatake et al.	358/300
5,032,927	7/1991	Watanabe et al.	358/335
5,157,511	10/1992	Kawai et al.	358/335
5,164,831	11/1992	Kuchta et al.	358/209
5,175,624	12/1992	Hieda et al.	358/183
5,184,227	2/1993	Foley	358/302
5,251,034	10/1993	Na	358/183
5,301,026	4/1994	Lee	348/584
5,365,384	11/1994	Choi	360/72.2
5,414,471	5/1995	Saitoh et al.	348/565
5,633,678	5/1997	Parulski et al.	348/232
5,706,097	1/1998	Schelling et al.	358/296
5,742,339	4/1998	Wakui	348/233
5,796,428	8/1998	Matsumoto et al.	348/231
5,799,219	8/1998	Moghadam et al.	396/319
5,812,736	9/1998	Anderson	386/96
5,861,918	1/1999	Anderson et al.	348/233
6,020,920	2/2000	Anderson	348/231

OTHER PUBLICATIONS

"Mosaic Pucture Track on Video Disk"; Research Disclosure; Feb. 1988; 28618.

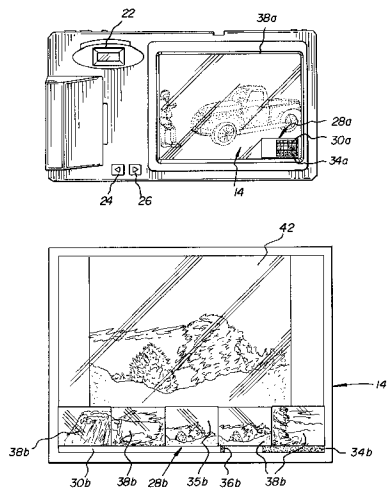
"Liquid Crystal Digital Camera QV–10B" Owner's Manual Manual by Casio.

Primary Examiner—Wendy Garber
Assistant Examiner—Jacqueline Wilson
Attorney, Agent, or Firm—Pamela R. Crocker

[57] **ABSTRACT**

An electronic camera for capturing images and for reviewing selected images, the camera comprising an arrangement for capturing an image of a real world scene as an image signal, a storage structure for storing captured images and from which stored images can be read, a screen, and a structure for displaying on the screen a graphical representation of a list of the stored images and a user selected location within the list. The camera further comprises a user interface which allows a user to select the location within the list, and a structure for displaying on the screen the image within the list corresponding to the selected location.

16 Claims, 7 Drawing Sheets



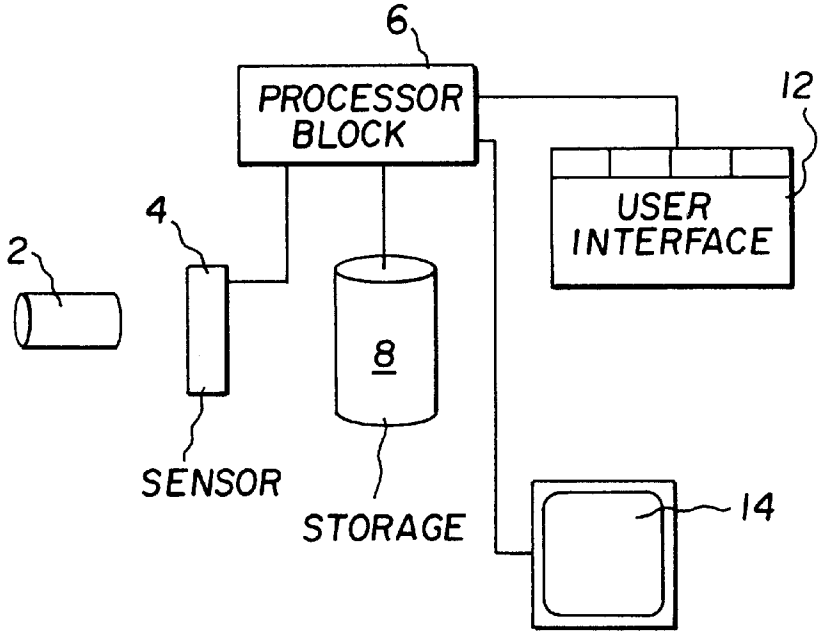

6
PROCESSOR BLOCK
12
USER INTERFACE
4
2
8
SENSOR
STORAGE
14

FIG. 1

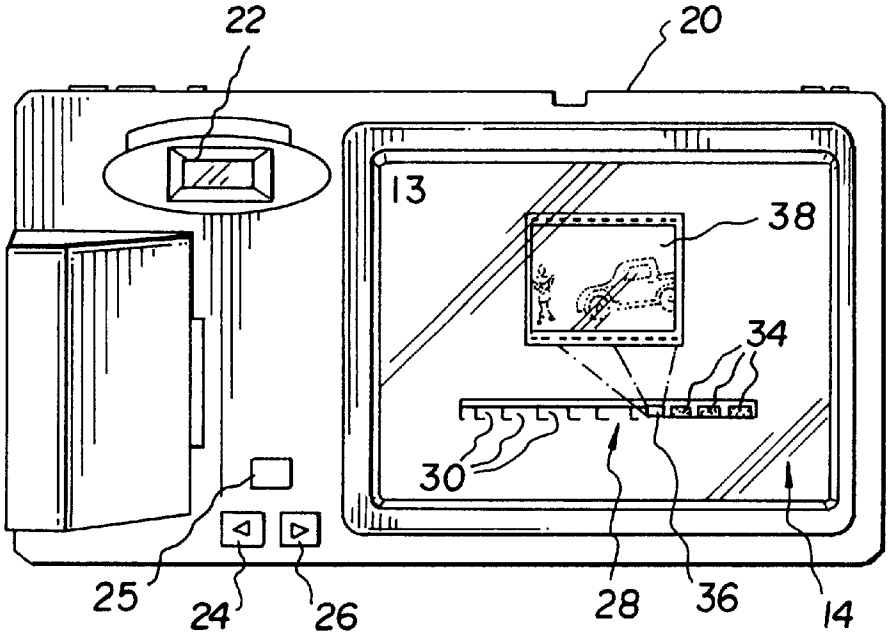

22
20
13
38
34
30
25
24
26
28
36
14

FIG. 2

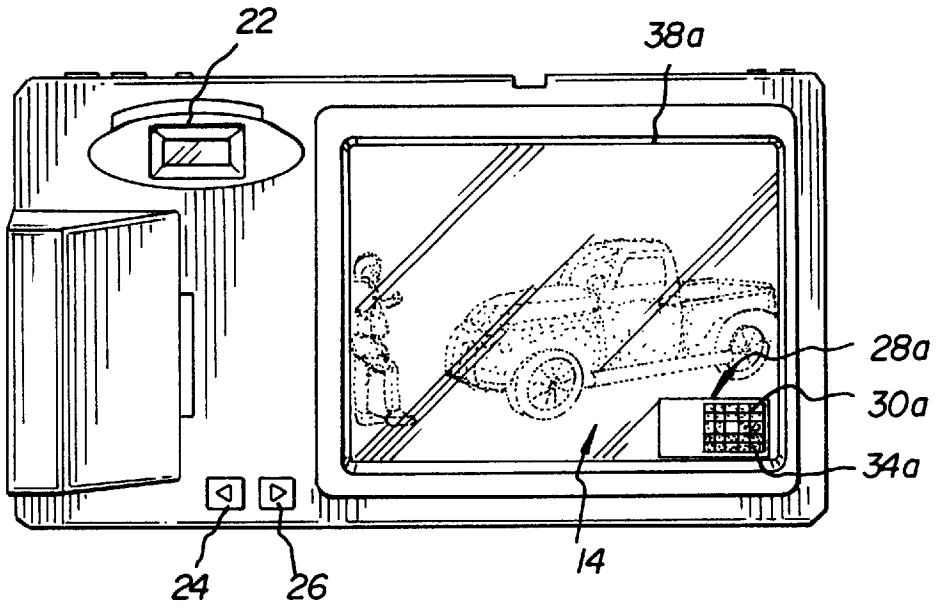


FIG. 3

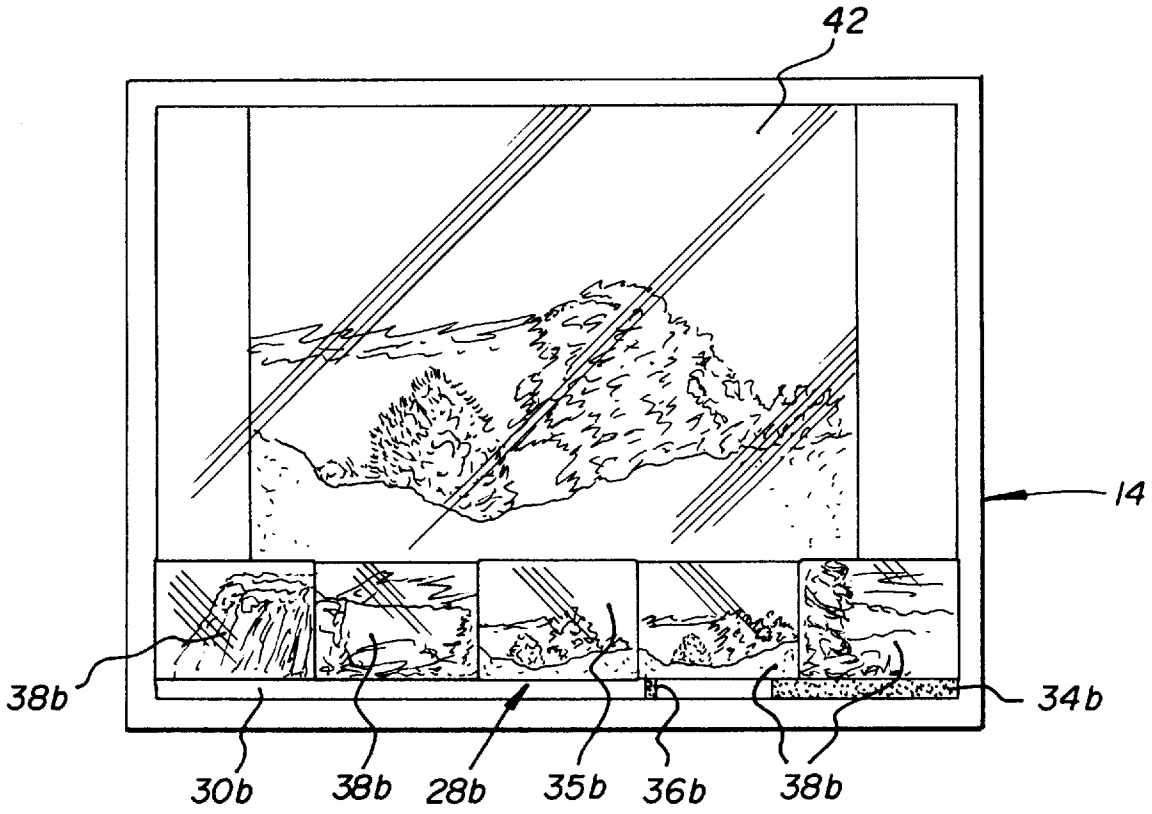


FIG. 5

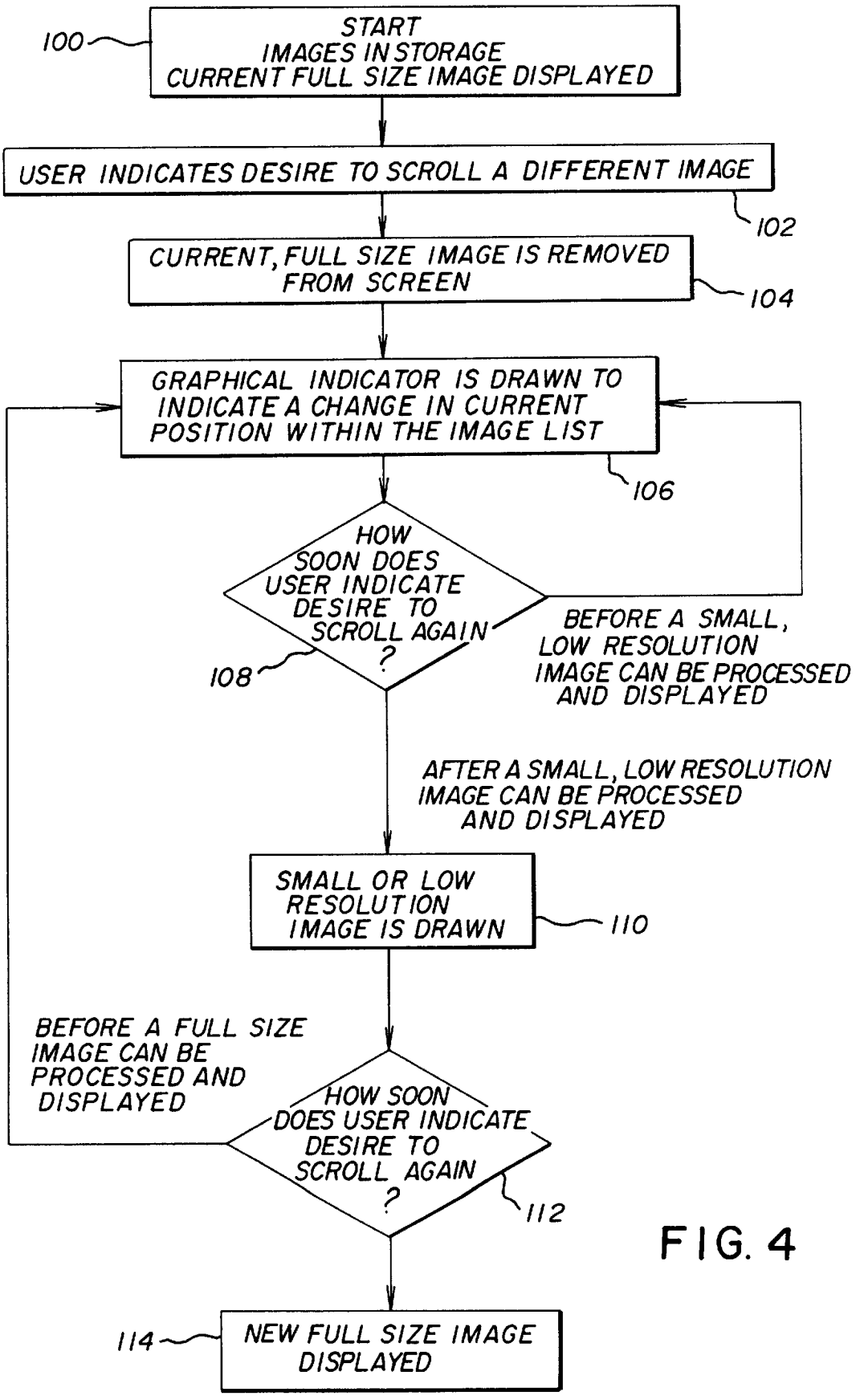

100
START
IMAGES IN STORAGE
CURRENT FULL SIZE IMAGE DISPLAYED
USER INDICATES DESIRE TO SCROLL A DIFFERENT IMAGE
102
CURRENT, FULL SIZE IMAGE IS REMOVED FROM SCREEN
104
GRAPHICAL INDICATOR IS DRAWN TO INDICATE A CHANGE IN CURRENT POSITION WITHIN THE IMAGE LIST
106
HOW SOON DOES USER INDICATE DESIRE TO SCROLL AGAIN ?
108
BEFORE A SMALL, LOW RESOLUTION IMAGE CAN BE PROCESSED AND DISPLAYED
AFTER A SMALL, LOW RESOLUTION IMAGE CAN BE PROCESSED AND DISPLAYED
SMALL OR LOW RESOLUTION IMAGE IS DRAWN
110
BEFORE A FULL SIZE IMAGE CAN BE PROCESSED AND DISPLAYED
HOW SOON DOES USER INDICATE DESIRE TO SCROLL AGAIN ?
112
114
NEW FULL SIZE IMAGE DISPLAYED

FIG. 4

FIG.6A

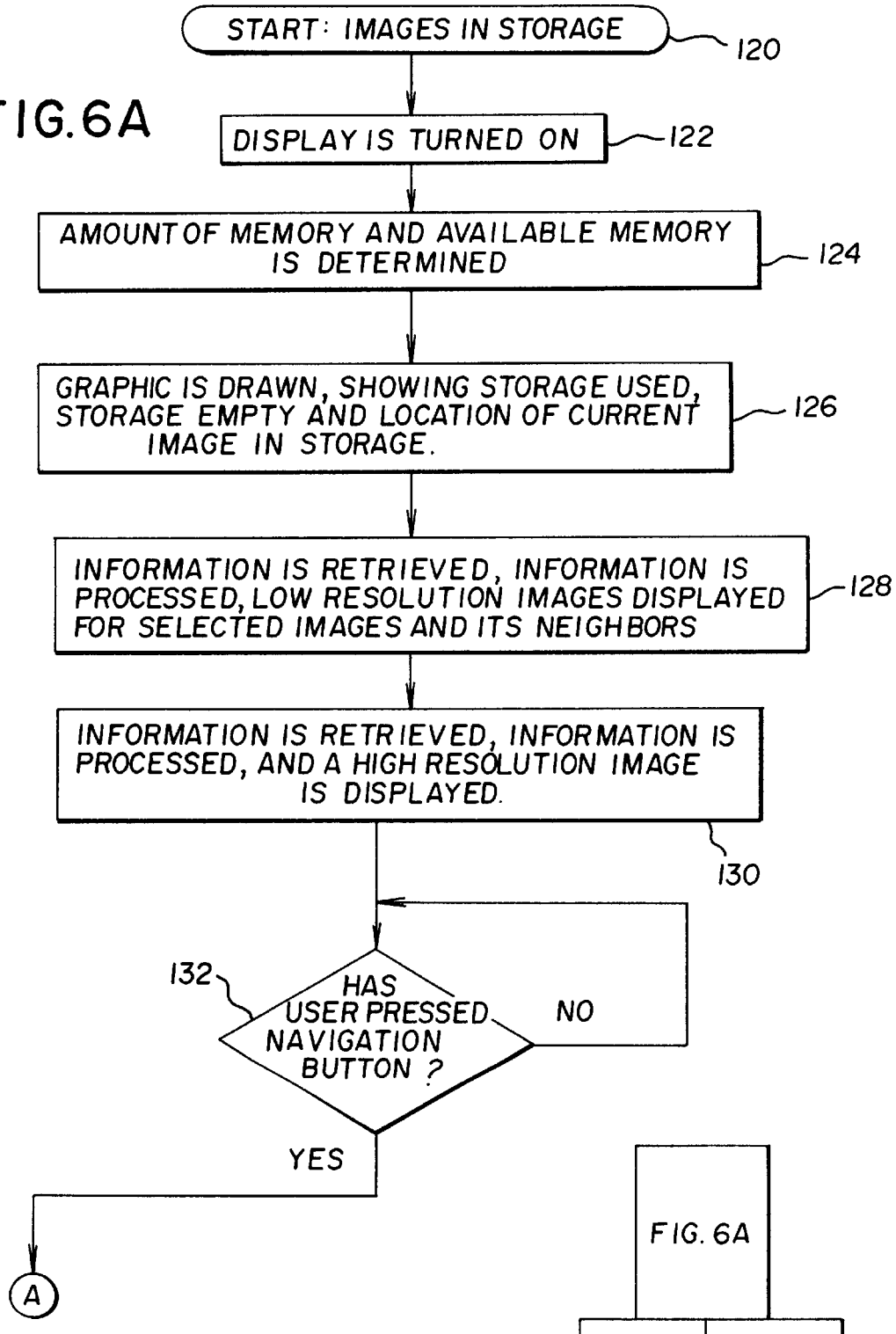

START: IMAGES IN STORAGE
120
DISPLAY IS TURNED ON
122
AMOUNT OF MEMORY AND AVAILABLE MEMORY IS DETERMINED
124
GRAPHIC IS DRAWN, SHOWING STORAGE USED, STORAGE EMPTY AND LOCATION OF CURRENT IMAGE IN STORAGE.
126
INFORMATION IS RETRIEVED, INFORMATION IS PROCESSED, LOW RESOLUTION IMAGES DISPLAYED FOR SELECTED IMAGES AND ITS NEIGHBORS
128
INFORMATION IS RETRIEVED, INFORMATION IS PROCESSED, AND A HIGH RESOLUTION IMAGE IS DISPLAYED.
130
132
HAS USER PRESSED NAVIGATION BUTTON ?
NO
YES
A

FIG. 6A
FIG. 6B
FIG. 6C

FIG. 6

FIG. 6B

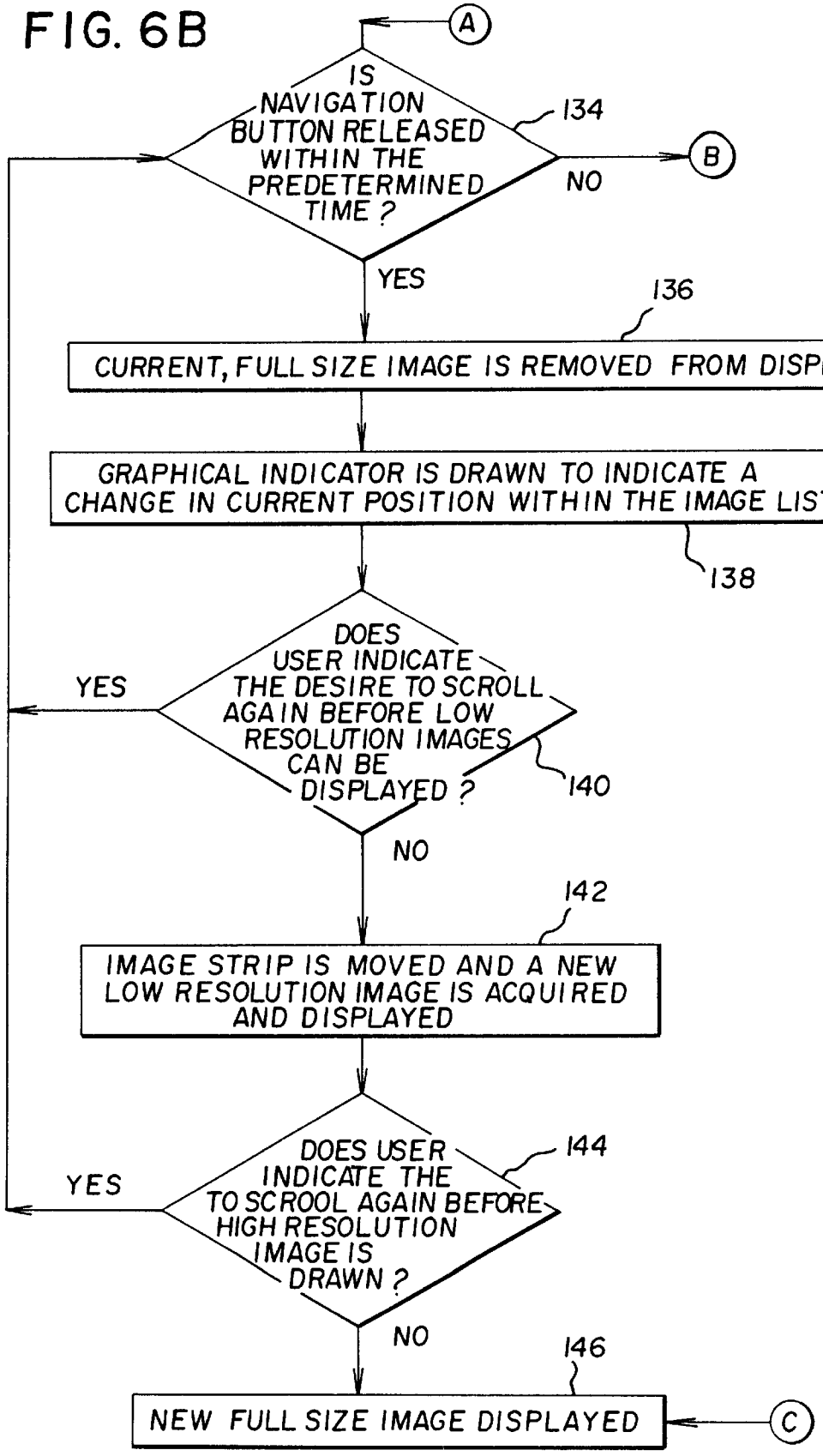
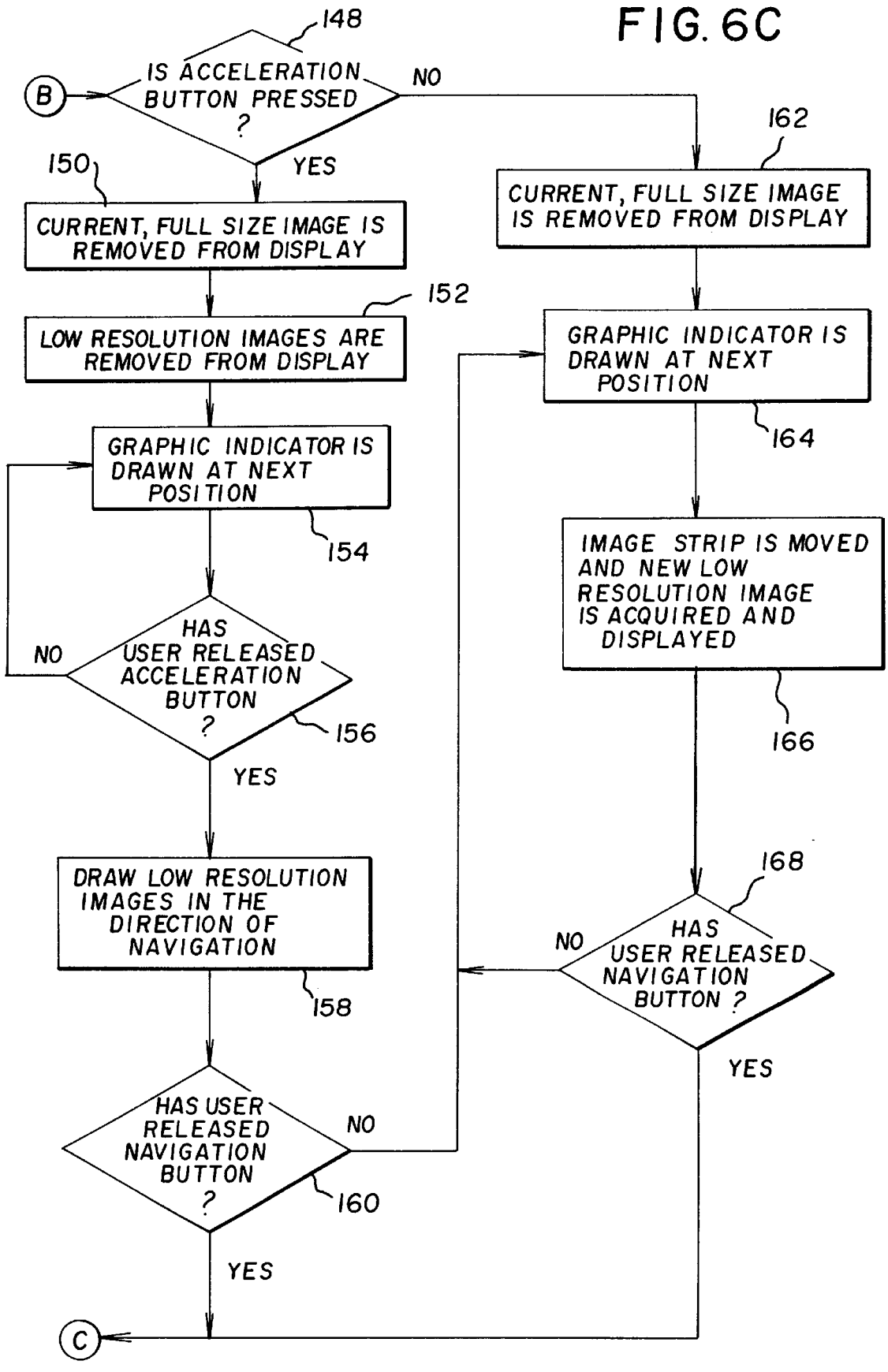

A
IS NAVIGATION BUTTON RELEASED WITHIN THE PREDETERMINED TIME ?
134
NO
B
YES
136
CURRENT, FULL SIZE IMAGE IS REMOVED FROM DISPLAY
GRAPHICAL INDICATOR IS DRAWN TO INDICATE A CHANGE IN CURRENT POSITION WITHIN THE IMAGE LIST
138
DOES USER INDICATE THE DESIRE TO SCROLL AGAIN BEFORE LOW RESOLUTION IMAGES CAN BE DISPLAYED ?
140
YES
NO
142
IMAGE STRIP IS MOVED AND A NEW LOW RESOLUTION IMAGE IS ACQUIRED AND DISPLAYED
DOES USER INDICATE THE TO SCROOL AGAIN BEFORE HIGH RESOLUTION IMAGE IS DRAWN ?
144
YES
NO
146
NEW FULL SIZE IMAGE DISPLAYED
C

FIG. 6C


148
IS ACCELERATION BUTTON PRESSED ?
B
NO
YES
150
CURRENT, FULL SIZE IMAGE IS REMOVED FROM DISPLAY
152
LOW RESOLUTION IMAGES ARE REMOVED FROM DISPLAY
GRAPHIC INDICATOR IS DRAWN AT NEXT POSITION
154
HAS USER RELEASED ACCELERATION BUTTON ?
NO
156
YES
DRAW LOW RESOLUTION IMAGES IN THE DIRECTION OF NAVIGATION
158
HAS USER RELEASED NAVIGATION BUTTON ?
NO
160
YES
C
162
CURRENT, FULL SIZE IMAGE IS REMOVED FROM DISPLAY
GRAPHIC INDICATOR IS DRAWN AT NEXT POSITION
164
IMAGE STRIP IS MOVED AND NEW LOW RESOLUTION IMAGE IS ACQUIRED AND DISPLAYED
166
168
HAS USER RELEASED NAVIGATION BUTTON ?
NO
YES

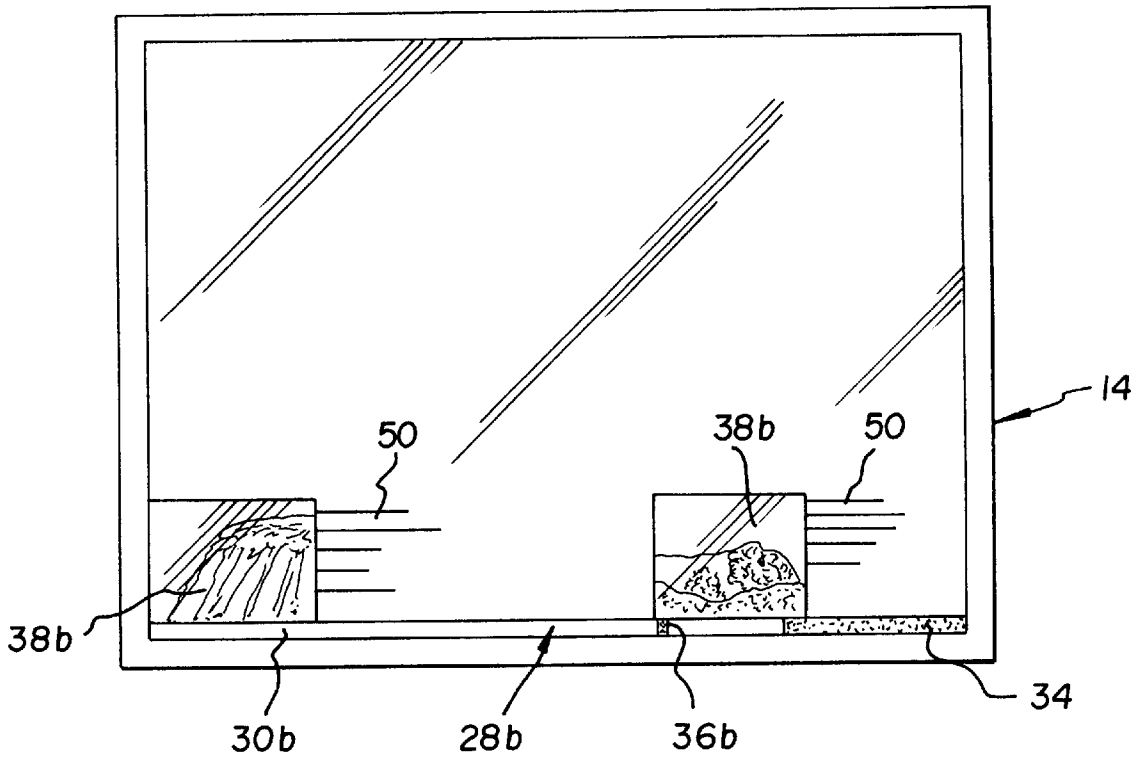


FIG. 7

ELECTRONIC CAMERA WITH IMAGE REVIEW

FIELD OF THE INVENTION

The invention relates generally to the field of photography, and in particular to electronic cameras.

BACKGROUND OF THE INVENTION

Traditional silver halide cameras typically display the number of the current frame to be exposed to the user. The user must use this information in conjunction with the number of frames available in the film canister to calculate the number of frames that remain to be exposed. All of this information is never provided to the user in a concise fashion and the number has to be read and understood. Recently introduced Advanced Photographic System ("APS") cameras will provide some assistance in this area by providing a number that corresponds to the number of frames remaining to be exposed. However, the user will have no method for determining the number of frames that he or she has previously exposed. Software has recently become available which allows scrolling through images on a computer platform. For example, the recently available PICTURE DISK software from Eastman Kodak, which is provided to a customer on a diskette along with scanned images from a roll of film, presents a screen in a Microsoft Windows environment with thumbnails of the images, and a vertical scroll bar on the Windows screen which allows a user to scroll through the thumbnails.

The above problem is exacerbated in cameras that provide an electronic review feature. Such cameras typically have a storage medium on which to store captured images as image signals, and a screen on which any previously captured stored images can be reviewed. In such cameras it is desirable not only to indicate to the user the number of frames exposed and the number of frames remaining to be exposed, but also to indicate which frame is currently being viewed on the electronic display. The Casio QV-10 digital camera assists somewhat with this latter problem by numbering the image frames as they are taken and displaying this number over the image during image review. While this tells the user which frame is currently being viewed, the user has no direct way of determining the number of frames left to be exposed and only knows how many frames have been exposed by scrolling to the last image in the image list and reading the number of this image.

In addition, in an electronic digital camera such as the Casio QV-10, it is necessary for a user to review the stored images one by one to reach a particular one to be reviewed. For example, if the user is viewing image **1** and wishes to view image **20**, he or she must press a button to advance to the next image at which time image **2** is generated and brought to the screen after about a 2 second delay required for the camera electronics to read and display the stored image. The user must again press the advance button at which time image **3** is generated and brought to the screen after another 2 second delay. This process must be repeated 19 times by the user who wishes to view image **20**. This process requires better than 0.5 minute to complete. Such a method of scrolling through the images is therefore relatively time consuming and tedious.

It would be desirable then, to have an electronic camera which stores captured images and which allows a user to relatively rapidly review any desired stored image, and to do so without repetitive actions. It would further be desirable that the user can also readily ascertain the number of images stored and further also the space remaining for storage of further captured images.

SUMMARY OF THE INVENTION

The present invention, then, provides a camera comprising:

(a) means for capturing an image of a real world scene as an image signal;

(b) storage means for storing captured images and from which stored images can be read;

(c) a screen;

(d) a means for displaying on the screen a symbolic representation of the list of stored images and a user selected location within the list;

(e) a user interface which allows a user to select the location within the list; and

(f) means for displaying on the screen the image within the list corresponding to the selected location.

The present invention further provides a method for capturing, storing and displaying stored images, on a camera, comprising:

(a) capturing on the camera, images of real world scenes as image signals;

(b) storing the captured images in the camera;

(c) displaying on a screen on the camera, a symbolic representation of the list of stored images and a user selected location within the list; and

(d) displaying on the screen the image within the list corresponding to the selected location.

The present invention provides a simple means of allowing, in an electronic camera, a user to relatively quickly review any desired stored image, and to do so without repetitive actions. Additionally, the user can also readily ascertain the number of images stored and further also the space remaining for storage of further captured images (i.e. the number of exposures that remain to be taken).

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described with reference to the drawings, in which:

FIG. **1** is a schematic diagram of a camera of the present invention;

FIG. **2** is a back view of a camera of the present invention illustrating a particular output of the symbolic representation displaying means and image displaying means,

FIG. **3** is a view similar to FIG. **2** but with an alternative output of the symbolic representation displaying means and image displaying means;

FIG. **4** is a flowchart illustrating elements of the method of the present invention as executed on the camera of FIG. **2** or **3**;

FIG. **5** is a view of the screen of a camera of the present invention, showing a further alternative output of the symbolic representation displaying means and image displaying means;

FIG. **6** is a flowchart illustrating elements of the method of the present invention as executed on the camera of FIG. **5**; and

FIG. **7** is a view of the screen of a camera of the present invention, showing an output of an alternative image displaying means.

To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures.

DETAILED DESCRIPTION OF THE INVENTION

In the present invention, the symbolic representation displayed may, for example, be alphanumeric characters such as a list of numbers identifying each stored image as well as unexposed image frames. For example, the list of numbers may represent images numbered **1** to **24**, which numbers are of different appearances (such as different color, texture, or font) depending on whether the image frame is exposed or not. Another example of a symbolic representation is a graphical representation, such as a bar along which a pointer is moved, or a rectangle divided into smaller regions each representing a captured image. In any event, the user interface may conveniently allow a user to scroll through the symbolic representation (such as pressing a button which moves the pointer on the bar) to the user selected location. However, the symbolic representation displays within the confines of the camera screen, a representation of all the stored images (that is, exposed image frames) and preferably also all the space remaining on which images can be stored (that is, unexposed image frames). To prevent an undue amount of time being required to generate the symbolic representation, it does not display the images themselves (either in the stored resolution or a lower resolution in which image features are visually identifiable).

Turning first to the schematic of FIG. **1**, the camera shown includes a lens **2** which directs light from real world scene onto a sensor **4**. Typically the light passes through known shutter and aperture mechanisms (not shown), before falling on sensor **4**. The shutter would be activated by a push button or similar user control. Sensor **4** is most typically a single array Charge Coupled Device ("CCD") sensor covered by a color filter array ("CFA"), or could be three CCD sensors with appropriate filters/mirrors (not shown) being provided to direct red, green, and blue light onto respective sensors. All of the camera elements in FIG. **1** will typically be mounted on/in a single housing (such as housing **20** of FIGS. **2** and **3**). A battery compartment (not shown) is typically provided to receive one or more batteries for power. All of these are conventional elements in electronic cameras. The camera is preferably portable, weighing no more than about 5 kg and preferably less than 2 kg (or even 1 kg), without batteries.

Processor block **6** includes appropriate circuitry including analog to digital converters, to convert the signal from sensor **4** to a digital signal for storage in storage device **8**, in a known manner. Storage device **8** can be any suitable digital signal storage device, including optical, magnetic (such as a disk drive) or solid state memory devices. The actual memory media used in storage device **8** is preferably removable but need not be. Captured images of real world scenes in the form of corresponding digital image signals, can therefore be stored in storage device **8** in a list ordered in the sequence in which the images were stored, and retrieved therefrom by processor block **6** for display on user viewing screen **14**. Screen **14** may be any suitable compact, low power consuming display, preferably a liquid crystal display ("LCD"). Features of the camera are controlled by a user through user interface **12**. Processor block **6** may further include a processor and other further necessary hardware and/or software for any apparatus or method of the present invention. Processor block **6** then, may act as the symbolic displaying means and image displaying means of the present invention.

As described above, a camera of the present invention includes a symbolic representation of the list of image frames (whether exposed or not) within the camera, and a user selected location within the list of images. Additionally, a small or low resolution representation of the image at the user selected location within the list may also be provided. The fact that only a small or low resolution image may be displayed, reduces time to retrieve the stored image at the user selected location, and allows faster movement through the list by a user. Turning particularly to FIGS. **1** and **2**, the back of the camera carries on housing **20**, and LCD screen, a viewfinder **22**, and user interface controls in the form of reverse and forward buttons **24, 26** respectively. As captured images of real world scenes are stored in storage device **8** of the camera, a list of images are generated. The size of this list is limited by the storage capacity of storage device **8**, and is known. Therefore, the storage capacity of the camera can be represented as a list of sequenced slots into which images can be placed (that is, exposed or unexposed image frames). This graphical representation of the image frame list can be generated by processor block **6**. FIGS. **1** and **2** illustrate different forms of such a graphical representation. This is depicted as a film strip **28** in FIG. **2** and as an index print **28***a* in FIG. **3**. The single graphical representation **28** or **28***a* displays the list of captured images as small gray rectangles **30**. The unexposed image frames (space remaining in storage device **8**) are displayed as black rectangles **34** (FIG. **2**) or **34***a* (FIG. **3**). The user selected location is indicated by white rectangle **36** (FIG. **2**) or rectangel **36***a* (FIG. **3**), which will typically be positioned by a user on one of the exposed image frame rectangles **30** or **30***a* (which will turn white when selected). Of course, the foregoing regions of different appearance could be obtained, for example, by using other different colors than the gray, black white combination, or by using different textures or regions of other different appearance (such as different numbers representing each image frame), or any combination of the foregoing. Additionally, the user selected location may also be indicated by display of a frame number such as frame number "13" in shown in the upper left hand corner of screen **14** in FIG. **2**, and the lower left hand corner of screen **14** in FIG. **3**.

Processor block **6** also causes the image corresponding to the user selected location **36** within the graphical list representation **28** or index **28***a* (particularly, image frame "13" in FIGS. **1** and **2**), to be displayed on screen **14**. The displayed image **38** is preferably in the form of a smaller or lower resolution form of the larger, higher resolution image that is stored in the storage device **8**. This smaller or lower resolution image provides the user an indication of the image that is stored within the currently selected slot in the image list. In the case of FIG. **2**, this image is displayed as a reduced size image, while in FIG. **3** it is displayed as a larger size the same size as which the image will later be displayed, but at a lower resolution.

It is important to note that before the images can be displayed, they have to be retrieved from the memory of the camera and processed to provide a pleasing image. Completing this process for the entire image can require a significant amount of processing. The speed at which this process is completed will be dictated by the complexity of the process and by the power of the processing path in the camera. However, it is possible to use a number of techniques to obtain only a small segment of the entire image and to process this small segment much more rapidly than the entire image can be processed, thus allowing a smaller or lower resolution version of the image to be processed and displayed much more quickly than the entire image can be processed and displayed. Therefore, displaying a small or low resolution representation of the image during scrolling can increase the perceived speed of scrolling.

Other additional features can be provided by processor block **6** so that the speed at which a user can scroll through a graphical list representation, such as representations **28** or **28***a* is further enhanced. For example, processor block **6** may, during scrolling, not display images corresponding to positions on the graphical representation **28** or **28***a* intermediate beginning and end scrolling positions. This can be accomplished simply by processor block **6** waiting a predetermined time (normally factory preset) after button **24** or **26** is pushed to see if it is pushed again (or is still being pushed), before retrieving a small or low resolution form of an image (such as image **38** or **38***a*) corresponding to the new user selected location. Alternatively, processor block **6** may start retrieving a form of the image corresponding to the new user selected location but terminate retrieval if during the time required for retrieval, the user selects another location.

As stated earlier, besides the advantage of providing the user with information as to how many images have been exposed, how many images remain to be exposed, and which image is currently being viewed, the camera described herein allows the user to scroll through images in a way that is perceived to be faster than simply scrolling through each of the full resolution images one at a time. The preferred method for scrolling through images using this camera is depicted in the flow chart in FIG. **4** and described below.

Referring particularly to FIG. **4**, as indicated therein, it will be assumed that a user has previously captured a number of images. The full size, full resolution stored image at the user selected location in the graphical representation **28** or **28***a* is displayed (**100**) on screen **14** by processor block **6**. When the user indicates (**102**), by pushing reverse or forward buttons **24**, **26**, that he or she wants to scroll to an image that corresponds to another location in the graphical representation, the image is instantly removed (**104**) from screen **14** and the graphical representation of the image list is drawn (**106**) to indicate the position of the new image in the image list. For example, looking at FIG. **2** if the user indicated that they wanted to scroll from the thirteenth to the twelfth image, the film strip **28** would be drawn with the twelfth image highlighted in white and the thirteenth image would be shown as gray. The number indicating the current image (the number 13 in FIG. **1**) would then be updated to indicate the change (e.g., the 13 would be changed to the number 12). The camera would then begin retrieving a small or low resolution representation of the image to display it on the camera.

At this point in time, processor block **6** continues to monitor (**108**) how soon the user indicates that he wishes to scroll to a new location. If the user indicated that they wanted to move to a different image in the image list, before the camera could retrieve and display the small or low resolution representation of the image, the camera would simply redraw the graphic and number to indicate this change, and the camera would begin processing a small or low resolution representation of this new image (that is, return to step **106** in FIG. **4**). However, if the user waited beyond the predetermined time for the camera to complete the processing of the small or low resolution image, this image would be displayed (**110**) and the camera would begin to process (**112**) the full size, full resolution version of this image for display. Once again, the user can indicate that they want to move to a different image in the image list, at which time the image is removed and the graphic is redrawn. However, if the user does not indicate that he or she wishes to move to a different image in the image list, the full size, full resolution image replaces (**114**) the graphic and small image after it has been processed by the camera.

The progressive display of information to the user as described provides the user the opportunity to decide to continue to scroll before enough time has passed to allow the reduced resolution or full size image to be processed. By providing this capability, the user will be able to scroll to the image they desire to review more quickly than they would if they were forced to wait for the entire image to be processed.

A particularly preferred implementation of the present invention is further illustrated in FIG. **5**. In particular, in the embodiment of FIG. **5** processor block **6** causes to be displayed on screen **14**, a single graphic representation in the form of bar **28***b* showing the complete image frame list. The exposed image frames on bar **28***b* are represented by continuous light gray portion **30***b* of bar **28***b*, while unexposed image frames are represented by darker gray portion **34***b* of bar **28***b*. A sliding indicator **36***b* represents the user selected position within bar **28***b*. Portions **30***b* and **34***b* of bar **28***b*, and cursor **36***b*, while shown as different shades of gray in FIG. **5**, can all be of different colors, shadings or have other different features which makes them visually distinctive from one another. Processor block **6** can vary the position of indicator **36***b* under control of user operated reverse and forward buttons **24**, **26** respectively shown in FIG. **2**.

When indicator **36***b* is at rest (that is, the user has not pressed reverse or forward buttons **24**, **26** for some time), processor block **6** also displays on screen **14** a lower resolution version **35***b* of the stored full size and full resolution exposed image corresponding to the location of indicator **36***b* within bar **28***b*. Additionally, processor block **6** further displays lower resolution versions **38***b* of each of the two full size and full resolution images corresponding to positions on either side of indicator **36***b* on bar **28***b*. A larger resolution version **42** of the selected image is also displayed. Version **42** may be the full resolution image stored in storage **8**, or may be a resolution intermediate the full stored resolution and the resolution of version **35***b*.

The user can then navigate backwards and forwards through the list of images in storage device by simply pressing a forward button **24** or reverse button **26**. The user will be able to scroll along through the list of images and then loop to the beginning of this list after passing through a screen that indicates beginning/ending of the strip. Graphical overlays will be displayed on the screen to indicate the format of the type or format of the image being viewed.

If the user simply presses and releases forward or reverse buttons **24**, **26**, the next large image is displayed, the low resolution images move one image in the direction opposite to the direction indicated by the navigation button, and the position indicator moves to the right by a distance proportional to the amount of total memory used by the image. An acceleration button **25** can also be provided on the camera if a user wishes to increase the speed of scrolling beyond the speed provided when forward or reverse buttons **24**, **26** are pressed. The acceleration button **25** would be pressed after the forward or reverse buttons **24**, **26** are pressed.

The operation of the method of the present invention in which the display illustrated in FIG. **5** is generated, is depicted in the flowchart in FIG. **6** and described below. It is assumed that there are previously captured images from sensor **4**, already stored in storage device **8**.

The start-up sequence when the screen **14** is first turned on, is illustrated in steps **120**–**130**. The amount of total memory and available memory is first determined (**124**), and the graphic representation **28***b* is drawn (**126**). The necessary information is retrieved (**128**) from storage device **8** to cause

the lower resolution images **35***b* and **38***b* to be displayed on screen **14**. Additionally, the higher resolution image **42** is also displayed (**130**).

When the user presses reverse or forward buttons **24**, **26** (**132**) and the button is released within a predetermined time (**134**), the current full size image is removed from the display (**136**), the graphical indicator is drawn to indicate a change in the current position within the image list (**138**), the image strip is moved in the direction opposite the direction of the reverse or forward buttons and the low resolution image is then acquired and displayed (**142**). The full size image is then acquired and displayed (**146**). If the user presses the reverse or forward buttons **24**, **26** before the low resolution image is displayed (**140**) or before the new full size image is displayed (**144**), the camera's current activity is interrupted and it behaves as if the reverse of forward button was just pressed (**134**).

If the user presses and holds the reverse or forward buttons for longer than a predetermined time, and the user has not pressed the acceleration button **25** (**148**) the camera removes the current full size image from the display (**162**), draws the graphic indicator at its next position (**164**), moves the image strip and displays the new low resolution image (**166**). The camera then repeats the steps **164** and **166** until the user releases the reverse or forward button. When the user releases the reverse or forward button, the new full size image that is represented by the center low resolution image is displayed (**146**).

If the user presses and holds the reverse or forward button and then presses and holds the acceleration button **25** (**148**), the full size image is removed from the display and steps **150** through **160** are completed. These steps are the same as described in steps **162** to **168** except the images in the image strip are not drawn until the user releases the acceleration button **25** (**156**).

It may be that a user will desire to scroll through the image list represented by bar **28***b* at a rate which exceeds the ability of storage **8** and processor block **6** to retrieve and display the low resolution versions of all of images represented by the space on bar **28***b* over which sliding indicator **36***b* is moved. For example, this might be the case when the acceleration button is pressed. However, the user may still want to see at least some low resolution versions of the images. In this case, processor block **6** will acquire and display only interspersed ones of the low resolution images **38***b* in a manner as shown in FIG. **7**. For example, only every second, third, or fourth image might be retrieved and displayed on screen **14** (that is, the displayed images are separated in the image list by one, two, or three images). In addition, some visual indication can be provided on screen **14** to show the user that they are engaged in a rapid scrolling and that only interspersed low resolution images are being retrieved. For example, as low resolution images **38**b are moved to the left in FIG. **7**, trailing lines **50** can be displayed to suggest rapid scrolling through the images. Other visual indications could be attached or displayed with the low resolution images **38***b* which indicates a faster or different rate or mode of review.

It will be appreciated that forward and reverse buttons **24**, **26** may generate other than discrete signals when pressed. For example, those buttons may generate signals which vary with the degree of pressure applied by a user. Such signals may then be used by processor block **6** to vary the rate at which new low resolution images are acquired and displayed on screen **14**, such that the rate of acquisition and display is a function of pressure applied by the user. Thus, when a user presses forward or reverse buttons **24**, **26** harder, the rate of acquisition and display of the low resolution images is increased. If the desired rate of acquisition and retrieval, as indicated by the user's pressure on one of the buttons **24** or **26**, exceeds the rate at which storage **8** and processor block **6** allows for retrieval, then processor **6** may then cause only interspersed to be acquired and displayed such as in the manner described in connection with FIG. **7** (for example, only every second, third, or fourth image, may be displayed as pressure on buttons **24** or **26** is increased).

The present invention can also advantageously be applied to display devices for reviewing images electronically stored on a media. This is particularly true of other portable display devices which, like the camera described above, will often have limited processing power and storage space. Such portable devices will generally weigh less than about 5 kg and preferably less than about 2 kg (and even less than 1 kg), without batteries. In such a device, the image capturing means (particularly, lens **2**, sensor **4**, and the hardware and/or software components of processor block **6** which convert the signal from sensor **4** to a digital electrical signal) can be eliminated and the storage means can be replaced by a media reader for reading images stored on the media. The other features of such a portable device can be the same as for the cameras described above, although viewfinder **22** (FIGS. **2** and **3**) can also be eliminated.

In such a device, the media reader will preferably use a removable media using any suitable media, such as optical, magnetic or solid state memory media described above. Optionally, the media reader could be a storage device such as storage device **8**, which also can store image signals on the storage media. Such image signals might be received from a remote source (such as over a telephone line, network interface, radio link, or other communications link). In this case then, the portable display device would be as illustrated in FIGS. **1** to **5**, except lens **2** is deleted and sensor **4** is replaced by a suitable interface module (such as a modem, network interface or other communications hardware) with processor block **6** including any further necessary hardware and/or software. Such a display device may incorporate all other features of the camera describe above, and execute the methods described above for displaying stored images.

The invention has been described with reference to a preferred embodiment. However, it will be appreciated that variations and modifications can be effected by a person of ordinary skill in the art without departing from the scope of the invention.

PARTS LIST

2 Time Image
4 Sensor
6 Processor Block
8 Storage Device
12 User Interface
14 User Viewing Screen
20 Housing
22 Viewfinder
24 Reverse Button
26 Forward Button
28 Film Strip
28*a* Index Print
28*b* Bar
30 Gray Rectangles
30*a* Gray Rectangles
30*b* Light Gray Portion
34 Black Rectangles
34*a* Black Rectangles

34*b* Darker Gray Portion
35*b* Lower Resolution Version Of Image
36 Selected Location
36*b* Sliding Indicator
38 Displayed Image
38*a* Displayed Image
38*b* Lower Resolution Versions
42 Larger Resolution Version
50 Trailing Lines

What is claimed is:

1. A camera comprising:

(a) means for capturing an image of a real world scene as an image signal;

(b) storage means for storing captured images and from which stored images can be read, the images being in a list ordered in the sequence in which the images were stored;

(c) a screen;

(d) means for displaying on the screen a plurality of interspersed images from the list of stored images, the interspersed images being moved across the screen as a user moves the location within the list; and

(e) a user interface which allows a user to move the location within the list from which the interspersed images are to be displayed.

2. A camera according to claim **1** wherein the user interface allows the user to move the location at least at a slower rate and a faster rate, and wherein the display means causes an additional visual indication to be displayed on the screen when the faster rate is selected.

3. A camera according to claim **1** wherein the user interface allows the user to move the location at a slower rate and a faster rate, and wherein at the faster rate the interspersed images are displayed at a separation in the list greater than the separation of images at the slower rate.

4. A camera according to claim **3** wherein there is no separation in the list between images displayed at the slower rate.

5. A camera comprising:

(a) means for capturing an image of a real world scene as an image signal;

(b) storage means for storing captured images and from which stored images can be read, the images being a list ordered in the sequence in which the images were stored;

(c) a screen;

(d) means for displaying on the screen a graphical representation of the list of the stored images and a user selected location within the list, the images being moved across the screen as a user moves the location within the list;

(e) a user interface which allows the user to move the location within the list from which the images are to be displayed, the user interface allowing the user to move the location at least at a slower rate and a faster rate; and

(f) means for displaying a selected image on the screen, wherein at the faster rate the interspersed images are displayed at a separation in the list greater than the separation of images at the slower rate.

6. A camera according to claim **5** wherein there is no separation in the list between images displayed at the slower rate.

7. A camera comprising:

(a) means for capturing an image of a real world scene as an image signal;

(b) storage means for storing captured images and from which stored images can be read;

(c) a screen;

(d) means for displaying on the screen a graphical representation of a list of the stored images and a user selected location within the list;

(e) a user interface which allows a user to select the location within the list; and

(f) means responsive to a predetermined retrieval time for displaying on the screen the image within the list corresponding to the selected location, wherein if during the retrieval time a user selects another location within the list, the retrieval is terminated.

8. A camera comprising:

(a) means for capturing an image of a real world scene as an image signal;

(b) storage means for storing captured images and from which stored images can be read;

(c) a screen;

(d) means for displaying on the screen a graphical representation of a list of the stored images and a user selected location within the list;

(e) a user interface which allows a user to select the location within the list; and

(f) means for displaying on the screen the image within the list corresponding to the selected location, provided a user does not select another location within a predetermined time.

9. A camera comprising:

(a) means for capturing an image of a real world scene as an image signal;

(b) storage means for storing captured images and from which stored images can be read;

(c) a screen;

(d) means for displaying on the screen a graphical representation of a list of the stored images and a user selected location within the list;

(e) a user interface which allows a user to select the location within the list; and

(f) means for displaying on the screen a low resolution version of the image within the list corresponding to the selected location, and including means for causing a higher resolution version of the image to be displayed provided a user does not select another location within a time required to display the low resolution version.

10. A method of capturing, storing and displaying stored images on a camera, comprising:

(a) capturing on the camera, images of real world scenes as image signals;

(b) storing the captured images in the camera;

(c) displaying on a screen on the camera, a graphical representation of the list of stored images and a user selected location within the list; and

(d) displaying on the screen the image within the list corresponding to the selected location, wherein a predetermined retrieval time is required to display the image, and wherein if during the retrieval time a user selects another location, the retrieval is terminated.

11. A method of capturing, storing and displaying stored images on a camera, comprising:

(a) capturing on the camera, images of real world scenes as image signals;

(b) storing the captured images in the camera;

(c) displaying on a screen on the camera, a graphical representation of the list of stored images and a user selected location within the list; and

(d) displaying on the screen the image within the list corresponding to the selected location provided a user does not select another location within a predetermined time.

12. A method of capturing, storing and displaying stored images on a camera, comprising:

(a) capturing on the camera, images of real world scenes as image signals;

(b) storing the captured images in the camera;

(c) displaying on a screen on the camera, a graphical representation of the list of stored images and a user selected location within the list;

(d) displaying on the screen a low resolution version of the image within the list corresponding to the selected location; and

(e) displaying a higher resolution version of the image provided a user does not select another location within a time required to display the low resolution version.

13. A camera comprising:

(a) means for capturing an image of a real world scene as an image signal;

(b) storage means for storing captured images and from which stored images can be read, the images being a list ordered in the sequence in which the images were stored;

(c) a screen;

(d) means for displaying on the screen a graphical representation of the list of the stored images and a user selected location within the list, the images being moved across the screen as a user moves the location within the list;

(e) a user interface which allows the user to move the location within the list from which the images are to be displayed; and

(f) means responsive to a predetermined retrieval time for displaying a selected image on the screen, wherein if during the retrieval time a user selects another location with the list, the retrieval is terminated.

14. A camera comprising:

(a) means for capturing an image of a real world scene as an image signal;

(b) storage means for storing captured images and from which stored images can be read, the images being a list ordered in the sequence in which the images were stored;

(c) a screen;

(d) means for displaying on the screen a graphical representation of the list of the stored images and a user selected location within the list, the images being moved across the screen as a user moves the location within the list;

(e) a user interface which allows the user to move the location within the list from which the images are to be displayed; and

(f) means for displaying a selected image on the screen provided a user does not select another location within a predetermined time.

15. A camera comprising:

(a) means for capturing an image of a real world scene as an image signal;

(b) storage means for storing captured images and from which stored images can be read, the images being a list ordered in the sequence in which the images were stored;

(c) a screen;

(d) means for displaying on the screen a graphical representation of the list of the stored images and a user selected location within the list, the images being moved across the screen as a user moves the location within the list;

(e) a user interface which allows the user to move the location within the list from which the images are to be displayed; and

(f) means for displaying a low resolution version of a-selected image on the screen, and including means for displaying a higher resolution version of the image provided a user does not select another location within a time required to display the low resolution version.

16. A camera comprising:

(a) means for capturing an image of a real world scene as an image signal;

(b) storage means for storing captured images and from which stored images can be read, the images being a list ordered in the sequence in which the images were stored;

(c) a screen;

(d) means for displaying on the screen a graphical representation of the list of the stored images and a user selected location within the list, the images being moved across the screen as a user moves the location within the list;

(e) a user interface which allows the user to move the location within the list from which the images are to be displayed, the user interface allowing the user to move the location at least at a slower rate and a faster rate; and

(f) means for displaying a selected image on the screen, including means for causing an additional visual indication to be displayed on the screen when the faster rate is selected.

* * * * *

EXHIBIT 4

US006292218B1

(12) **United States Patent**
Parulski et al.

(10) **Patent No.: US 6,292,218 B1**
(45) **Date of Patent: *Sep. 18, 2001**

(54) **ELECTRONIC CAMERA FOR INITIATING CAPTURE OF STILL IMAGES WHILE PREVIEWING MOTION IMAGES**

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(73) Assignee: **Eastman Kodak Company**, Rochester, NY (US)

(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **08/895,094**

(22) Filed: **Jul. 16, 1997**

Related U.S. Application Data

(62) Division of application No. 08/367,399, filed on Dec. 30, 1994.

(51) **Int. Cl.**[7] **H04N 5/225**; H04N 5/222

(52) **U.S. Cl.** **348/220**; 348/333.11

(58) **Field of Search** 348/220, 221, 348/222, 333, 321, 223, 333.11, 333.12

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,819,059 * 4/1989 Pape 348/220
4,876,590 * 10/1989 Parulski 348/220
5,226,114 * 7/1993 Martinez et al. 395/128
5,440,343 * 8/1995 Parulski et al. 348/316
5,452,017 * 9/1995 Hickman 348/646
5,493,335 * 2/1996 Parulski et al. 348/233
5,828,406 * 10/1998 Parulski et al. 348/220
5,923,816 * 7/1999 Ueda 348/220

* cited by examiner

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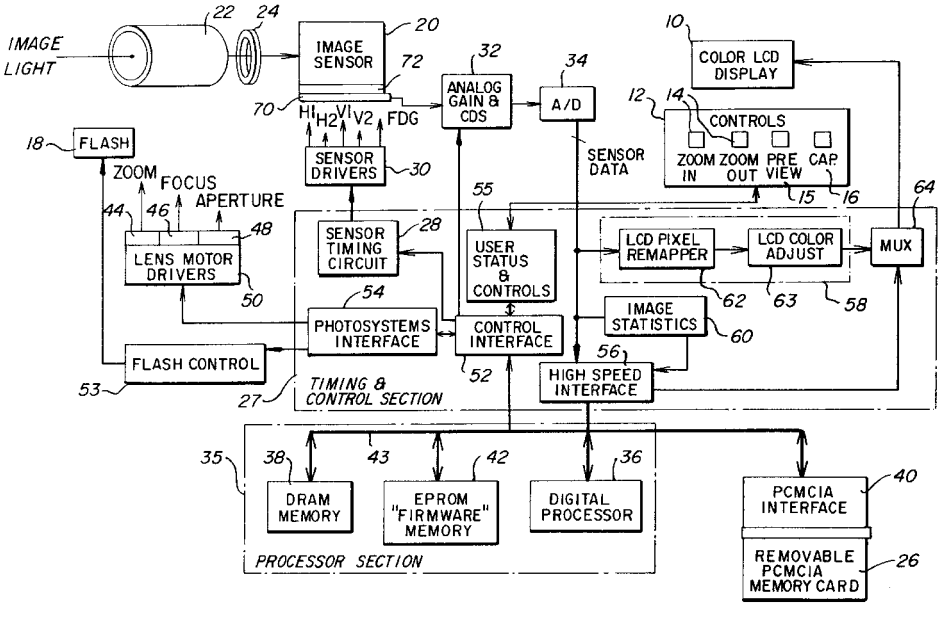
(57) **ABSTRACT**

An electronic camera uses a relatively more complex digital image processing technique in a still image mode to produce high quality still images, and a relatively more simple image processing technique in a motion preview mode to produce preview images of acceptable quality prior to initiation of the still image mode. The more complex digital technique is done in software in a general purpose processor section **35**, while the more simple digital technique is implemented in a fixed digital circuit in an application specific integrated circuit **27**, which also implements timing and control functions. The motion preview mode uses a shorter image readout period than the still mode and further involves mapping image sensor pixels into a fewer number of color display pixels on a color LCD display **10**. The mapping further converts color pixel signals from a mosaic array into a different color pattern on the color LCD display **10**.

28 Claims, 10 Drawing Sheets



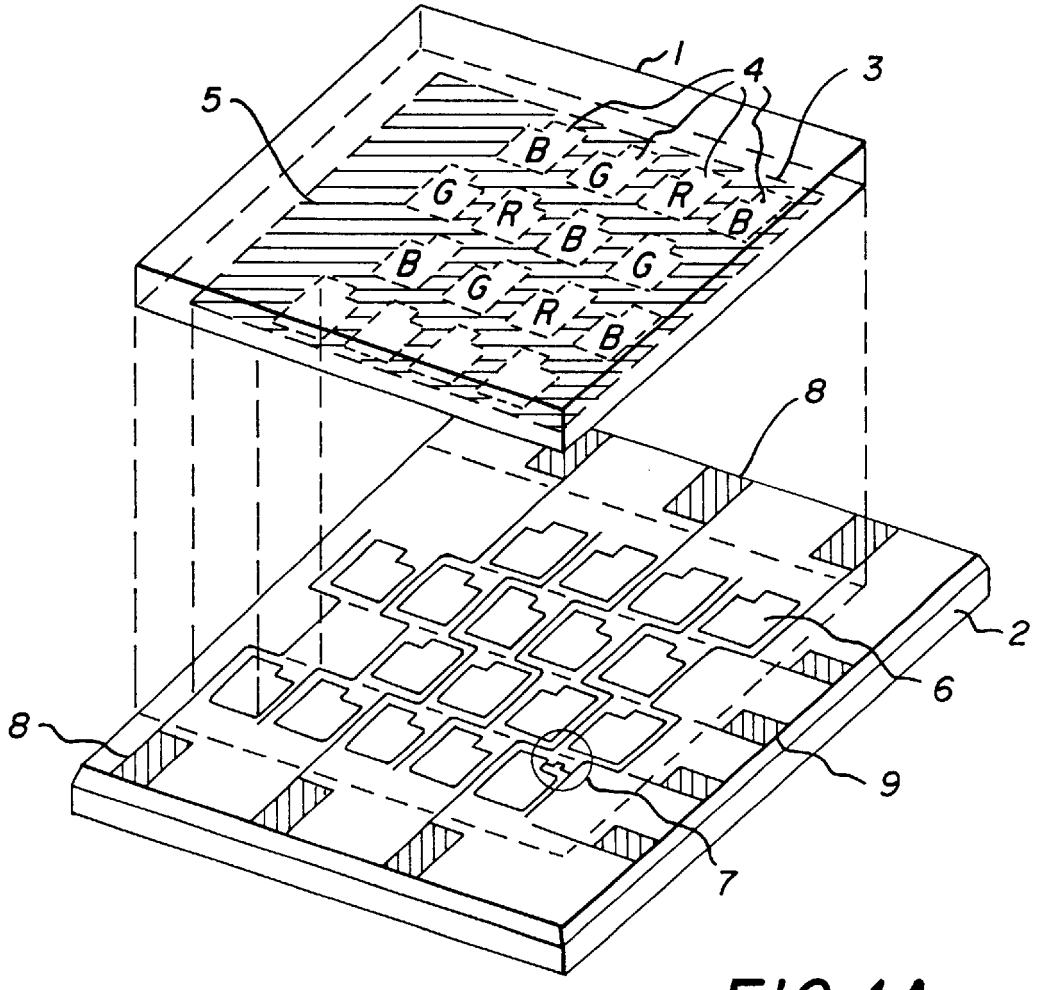


FIG. 1A

G	R	B	G	R	B	G	R
B	G	R	B	G	R	B	G
R	B	G	R	B	G	R	B
G	R	B	G	R	B	G	R

FIG. 1B

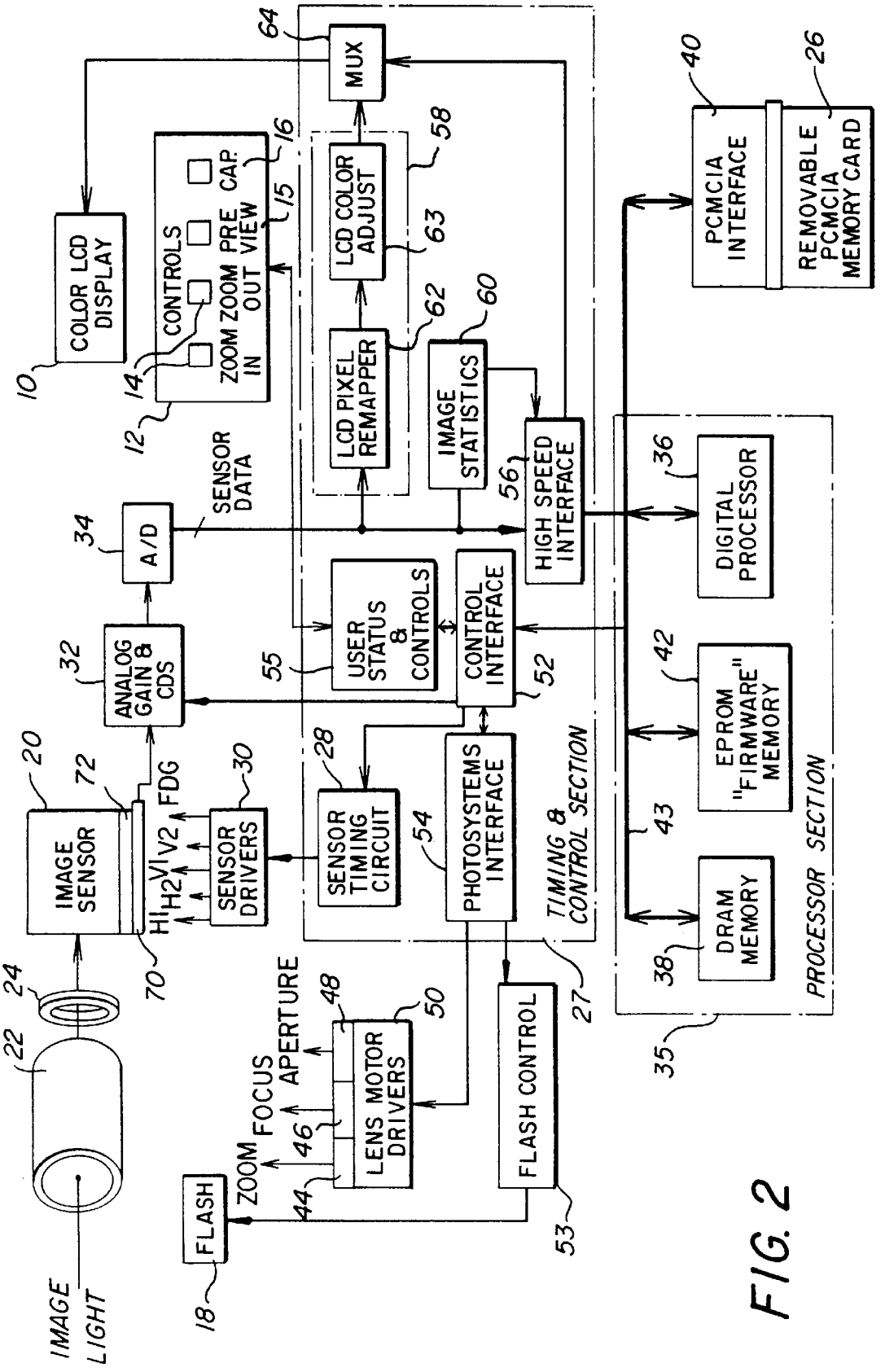


IMAGE LIGHT
22
24
IMAGE SENSOR
20
72
70
H1 H2 V1 V2 FDG
SENSOR DRIVERS
30
ANALOG GAIN & CDS
32
A/D
34
SENSOR DATA
SENSOR TIMING CIRCUIT
28
PHOTOSYSTEMS INTERFACE
54
TIMING & CONTROL SECTION
27
USER STATUS & CONTROLS
55
CONTROL INTERFACE
52
HIGH SPEED INTERFACE
56
LCD PIXEL REMAPPER
62
IMAGE STATISTICS
60
LCD COLOR ADJUST
63
58
MUX
64
CONTROLS
ZOOM IN
ZOOM OUT
PRE VIEW
15
CAP.
16
14
12
COLOR LCD DISPLAY
10
FLASH
18
ZOOM
FOCUS
APERTURE
46
44
48
LENS MOTOR DRIVERS
50
FLASH CONTROL
53
DIGITAL PROCESSOR
36
PCMCIA INTERFACE
40
REMOVABLE PCMCIA MEMORY CARD
26
EPROM "FIRMWARE" MEMORY
42
DRAM MEMORY
43
38
35
PROCESSOR SECTION

FIG. 2

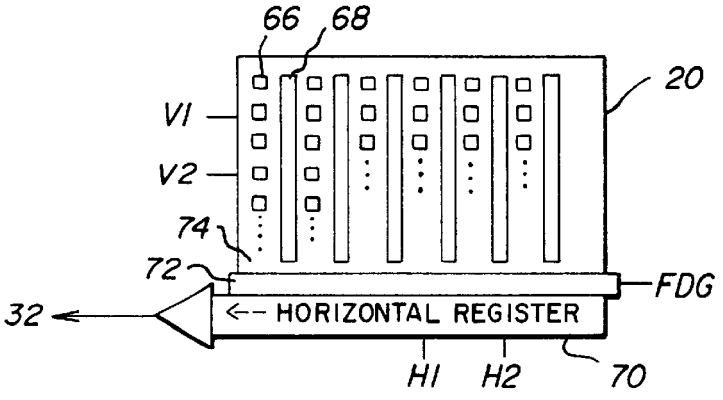


FIG. 3A

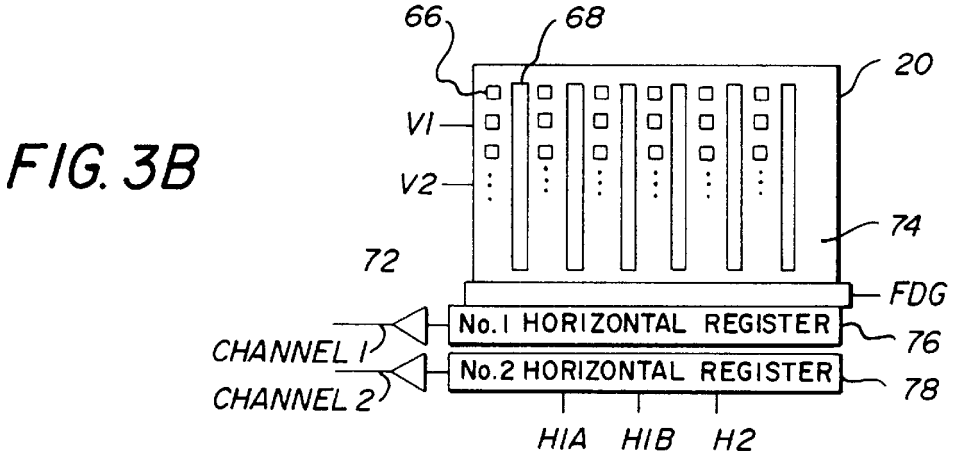


FIG. 3B

CCD LINES

LINE 1	G	R	G	R	G	R	G	R
LINE 2	B	G	B	G	B	G	B	G
LINE 3	G	R	G	R	G	R	G	R
LINE 4	B	G	B	G	B	G	B	G
LINE 5	G	R	G	R	G	R	G	R
LINE 6	B	G	B	G	B	G	B	G
LINE 7	G	R	G	R	G	R	G	R
LINE 8	B	G	B	G	B	G	B	G

FIG. 4

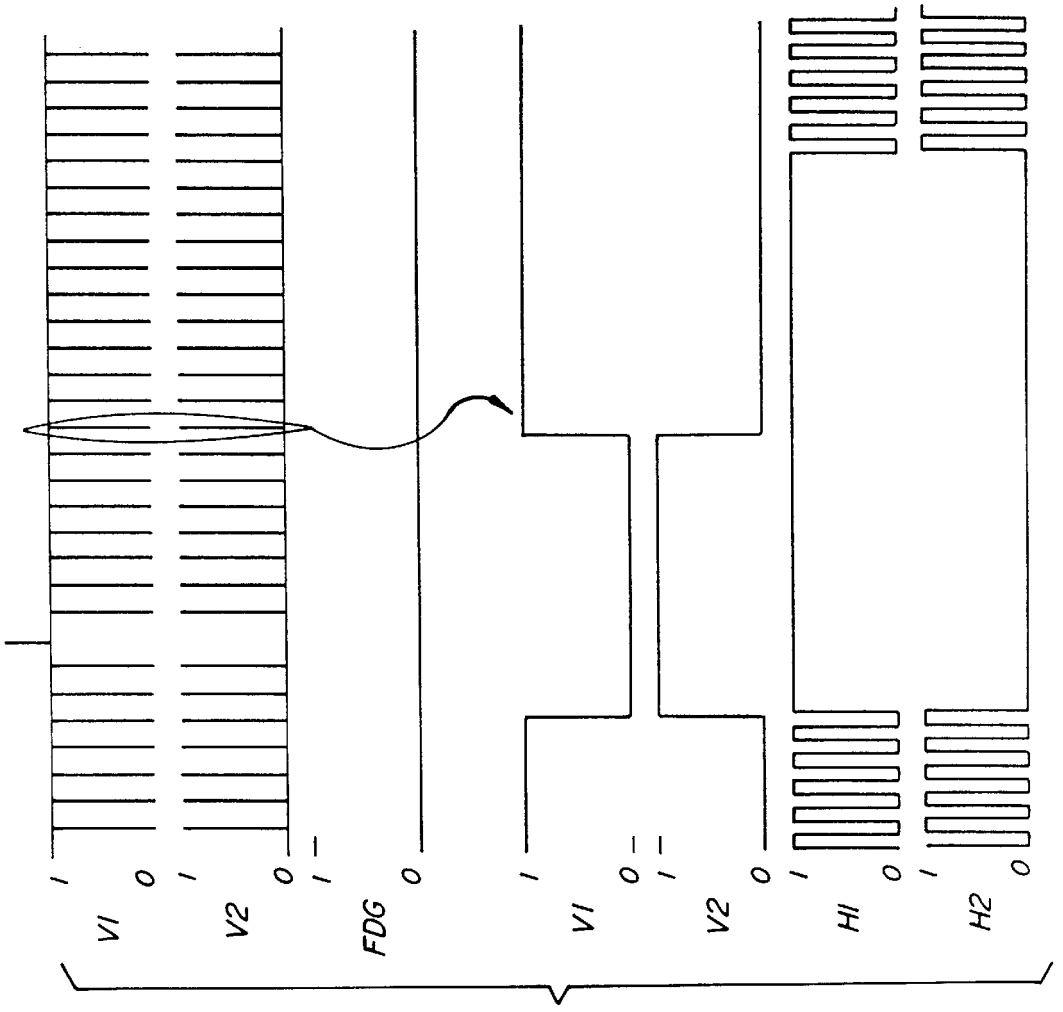


FIG. 5

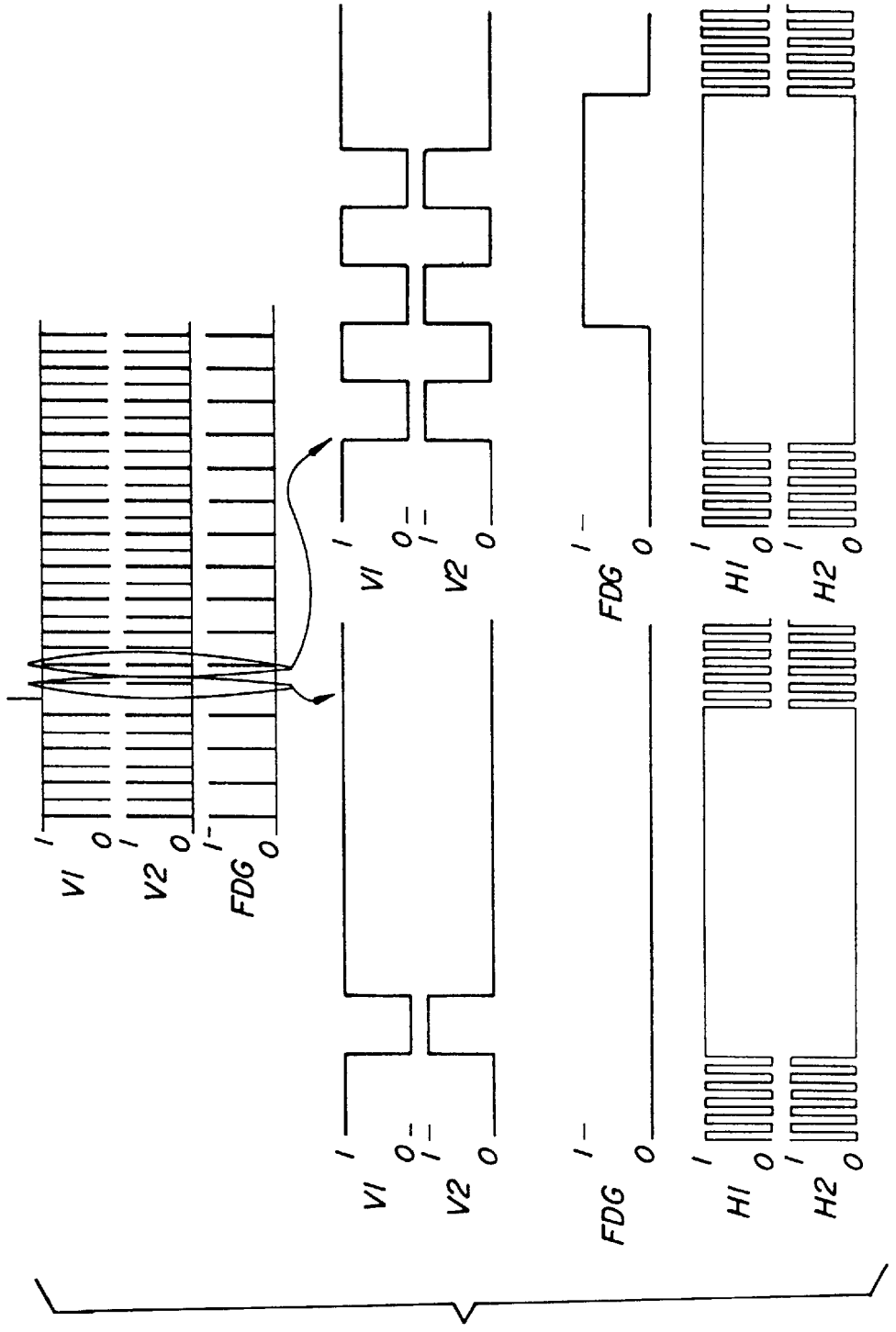


FIG.6a

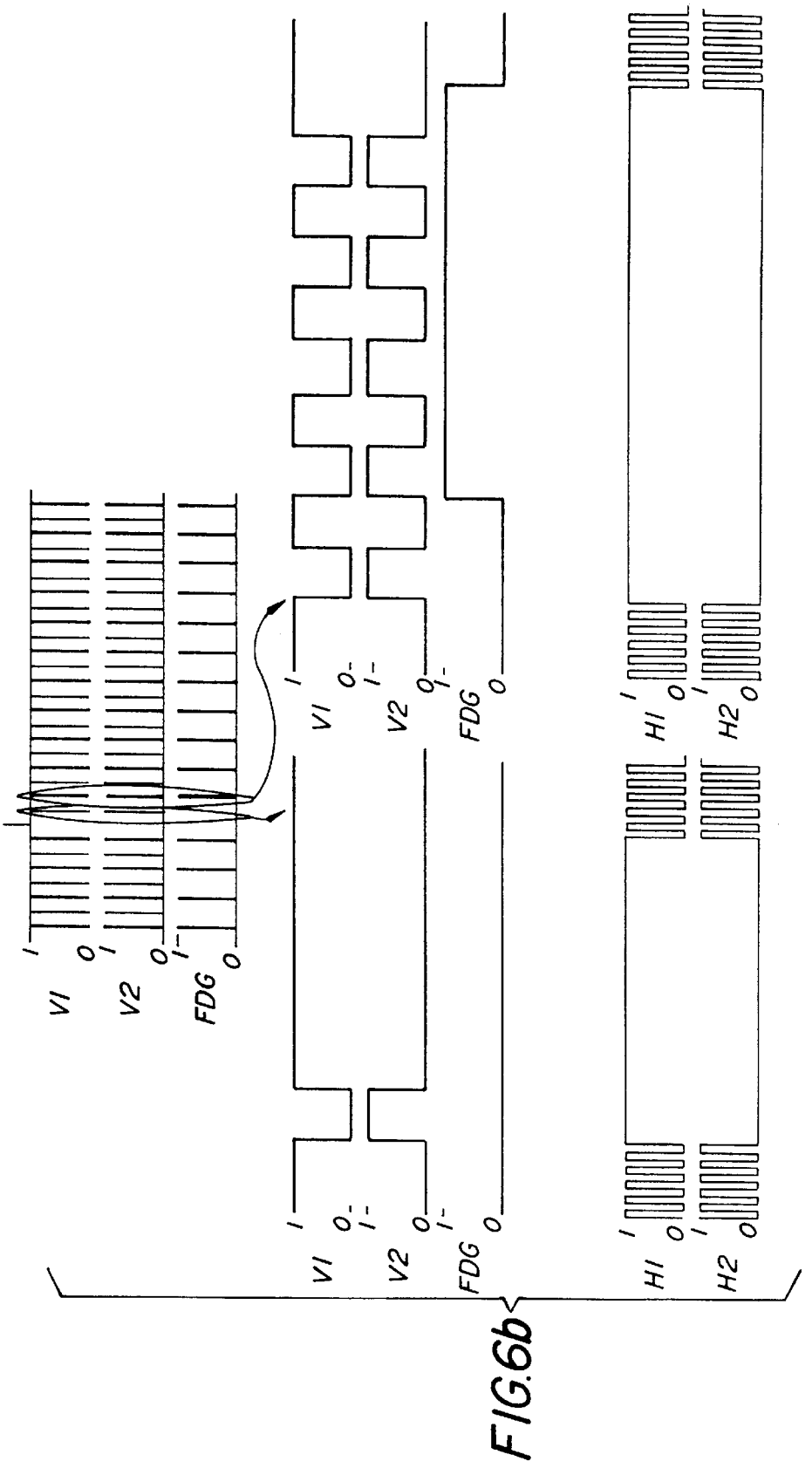


FIG.6b

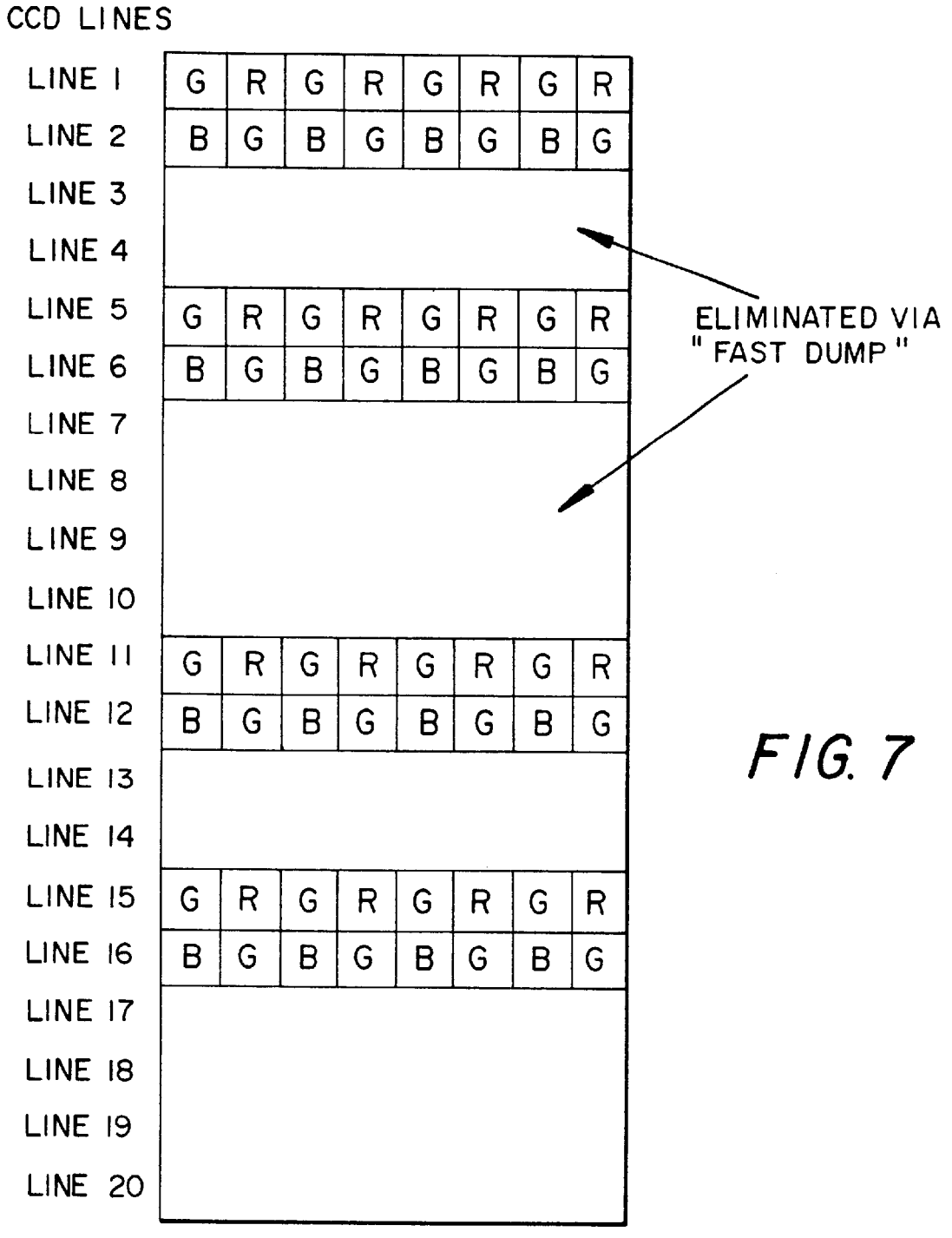

CCD LINES
LINE 1
LINE 2
LINE 3
LINE 4
LINE 5
LINE 6
LINE 7
LINE 8
LINE 9
LINE 10
LINE 11
LINE 12
LINE 13
LINE 14
LINE 15
LINE 16
LINE 17
LINE 18
LINE 19
LINE 20
G R G R G R G R
B G B G B G B G
ELIMINATED VIA
" FAST DUMP "

FIG. 7

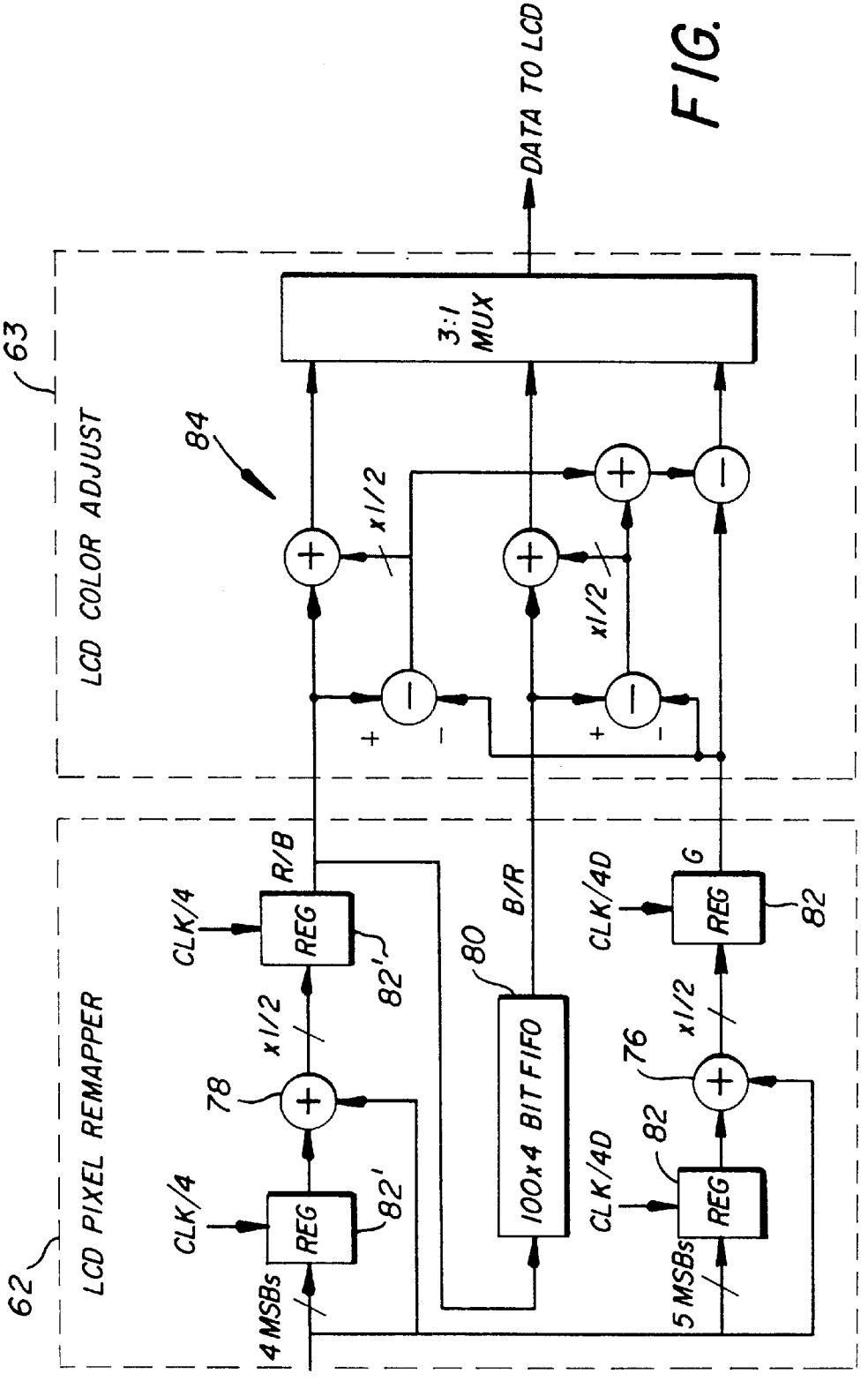

DATA TO LCD
63
LCD COLOR ADJUST
3:1 MUX
84
x1/2
x1/2
+
-
62
LCD PIXEL REMAPPER
CLK/4
R/B
REG
82'
78
x1/2
CLK/4
REG
82'
4 MSBs
80
B/R
100x4 BIT FIFO
CLK/4D
G
REG
82
76
x1/2
CLK/4D
82
REG
5 MSBs

FIG. 8

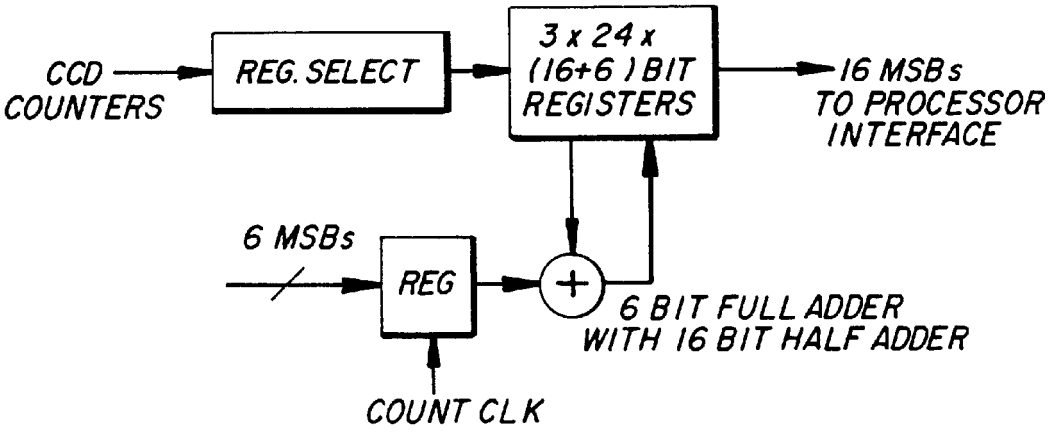

CCD COUNTERS
REG. SELECT
3 x 24 x (16+6) BIT REGISTERS
16 MSBs TO PROCESSOR INTERFACE
6 MSBs
REG
6 BIT FULL ADDER WITH 16 BIT HALF ADDER
COUNT CLK

FIG. 9A

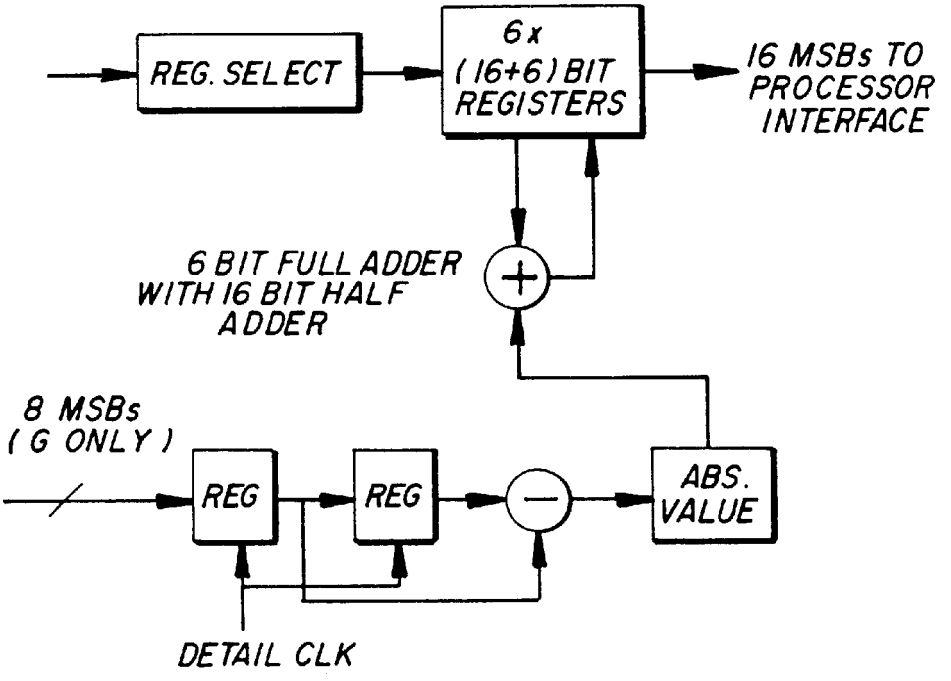

REG. SELECT
6 x (16+6) BIT REGISTERS
16 MSBs TO PROCESSOR INTERFACE
6 BIT FULL ADDER WITH 16 BIT HALF ADDER
8 MSBs (G ONLY)
REG
REG
ABS. VALUE
DETAIL CLK

FIG. 9B

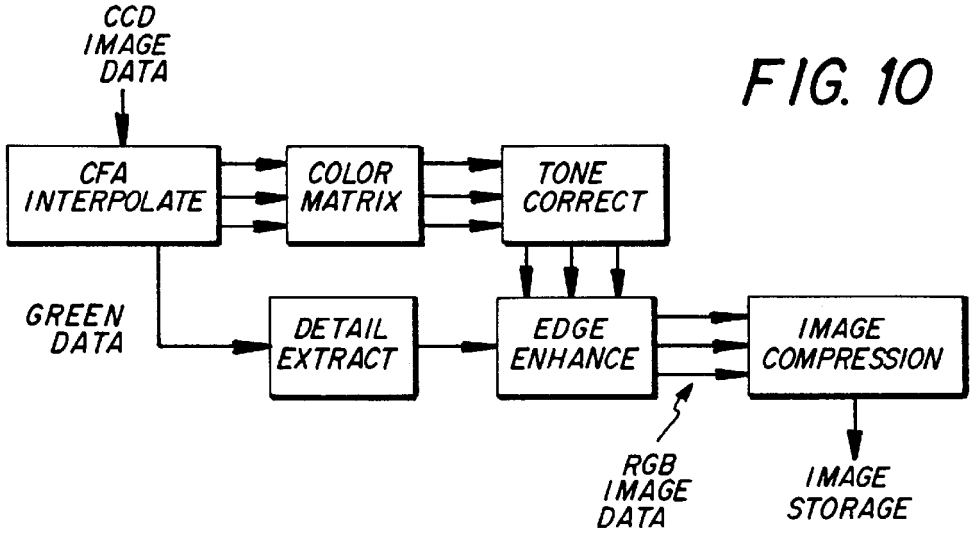


FIG. 10

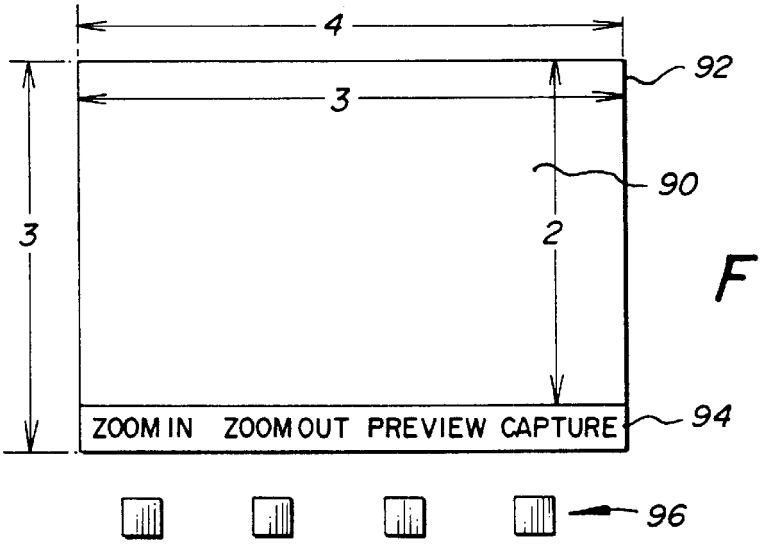


FIG. 11

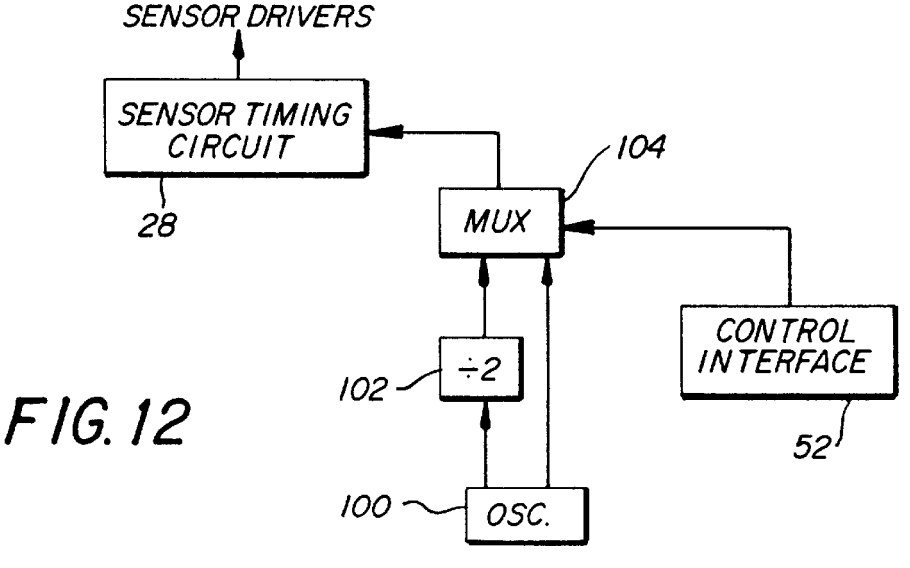


FIG. 12

ELECTRONIC CAMERA FOR INITIATING CAPTURE OF STILL IMAGES WHILE PREVIEWING MOTION IMAGES

This application is a division of 08/367,399 filed Dec. 30, 1994.

FIELD OF THE INVENTION

The invention pertains to an electronic still camera for composing and capturing still images, and, more particularly, to an electronic camera having a "motion" mode for previewing a scene and a "still" mode for capturing a particular image in the scene.

BACKGROUND OF THE INVENTION

Consumer camcorders which include the capability of recording analog motion and/or still images on 8mm or VHS videotape have been developed by a number of companies. Motion images are recorded in the same manner as in any standard camcorder. These cameras include a single chip charge coupled device (CCD) sensor having a color filter array that provides a spatially color-sampled image. To record still images, the user pushes a "still capture" button at the desired instant. The image obtained from the CCD sensor is temporarily stored in a digital memory. The image is then read from the memory and recorded onto the videotape. Some camcorders include color liquid crystal displays (LCD), which are also spatially color-sampled devices. Some are relatively large, for example, ranging from approximately 2.5" to 4" in diagonal. Such a display is used, instead of a normal eyepiece viewfinder, to allow the user to properly frame the subject and view the images as they are being recorded. It is also used to view the recorded images as the videotape is played back.

FIG. **1A** shows a typical color LCD display, in which the liquid crystal material is trapped between an upper glass plate **1** and a lower glass plate **2**. The upper plate **1** has a common transparent electrode **3** and an array **4** of color filters surrounded by a black mask **5**. The lower plate **2** includes an array **6** of transparent pixel electrodes juxtaposed underneath the array **4** of color filters. Individual pixel electrodes are activated via thin film transistors (TFT) **7** that are controlled from a video signal on the source lines **8** and a scanning signal on the gate line **9**. The LCD display includes the usual polarizer layers (not shown) on the glass plates **1** and **2**, such that activation of selected transparent pixel electrodes allows light to pass through the corresponding color filters and reflect to the viewer, thereby creating a color image. A typical LCD display such as the Epson LB 2F-BC00, manufactured by Seiko-Epson Company, Japan, has about 240 lines of pixels and about 300 pixels per line, with an image aspect ratio of 4:3. Such an aspect ratio allows the entire area of the image obtained from the 4:3 aspect ratio NTSC format CCD sensor to be displayed on the LCD screen, so that the LCD screen composition will be the same as the image that is recorded by the camcorder NTSC format recorder, for later display on an NTSC format television display. Note that because the LCD has only 240 lines of pixels, the interlaced NTSC signal is displayed using a "repeat field" technique, where both the odd and even fields from the NTSC format sensor are displayed using the same lines of pixels on the LCD. This LCD, like most commercially available LCDS, has "rectangular" pixels, rather than square pixels, where the distance between pixels in the horizontal direction is for example ⅔ the distance in the vertical direction. The LCD pixels are overlaid with a diagonal RGB stripe pattern as shown in FIG. **1B**.

In camcorders, the processing for both the still images and the motion images is identical. Such processing is normally implemented by hardwired analog integrated circuits, although camcorders which use digital image processing integrated circuits have been produced. Such camcorders convert the signal from the CCD sensor into an NTSC composite or component format signal, which is provided to a video recording subsystem or a video output jack. The color LCD display includes circuitry to decode the NTSC composite or component signal back into spatially subsampled RGB signals to drive the individual RGB pixels on the LCD sensor.

In a system oriented toward still photography, and in particular a digital still system, it would be desirable to avoid the necessity of generating an NTSC format signal in order to reduce the complexity of the required circuitry. In a totally digital system, that is, both the recording and display channels are digital, it is further desirable to minimize incompatibility between the channels. The problem is to achieve these objective in an architecture that minimizes cost and complexity and maximizes user handling.

SUMMARY OF THE INVENTION

This problem is solved according to the invention by a number of features. In one aspect, the electronic camera is operable in a still image mode according to a relatively more complex digital image processing technique to produce high quality still images, and in a motion preview mode according to a relatively more simple digital image processing technique to produce a preview image of acceptable quality prior to initiation of the still image mode. Such an architecture is particularly adapted to mapping an array of color image pixels from a sensor into an array of color display pixels on an LCD display comprising discrete LCD display pixels fewer in number than image sensor pixels. In that case, a relatively simple digital processing technique combines samecolored image pixel signals into a fewer number of intermediate pixels that correspond to the arrangement of the color display pixels.

The advantage of the invention is that the two modes can be tailored for a relatively low quality "motion" mode and a much higher quality "still" mode. The motion mode images from the CCD sensor are processed by a hardwired digital signal processing circuit that generates low resolution, spatially subsampled digital image data which can directly drive the relatively low resolution LCD display. This reduces the complexity and clock frequency of the required circuitry, compared to generating an NTSC format signal, as is normally done in the prior art. The still mode image from the CCD sensor is processed by a general purpose processor (CPU) which executes an image processing software program in order to produce a high quality digital still image.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in relation to the drawings, whereon

FIGS. **1A** and **1B** show the structure and color filter pattern of a known color liquid crystal display (LCD);

FIG. **2** is a block diagram of an electronic camera incorporating dual modes for composing and capturing a still image according to the invention;

FIGS. **3A** and **3B** are diagrams of progressive scan image sensors useful with the camera of FIG. **2**;

FIG. **4** is a diagram of the Bayer color filter geometry for the sensor used with the camera of FIG. **1**;

FIG. **5** shows the line timing for the still mode of operation;

FIGS. **6**A and **6**B show the line timing for the preview mode of operation;

FIG. **7** shows the special line skipping pattern used in the preview mode;

FIG. **8** shows further detail of the preview mode processing circuit shown in FIG. **2**;

FIGS. **9**A and **9**B show further detail of the image statistics processor shown in FIG. **2**;

FIG. **10** shows one example of still mode image processing;

FIG. **11** shows the effect of pixel mapping from a sensor to an LCD display, each having different aspect ratios; and

FIG. **12** shows an enhancement to the block diagram of FIG. **2** in which a different sensor clock frequency is used in each of the dual modes.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A block diagram of a camera incorporating dual modes of processing according to the invention is shown in FIG. **2**. The camera includes an electronic color display, for example, a color liquid crystal (LCD) display **10** of the type shown in FIG. **1**A, and a user control section **12** having a number of user control buttons, including zoom buttons **14**, a preview button **15** and a capture button **16**. To take a still picture, the user turns on the camera (using a power switch (not shown), which may be automatically enabled when the user depresses the zoom buttons **14** or the preview button **15**, or partially depresses the capture button **16**). The user composes the picture by depressing the "zoom in" or "zoom out" buttons **14**, and by adjusting the position of the camera, while observing the display image. When the user is satisfied with the composition on the color LCD display **10**, the user depresses the capture button **16**. The camera then captures a single still image, firing a flash **18** if necessary when the ambient illumination level is low. The still image is focused upon an image sensor **20** by a motor driven zoom lens **22**. The intensity of the image light upon the sensor **20** is regulated by a motor-driven, variable, mechanical aperture **24**, while exposure time is regulated electronically by appropriate clocking of the sensor **20**. The still image from the image sensor **20** is processed and digitally stored on a removable memory card **26**.

Control of the sensor is provided by a timing and control section **27**, which is an application specific integrated circuit (ASIC) with processing and timing functions, for both capture and preview operating modes. For instance, the timing and control section **27** includes a sensor timing circuit **28** for controlling the image sensor functions. The sensor timing circuit **28** provides the signals to enable sensor drivers **30**, which provide horizontal clocks (H1, H2), vertical clocks (V1, V2), as well as a signal FDG for activating a drain structure on the sensor **20**. The output of the image sensor **20** is amplified and processed in an analog gain and sampling (correlated double sampling (CDS)) circuit **32**, and converted to digital form in A/D converter stage **34**. The A/D output signal is provided to a processor section **35**, which includes a digital processor **36** for temporarily storing the still images in a DRAM memory **38**. The digital processor **36** then performs image processing on the still images, and finally stores the processed images on the removable memory card **26** via a memory card interface circuit **40**, which may use the PCMCIA 2.0 standard interface. An EPROM memory **42** is used to store the firmware which operates the processor **36**. The components of the processor **35** are interconnected through a data bus **43**, which also connects to the timing and control section **27** and to the card interface **40**.

The motor-driven zoom lens **22** includes a zoom motor **44**, a focus motor **46**, and an aperture motor **48** (all controlled by lens motor drivers **50**). The timing and control section **27** further includes a control interface **52** connected to the lens motor drivers **50** and to a flash control circuit **53** via a photosystem interface block **54**, which controls the operation of the zoom lens **22** and the flash **18**. The lens zoom position is controlled by the photosystem interface block **54** based on position input from the zoom control buttons **14** through a user status and control section **55**. The focusing, exposure control, and white balance is done automatically, as is typically the case in consumer camcorders. This is done by computing "image statistics" in an image statistics processor **60** in the real-time ASIC (timing and control section **27**) as preview images are continuously read out of the image sensor **20**. The computed values are then used by a program implemented in the digital processor **36**, which decides how to adjust the focus motor, aperture, analog gain control, and analog white balance controls via the control interface **52** and the photosystems interface **54** on the ASIC timing and control section **27**. Although the digital processor **36** and the control interface **52** are shown as being within two separate sections, in some implementations the same component could be used to perform both of these functions (as well as other of the recited functions). Sensor image data is passed to the processor section **35** through a high speed interface **56** in the timing and control section **27**. The sensor image data is also directed to the color LCD display **10** through a preview mode processing circuit **58**.

The timing and control section (ASIC) **27** is operable in two modes, a relatively low quality "motion" mode and a much higher quality "still" mode. In the motion mode, images from the sensor **20** are processed by the preview mode processing circuit **58**; in the still mode, images from the sensor **20** are processed in the processor **35**. The processor **35** is a software driven digital processing system that is slower than the ASIC **27**. The preview mode processing circuit **58** is a hardwired digital signal processing circuit (part of the ASIC **27**) that generates low resolution, spatially subsampled digital image data which can directly drive the relatively low resolution color LCD display **10**. This reduces the complexity and clock frequency of the required circuitry, compared to generating an NTSC format signal, as is normally done in the prior art. The preview mode processing circuit includes a pixel remapper **62** for mapping the greater number of image pixels from the sensor **20** into the lesser number of display pixels (i.e., corresponding to the array **6** of transparent pixel electrodes in FIG. **1**) in the color LCD display **10**. The color saturation of the remapped pixels is then adjusted in a color adjustment circuit **63** and its output is applied to a multiplexer **64**. The multiplexer **64** selects image data either from the preview mode processing circuit **58**, producing a preview image, or from the high speed interface **56**, which allows for suitably preprocessed viewing of stored images.

In this camera, the image processing used to create the preview mode is done in the timing and control ASIC **27**, since the processing must be done rapidly. About **60** images per second are processed in preview mode. However, since the image quality of the displayed image is limited by the resolution and color gamut of the LCD screen of the LCD color display **10**, there is no need for elaborate image

processing. Therefore, simple "preview mode" image processing is performed in a fixed digital circuit embedded in the preview mode processing circuit **58** (which is part of the ASIC). The quality requirements for the still mode are much greater, since these images will be downloaded to a computer, and may be displayed on a high resolution CRT display, or printed on a high quality thermal printer. Therefore, the digital image processing must be more elaborate. By using the digital processor **36** to implement software procedures stored in the firmware memory **42**, complex procedures can be implemented. These procedures can take several seconds to complete, since real-time operation is not required. Use of firmware-stored software allows the still mode image processing to be upgraded without requiring a new ASIC design. In effect, what happens is that a relatively less complex digital image processing technique is used in the motion preview mode, but at a higher data rate, and a relatively more complex digital image processing technique is used in the still mode, but at a slower data rate.

Since the update rate, that is, the number of images that need to be supplied per unit time, is different for the still mode than for the motion mode, it is beneficial to use different clock frequencies for the different modes of operation. For example, as shown in FIG. **12**, a system oscillator **100** produces a 12 mHz clock frequency for use in the motion mode to obtain more updates/second (e.g., 60 images per second), while a divider **102** divides by two to provide a 6 mHz clock frequency for the still mode. The lower frequency allows more time to accurately position the clamp and sample pulses so as to avoid CCD output signal transitions. This increases noise immunity in the still mode. A multiplexer **104** is enabled by the control interface **52** to determine which clock frequency is applied to the sensor timing circuit **28**. Though not specifically shown, the changed timing is also communicated to the A/D stage **34** and other timing and control circuits.

The sensor **20** is a progressive scan interline image sensor having a noninterlaced architecture, as shown in more detail in FIG. **3**A. The sensor comprises a two-dimensional array of photosites **66**, e.g. photodiodes, arranged in rows and columns of image pixels, a plurality of vertical registers **68** adjacent photosite columns for transferring rows of image pixel charge from the photosites **66** to a horizontal register **70** for readout responsive to clock signals from the sensor drivers **30**, and a charge drain (specifically, a fast dump structure **72**) interposed between the output of the vertical registers **68** and the horizontal register **70** for eliminating complete rows of image pixels at a time from the image sensor **20**. A preferred image sensor is the Kodak model CCD KAI-0400CM image sensor, which has approximately 512 active lines with approximately 768 active pixels per line and an image aspect ratio of 3:2. This sensor is described in a Performance Specification document available from Eastman Kodak Company, Rochester, N.Y. Each pixel is 9 microns "square", since both the vertical and horizontal distances between the centers of adjacent pixels are 9 microns. The 3:2 image aspect ratio of the CCD sensor, although wider than the 4:3 aspect ratio of the display, is considered to be a preferred aspect ratio for still photography, in that the standard 35 mm film format, and standard 4R (4"×6") prints also have a 3:2 image aspect ratio. The sensor uses a color filter array pattern known as the "Bayer checkerboard" pattern, described in U.S. Pat. No. 3,971,065, which is shown in FIG. **4**. Such a color filter array is characterized by a mosaic pattern in which the filter colors alternate in both line and column directions. In the normal operating mode, all of the image pixels on the sensor are transferred as color image pixels to the horizontal register **70**, which delivers a stream of color pixel signals to the analog gain and CDS circuit **32** (see FIG. **2**). The color pixel signals are subsequently converted to digital pixel signals in the A/D converter **34**.

The sensor **20** uses a progressive scan readout method, which allows the entire image to be read out in a single scan. The accumulated or integrated charge for the photodiodes comprising the pixels **66** is transported from the photosites to light protected vertical (parallel) registers **68** by applying a large positive voltage to the phase-one vertical clock (**V1**). This reads out every row, or line, into the vertical registers **68**. The image pixel charge is then transported from the vertical registers **68** to the horizontal register **70** by two-phase clocking of the vertical clocks (**V1**, **V2**). Between the vertical and horizontal registers is the fast dump structure **72**, which is further described in the Performance Specification document for the KAI-0400CM sensor. By setting a suitable positive potential on a fast dump gate line FDG, charge from the row of pixel values currently adjacent to the fast dump structure **72** is transferred from the CCD directly into the sensor substrate **74** rather than to the horizontal register **70**. This dump, or line clear, is accomplished during the vertical-to-horizontal transfer time. When properly controlled by the sensor timing circuit **28**, the fast dump structure **72** allows lines of charge to be eliminated.

The timing and control section **27** operates the electronic camera shown in FIG. **2** in the two aforementioned modes, including a first "still" mode wherein all rows of image pixel charge corresponding to each line are progressively read out through the horizontal register **70** during a single scan, and a second "motion" mode wherein some of the rows of image pixel charge corresponding to some lines are eliminated through the fast dump structure **72** prior to readout. As applied to the embodiment of FIG. **2**, the first mode corresponds to a high quality still imaging mode while the second mode corresponds to a special "line skipping" mode for driving the color LCD display **10**. In the second mode, the timing and control section **27** controls the fast dump structure **72** to eliminate two or more consecutive lines of image charge from the image sensor **20** for every one or more lines of image charge that are transferred to the horizontal register **70** for readout, thereby generating a pattern of lines (shown in FIG. **7**) suitable for driving the LCD display in a "repeat field" mode. An appropriate video signal which displays the entire 3:2 aspect ratio sensor image on the 4:3 aspect ratio LCD, without introducing geometric distortion, is generated by alternately eliminating two or four consecutive lines of image charge for every pair of lines of image charge that are transferred to the horizontal register **70**.

The sensor timing circuit **28** is controlled by the control interface **52** to provide the clock signals **V1**, **V2**, **H1**, **H2**, and the gate signal FDG according to the two modes of operation. The timing signals for the first mode are shown in FIG. **5**; those for the second mode are shown in FIGS. **6***a* and **6***b*. The two-phase cycling of signals **V1** and **V2** control the transfer of lines of image pixel charge from the vertical registers **68** to the horizontal register **70**. The two-phase cycling of signals **H1** and **H2** control the transfer of a stream of color pixel signals from the horizontal register **70** to subsequent circuits in the camera. The level of the signal FDG determines whether the image charge is dumped to the substrate **74** or transferred to the horizontal register **70**. When the sensor **20** is clocked using the first timing mode shown in FIG. **5** for all lines of the sensor, all lines of the sensor are clocked out, one after the other, through the horizontal register **70**, processed in subsequent camera

circuitry, and stored in the removable memory **26**. This timing mode provides a high quality progressive scan still image, but may take 1/30 second or longer to read out the still image. Such timing, however, is acceptable for still mode usage, and, as mentioned before, does not require unusually high speed components and, indeed, may benefit from a lower speed lock.

To provide an image to the color LCD display **10**, a lower resolution image is suitable, but the update rate must be sufficient to provide good motion rendition and eliminate display flicker. Moreover, the sensor **20** includes the aforementioned array of color filters arranged in a particular mosaic color pattern (e.g., the checkerboard Bayer pattern of FIG. **3**), and the lines of image charge that are transferred to the horizontal register **70** should preserve that particular color pattern in the pattern of lines that are generated for the line-skipping readout. To provide this kind of image, the sensor is read out in the second mode as shown in FIG. **7**, using the timing shown in FIGS. **6**A and **6**B. As shown in FIG. **6**A, the first two lines (**1** and **2**) are read out as in the normal mode. These provide a green-red and a blue-green line. The next two lines (**3** and **4**) are eliminated by turning on the fast dump structure **72** during the time that these lines are transferred past the fast dump structure **72**. Next, as shown in FIG. **6**B, lines **5** and **6** are read out normally, and then lines **7**, **8**, **9**, and **10** are eliminated. Next, the FIG. **6**A timing is used to read out lines **11** and **12**, while eliminating lines **13** and **14**, and then the FIG. **6**B timing is used to read out lines **15** and **16**, while eliminating lines **17–20**. This process proceeds for the entire image readout period, during which **102** pairs of lines are read out, and 154 pairs of lines are eliminated.

This special "line skipping" readout mode, as shown in FIG. **7**, allows the sensor 3:2 aspect ratio image to be fully displayed on a 4:3 aspect ratio LCD without "geometric distortion", that is, without stretching the image vertically, and without cropping off the horizontal edges of the image from the image sensor. This allows the LCD to properly show the entire 3:2 aspect ratio image captured by the sensor, so that an image can be properly composed.

As the 512 lines of the CCD imager are read out using the special "line skipping" mode, they are displayed using only 204 out of the approximately 240 LCD lines of pixels. The remaining approximately 36 lines can either be masked behind a bezel, so that they are not visible, or preferably may be used to display status information, such as the time-of-day, image number, or a "push-button menu" for the user buttons. FIG. **11** shows a useful application of such conversions. A sensor having a 3:2 aspect ratio is shown mapped into an image area **90** of an LCD display screen **92** having a 4:3 aspect ratio. A proportional remapping leaves a status area **94** available for other purposes, specifically to show text indicating the function of a set of reconfigurable control buttons **96** in the control section **12**. The function of the buttons is specified by the user status and control section **55** (FIG. **2**). This status information graphics data can be supplied by the digital processor to the LCD **10** via high speed interface **56**, when the MUX **64** is controlled so as to use the digital data from interface **56**, rather than from circuit **58**, for supplying data to the final approximately **32** lines of the display **10**.

The "line skipping" readout causes some minor vertical sampling artifacts, but these are not noticeable in the small LCD displays. The pixels output for the sensor **20** in line skipping mode continue to have the Bayer-type color filter repeating pattern, so that they can be processed using processing techniques designed for the Bayer pattern.

The processing complexity of the camera of FIG. **2** is considerably simplified by directly mapping the RGB sensor pixels **66** to the RGB pixels of the display **10**. The easiest way to do this for the image sensor **20** (512 lines×768 pixels and 3:2 aspect ratio) is to have an LCD display with 512×768 pixels and the same aspect ratio and color filter pattern. However, this would be a custom, costly LCD. Instead, LCDs have fewer display pixels than image pixels on the image sensor, normally have a 4:3 image aspect ratio, and use the diagonally striped RGB pattern shown in FIG. **1**B. In this discussion, an LCD pixel array of about 240 lines×312 pixels per line is assumed.

Therefore, the sensor pixels are processed in a "pixel mapping circuit", such as the LCD pixel remapper **62**. A block diagram of this circuit is shown in FIG. **8**. Note that there are 768/2=384 green or red/blue pixels per line on the sensor (see FIG. **4**). There are about 300/3=100 green, red, or blue pixels per line on the LCD (see FIG. **1**B). Thus, there are approximately ¼ as many LCD pixels per line (per color) as there are sensor pixels per line. Therefore, the basic plan is to combine same-colored image pixels into a fewer number of intermediate, combination pixel signals that are then mapped into the color display pixels. For instance, a simple "pixel mapping" circuit maps four green sensor pixel signals into one green LCD pixel for one line by summing two green sensor values, spaced apart by 4 CCD pixel positions, in the green pixel summer **76** and dividing by two via bit-shift wiring. The necessary delay is provided by the registers **82** clocked at one fourth the pixel rate, further delayed by one pixel clock. It also maps four red sensor pixels into one LCD pixel in the same manner (using the red/blue summer **78**), and also stores this value in a 100 pixel FIFO **80**. The FIFO **80** compensates for the fact that the sensor has line sequential red and blue pixels, by supplying blue pixels on the red sensor lines, and red pixels on the blue sensor lines. Four pixel delays are provided by the registers **82**' clocked at one fourth pixel rate (CLK/4). The mapping process is basically, therefore, a process which, in its simplest form, involves averaging of signals to produce a smaller number of output color pixels than input color pixels. (The CFA interpolation algorithm discussed in reference to FIG. **10**, on the other hand, produces a larger number of "output" color pixels than input color pixels.) Alternate groups of 2 or 4 lines of sensor values are discarded during preview mode by using the fast dump gate shown in FIG. **3**A, as described in connection with the "line skipping" mode. This allows the sensor readout time to be decreased by more than ½ during the preview mode.

Another feature of the design is that by removing the NTSC rate driving circuitry from the color LCD display **10**, the active matrix LCD can be updated at a slower frequency than is normally used. This reduces the cost and power consumption of the LCD driver circuits (not shown). For example, the LCD can be updated at 30 Hz (provided the LCD active matrix display is designed so as not to exhibit noticeable flicker at this update rate), instead of 60 Hz.

Once the LCD pixel values are calculated, the LCD color adjust circuit **63** increases the color saturation of the image by forming R-G and B-G color difference signals, and adding or subtracting a fraction of these signals in an array **84** of adders and subtractors from the original RGB signals in order to increase the color saturation of the displayed image. This circuit performs a similar function as a 3×3 color matrix, but uses less hardware and provides less color accuracy. The color accuracy is not critical for the LCD display, however, due to the limited color reproduction quality of such displays. The color reproduction of the still

image is much more important, and is done with a more complicated and precise color correction method with the stored firmware in EPROM **42**.

FIGS. **9**A and **9**B show the processing in the image statistics processor **60**, which computes real-time values for both still and motion image capture, all during the preview mode. These values include 24 R, G, and B averages used to set white balance and exposure, and 6 average high frequency "detail" values used to set focus. The 24 RGB averages for white balance are calculated for a group of 4×6 rectangular image regions, for each of R, G, and B; a block diagram of the calculation in one color is shown in FIG. **9**A. The 6 average "detail" values for focusing are calculated for green pixels only by accumulating the absolute value of the differences between nearby green values; a block diagram of this calculation is shown in FIG. **9**B. These values are computed for each preview image and downloaded to the processor **36**. The processor **36** implements a firmware stored procedure which determines the optimum exposure parameters (exposure time, f/stop, and analog gain), white balance settings, and lens focus setting. For the still mode, the processor **36** also decides, based on the last preview images, whether to fire the flash, and determines the optimum exposure parameters, white balance settings, and lens focus setting for the still mode.

Once the still image is captured, the digital processor **36** implements the stored firmware procedures to process and store the still image. FIG. **10** shows a diagram of one possible still image processing method. The CFA interpolation diagram may include the green interpolation method described in U.S. patent application Ser. No. 085,520, filed Jun. 30, 1993, in the name of the same assignee as the present application, and the chrominance interpolation method described in U.S. Pat. No. 4,642,678, both of which are incorporated herein by reference. The color matrix, tone correction, and edge enhancement steps may be similar to those described in U.S. Pat. No. 5,189,511, also incorporated herein by reference. The image compression method may be the JPEG standard compression technique.

The foregoing description envisions taking a single still picture following the motion preview mode. The camera can also optionally capture "bursts" of high quality still images into the DRAM memory during the "still" mode, which are then processed as shown in FIG. **10**. Owing to the flash recharge time and other limitations of the "burst" mode, the "burst" mode could utilize different exposure parameters (exposure time, aperture, analog gain, flash, and digital processing) than either the motion or the single still mode.

The invention has been described with reference to a preferred embodiment. However, it will be appreciated that variations and modifications can be effected by a person of ordinary skill in the art without departing from the scope of the invention. For instance, FIG. **3**B shows a progressive scan sensor with two readout registers **86** and **88** (which corresponds to the Performance Specification document for the Kodak KAI-031CM image sensor; the preferred embodiment of FIG. **3**A simply uses but one register). The purpose is to eliminate the FIFO line delay **80** in the LCD pixel remapper **62**. The pairs of lines read out by the registers include both a green/red line and a blue/green line. Therefore, by adding an analog multiplexer between the outputs of the two channels and the analog gain and CDS block **32**, which is switched at ½ the sensor horizontal clock rate, it is possible to obtain a GRBG sequence of sensor data values at the output of the A/D stage **34**. The LCD pixel remapper **62** can then be designed to map from the CCD sensor color pixel pattern to the required RGBRGB LCD pixel pattern, without using a line delay. Since two CCD lines are read out in parallel, for each LCD line, fewer lines are eliminated via the fast dump gate than for the single-register sensor shown in FIG. **3**A.

In particular, if the dual register CCD in FIG. **3**B had 512×768 square pixels with a 3:2 aspect ratio, and the LCD had approximately 240 display lines and a 4:3 aspect ratio, the CCD readout would involve fast dumping one pair of lines for every four pairs of lines read out from the CCD sensor. The pixel readout procedure for the horizontal registers can then be varied depending on the mode of operation: both registers are used for the motion imaging mode and one register is used for the still imaging mode. Furthermore, although the Bayer pattern was described, other mosaic-type filter patterns could be used to advantage, for example, complementary patterns involving cyan, magenta, yellow and green filters. The processing for the LCD pixel remapper **62** and the LCD color adjust circuit **63** would be accordingly modified to account for the different color arrangement.

PARTS LIST

1 upper plate
2 lower plate
3 common transparent electrode
4 array of color filters
5 black mask
6 array of transparent pixel electrodes
7 thin film transistors
8 source lines
9 gate line
10 color LCD display
12 control section
14 zoom buttons
15 preview button
16 capture button
18 flash
20 progressive scan interline
22 zoom lens
24 mechanical aperture
26 memory card
27 timing and control section
28 sensor timing circuit
30 sensor drivers
32 analog gain and CDS
34 A/D converter
36 digital image processor
38 DRAM memory
40 card interface
42 EPROM memory
44 zoom motor
46 focus motor
48 variable aperture
50 lens motor drivers
52 control interface
53 flash control circuit
54 photosystems interface
55 user status and control section
56 high speed interface
58 preview mode processing circuit
60 image statistics processor
62 pixel remapper
63 color adjustment circuit
64 multiplexer
66 pixel
68 vertical readout register
70 horizontal register

72 fast dump structure
74 sensor substrate
76 green pixel summer
78 red/blue summer
80 fifo
82 two pixel delay registers
84 array
86 first readout register
88 second readout register
90 image area
92 LCD display screen
94 status area
96 reconfigurable buttons
100 oscillator
102 divider
104 multiplexer

What is claimed is:

1. An electronic still camera for initiating capture of a still image while previewing motion images on a display, comprising:

(a) an image sensor having a two-dimensional array of photosites covered by a mosaic pattern of color filters including at least three different colors for capturing images of a scene, each captured image having a first number of color pixel values provided in a first color pattern;

(b) motion processing means for generating from the captured images, a second number of color pixel values provided in a second color pattern having at least three different colors and representative of a series of motion images to be previewed, the second number of color pixel values being less than the first number of color pixel values, and the second color pattern being different from the first color pattern;

(c) a color display for presenting at least some of the motion images of the series of motion images corresponding to the captured images of the scene, the color display having an arrangement of color display pixels including at least three different colors in a pattern different from the first color pattern;

(d) a capture button for initiating capture of a still image while previewing the motion images presented on the color display;

(e) still processing means for generating a third number of color pixel values including at least three different colors representative of a processed captured still image; and

(f) a digital memory for storing the processed captured still image.

2. The electronic still camera of claim 1 further including a multiplexer having first and second inputs and an output, wherein the first input is coupled to the first processing means, the second input is coupled to the second processing means, and the output is coupled to the display so that a captured still image can be viewed on the display.

3. The electronic still camera of claim 1 wherein the first processing means and the second processing means are integrated into a single integrated circuit.

4. The electronic still camera of claim 1 wherein the motion processing means and the still processing means produce the second number of pixels and the third number of pixels, respectively, prior to transferring the image pixels to the display and the digital memory, respectively.

5. The electronic still camera of claim 1 wherein the second number of pixel values representative of the series of motion images are transferred to the display in a digital format.

6. The electronic still camera of claim 1 wherein the second number of pixel values representative of the series of motion images are mapped into a form suitable for display.

7. The electronic still camera of claim 6 wherein after the second number of pixel values representative of the series of motion images are mapped into a form suitable for display, the signals representing the captured images are converted back into an analog form.

8. The electronic still camera of claim 1 further including a firmware memory, a processor, and an application specific integrated circuit, and wherein the first processing means is provided in the application specific integrated circuit, and the second processing means is provided using the processor which implements software procedures stored in the firmware memory.

9. The electronic still camera of claim 1 wherein the image sensor includes a color filter array to produce color image data, the second processing means processes the color image data and performs JPEG image compression on the captured still image, and the JPEG compressed still image is stored in the digital memory.

10. The electronic still camera of claim 9 wherein the digital memory is a removable memory card.

11. The electronic still camera of claim 1 wherein the first color pattern includes substantially one-half green color filters.

12. The electronic still camera of claim 11 wherein the color display pixels are arranged in a pattern having substantially one-third green color filters.

13. The electronic still camera of claim 1 wherein the first color pattern is a Bayer checkerboard pattern.

14. The electronic still camera of claim 1 wherein the distance between adjacent image sensor photosites in the horizontal direction are substantially equal to the distance between the adjacent image sensor photosites in the vertical direction, and wherein the distance between the adjacent color display pixels in the horizontal direction is different than the distance between the adjacent color display pixels in the vertical direction.

15. An electronic still camera for initiating capture of a still image while previewing motion images on a display, comprising:

(a) an image sensor having a two-dimensional array of photosites covered by a mosaic pattern of color filters including at least three different colors for capturing images of a scene, each captured image having a first number of color pixel values provided in a first color pattern;

(b) a motion processor for generating from the captured images, a second number of color pixel values provided in a second color pattern having at least three different colors and representative of a series of motion images to be previewed, the second number of color pixel values being less than the first number of color pixel values, and the second color pattern being different from the first color pattern;

(c) a color display for presenting at least some of the motion images of the series of motion images corresponding to the captured images of the scene, the color display having an arrangement of color display pixels including at least three different colors in a pattern different from the first color pattern;

(d) a capture button for initiating capture of a still image while previewing the motion images presented on the color display;

(e) a still processor for generating a third number of color pixel values including at least three different colors representative of a captured still image; and

(f) a digital memory for storing the processed captured still image.

16. The electronic still camera of claim **15** further including a multiplexer having first and second inputs and an output, wherein the first input is coupled to the first processor, the second input is coupled to the second processor, and the output is coupled to the display so that a captured still image can be viewed on the display.

17. The electronic still camera of claim **15** wherein the first processor and the second processor are integrated into a single integrated circuit.

18. The electronic still camera of claim **15** wherein the motion processor and the still processor produce the second number of pixels and the third number of pixels, respectively, prior to transferring the image pixels to the display and the digital memory, respectively.

19. The electronic still camera of claim **15** wherein the second number of pixel values representative of the series of motion images are transferred to the display in a digital format.

20. The electronic still camera of claim **15** wherein the second number of pixel values representative of the series of motion images are mapped into a form suitable for display.

21. The electronic still camera of claim **20** wherein after the second number of pixel values representative of the series of motion images are mapped into a form suitable for display, the signals representing the captured images are converted back into an analog form.

22. The electronic still camera of claim **15** further including a firmware memory, and an application specific integrated circuit, and wherein the first processor is provided in the application specific integrated circuit, and the second processor implements software procedures stored in the firmware memory.

23. The electronic still camera of claim **15** wherein the image sensor includes a color filter array to produce color image data, the second processor processes the color image data and performs JPEG image compression on the captured still image, and the JPEG compressed still image is stored in the digital memory.

24. The electronic still camera of claim **23** wherein the digital memory is a removable memory card.

25. The electronic still camera of claim **15** wherein the first color pattern includes substantially one-half green color filters.

26. The electronic still camera of claim **25** wherein the color display pixels are arranged in a pattern having substantially one-third green color filters.

27. The electronic still camera of claim **15** wherein the first color pattern is a Bayer checkerboard pattern.

28. The electronic still camera of claim **15** wherein the distance between adjacent image sensor photosites in the horizontal direction are substantially equal to the distance between the adjacent image sensor photosites in the vertical direction, and wherein the distance between the adjacent color display pixels in the horizontal direction is different than the distance between the adjacent color display pixels in the vertical direction.

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(45) **Certificate Issued: Sep. 6, 2011**

(54) **ELECTRONIC CAMERA FOR INITIATING CAPTURE OF STILL IMAGES WHILE PREVIEWING MOTION IMAGES**

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H04N 1/21 (2006.01)

(52) **U.S. Cl.** **348/220.1**; 348/333.11; 348/E3.02; 348/E3.022; 348/E5.047; 348/E5.091; 348/E9.01

(58) **Field of Classification Search** ..... None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,971,065	A	7/1976	Bayer
4,456,931	A	6/1984	Toyoda et al.
4,541,010	A	9/1985	Alston
4,691,253	A	9/1987	Silve
4,740,828	A	4/1988	Kinoshita
4,746,980	A	5/1988	Petersen
4,746,988	A	5/1988	Nutting et al.
4,754,333	A	6/1988	Nara
4,764,805	A	8/1988	Rabbani et al.
4,774,562	A	9/1988	Chen et al.
4,802,020	A	1/1989	Miyake et al.
4,819,059	A	4/1989	Pape
4,837,628	A	6/1989	Sasaki
4,876,590	A	10/1989	Parulski
4,881,127	A	11/1989	Isoguchi et al.

(Continued)

FOREIGN PATENT DOCUMENTS

EP	0 129 122	12/1984
EP	0 202 009	11/1986
EP	0 212 784	3/1987

(Continued)

OTHER PUBLICATIONS

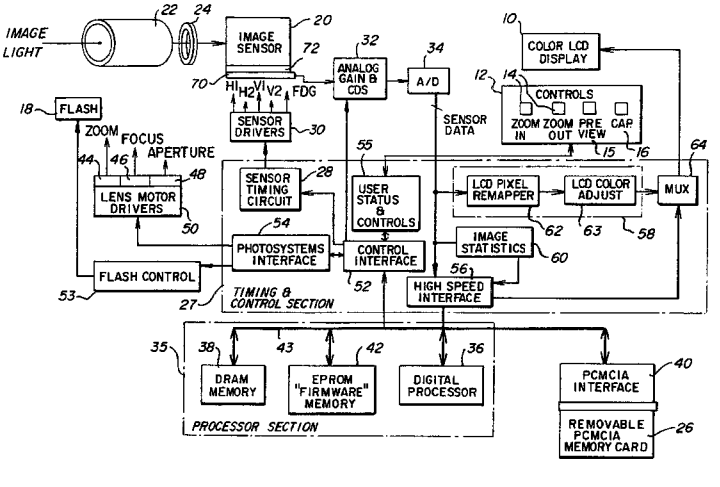
L. J. D'Luna et al., A Digital Video Signal Processor for Color Image Sensors, ISSCC 89, Feb. 16, 1989.

(Continued)

Primary Examiner—Linh M. Nguyen

(57) **ABSTRACT**

An electronic camera uses a relatively more complex digital image processing technique in a still image mode to produce high quality still images, and a relatively more simple image processing technique in a motion preview mode to produce preview images of acceptable quality prior to initiation of the still image mode. The more complex digital technique is done in software in a general purpose processor section **35**, while the more simple digital technique is implemented in a fixed digital circuit in an application specific integrated circuit **27**, which also implements timing and control functions. The motion preview mode uses a shorter image readout period than the still mode and further involves mapping image sensor pixels into a fewer number of color display pixels on a color LCD display **10**. The mapping further converts color pixel signals from a mosaic array into a different color pattern on the color LCD display **10**.



U.S. PATENT DOCUMENTS

4,928,137	A	5/1990	Kinoshita
5,018,017	A	5/1991	Sasaki et al.
5,067,019	A	11/1991	Juday et al.
5,138,454	A	8/1992	Parulski
5,138,459	A	8/1992	Roberts et al.
5,161,025	A	11/1992	Nakao
5,164,831	A	11/1992	Kuchta et al.
5,164,834	A	11/1992	Fukuda et al.
5,177,614	A	1/1993	Kawaoka et al.
5,251,036	A	10/1993	Kawaoka et al.
5,264,939	A	11/1993	Chang
RE34,654	E	7/1994	Yamawaki
5,335,016	A	8/1994	Nakagawa
5,341,153	A	8/1994	Benzschawel et al.
5,379,069	A	1/1995	Tani
5,396,290	A	3/1995	Kannegundla et al.
5,444,482	A	8/1995	Misawa et al.
5,479,206	A	12/1995	Ueno et al.
5,497,193	A	3/1996	Mitsuhashi et al.
5,581,301	A	12/1996	Ninomiya
5,612,732	A	3/1997	Yuyama et al.
5,717,496	A	2/1998	Satoh et al.
6,084,633	A	7/2000	Gouhara et al.
6,487,366	B1	11/2002	Morimoto et al.

FOREIGN PATENT DOCUMENTS

EP	0 323 194	7/1989
EP	0 405 491	1/1991
EP	0 458 369	4/1991
EP	0 533 107	9/1991
EP	0 456 369	11/1991
GB	2 089 169	6/1982
JP	82-78281	5/1982
JP	57-078281	5/1982
JP	60-136481	7/1985
JP	61-253982	11/1986
JP	61-264880	11/1986
JP	62-108678	5/1987
JP	6-3064485	3/1988
JP	63-128879	6/1988
JP	63-286078	11/1988
JP	64-013877	1/1989
JP	01-221985	9/1989
JP	01-221989	9/1989
JP	H1-243686	9/1989
JP	02-007680	1/1990
JP	2-105786	4/1990
JP	H2-214271	8/1990
JP	03-1681	1/1991
JP	03-500119	1/1991
JP	03-143084	6/1991
JP	03-234182	10/1991
JP	3-252282	11/1991
JP	3-284079	12/1991
JP	04-35181	2/1992
JP	H04-35181	2/1992
JP	04-142892	5/1992
JP	04-170176	6/1992
JP	04-213970	8/1992
JP	4-239279	8/1992
JP	4-319893	11/1992
JP	4-324778	11/1992
JP	4-348685	12/1992
JP	5-122574	5/1993
JP	H5-122574	5/1993
JP	05-167908	7/1993
JP	06-110107	4/1994
JP	07-264489	10/1995
JP	07-312714	11/1995
WO	89/12939	12/1989
WO	91/14334	9/1991

OTHER PUBLICATIONS

T. J. Tredwell, Sensors and Signal Processing for Digital Electronic Photography, Optoelectronics—Devices & Technologies, Dec. 1991, pp. 287–300, vol. 6 No. 2.

l. Shenberg et al., An lmage Compression Chip Set for Digital Still Cameras and Peripherals, Electronic lmaging lnternational, Sep. 30, 1991.

G. K. Wallace, Overview of the JPEG (lSO/CCITT) Still lmage Compression Standard, SPlE, 1990, pp. 220–233, vol. 1244.

S. Tsuruta et al., Color Pixel Arrangement Evaluation for LC–TV, 1985 lnternational Display Research Conference.

Exhibit 23 of the Hunt Expert Report—ECAM lmage Card File Format Preliminary Specifications EM ECAM Program, Prepared by Noel Reyner, Jul. 26, 1990; Capture and Transmission Dept lmage Acquisition Products Division; pp. 1–8.

Exhibit 24 of the Hunt Expert Report—ECAM C30/CL550 lnterface, Prepared by David Zimmer, Eastman Kodak Company, Rochester, N.Y., Ver. A; Jul. 23, 1990.

Exhibit 28 of the Hunt Expert Report—Hawkeye ll SCSl lnterface Specification—Draft; J. McGarvey.

Exhibit 29 of the Hunt Expert Report—Hawkeye ll SCSl lnterface Specification; Oct. 26, 1990; J. McGarvey.

Exhibit 66 of the Hunt Expert Report—l. Shenberg, et al., An lmage Compression Chip Set for Digital Still Cameras and Peripherals, Electronic lmaging lnternational, Sep. 30, 1991; pp. 439–447.

Exhibit 95 of the Hunt Expert—Venus Digital Electronic Camera Preliminary Specification [Smith Dep. Ex 5]; Dec. 2, 1993.

Exhibit 96 of the Hunt Expert Report—User's Manual: Kodak Professional Digital Camera System [McGarvey Dep. Ex. 11]; 1991/1992.

Exhibit 108 of the Hunt Expert Report—Apple QuickTake 100 User's Manual [Napoli Dep. Ex. 3].

Exhibit 109 of the Hunt Expert Report—Chameleon Technical Plan v. 0.2; May 12, 1992 [Parulski Dep. Ex. 16].

lmaide, T., et al.; A Multimedia Color Camera Providing Multi–Format Digital lmages (lEEE Transactions on Consumer Electronics—Aug. 1993; vol. 39; No. 3); Jun. 11, 1993; pp. 467–473.

Japanese News Release Article (Casio); 3 Pgs.

Japanese Article—Electronic Engineering; 1993, vol. 35, No. 1; pp. 1–5.

Apple QuickTake 100—User's Guide for Macintosh; 1994; pp. 1–71.

Printout—Ohnıori, S.; EKJRD Program: Computer Camera (KJP–315); MO: Dec. 1992; 1 Pg.

Ochi, S., et al.; Development of the "DS–1P" Memory Card Camera; Fuji Film and Research & Development (No. 35); 1990; pp. 52–57.

lzawa, F., et al.; Digital Still Video Camera Using Semiconductor Memory Card; 1990 lEEE; pp. 1–9.

Japanese Printout—Ricoh (1993); pp. 7–11.

Tredwell, T.J.; Sensors and Signal Processing for Digital Electronic Photography; pp. 287–300; Optoelectronics—Devices and Technologies—Special lssue on lmage Sensing Devices; vol. 6, No. 2; Dec. 1991.

D'Luna L., et al.; A Digital Video & lmage Processor; 1989 lEEE lnternational Solid State Circuits Conference; pp. 158–159 & Con't on p. 323.

M. Sasaki, et al.; Signal Processing Technologies for a Digital Still Camera; Toshiba; 1991, vol. 46, No. 2; pp. 125–128 (w/Certified English Translation).

Wallace, G. K.; Overview of the JPEG (lSO/CCITT) Still lmage Compression Standard—SPlE vol. 1244 lmage Processing Algorithms and Techniques (1990); p. 220–233.

Watanabe, M., et al., A Bit Rate Controlled DCT Compression Algorithm for Digital Still Camera—SPlE vol. 1244 lmage Processing Algorithms and Techniques (1990); pp. 234–239.

Article—lTEJ Technical Report, vol. 13, No. 22, Mar. 31, 1989 (w/Certified English Translation).

Shinbun, D., Digital Still Camera—The First for Commercial Use in a Joint Development, Toshiba and Fuji Film Move Toward December Sales (7th Edition); Oct. 17, 1989 (w/Certified English Translation).

Nippon, K. K., Digital Still Camera on Sale—Toshiba and Fuji Film will Move to a Commercial Use [product] in December, Oct. 17, 1989; (w/Certified English Translation).

Printout—Digital Still Camera System Joint Announcement Q & A; pp. 1–3 (w/Certified English Translation).

Shibun, N. K.; lC Camera in Test Production—Toshiba and Fuji Photo Film in Collaboration; Mar. 24, 1989 (w/Certified English Translation).

Printout—Corporate–External Announcement Permission Request Form (w/Certified English Translation; Feb. 6, 1990.

Printout—Fuji Film—Fujix Memory Card Camera; 2 Pgs.

Printout—Fujix—Digital Still Camera System—Memory Card Camera DS–X (w/Certified English Translation).

Patent Specification for Application No. 204,626; Jan. 18, 1923.

Patent Specification for Application No. 289,944; Feb. 8, 1927.

Fujimori, H., et al.; Digital Card Camera—lTEJ Technincal Report vol. 14, No. 5, pp. 7–11; Jan. 18, 1990 (w/Certified English Translation).

Printout—lC Card Camera System—Toshiba & Fuji Photo Film (Mar. 30, 1989 Dempa Daily Newspaper Technical Report).

Ohnishi, K., et al.; Electronic Still–Picture Camera Using Magnetic Bubble Memory—1982 lEEE; pp. 321–324.

Parulski, K.; Color Filters and Processing Alternatives for One–Chip Cameras—lEEE Transactions on Electron Devices, vol. ED–32, No. 8, Aug. 1985; pp. 1381–1389.

D'Luna, L., et al.; A Systems Approach to Custom VLSl for a Digital Color lmaging System—lEEE Journal of Solid–State Circuits, vol. 26, No. 5, May 1991; pp. 727–737.

Nakagawa, M., et al.; DCT–Based Still lmage Compression lCS with Bit–Rate Control—1992 lEEE; pp. 711–717.

Kihara, N., et al.; The Electronic Still Camera a New Concept in Photography—1982 lEEE; pp. 325–331.

Wood, R. C.; Japan Watch—Photos Go Electronic—New Standard Pulls lmages into Computer Age; Feb. 1988—High Technology Business; p. 15.

Gray, R.; Multispectral Data Compression Using Staggered Detector Arrays, A Dissertation Submitted to the Faculty of the Committe on Optical Sciences (Graduate)—ln Partial Fulfillment of the Requirement for the Degree of Doctor of Philosophy in the Graduate College—The University of Arizona; 140 Pgs.

Okada, S., et al.; A Single Chip Motion JPEG Codec LSl—lEEE 1997 Custom lntegrated Circuits Conference; pp. 233–236.

ltoh, Y., et al; Nonvolatile Memories; 1989 lEEE lnternational Solid State Circuits Conference; pp. 134–135 & Cont. on p. 314.

Printout—Black and White Photo of Camera.

Suzuki, M., et al.; Standard Subscriber Line Compatible Color Videophone—1988 lEEE; pp. 759–768.

Hoshikowa, E., et al.; Development of High Quality MS Camcorder VL–HL1; pp. 67–70 (Sharp Technical Journal).

Printout—Black and White Photo of Camera (Olympus) VC–1000 Digital Still Camera; 1 Pg.

Printout (Japanese) w/out Eng. Translation; pp. 57–112.

EX PARTE REEXAMINATION CERTIFICATE ISSUED UNDER 35 U.S.C. 307

NO AMENDMENTS HAVE BEEN MADE TO THE PATENT

AS A RESULT OF REEXAMINATION, IT HAS BEEN DETERMINED THAT:

The patentability of claims **15** and **23-27** is confirmed.

Claims **1-14**, **16-22**, and **28** were not reexamined.

* * * * *

EXHIBIT 5

US006441854B2

(12) **United States Patent**
Fellegara et al.

(10) **Patent No.: US 6,441,854 B2**
(45) **Date of Patent: *Aug. 27, 2002**

(54) **ELECTRONIC CAMERA WITH QUICK REVIEW OF LAST CAPTURED IMAGE**

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(73) Assignee: **Eastman Kodak Company**, Rochester, NY (US)

(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **08/803,342**

(22) Filed: **Feb. 20, 1997**

(51) **Int. Cl.**[7] **H04N 5/222**

(52) **U.S. Cl.** **348/333.13**; 348/333.01; 348/231; 348/372

(58) **Field of Search** 348/64, 231, 233, 348/333, 334, 207, 220, 372, 333.01, 333.13; 358/909.1, 906; 396/429

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,751,583	A	*	6/1988	Levine 358/403
4,887,161	A		12/1989	Watanabe et al.
5,412,425	A	*	5/1995	Nagano 348/372
5,473,370	A	*	12/1995	Moronaga et al. 348/231
5,541,656	A	*	7/1996	Kare et al. 348/334
5,576,759	A	*	11/1996	Kawamura et al. 348/231
5,742,339	A	*	4/1998	Wakui 348/233
5,767,904	A	*	6/1998	Miyake 348/362
5,774,754	A	*	6/1998	Ootsuka 396/380
5,812,736	A	*	9/1998	Anderson 366/96
5,875,120	A	*	2/1999	Matsushima et al. 364/707
5,929,951	A	*	7/1999	Sasakura et al. 349/62

FOREIGN PATENT DOCUMENTS

EP	0 356 351	A	2/1990

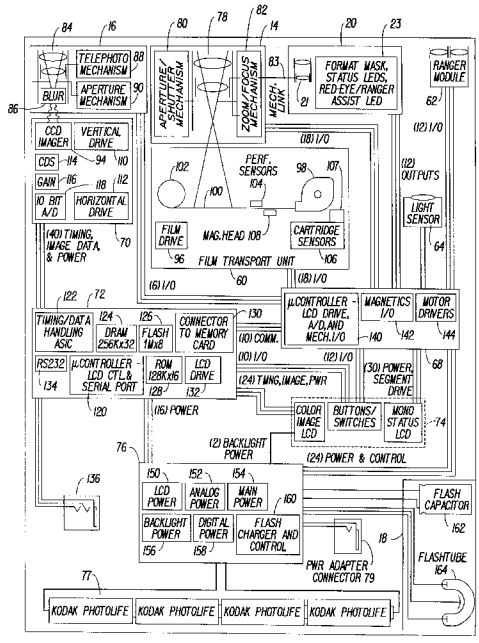
* cited by examiner

Primary Examiner—Wendy R. Garber
Assistant Examiner—Mitchell White
(74) *Attorney, Agent, or Firm*—David A. Novais

(57) **ABSTRACT**

A camera incorporates a working memory **(124)** for storing a working image corresponding to the last captured image. The working image is displayed on a display screen **(36)** in a quick review mode of operation in response to a quick review signal entered by the camera operator via a camera control interface **(74)** to control processing circuitry **(68,72)** of the camera. The processing circuitry controls the display screen to keep it in an inactive state until the quick review signal is entered, and returns it to an inactive state after a predetermined time period or when the quick review signal is discontinued to conserve energy. In addition, the working image is displayed in the quick review mode regardless of whether a non-volatile memory is available in the camera or, in the case of a hybrid camera, whether a film cartridge is contained in a film chamber **(98)** of the camera.

21 Claims, 13 Drawing Sheets



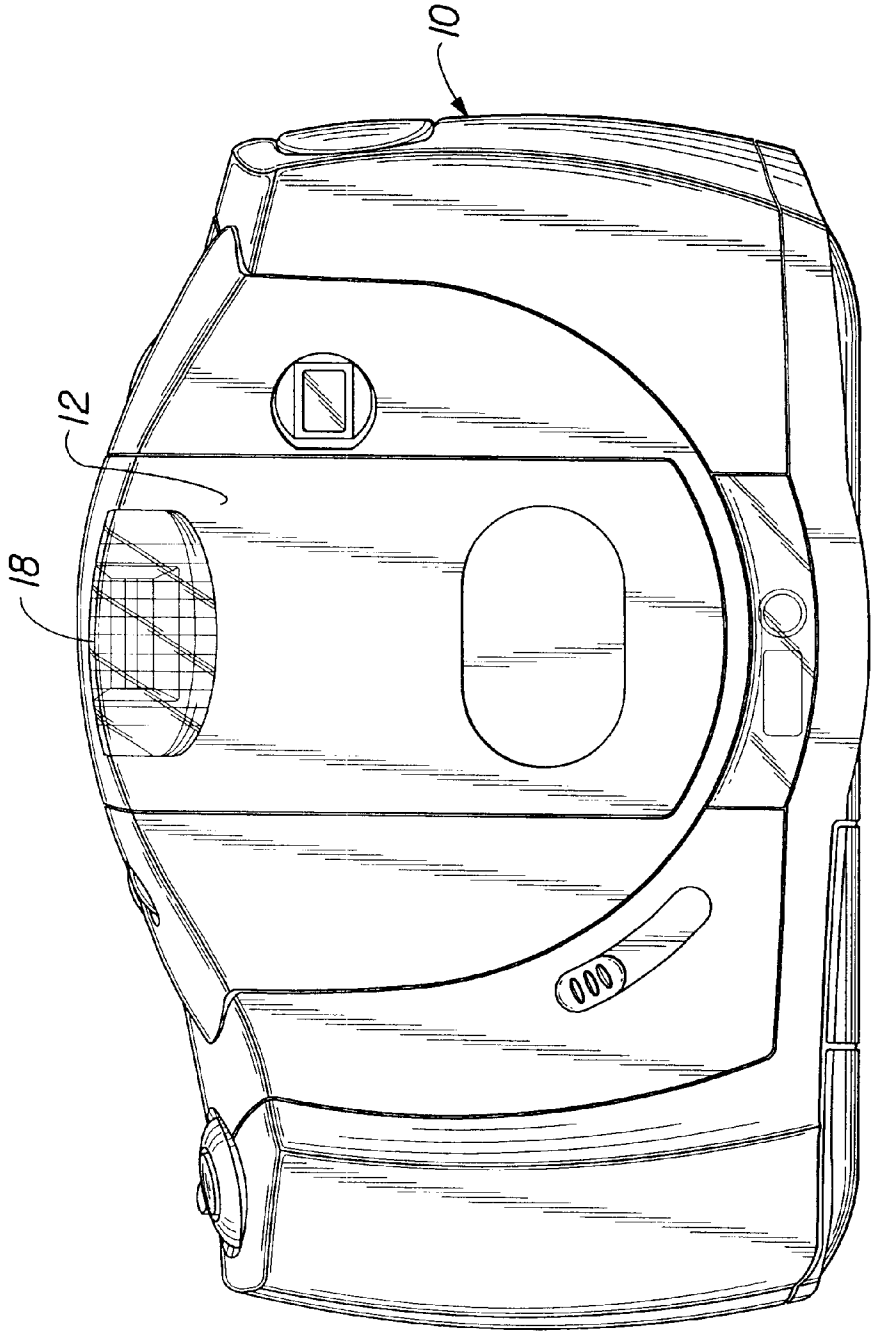


FIG. 1

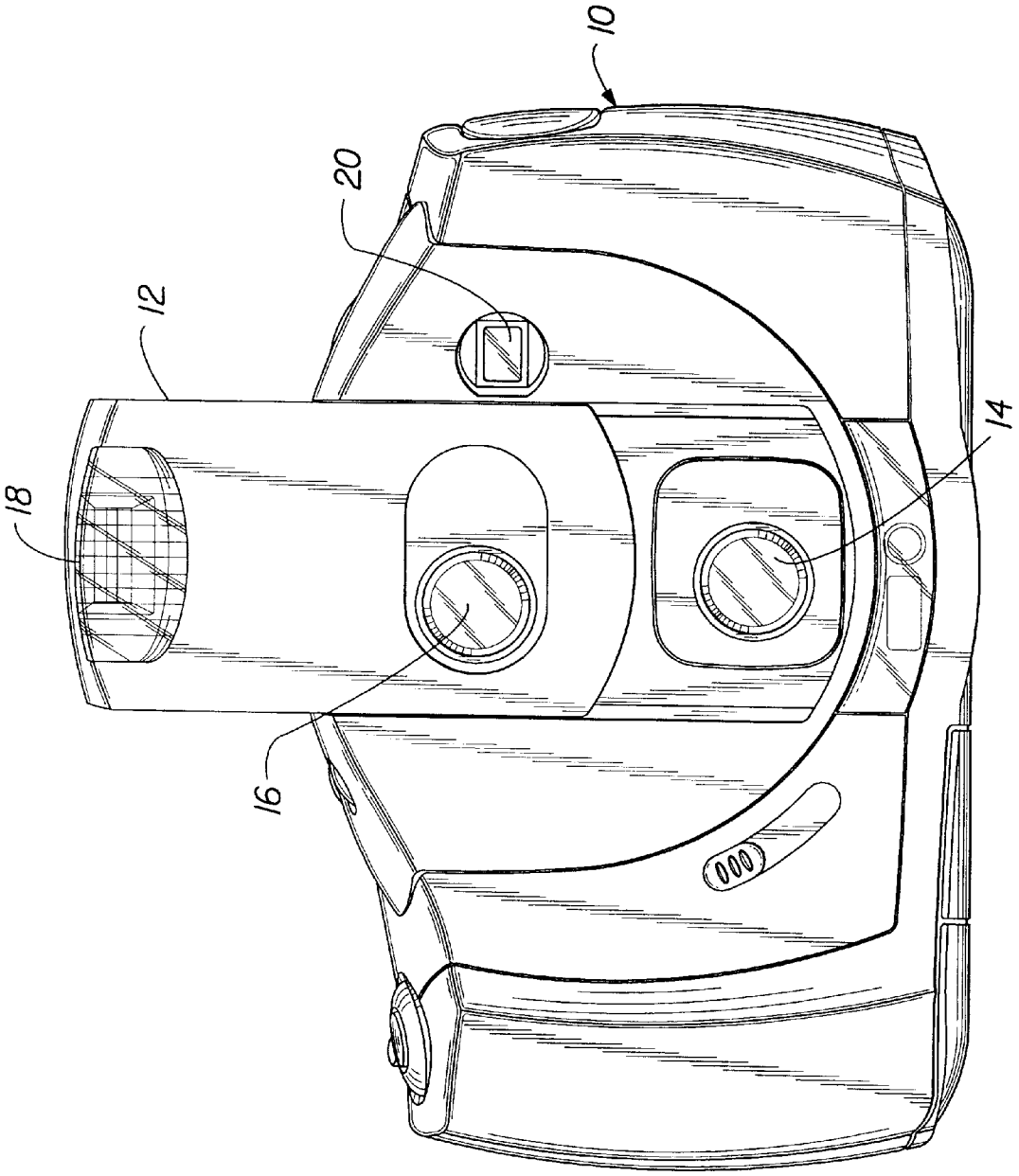


FIG. 2

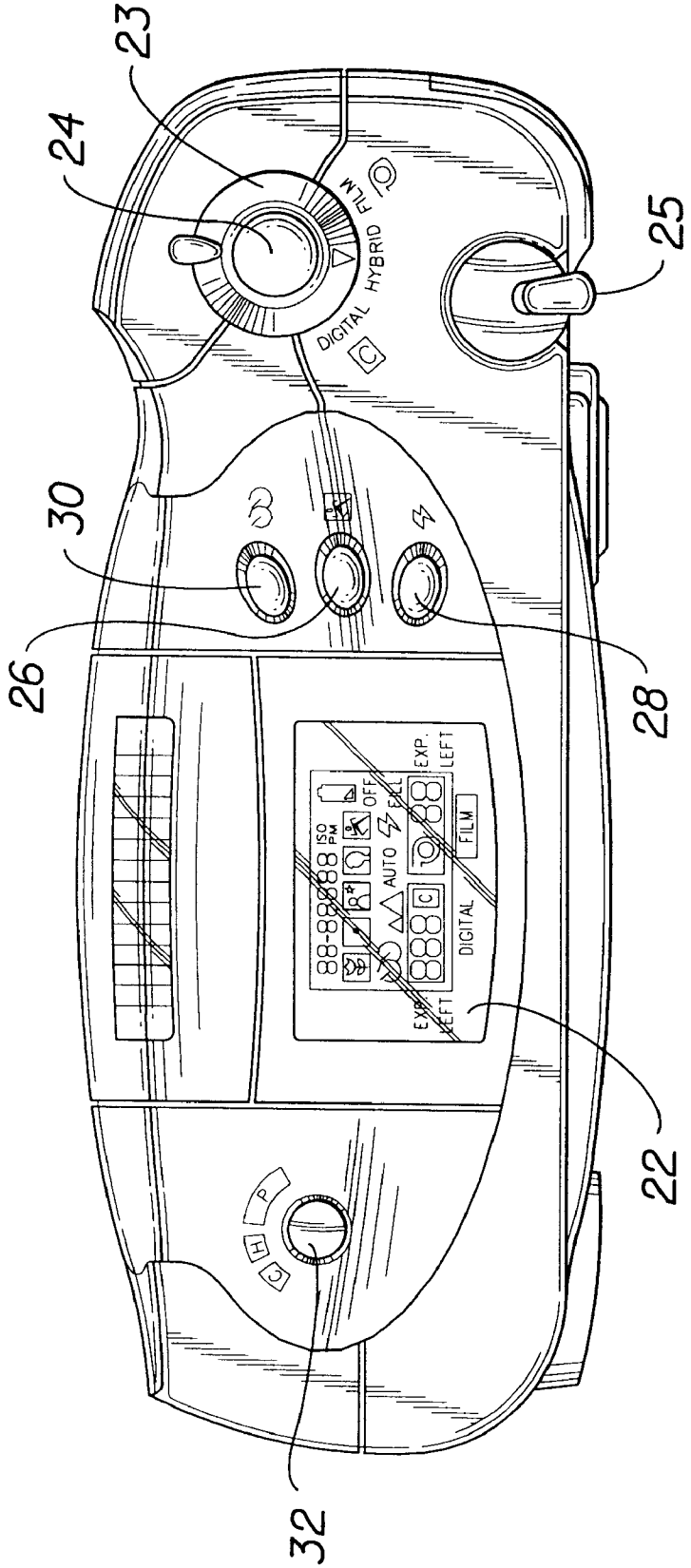

23
24
25
30
26
28
22
32
DIGITAL HYBRID FILM
AUTO
OFF
EXP.
LEFT
FILM
DIGITAL

FIG. 3

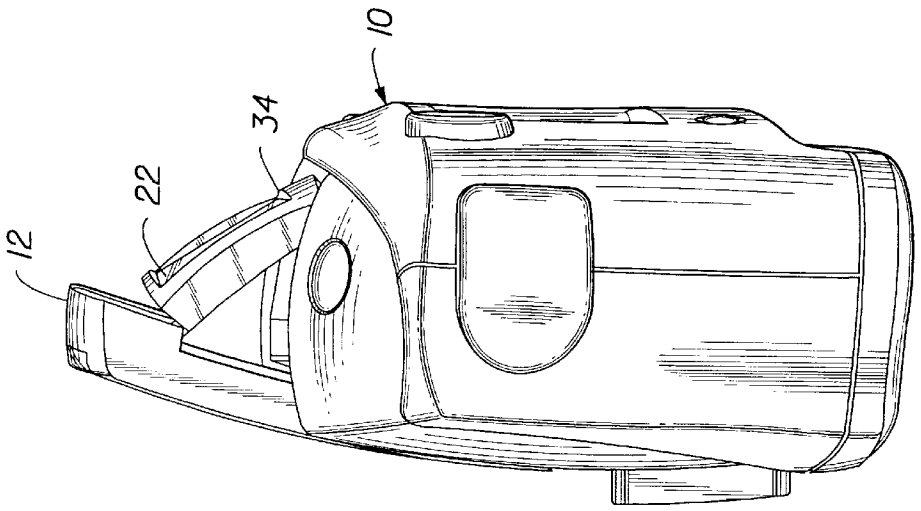


FIG. 4

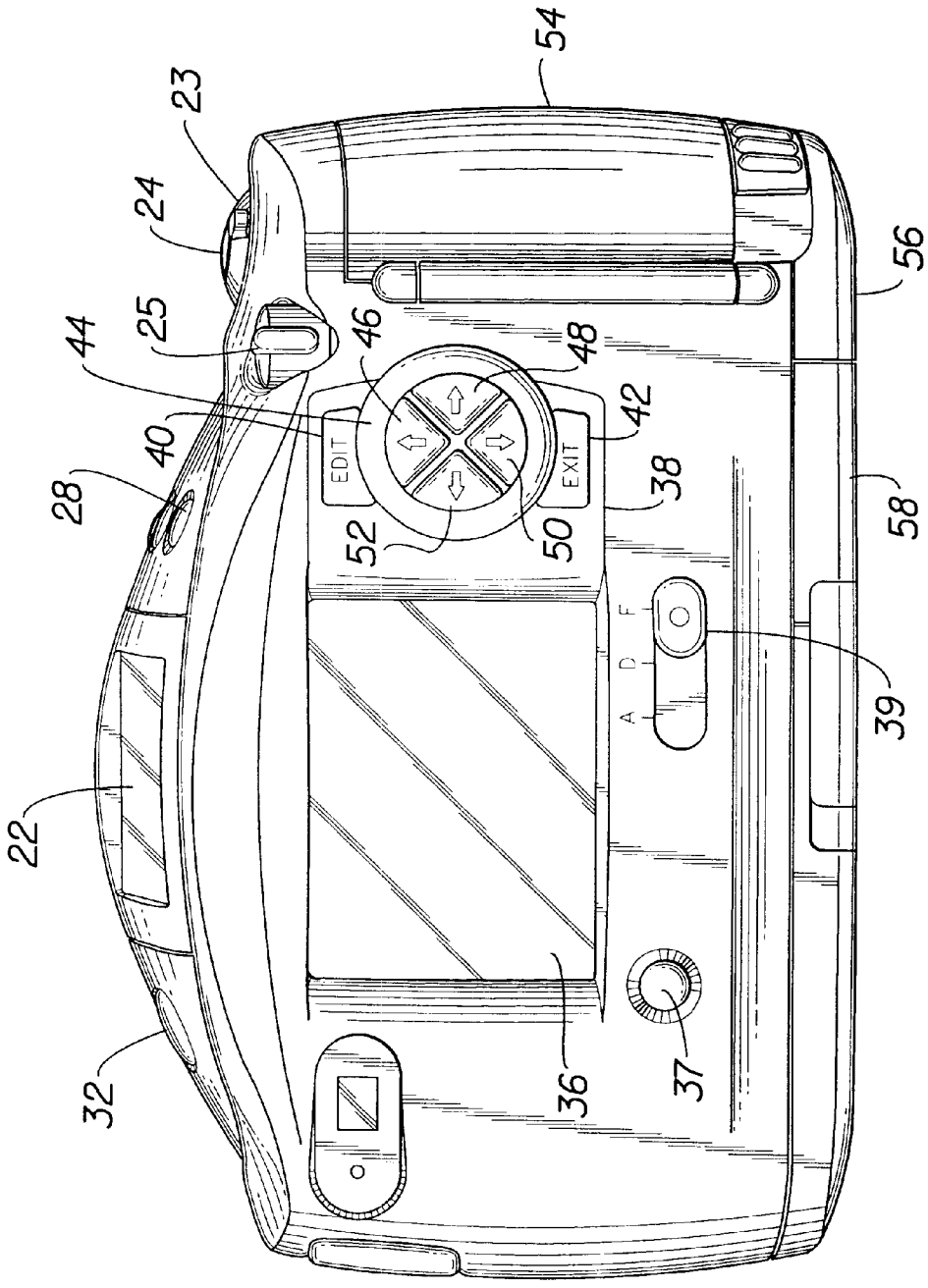

54
23
24
56
25
44
46
48
42
40
EDIT
EXIT
38
28
58
52
50
A D F
39
22
32
36
37

FIG. 5

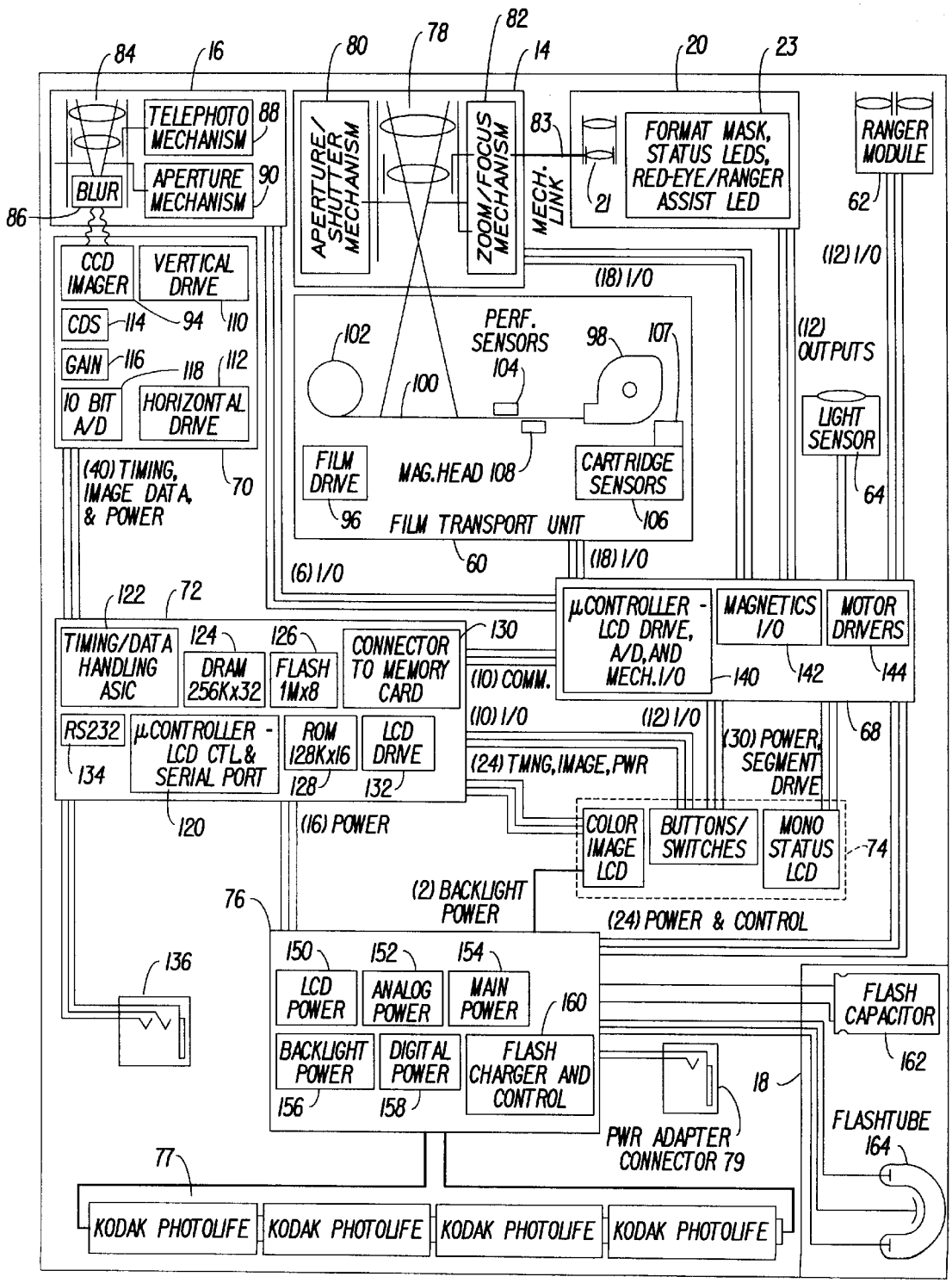

84
16
80
78
82
14
20
23
TELEPHOTO MECHANISM
88
APERTURE MECHANISM
90
BLUR
86
APERTURE/ SHUTTER MECHANISM
ZOOM/FOCUS MECHANISM
MECH. LINK
83
21
FORMAT MASK, STATUS LEDS, RED-EYE/RANGER ASSIST LED
RANGER MODULE
62
(12) I/O
(18) I/O
CCD IMAGER
VERTICAL DRIVE
94
110
CDS
114
GAIN
116
118
112
10 BIT A/D
HORIZONTAL DRIVE
(40) TIMING, IMAGE DATA, & POWER
70
102
PERF. SENSORS
104
98
107
100
(12) OUTPUTS
LIGHT SENSOR
64
FILM DRIVE
96
MAG.HEAD 108
CARTRIDGE SENSORS
106
FILM TRANSPORT UNIT
60
(6) I/O
(18) I/O
122
72
µCONTROLLER - LCD DRIVE, A/D, AND MECH. I/O
140
MAGNETICS I/O
142
MOTOR DRIVERS
144
TIMING/DATA HANDLING ASIC
124
DRAM 256Kx32
126
FLASH 1Mx8
CONNECTOR TO MEMORY CARD
130
(10) COMM.
(10) I/O
(12) I/O
68
RS232
134
µCONTROLLER - LCD CTL. & SERIAL PORT
120
ROM 128Kx16
128
LCD DRIVE
132
(24) TMNG, IMAGE, PWR
(30) POWER, SEGMENT DRIVE
(16) POWER
COLOR IMAGE LCD
BUTTONS/ SWITCHES
MONO STATUS LCD
74
(2) BACKLIGHT POWER
(24) POWER & CONTROL
76
150
152
154
LCD POWER
ANALOG POWER
MAIN POWER
160
136
BACKLIGHT POWER
156
DIGITAL POWER
158
FLASH CHARGER AND CONTROL
FLASH CAPACITOR
162
18
PWR ADAPTER CONNECTOR 79
FLASHTUBE
164
77
KODAK PHOTOLIFE
KODAK PHOTOLIFE
KODAK PHOTOLIFE
KODAK PHOTOLIFE

FIG. 6

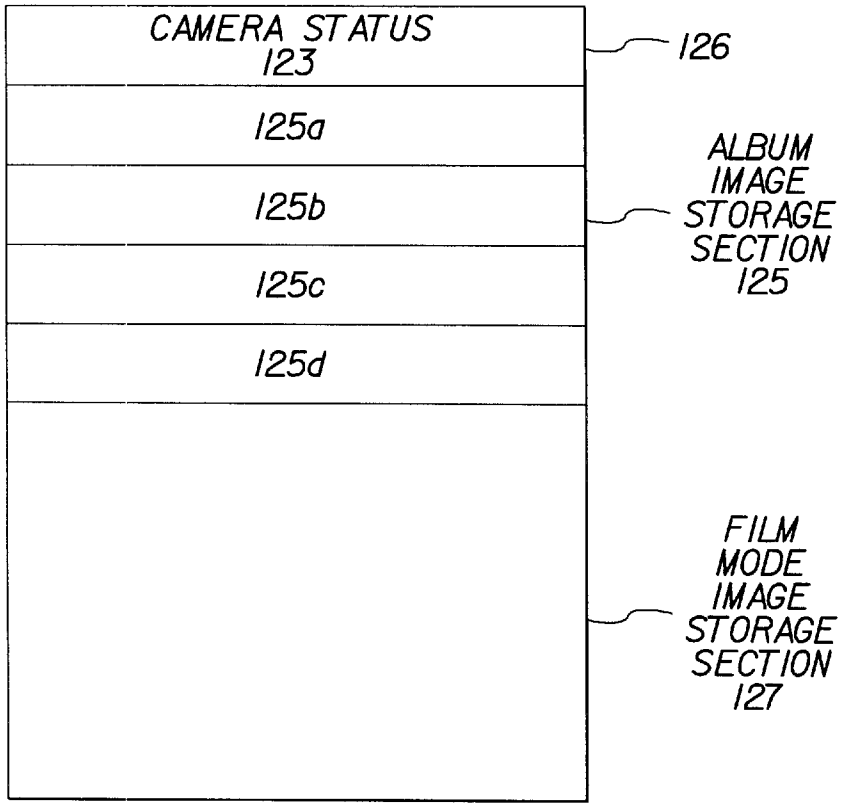

CAMERA STATUS
123
126
125a
125b
125c
125d
ALBUM
IMAGE
STORAGE
SECTION
125
FILM
MODE
IMAGE
STORAGE
SECTION
127

FIG. 7

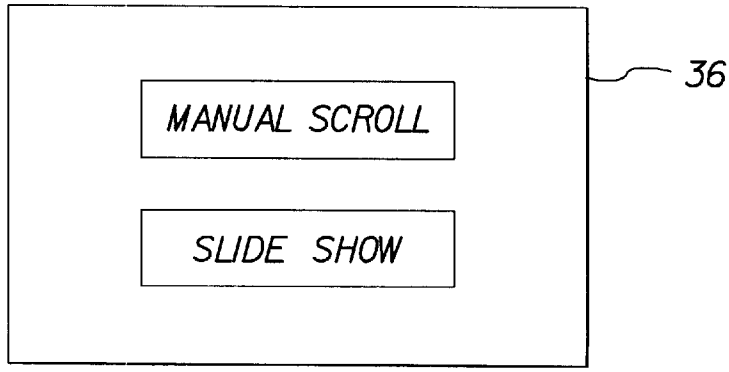

MANUAL SCROLL
SLIDE SHOW
36

FIG. 8

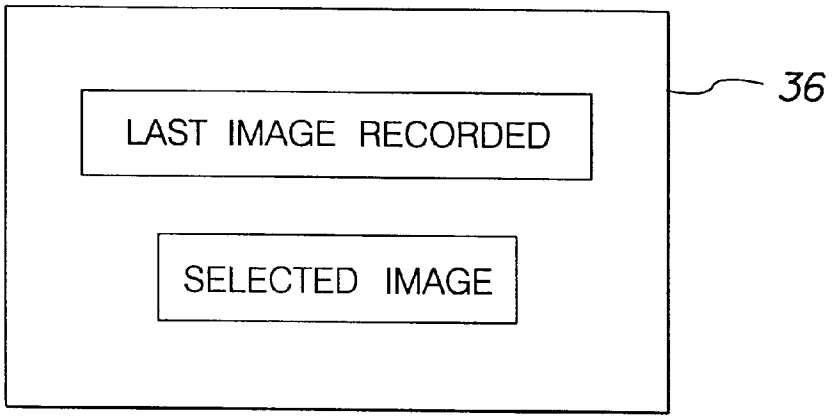


FIG. 9

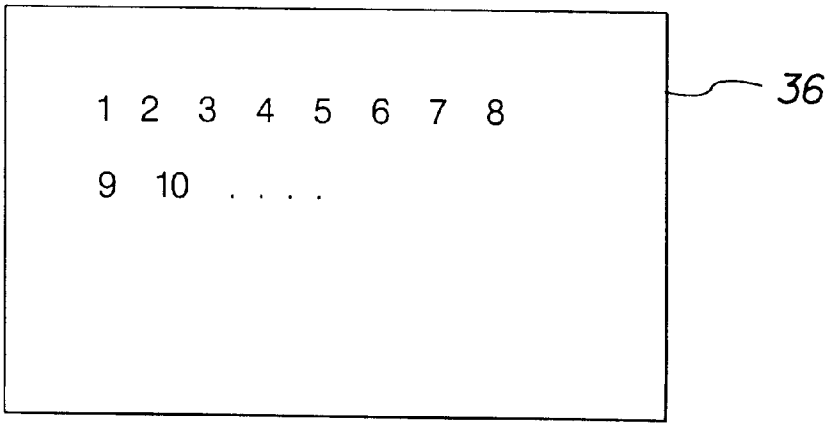


FIG. 10

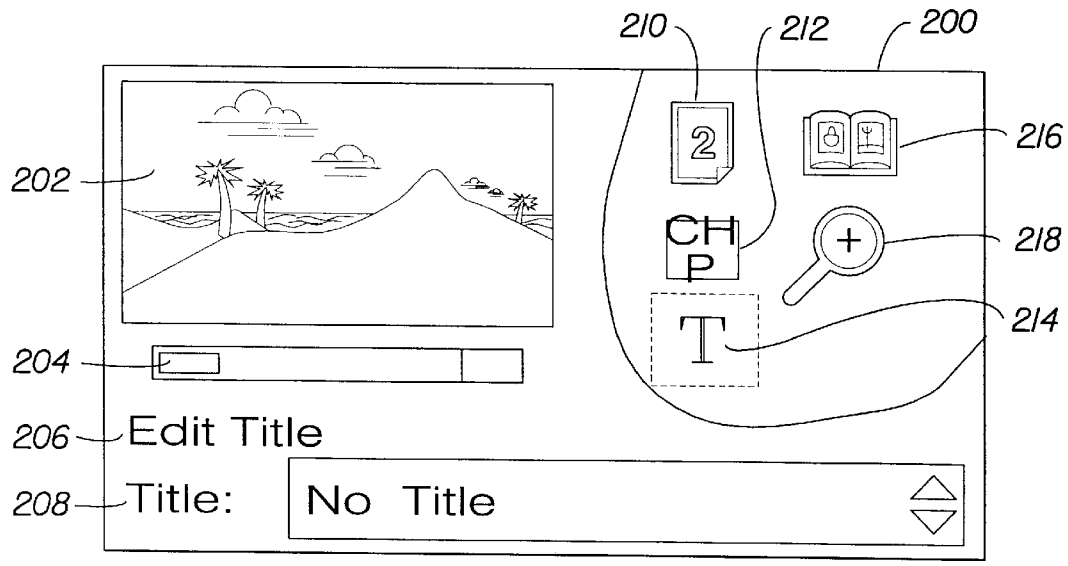

210
212
200
202
216
218
214
204
206
Edit Title
208
Title:
No Title

FIG. 11

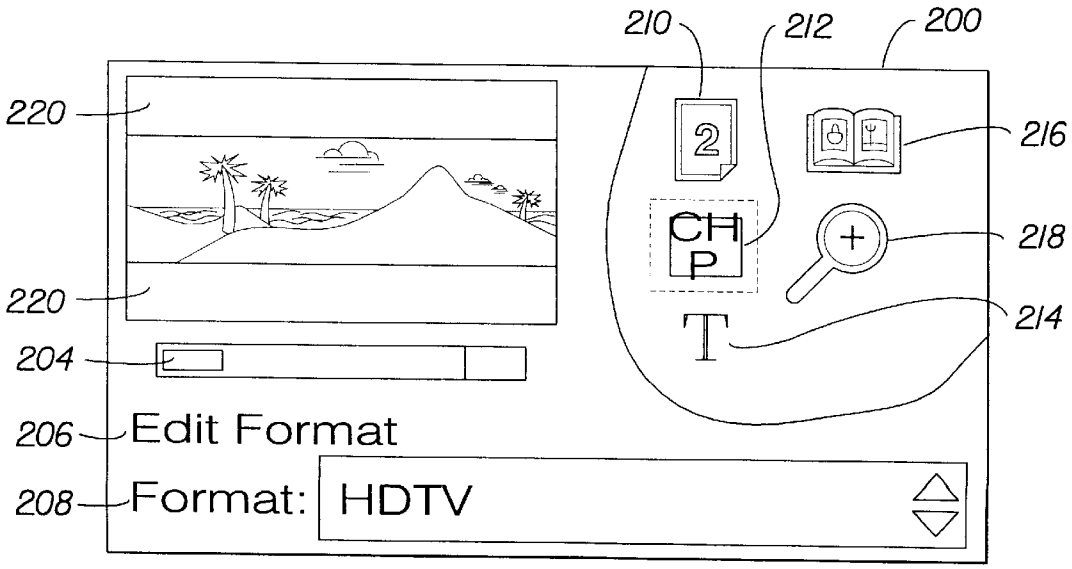

210
212
200
220
216
218
220
214
204
206
Edit Format
208
Format:
HDTV

FIG. 12

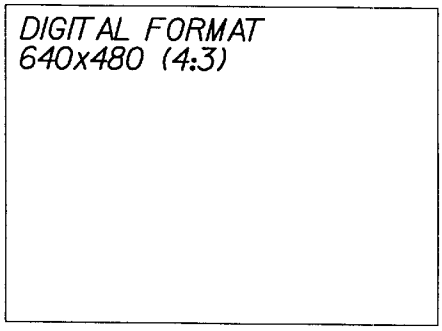


FIG. 13A

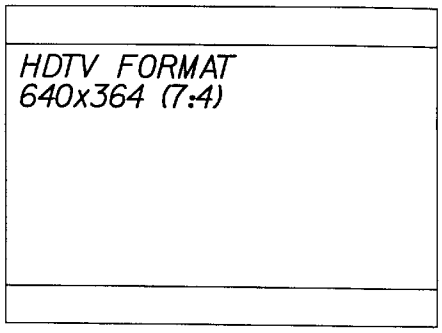


FIG. 13B

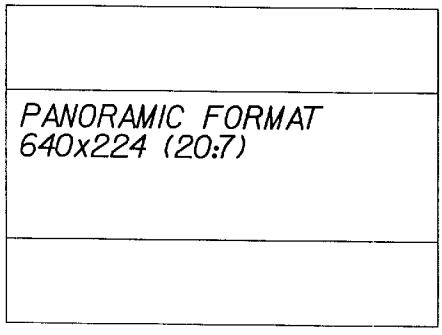


FIG. 13C

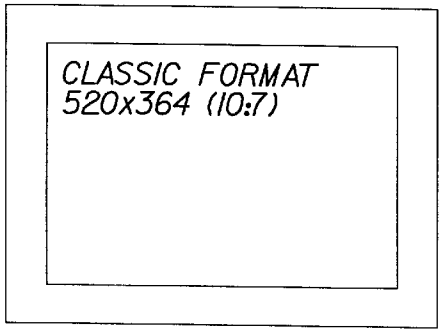


FIG. 13D

FIG. 14

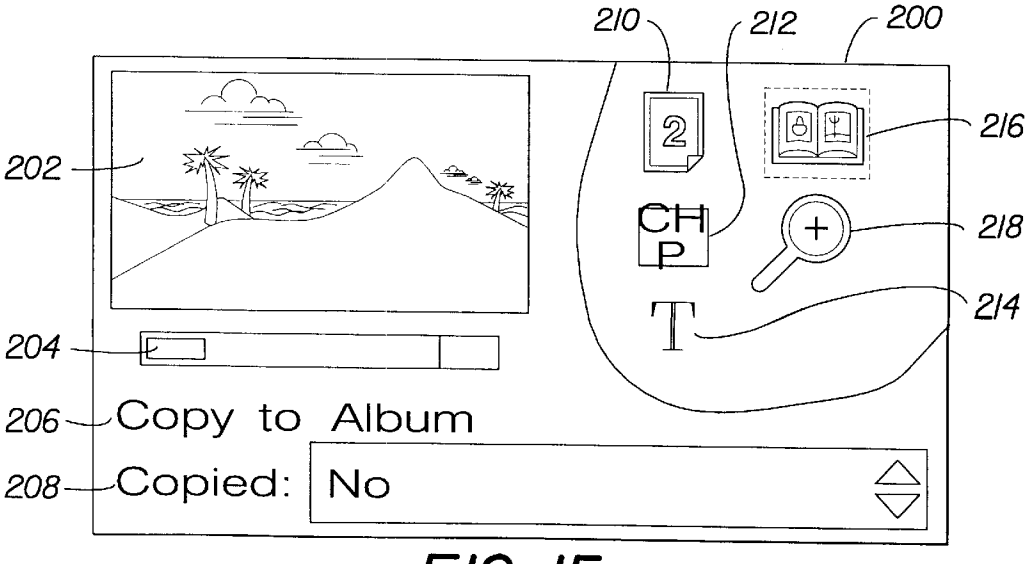


FIG. 15

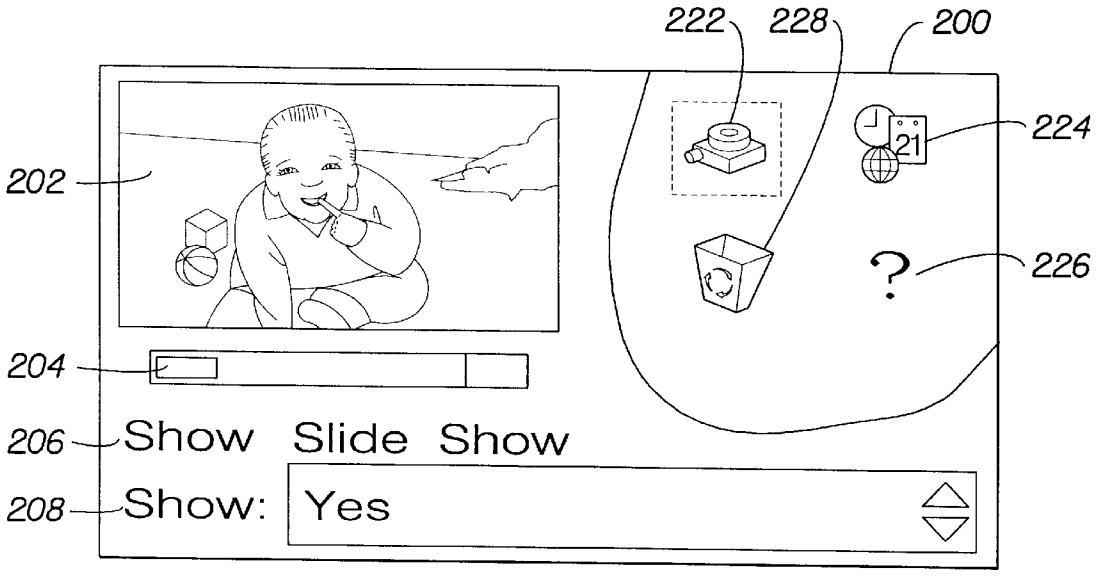


FIG. 16

Current Film Order

Classic:	5
HDTV:	20
Panoramic:	8

Press "Edit" to Change Order
Press "Exit" to Rewind Film

FIG. 17

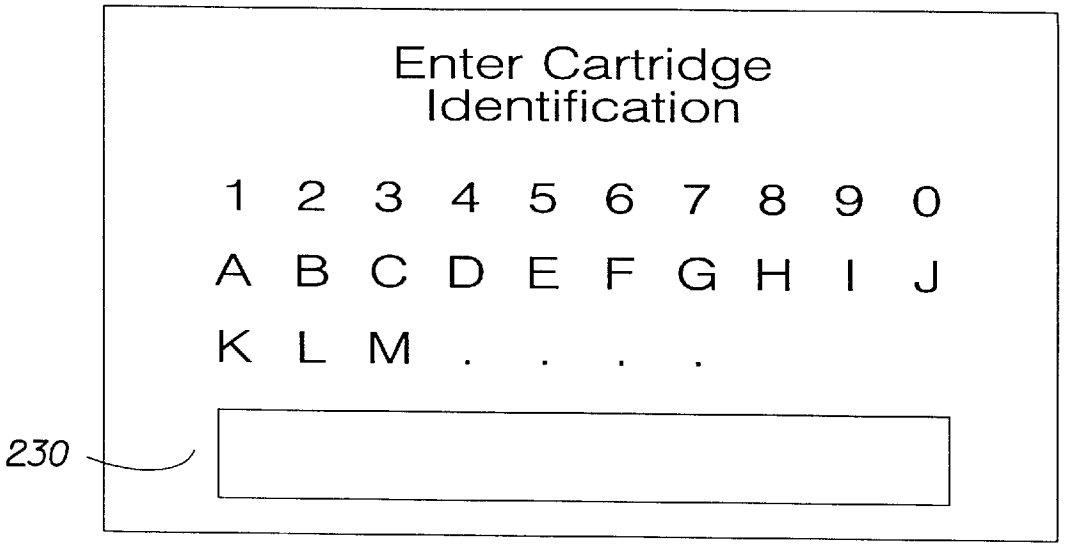

Enter Cartridge Identification
1 2 3 4 5 6 7 8 9 0
A B C D E F G H I J
K L M . . . .
230

FIG. 18

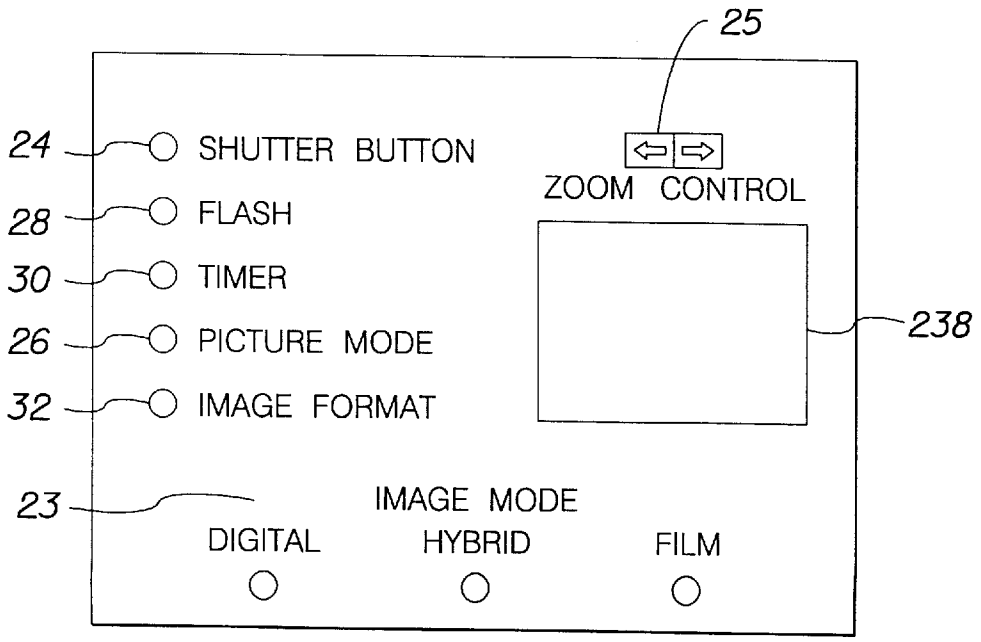

25
24
SHUTTER BUTTON
ZOOM CONTROL
28
FLASH
30
TIMER
26
PICTURE MODE
238
32
IMAGE FORMAT
23
IMAGE MODE
DIGITAL
HYBRID
FILM

FIG. 20

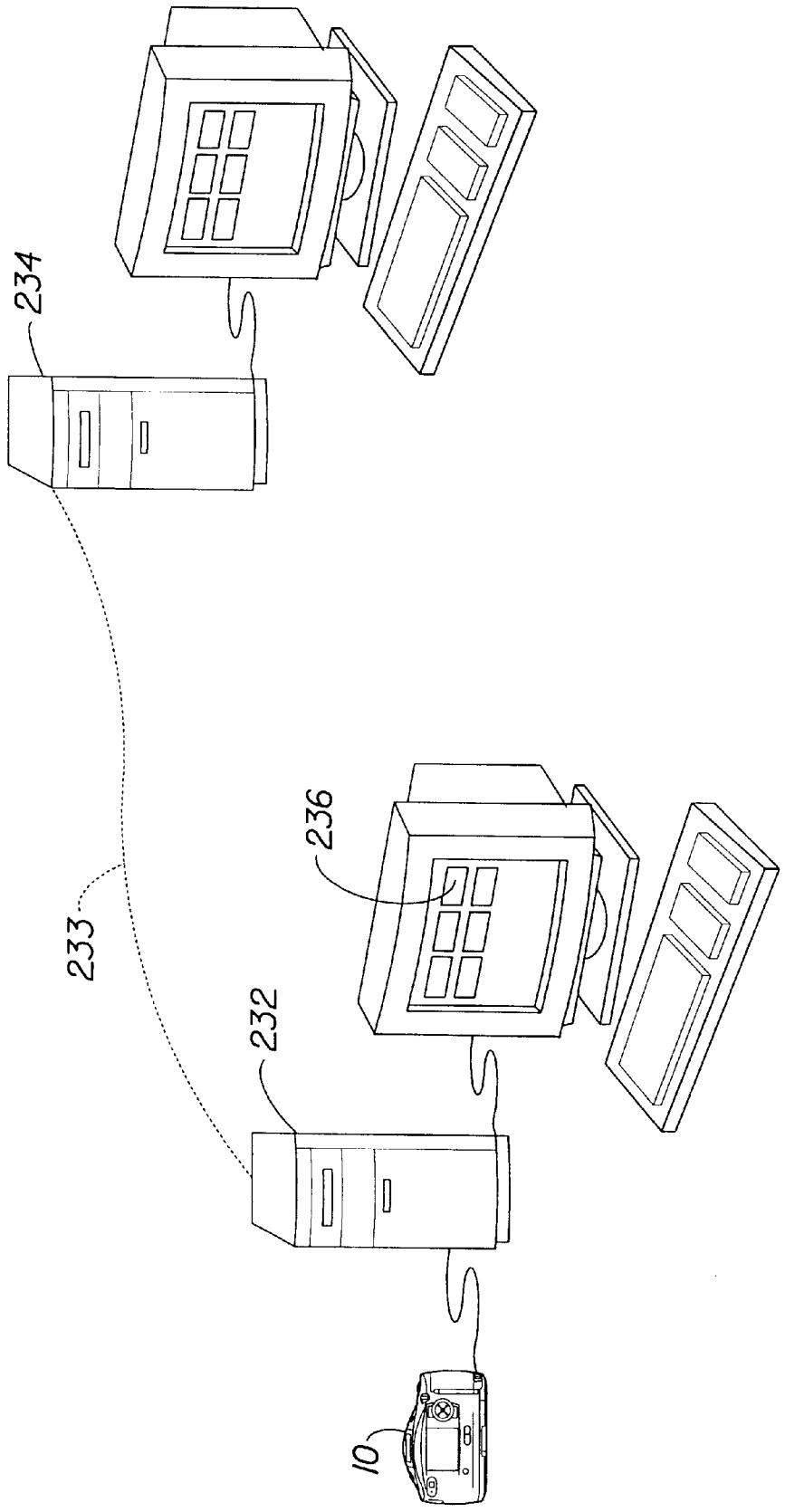


FIG. 19

ELECTRONIC CAMERA WITH QUICK REVIEW OF LAST CAPTURED IMAGE

FIELD OF THE INVENTION

The invention relates in general to cameras that generate digital images for storage on a removable storage medium. More specifically, the invention relates to a camera that includes a working memory that stores a working image which is updated for each subsequent exposure operation, wherein the working image can be displayed in a quick review mode on a display screen regardless of whether the removable storage medium is attached to the camera. The invention is particularly directed to a hybrid camera that includes both a digital imaging system and a silver-halide imaging system, wherein a working image can be displayed in the quick review mode regardless of whether the removable storage medium is attached to the camera or a film cartridge is loaded in the camera.

BACKGROUND OF THE INVENTION

There have been a number of conventional electronic still cameras and hybrid cameras either proposed and/or commercially developed. In each of the conventional cameras, electronic images are generally captured and stored on a recording medium that can be removed from the camera or transmitted by a data link to a remote location. Early electronic and hybrid cameras, for example, utilized magnetic recording disks as an image storage medium, while more recent developments in electronics have led to the use of semiconductor device memory cards. It is desirable to include a display screen on the camera to permit images captured and stored on the memory cards to be reviewed. U.S. Pat. No. 4,742,369 issued to Ishii et al., for example, describes a camera that includes a display device so that an operator can confirm whether the captured image is acceptable. Image display devices large enough to display a digital image of acceptable size, such as a large array liquid crystal device, still consume a relatively large amount of power when active. Accordingly, the batteries of the camera can be quickly drained if the display device is utilized during imaging operations. Further, it would be desirable to be able to review the last captured image regardless of whether the removable memory medium was attached to the camera.

In view of the above, it is an object of the invention to provide a camera that incorporates an apparatus for allowing the camera operator to review a last captured image without causing a large energy drain. It is a further object to provide a camera in which the last captured image can be reviewed regardless of whether a removable memory medium is attached to the camera.

SUMMARY OF THE INVENTION

The invention provides a camera that incorporates a working memory for storing a working image corresponding to the last captured image. The working image is displayed on a display screen in a quick review mode of operation in response to a quick review signal entered by the camera operator. The display screen is kept in an inactive state until the quick review signal is entered, and returns to an inactive state after a predetermined time period or when the quick review signal is discontinued thereby conserving energy. In addition, the working image is displayed in the quick review mode regardless of whether a removable memory medium is attached to the camera or, in the case of a hybrid camera, whether a film cartridge is contained in the camera.

Specifically, a camera in accordance with the invention may include digital imaging means for generating a digital image representative of a subject scene; fixed working memory means for receiving and storing the digital image generated by the digital imaging means as a working image; a non-volatile memory for storing digital images; a display screen; and control processing means for controlling the operation of the digital imaging means, the fixed working memory means and the display screen. In accordance with the invention, the control processing means generates a digital mode image from the working image stored in the working memory and transfers the digital mode image to the non-volatile memory while retaining the working image in the working memory. The control processing means also selectively generates a display image from a digital mode image stored in the non-volatile memory and transfers the display image to the display screen for display. Finally, the control processing means selectively generates a quick review image from the working image stored in the working memory and supplies the quick review image to the display screen for display without requiring availability of the non-volatile memory.

The-digital imaging means may generate a plurality of digital images under control of the control processing means; so that, each subsequent one of the plurality of digital images replaces a preceding one of the plurality of digital images as the working image stored in the working memory, whereby the working image is representative of the last subject scene imaged by the camera. A hybrid version of the camera may include a photographic imaging means for imaging the subject scene onto a photographic film plane of the camera under control of the control processing means. The control processing means may include a camera operator interface that includes an image mode selector for selecting one of a film imaging mode, a hybrid imaging mode and the digital imaging mode of operation. The photographic imaging means may image the subject scene onto the photographic image plane in the film imaging mode and the hybrid imaging mode to generate a corresponding photographic film image on a photographic film located at the photographic imaging plane that corresponds with the digital image generated by the digital imaging means. The control processing means may generate a film mode digital image from the working image in the film imaging mode of operation and stores the film mode digital image in an internal fixed base camera memory of the camera, and wherein the control processing means selectively generates a display image from the film mode digital image and transfers the display image to the display screen for display.

The camera may include a removable interface connection means for receiving a removable memory device; wherein the non-volatile memory is comprised in a removable memory, such as a card coupled to the interface connection means. The control processing means may generate a hybrid mode digital image from the working image in the hybrid mode of operation and transfer the hybrid mode digital image to the removable memory interface connection means for storage on the memory card. The control processing means may selectively generate a display image from a hybrid mode digital image stored on the memory card coupled to the memory interface connection means and transfers the display image to the display screen for display.

The control processing means may activate the display screen for a predetermined time period to display the quick review image. The camera operator interface may include a quick review switch; so that, the control processing means activates the display screen to display the quick review image as long as the quick review switch is activated. Means may be included for storing the quick review image in the non-volatile memory or in removable memory.

Other features and advantages of the invention will become apparent and appreciated after review of the following detailed description of the invention, the appended claims and the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in greater detail below with reference to the accompanying figures, wherein:

FIG. **1** is a front view of a camera in accordance with the present invention illustrated with a lens cover in a closed position;

FIG. **2** is a front view of the camera of FIG. **1** with the lens cover illustrated in an extended position;

FIG. **3** is a top view of the camera illustrated in FIG. **1**;

FIG. **4** is a side view of the camera illustrated in FIG. **2** with the lens cover in the extended position;

FIG. **5** is a back view of the camera illustrated in FIG. **1** with the lens cover in the closed position;

FIG. **6** is a schematic block diagram of the system architecture of the camera illustrated in FIG. **1**;

FIG. **7** is a block diagram illustrating the functional division of a base camera memory illustrated in the schematic block diagram of FIG. **6** into a camera status storage section, an album image storage section, and a film mode image storage section;

FIG. **8** is an illustration of a user interface window displayed on the main screen display unit illustrated in FIG. **5** for selecting a scroll option;

FIG. **9** is an illustration of a user interface window displayed on the main screen display unit illustrated in FIG. **5** for selecting a starting image for the scrolling function illustrated in FIG. **8**;

FIG. **10** is an illustration of a user interface window displayed on the main screen display unit illustrated in FIG. **5** for selecting a specific image number as a starting image for the scrolling function illustrated in FIG. **8**;

FIG. **11** is an illustration of a graphical user interface displayed on the main screen display unit illustrated in FIG. **5** for a title function;

FIG. **12** is an illustration of a graphical user interface displayed on the main screen display unit illustrated in FIG. **5** for an image format function;

FIGS. **13**A, B, C and D are illustrations of the a digital mode image format, a hybrid or film mode HDTV image format, a hybrid or film mode panoramic image format and a hybrid or film mode classic image format;

FIG. **14** is a schematic block diagram illustrating an image record for a digital image;

FIG. **15** is an illustration of a graphical user interface displayed on the main screen display unit illustrated in FIG. **5** for an album function;

FIG. **16** is an illustration of a graphical user interface displayed on the main screen display unit illustrated in FIG. **5** for a slide show function;

FIG. **17** is an illustration of a current film order status window displayed on the main screen display unit illustrated in FIG. **5**;

FIG. **18** is an illustration of a graphical user interface displayed on the main screen display unit illustrated in FIG. **5** for entering cartridge identification information;

FIG. **19** is schematic diagram illustrating the connection of a camera in accordance with the invention to a host computer; and

FIG. **20** is an illustration of a graphical user interface displayed on a monitor of the host computer illustrated in FIG. **19** for entering camera commands.

DETAILED DESCRIPTION OF THE INVENTION

A hybrid camera in accordance with the invention is shown in FIG. **1** as including a main camera body **10** on which a sliding lens cover **12** is attached. A silver-halide optical system **14** and a digital imaging optical system **16** are located behind the sliding lens cover **12**, and are both exposed to scene light when the sliding lens cover **12** is extended as illustrated in FIG. **2**. An electronic flash unit **18** is preferably located on a top edge of the sliding lens cover **12**, such that the extension of the lens cover **12** places the electronic flash unit **18** in a position sufficiently distant from the silver-halide optical system **14** and the digital imaging optical system **16** to prevent the occurrence of "red eye" in photographic and digital images captured by the camera. In the illustrated embodiment, a separate optical viewfinder **20** is provided adjacent to the lens cover **12**, although it will be understood that viewfinders incorporated within or utilizing elements of either the silver-halide optical system **14** and/or the digital imaging optical system **16** may be readily employed. The optical viewfinder **20** includes a masking device, for example a segmented LCD or mechanical mask, that is used to match the image viewed by a camera operator through the viewfinder **20** to a corresponding image format selected by the camera operator. In a preferred embodiment, the optical viewfinder **20** provides several different aspect ratios including: a full VGA aspect ratio corresponding to an aspect ratio, such as 4:3, of the digital imaging optical system **16**; an HDTV aspect ratio corresponding to the aspect ratio, such as 7:4, of the silver-halide optical system **14**; a classic film aspect ratio, such as 10:7; and a panoramic aspect ratio, such as 20:7. The HDTV, classic and panoramic aspect ratios are the same as those used for the Advanced Photo System (APS) cameras introduced in 1996.

A top view of the camera body **10** is illustrated in FIG. **3**. A liquid crystal display (LCD) status unit **22** is provided on the top of the main camera body **10** to display various camera status data to the camera operator. The LCD status unit **22** is roughly partitioned into three areas: an area for displaying information specific to film images; an area for displaying information specific to digital images; and a general information area that displays information related to both film images and digital images. In addition to the status unit **22**, various operator controls are provided on the top of the camera body **10** including an image capture mode selector switch **23**, a shutter button **24**, a zoom control switch **25**, a picture taking mode selector switch **26**, a flash mode selector switch **28**, a timer mode selector switch **30**, and an image format selector switch **32**. As illustrated, image capture mode switch **23** allows for settings of Digital, Hybrid or Film. However, those skilled in the art will appreciate that many features of the invention would be applicable in cameras where only Digital and Hybrid modes are provided, or only Digital and Film, or only Hybrid and Film, or only Hybrid. The LCD status unit **22** is preferably mounted on a hinged support element **34** that is coupled to the lens cover **12**, such that the LCD status unit **22** is tilted toward the camera operator when the lens cover **12** is extended during an image capture operation as shown in FIG. **4**.

A color main screen display unit **36** is provided on the back of the main camera body **10**, as illustrated in FIG. **5**, and is preferably recessed from the back surface of the main

camera body **10** for protection. A main screen operator control unit **38** is provided adjacent to the main screen display unit **36** and includes an edit switch **40**, an exit switch **42** and a directional switch unit **44**. The directional switch unit **44** is preferably a four directional thumb pad segmented into four different individual directional switches including an up directional switch **46**, a down directional switch **50**, a right directional switch **48** and a left directional switch **52**. It will be understood, however, that other types of directional switch units, for example track balls, pressure pads, etc., may be readily employed to enter directional signals. The main screen operator control unit **38** is utilized in conjunction with elements of graphical user interfaces displayed on the main screen display unit **36** to control various camera functions that will be described in greater detail below.

The main camera body **10** is also provided with a memory card door **54**, a battery compartment door **56** and a film chamber door **58** as illustrated in FIG. **5**. The memory card door **54** is provided to protect a memory card interface connector located in the main camera body **10**. The battery compartment door **56** and film chamber door **58** are provided in the bottom of the main camera body **10** in a conventional manner to provide access to an internal film chamber and a battery compartment.

The overall system architecture of the hybrid camera is provided in FIG. **6**. The basic system components of the system architecture include the silver-halide optical system **14**, the digital imaging optical system **16**, the electronic flash unit **18**, the optical viewfinder **20**, a film transport unit **60**, a range finding module **62**, a light sensor **64**, a main camera controller **68**, an analog subsystem unit **70**, a digital subsystem unit **72**, a camera operator interface **74**, and a power supply unit **76**. A detailed description of each of the basic system components will be provided below.

The silver-halide optical system **14** preferably includes a multi-element lens **78**, an aperture/shutter mechanism **80**, and a zoom/focus mechanism **82**. The operation of the aperture/shutter mechanism **80** and zoom/focus mechanism **82** is controlled in a conventional manner by the main camera controller **68** to adjust focusing and exposure operations of the silver-halide optical system **14** in response to various inputs including signals received from the range finding module **62**, the light sensor **64**, the shutter button **24**, and zoom control switch **25**. The silver-halide optical system **14** is located within the camera body **10** to focus a subject image on a film plane **100** of the film transport **60** during both a film image capture mode of operation and a hybrid image capture mode of operation as will be described in greater detail below.

The digital imaging optical system **16** includes a fixed focus, dual focal length, multi-element lens **84**, a blur filter **86**, a telephoto drive mechanism **88**, and an aperture drive mechanism **90**. The telephoto drive mechanism **88** moves part of the lens **84** to provide multiple focal lengths in accordance with instructions received from the main camera controller **68**. Similarly, under control of the main camera controller **68**, the aperture drive mechanism **90** adjusts an aperture **92** of the digital optical system **16** to a desired setting. The digital imaging optical system **16** is located within the camera body **10** to focus a subject image onto an electronic CCD image sensor **94** provided within the analog subsystem unit **70**.

The optical viewfinder **20** is preferably mechanically linked to the zoom/focus mechanism **82** of the silver-halide optical system **14** via a mechanical linkage **83**, such that operation of the zoom/focus mechanism **82** causes a corresponding change in the optical system **21** of the optical viewfinder **20**. The optical viewfinder **20**, as discussed above, includes a masking device **23** that is utilized to appropriately frame the subject image for different imaging formats selected by the camera operator with the image format selector switch **32**. In the preferred embodiment, icons located within the viewfinder **20** indicate various operating modes of the camera including digital image capture mode, film image capture mode or hybrid image capture mode. In addition, conventional light-emitting-diode (LED) status indicators are provided within the optical viewfinder **20** to inform the camera operator of various camera conditions while the camera operator is looking through the viewfinder **20**.

The electronic flash unit **18**, the range finding module **62** and the light sensor **64** are of conventional design. A Fuji AF-Module FM6224T31 (available from Fuji Electric Co., Ltd. of Japan), for example, is preferably utilized as the range finding module **62** to provide subject distance information to the main camera controller **68**. Although the light sensor **64** can be implemented as a discrete component to provide light level data to the main camera controller **68**, it is preferable to utilize the CCD image sensor **94** provided in the analog subsystem unit **70** to perform the light sensing operation in additional to image capture. Individual pixel elements or groups of pixel elements within the CCD image sensor **94**, for example, are sampled prior to an exposure operation to provide light level data to the main camera controller **68**, thereby eliminating the need for a separate light level sensor.

The film transport unit **60** includes a conventional film drive **96** that advances photographic film from a film cartridge located in a film chamber **98** to the image plane **100** of the film transport unit **60**, where the photographic film is exposed to scene light by the silver-halide optical system **14** described above, and then to a winding spool **102**. The film drive **96** also works in reverse in a conventional manner to rewind exposed film from the winding spool **102** back into the cartridge located in the film chamber **98** in response to a rewind signal provided either automatically from the main camera controller **68** or by the activation of a rewind switch on the camera operator interface **74**. Various sensors, including a film perforation sensor **104** and cartridge sensors **106**, are provide within the film transport unit **60** to provide information regarding the presence and type of the film cartridge and the advance of the film to the main camera control unit **68** in a conventional manner. In addition, at least one magnetic head **108** is provided to write data supplied from the main camera controller **68** to a magnetic layer provided on the photographic film. For example, as in the known film for APS cameras, specific areas located adjacent to each photographic image are defined as camera magnetic recording tracks and photo-finisher magnetic recording tracks where data is magnetically recorded on a magnetic layer of the photographic film. In some applications, it is also desirable for the magnetic head **108** to read data already provided on the magnetic layer of the photographic film for transfer to the main camera controller **68**.

The analog subsystem unit **70** includes the CCD image sensor **94**, a vertical clock drive circuit **110**, a horizontal clock drive circuit **112** and support electronics for the CCD image sensor **94** including a correlated double sample (CDS) circuit **114**, a programmable gain amplifier **116**, and an analog-to-digital (A/D) converter **118**. In a preferred embodiment, the CCD image sensor **94** is a KAI-0320CM device (manufactured by Eastman Kodak Company of

Rochester, N.Y.) that includes a 640×480 array of imaging elements with a Bayer color filter array. The signal from the CCD image sensor **94** is provided to the CDS circuit **114**, which takes into account a pixel by pixel reference level provided by the CCD image sensor **94**. The signal output from the CDS circuit **114** is supplied to the programmable gain stage **116**. The use of the programmable gain stage **116** allows the operating range of the system to be extended under low light conditions by boosting the signal level received from the CCD image sensor **94**. The programmable gain stage **116** is programmed digitally via a serial data connection provided to the digital subsystem unit **72**. The A/D converter **118** converts the sampled and amplified analog signal output from the programmable gain stage **116** into a ten bit digital value. The CDS circuit **114**, the programmable gain stage **116**, and the A/D converter **118** are preferably implemented with a Philips TDA8786 integrated circuit device. The TDA8786 integrated circuit device also includes a digital-to-analog (D/A) converter (not shown) that is used to control the substrate voltage of the CCD image sensor **94**, thereby eliminating the need for a potentiometer or other adjustment to provide this function. Accordingly, manufacturing adjustments for variations in different CCD image sensors are greatly simplified. The D/A converter of the TDA8786 integrated circuit device is programmed by the same serial data connection to the digital subsystem **72** used to program the programmable gain stage **114**.

The digital subsystem unit **72** includes a microcontroller **120**, an application specific integrated circuit (ASIC) **122** that includes various timing and data handling circuits, a DRAM or non-volatile working memory **124**, a non-volatile base camera flash memory **126**, a read only memory (ROM) **128**, a memory card interface connector **130** for receiving a nonvolatile memory card, LCD interface drive circuitry **132** for driving the main screen unit **36**, and a standard communications interface circuit **134** (for example RS232) coupled to a data communications port **136** provided on the main camera body **10**. The digital subsystem unit **72** works in cooperation with the main camera controller **68** to control the operation of the various system components. In addition, the digital subsystem unit **72** interfaces with a host computer to perform various operations when the main camera body **10** is coupled to the host computer via the data communications port **136**. The data communications port **136** can either be a hard wire type communications port (i.e. requiring a physical connection to the host computer) or a wireless type communication port (for example infrared or RF).

The microcontroller **120** is preferably implemented using a Motorola MPC823 PowerPC based reduced instruction set (RISC) microcontroller. In addition to the PowerPC core, this device includes a serial data communications channel for host communication, timers for monitoring or controlling the lengths of events, an LCD controller for providing image data to the main screen display unit **36**, and some digital signal processing (DSP) capabilities to facilitate processing image data. A DRAM controller is also provided by the MPC823 device to allow a direct connection to common DRAM type memories, and bit addressable input/output ports provide for low level control of digital image capture mechanisms, for example, serially programming the Philips TDA8786 integrated circuit device in the analog subsystem unit **70**, providing low speed clock signals (line rate and frame rate) to the analog subsystem unit **70**, and sensing synchronization event signals from the main camera controller **68** and the timing and data handling ASIC **122**.

The timing and data handling ASIC **122** includes basic timing and data handling circuits to provide the interface between the digital subsystem unit **72** and the analog subsystem unit **72** and the analog subsystem **70**, the interface between the MPC823's LCD controller and the main screen **36**, and the interface between the MPC823 and a non-volatile memory card connected to the interface connection **130**. For example, for the interface between the analog subsystem unit **70** and the digital subsystem unit **72**, the ASIC **122** includes an analog subsystem timing chain that provides clocks signals for the various components of the analog subsystem unit **70** as image data flows from the analog subsystem unit **70** and into the digital subsystem unit **72**. The timing for the analog subsystem **70** unit is line based, namely, the clocking, conditioning, conversion, and collection of image data for the pixels in a line, but additional timing signals are provided by the microcontroller **120** to begin each line, to begin a frame, and to control electronic exposure. The data handling circuit of the ASIC **122** collects the ten bit image data from the analog subsystem unit **70**, applies a function to the data for the purpose of compressing the data from ten bits to eight bits (selectable between a two bit right shift and a fixed function), packs the data into thirty-two bit words, and places the data into a small FIFO (32 bits wide by 2 bits deep) prior to subsequent transfer to the microcontroller **120**. For the interface to the main screen **36**, the ASIC **122** provides a timing chain that operates in conjunction with the LCD controller of the microcontroller **120** to refresh the main display screen unit **36** by providing both line rate and frame rate signals. The ASIC 122 operates autonomously and requires no periodic intervention from the microcontroller **120** in order to continuously refresh the main display screen unit **36**. For the interface to a non-volatile memory card coupled to the interface connector **130**, the ASIC 122 isolates the memory card from the bus of the microcontroller **120** and also provides control signal timing for accessing the memory card.

As described above, the digital subsystem unit **72** includes three types of memory: DRAM based working memory **124**, read only memory **128**, and EPROM based non-volatile flash base camera memory **126** that is internally fixed within the camera body **10**. The working memory **124** is used during image data collection and processing, and also serves as a frame buffer for the main display screen unit **36**. The ROM **128** is used to store the basic operating instructions for the microcontroller **120** of the digital subsystem unit **70**. The EPROM based non-volatile flash base camera memory **126** is used for storage of album images selected by the camera operator and film mode images captured during the film imaging mode of operation that correspond to photographic images. In addition, the flash memory **126** is also utilized to store basic camera status and operating data including the various operating modes selected by the camera operator. Accordingly, as shown in FIG. **7**, the base camera memory **126** is functionally divided into a camera status storage section **123** for storing the camera status and operational data, an album image storage section **125** for storing album images, and a film mode image storage section **127** for storing film mode digital images. As will be described in greater detail, the operator can select certain images for album storage in the album storage section **125** of the base camera memory **126** in addition to storage in a memory card (for example a flash memory card or PCMCIA card) coupled to the interface connector **130** or capture on photographic film. Alternatively, rather than using a removable memory card, base memory **126** could include a non-volatile memory or storage section for high resolution images captured in any mode.

The main camera controller **68** includes a microcontroller **140** that communicates with the digital subsystem unit **72**,

camera operator interface **74**, the light sensor **64** and the range finder module **62**, in order to control the operation of the various system components including the silver-halide optical system **14**, the digital imaging optical system **16**, and the film transport **60**. In addition, the main camera controller **68** includes a magnetics I/O circuit **142** and a motor drive circuit **144** to respectively drive the magnetic head **108** of the film transport unit **60** and the various motors in the aperture, telephoto and focusing mechanisms of the silver-halide optical system **14** and the digital imaging optical system **16**. The main camera controller **68** also manages power up and power down sequencing, keeps track of calendar and time, and controls the operation of the electronic flash unit **18**.

In a preferred embodiment, a Mitsubishi 38000 series microcontroller is utilized for the microcontroller **140** of the main camera controller **68**. The Mitsubishi 38000 series microcontroller includes a built-in LCD driver, which can be utilized to drive the LCD status unit **22**, and a low speed AID converter with several multiplexed inputs. Several of the AID inputs are used to measure the signals from the perforation sensor **104** and cartridge sensors **106** provided in the film transport unit **60**. The Mitsubishi 38000 series microcontroller also has an extremely low power mode with low frequency operation, which allows the microcontroller to wake up periodically to keep track of the time. During camera operation, the microcontroller **140** can switch to high frequency operation for the duration of any events requiring additional processing power, and then switch back to low frequency to conserve power. If a power on event is detected (actuation of the shutter button, opening of the lens cover, opening and closing the film cartridge door, etc.), the microcontroller **140** manages the power up sequencing for other subsystems by enabling appropriate modules within the power supply unit **76**. The microcontroller **140** holds the digital subsystem microcontroller **120** in reset until its power supply from the power supply unit **76** is stable. An asynchronous serial interface allows the main camera controller **68** to receive and send commands to and from the digital subsystem unit **72**. Various operator controls discussed above that constitute part of the camera operator interface **74** are also sensed by the microcontroller's **140** input lines.

The camera operator interface **74** includes the various operator controls mentioned above in conjunction with the main screen display unit **36** and LCD status unit **22**. The LCD status unit **22** is a preferably a monochrome device to reduce power requirements, and includes segments for displaying conventional camera data including: time and date data; battery condition data; film speed data; exposure mode data; flash mode data; the presence of a film cartridge; and the number of film exposures remaining. In addition, the LCD status unit **22** includes a segment that indicates the presence of a memory card coupled to the interface connector **130**, and the number of images that can be stored on the memory card. The main screen display unit **36** is a thin film transistor (TFI) type active matrix LCD available from Sharp, which includes **384** cells per row by **220** rows in the display, consequently 84,480 bytes of working memory are required for the display frame buffer of the main screen display unit **36**.

The power supply unit **76** preferably provides power to the other subsystems of the camera from four AA cells **77** (lithium or alkaline) or a main source of power via a power adapter connection **79**. A number of power modules are provided within the power supply unit **76** that can be independently controlled by the main camera controller **68** including: an LCD power module **150**; an analog subsystem module **152**; a main power module **154**; an LCD backlight power module **156**; a digital subsystem power module **158**; and a flash charger and control module **160**. The LCD backlight power module **156** is adjustable by the main camera controller **68** to allow customer brightness adjustment and automatic compensation for ambient light level. Power can be switched on and off independently for the analog subsystem module **152**, the digital subsystem module **158**, and the main power module **154**. The flash charger and control module **160** charges up a flash capacitor **162** of the electronic flash unit **18**. A conventional sensing circuit provides an indication to the main camera controller **68** when the capacitor **160** is charged sufficiently to allow a picture to be taken. The main camera controller **68** triggers the flashtube **164** of the flash unit **18** by means of a dedicated control line. All of the power modules of the power supply unit **76** can be separately enabled and disabled by the main camera controller **68** in order to conserve power.

The basic function of the above-described hybrid camera in three image capture modes of operations will now be described in greater detail. The three image capture modes of operation include: a digital capture mode in which digital mode digital images are captured and stored on a memory card coupled to the interface connector **130**; a film capture mode in which photographic images are captured on photographic film and film mode digital images are captured and stored in the base camera memory **126**; and a hybrid capture mode in which hybrid mode digital images are captured for storage on a memory card and corresponding photographic images are captured on photographic film. For the purposes of the initial discussion of the three image capture modes, it will be assumed that: a film cartridge has been loaded in the film transport unit **60**; a memory card has been connected to the interface connector **130** of the digital subsystem **72**; and the camera is in a power down mode in which the main camera controller **68** is waiting for an initialization event.

The main camera controller **68** waits for an initialization event in a power down mode to conserve energy. The initialization event may include, for example, the movement of the lens cover **12** to the extended position, which in turn activates a switch that supplies a corresponding signal to the main camera controller **68** to power-up. In response to the initialization event, the main camera controller **68** enters a power up mode and activates various power modules in the power supply unit **76** to power up the corresponding components of the camera. It should be noted that the analog subsystem unit **70** and electronic subsystem unit **72** are powered-up regardless of the type of image capture mode selected, as a full resolution and full size digital working image is generated and stored in the working memory **124** in each image capture mode. As will be explained in greater detail, however, the processing of the working image varies based on the type of image capture mode selected. The main camera controller **68** activates the LCD status unit **22** to display the camera status information stored in the flash memory **126**, and sets the digital optical system **16**, silver-halide optical system **14** and viewfinder **20** to the last image format previously selected or alternatively a default format.

At this point, the operator can initiate an exposure operation by activating the shutter button **24**. Alternatively, the operator may choose to change either the image format or the image capture mode by operating the image format selector switch **30** and the image capture mode selector switch **23** accordingly. If the image format mode is changed, the main camera controller **68** controls the viewfinder **20** to select the appropriate mask that corresponds to the selected image format setting corresponding to the new image for-

mat. The operator may also choose to use the zoom control switch **25** to adjust the lens of the silver halide optical system **14** and the digital optical system **16**. The main camera controller **68** controls the operation of the zoom/focus mechanism **82** and the telephoto mechanism **88** in response to signals received from the zoom control switch **25**. At the same time, the optical system **21** of the optical viewfinder **20** is adjusted via the mechanical linkage **83** coupled to the zoom/focus mechanism **82**. If the operator does not proceed with an exposure operation or the activation of some other camera function within a predetermined time period, the main camera controller **68** deactivates the LCD status unit **22** and controls the power supply unit **76** to once again power down the camera to conserve energy.

As stated above, a digital working image is captured in all three image capture modes of operation that corresponds to an image resolution and has an image size corresponding to an aspect ratio of the CCD image sensor **94**. The resolution of a digital image subsequently stored or displayed, however, is varied based on the type of image capture mode selected. In the digital image capture mode, a full resolution digital mode image is stored without cropping in a memory card coupled to the interface connector **130**. See FIG. **13**A, for example. In the film image capture mode, where the digital image will only be utilized for display on the main screen display unit **36** to show the operator what was captured on film, a film mode image of a lower resolution is prepared by electronically cropping and interpolating the full resolution digital image to respectively correspond to the resolution of the main screen display unit **36** and to the aspect ratio of the photographic film images, and is stored in the base camera memory **126**. See FIGS. **13**B–D, for example. In the hybrid image capture mode, where it is desirable to match the image size of the digital image to the aspect ratio of the image to be captured on photographic film but retain a high resolution digital image, the digital image is electronically cropped to create a hybrid mode image which is stored in a memory card coupled to the interface connector **30**. See also FIGS. **13**B–D. Accordingly, a film mode image and a hybrid mode image are essentially cropped versions of the digital mode image with respectively different and equal resolutions.

Prior to exposure in any digital image capture mode, the main camera controller **68** initiates pre-exposure operations, such as autofocusing and exposure control operations to determine subject distance and exposure conditions, in order to properly set the apertures and lenses of the silver-halide optical system **14** and the digital imaging optical **16** system and to determine if flash is required. In a preferred embodiment, the shutter button **24** is a two position switch. When the shutter button **24** is pressed to the first position, a signal is sent to the main camera controller **68** to perform the necessary pre-exposure operations. If the camera is in the power down mode, the movement of the shutter button **24** to the first position also causes the main camera controller **68** to initiate the power up mode prior to performing the pre-exposure operation. When the shutter button **24** is pressed to the second position, an exposure signal is sent to the main camera controller **68** to initiate an exposure operation.

When an exposure operation is initiated in the digital image capture mode, the main camera controller **68** informs the digital subsystem unit **72** that a full resolution and full size digital mode image is to be captured and stored in a memory card coupled to the interface connector **130**. The microcontroller **120** of the digital subsystem unit **72** sends the necessary control signals to the analog subsystem unit **70** to initiate image capture with the CCD image sensor **94**, to process the analog image signals from the CCD image sensor **94** with the CDS circuit **114**, the programmable gain amplifier **116**, and the A/D converter **118**, and to supply a full resolution and full size digital working image to the working memory **124** of the digital subsystem **72**. The full resolution and full size digital working image is then transferred to the interface connector **130** by the microcontroller **120** for subsequent storage in the memory card as a digital mode image.

When an exposure operation is initiated in the film capture mode, a full resolution and full size digital working image is again supplied from the analog subsystem unit **72** to the working memory **124** of the digital subsystem unit **70**. At the same time, the aperture/shutter mechanism **80** of the silver-halide optical system **14** is activated by the main camera controller **68** so that scene light is supplied to the image plane **100** of the film transport unit **60**. Accordingly, a photographic film image is captured that corresponds to the digital working image stored in the working memory **124**. In the case of the film capture mode, however, the digital image will be utilized primarily for display purposes to enable the camera operator to verify what was captured on the corresponding photographic film image. However, by using main control unit **38** to enter an editing mode and using the display of FIG. **15**, the last captured digital image may still be stored in the memory card. To store a film image for display, the microcontroller **120** of the digital subsystem unit **72** generates and transfers a lower resolution representation of the full resolution digital working image as a film mode image in a film image storage section of the flash memory **126**. In addition, the working image is cropped in size so that the film mode image corresponds to the aspect ratio of the corresponding photographic film image, as the film mode image need only contain the same scene information as the corresponding photographic film image. The reduction of the resolution and size of the film mode image permits the size of the film image storage section in the flash memory **126** to be minimized. As the flash memory **126** is integrated and internal to the camera structure, it is preferable to minimize the amount of memory required for the flash memory **126** in order to reduce the expense and size of the overall camera. Accordingly, standard image compression techniques, for example JPEG, are preferably utilized to compress the film mode image prior to storage. The film mode image is preferably tagged with identification data (ID data) the indicates the film frame number of the corresponding film image, so the film mode images stored in the film mode image storage section **127** can be properly matched to their corresponding photographic film images when displayed on the main screen display unit **36** in response to a display signal supplied to the microcontroller **120** from the camera operator interface **74**.

In the hybrid image capture mode, a full size working image is again captured with a corresponding photographic film image and supplied to the working memory **124** of the digital subsystem **70**. As in a film mode capture operation, the microcontroller **120** does not transfer the complete digital image, but generates and transfers a reduced sized digital image to the interface connector **130** for storage in the memory card as a hybrid mode image. The reduced sized hybrid mode digital image, as with the film mode image, has an aspect ratio that corresponds to the aspect ratio of the corresponding photographic film image, but maintains the same resolution as the working image stored in the working memory **124**. The effective cropping of the size of the working image to match the aspect ratio of the correspond-

ing photographic image allows for a reduction in the amount of memory required to store a hybrid mode image as compared with a digital mode image. Accordingly, a greater number of hybrid mode images can be stored on the memory card as compared with digital mode images. In the case of either hybrid mode images or digital mode images, it is further preferable to have the microcontroller **120** compress the images prior to storage as with the film mode images. Although a loss of information results from the cropping of the working images when storing a hybrid mode image, the image information removed to produce the hybrid mode image is not required, as the hybrid mode image contains the same image information as the corresponding photographic image. If the camera operator wishes to retain all image information, then a digital mode image should be captured instead of a hybrid mode image in the illustrated embodiment.

In a preferred embodiment, the last captured working image remains in the working memory **124** until a new exposure operation is initiated regardless of the image capture mode selected, and regardless of whether the film cartridge is removed from the film chamber **98** or the memory card is removed from the interface connector **130**. A quick review switch **37**, illustrated in FIG. **5**, is provided on the back of the camera body **10**. At any time after the capture of an image and before capture of a next image, the review switch **37** can be activated by the camera operator to display the last captured working image on the main screen display unit **36** as a review image. The last captured working image thus can be displayed without requiring the availability of the non-volatile memory of the memory card. Activation of the review switch **37** provides a signal to the microcontroller **120** to initiate the transfer of the working image stored in the working memory **124** to the LCD drive circuit **132** for subsequent display on the main screen display unit **36** as a review image. It should be noted that during the exposure operation described above, the main screen display unit **36** is not activated unless specifically turned on by the camera operator. Accordingly, when the review switch **37** is activated, the microcontroller **120** activates the main screen display unit **36** to display the review image, either for a predetermined period of time or until the review switch **37** is deactivated, and then deactivates the main screen display unit **36** to enter the power conservation mode.

In contrast to the last working image, the film mode images stored in the film mode image storage section **127** of the flash memory **126** are preferably erased by the microcontroller **120** when the film is rewound into the cartridge. The size of the film mode image storage section **127** of the flash memory **126** need therefore only be sufficient to store a number of film mode images corresponding to the maximum number of film images that could be captured on one film cartridge. As stated above, it is desirable to limit the size of the film mode image storage section **127** to reduce the expense and size of the camera. Accordingly, in the preferred embodiment, digital images corresponding to images captured on photographic film are only retained in the hybrid image capture mode unless selected for album storage as will be described in greater detail.

The camera operator can initiate a review of all digital images stored in either a memory card or the base camera memory **126** by activating the main screen display unit operation switch **39**, thereby sending a display signal to the microcontroller **120**. Review of film mode images corresponding to images captured on film is accomplished by setting the main screen display unit operation switch **39** to the illustrated "F" or "FILM" setting. In response, the microcontroller **120** retrieves the digital film mode image stored in the film mode image storage section **127** of the base camera memory **126** corresponding to the last photographic film image taken and displays the image on the main screen display unit **36**. The camera operator can then manually scroll through digital film mode images in forward and reverse directions by utilizing the right directional switch **48** of the main screen operator control unit **38** or the left directional switch **52**. Similarly, digital images stored in either the digital image capture mode or hybrid image capture mode can be displayed and scrolled by utilizing the same directional switches and setting the operation switch **39** to the illustrated "D" or "DIGITAL" setting. In addition, instead of starting at the last image stored in either the base camera memory **126** or the memory card, a menu option window can be displayed on the main screen display unit **36** to allow the operator to select a specific image as the first image to be displayed.

Still further, instead of requiring the operator to enter a manual command to scroll through each image, a "slide show" option is preferably provided to allow the automatic scrolling of images after either predetermined time periods or time periods selected by the operator. For example, upon setting the operation switch **39** to a selected setting, the microcontroller **120** of the digital subsystem **72** sends a scroll option window to the main screen display unit **36** for display. The scroll option window includes a "Manual Scroll" icon and an "Slide Show" icon as illustrated in FIG. **8**. The camera operator utilizes the main screen operator control unit **38** to enter control signals to the microcontroller **120** to select the desired scroll option. The microcontroller **120** sends an image selection list to the main screen display **36** for operator selection that includes a "Last Image Recorded" icon and a "Selected Image" icon as shown in FIG. **9**. If the "Last Image Recorded" icon is selected by the operator, the microcontroller **120** controls the transfer and display of the stored digital images in either manual or automatic scrolling modes starting with the last image recorded and then decrements. If the "Selected Image" icon is selected by the operator, the microcontroller **120** controls the display unit **36** to display a selected image list as illustrated in FIG. **10**. The operator can then scroll through the numeric list and select the desired starting image using the main screen operator control unit **38**. Alternatively, different user interfaces can be employed, for example scrolling numbers or the display of a virtual keyboard on the display unit **36**, to allow the operator to select a specific image as the start image. Still further, a small keyboard or keypad can be incorporated in the camera as part of the camera operator interface **74**. If the automatic scroll mode is selected, a further user interface window (not shown) is displayed on the main display screen **36** to allow the operator to select a desired time period between images or a default time period previously stored in memory.

In addition to scrolling through the stored images, a more advanced graphical user interface can be incorporated to permit the operator to select various camera functions. For example, as shown in FIG. **11**, camera function icons are displayed in an icon group **200** on the main screen display unit **36** to edit information related to the images (including conventional APS data), obtain help information, enter user defined data into the camera or perform other functions. An image display area **202** is used to display the digital image being reviewed or edited the display area **202** to indicate the respective position of the displayed digital image in its associated memory. A function name display area **206** dis-

plays the camera function currently selected. A function data entry area **208** displays data associated with the selected camera function. If desired, the icon group **200** can be generated as transparent icons that can be laid over the displayed digital image, so that the size of the image display area **202** can be expanded and the camera operator can see the displayed digital image through the displayed icons.

Each camera function selectable by the camera operator has a corresponding individual icon in the icon group **200**. In the illustrated example, a copy number function is accessed by selecting a copy number icon **210**, an image format function is accessed by selecting an image format icon **212**, a title function is accessed by selecting a title icon **214**, an album function is accessed by selecting an album icon **216**, and a magnifying function is accessed by selecting a magnification icon **218**. The camera operator activates the edit switch **40** to cause the first function icon displayed in the icon group **200**, in this case the copy number icon **210**, on the main screen display unit **36** to be highlighted. The up directional switch **46** and the down direction switch **50** are utilized to advance through the displayed function icons until the desired title icon **208** is highlighted. For example, by activating the down direction switch **50** twice, the highlighted icon sequentially moves from the copy number icon **210** to the image format icon **212** and then to the title icon **214**. Once the desired function icon is highlighted, for example the title icon **214**, the operator presses the edit switch **40** to enter the highlighted function mode. The name of the function mode is displayed in the function name display area **206** of the main screen display unit **36** and the current data for the selected image is displayed in the function data entry area **208**. In the case of titles, the up directional switch **46** and the down directional switch **50** are utilized to scroll through pre-programmed titles. Alternatively, the operator can enter a desired title by scrolling through and selecting individual characters displayed in the function data entry area **208**. A function is exited by pressing the exit switch **42**.

In a preferred embodiment, if the operator changes the title of one digital image and then uses the directional switches to selected another digital image without exiting the title function, the title selected for the previous digital image will be automatically selected for the newly selected digital image. The title will continue to be maintained for all digital images viewed in the title function mode until the camera operator either exits the function or selects a new title. Accordingly, the camera operator can modify a sequence of images to have the same title in a quick and convenient manner.

The camera operator can change the image format of the displayed hybrid or film mode image by selecting the image format function icon **212** to enter the image format function as illustrated in FIG. **12**. The operator can select image formats including classic, HDTV and panoramic formats associated with conventional APS cameras. Film mode images and hybrid mode images are stored and displayed on the main screen display **36** in a 9:16 aspect ratio corresponding to the aspect ratio of the silver-halide image system **14**, and digital mode images are stored and displayed in a 3:4 aspect ratio corresponding to the aspect ratio of the CCD image sensor **94**. The image format selected by the operator before the image was captured is displayed in the function data entry area **208**. The operator then uses the main screen operator control unit **38** to edit the image format selection. In a preferred embodiment, the full available digital image for a given image capture mode is displayed and a mask **220** may be used to indicate to the operator which portions of the image will be excluded for a given selected digital image, when an eventual photographic print is made from the corresponding film image. FIG. **12**, for example, illustrates a digital mode image that is being displayed in HDTV format. Accordingly, the operator can change an image format, for example from classic format to a panoramic format, and compare the differences between the two formats before making a final decision as to which format is desired for the selected image. FIG. **13**A illustrates an uncropped digital format. FIGS. **13**B, C and D illustrate the same digital format cropped, respectively, to the film or hybrid HDTV format, the film or hybrid panoramic format, and the film or hybrid classic format.

The film mode images, hybrid mode images and digital mode images are stored as image records that include an ID file, an image information file (IIF) and an image data field (IDF) as illustrated in FIG. **14**. The ID file contains data identifying the images and includes, for example, the frame number tag of a corresponding photographic film image in the case of film mode images and hybrid mode images. The IIF contains image data related to the images and includes, for example, conventional APS data in addition to other data associated with the image that can be entered by the camera operator through the camera operator interface **74** or downloaded via the data communications port **136**. The IDF contains the actual pixel data for the digital image. When an editing operation is performed, the IIF for the corresponding digital image is updated with the edited data by the microcontroller **120**. Further, in the cased mode images, the operator edited data is also written back to the magnetic recording tracks of the corresponding photographic film image. Accordingly, changes selected by the operator, as with data written to the film during the image capture operation, can be transmitted to a photo finisher with the exposed photographic film.

Data is conventionally written to the magnetic recording tracks of the photographic film by the magnetic head **108** after an exposure operation is completed and the film is advanced from one frame to the next frame by the film transport unit **60**. Accordingly, when editing information has been entered with respect to film mode images or hybrid mode images, the photographic film is rewound and advanced once again by the film transport unit **60** so that the edited data can be written to photographic film by the magnetic head **108**. Alternatively, the editing information can be written to the photographic film during a rewind operation prior to removing a film cartridge from the camera. In this manner, it is possible to edit data written to the photographic film at any time, either prior to the removal of the film cartridge **98** or even after re-insertion of a film cartridge into the film chamber **98**.

If the camera operator would like to save a particular image for future review, even after a film cartridge or memory card is removed, the camera operator can select the album function icon **216** in the function icon group as illustrated in FIG. **15**. When the album function **216** is selected, the digital image displayed on the main screen display unit **36** can be selectively stored as an album image in the album image storage section **125** of the base camera memory **126** by using the directional switches to select either a "Yes" or "No" album copy option. A stored album image remains in the base camera memory **126** until specifically deleted by the camera operator. Accordingly, the camera includes an integrated album of stored images that remains with the camera. If desired, the album image storage section **125** of the non-volatile flash memory **126** can be further sub-divided into different album storage sub-sections

(**125***a*, **125***b*, **125***c*, **125***d*, etc. as shown in FIG. **7**), so that the camera operator can store related images (for example related by subject, date or time) in the same album sub-section or different camera operators can utilize different album sub-sections to store their respective images. In the event of different camera operators, password protections are preferably utilized so that deletion and/or viewing of images can be performed only by the operator that stored the images.

Album images, as with film mode images, have a resolution corresponding to the resolution of the main screen display unit **36**. The size of the album image preferably corresponds to the size of the underlying digital image selected for album storage. For example, if a film mode image or a hybrid mode image is selected for album storage, the size of the album image will correspond to the image size of the hybrid mode image. Alternatively, if a digital mode image is selected from album storage, the size of the album image will correspond to the image size of the digital mode image.

The images stored in the album may be accessed by setting display unit operation switch **39** to the "A" or "ALBUM" position shown in FIG. **5**. An image in the album will be displayed on main display unit **36**. The directional switches **48**, **52** may then be used to scroll up or down and change the image displayed. The edit switch **40** may be used to display the screen of FIG. **16** and the slide show feature discussed above can also be utilized to display the album images. FIG. **16**, for example, illustrates a slide show icon **222** that, when selected, allows the camera operator to activate the slide show feature. While in the slide show function, the up directional switch **46** and the down directional switch **50** are used to control the speed at which images are presented or a default speed can be utilized. In a preferred embodiment, the microcontroller **120** will control the display of each album image once when the camera is powered by batteries **77** and then exit the function to conserve energy. When the camera is connected to a main power source via the power adapter connector **79** , the microcontroller **120** will control the display of the album images so that they continue to scroll through until the operator activates the exit switch **42**. A delete icon **228** may be used to remove images from the album.

Other functions include a magnifying function that allows the operator to temporarily magnify the image of the main display screen **36** when the magnification icon **218** is selected, a utilities function that allows the operator to enter time and date information when the utilities icon **224** is selected, a help function that the operator can access to obtain information from a help menu when the help icon **226** is selected, and a print copy function that can be accessed by clicking on the print copy icon **210**. By entering the number of print copy function, the camera operator can select the number of prints desired from a photographic film image corresponding to either a film mode digital image or a hybrid mode digital image. The number of prints data is then written to the corresponding photographic film image by the magnetic head **108**. Similarly, an image processing function is preferably incorporated that permits the operator to crop and pan images, where the image processing data is written to the photographic film for subsequently retrieval and use by a photo finisher.

In order to offer the operator the opportunity to edit image information prior to removal of a film cartridge from the film chamber **98**, it is preferable not to have the film automatically rewind after the completion of a roll. Instead, an indicator is provided, for example an LED indicator in the viewfinder, informing the camera operator that the end of roll has been reached. At this point, the camera operator can press a rewind switch to institute film rewinding if editing of image information is not desired. If editing is desired, however, the camera operator turns on the main display unit **36** the microcontroller **120** causes a current film order window of the type illustrated in FIG. **17** to be display indicating the type of images captured. The camera operator can then activate the edit switch **40** to cause the camera to go into the modes described above or activate the exit switch **42** to cause film rewinding.

It is desirable to provide a mechanism for identifying the hybrid mode images stored on the memory card with the film cartridge containing the corresponding film images. In one embodiment, the detection of the insertion of a film cartridge by the cartridge sensors **106** causes the microcontroller **120** to display a film cartridge identification prompts illustrated in FIG. **18**. The camera operator then utilizes the main screen operator control unit **38** to scroll through alphanumeric characters until a desired character is highlighted. The camera operator then presses the edit switch **40** to select the highlighted character which is then displayed in a ID display area **230**. The camera operator continues to select characters until the exit switch **42** is pressed to exit the function. The user is prompted to enter a roll identification code each time a film cartridge is inserted into the film chamber **98**. The microcontroller **120** then tags each film mode image and hybrid mode image with the roll identification code and frame number for each corresponding photographic image as part of the ID file.

Alternatively, an automatic mechanism for providing roll identification can be incorporated into the camera. For example, the cartridge sensors **106** include a cartridge identification sensor **107** that reads an optically encoded or magnetically encoded roll or cartridge identification code provided on a film cartridge, and supplies the identification code to the main camera controller **68** for transfer to the microcontroller **120** . The microcontroller **120** can therefore automatically tag each digital image, whether a film mode image or hybrid mode image, with the corresponding film cartridge ID. Although it is preferable to include the cartridge identification sensor **107** within the film chamber **98**, it is also possible to provide the cartridge identification sensor **107** in the main body **10** of the camera in a manner permitting the camera operator to pass a film cartridge over the cartridge identification sensor **107** prior to inserting it into the film chamber **98**. Also, the CCD array **94** could be used to image an identification code on a cartridge held before the camera, after which controller **120** would process the image of the cartridge to extract the code. Still further, the main body **10** can be provided with a detachable "wand" with the cartridge identification sensor **107** located on the end of the wand, thereby allowing the camera operator to scan the film cartridge with the wand to enter the cartridge identification data. In addition, roll or cartridge identification code can be provided on the magnetic layer of the photographic film, such as in the form of a header file on the leader portion of the film. The magnetic head **108** is then used to read the header file and transfer the roll identification code to the main camera controller **74** and subsequently the microcontroller **120**. The microcontroller **102** then stores the roll identification code as part of the ID file for a hybrid mode image or a film mode image.

In a preferred embodiment, only those hybrid mode images corresponding photographic film images located on the film cartridge presently retained within the camera -are displayed during a scrolling, review or editing operation,

thereby preventing the camera operator from editing information related to a hybrid mode image when the editing information cannot be stored on the corresponding photographic film image. Alternatively, the camera operator may be permitted to scroll through all of the hybrid mode images stored on the memory card. In the event, however, that the camera operator attempts to edit a hybrid mode image that does not have a corresponding photographic film image on the presently retained film cartridge, a warning indication is displayed on the main display screen unit **36** advising the operator to insert the correct film cartridge. Once the correct film cartridge is inserted, the camera operator is permitted to edit the information and the information is updated on the magnetic recording tracks of the corresponding photographic film image.

In a further embodiment, instead of writing a cartridge identification code on the hybrid mode image, a memory card identification code can be written to a film cartridge or the magnetic recording tracks of each corresponding photographic film image. In such a case, the microcontroller **120** keeps an identification table that indicates which film exposure corresponds to a given hybrid mode image. For example, when a film cartridge is removed, the information contained in the table is written to the photographic film, preferably in the form of a header file at the leader portion of the photographic film. Accordingly, when a memory card is inserted into the camera and the editing mode is selected to edit hybrid mode images, the microcontroller **120** can identify whether the film cartridge presently in the camera would contain images corresponding to the hybrid mode image desired to be edited. If not, the operator is notified and prompted to change the film cartridge. When a new cartridge is entered the identification table is updated with the information corresponding to that particular cartridge. It would be apparent to those of ordinary skill in the art that other addressing schemes can be employed to provide identification tags for corresponding rolls and memory card.

As illustrated in FIG. **19**, the camera body **10** can be connected to a host computer **232** via data communication port **136**. When tethered to the host computer **232**, all operator inputs usually selected by the various switches provided by the camera operator interface **74** can be sent to the camera by the host computer **232**. Accordingly, the camera can be operated remotely by a local operator working on the host computer **232** or a remote operator working on a remote computer **234** linked to the host computer **232** by any form of communication link **233**. In one embodiment, a graphical user interface is displayed on a monitor **236** of the host computer **232** (or the remote computer **234**) including virtual switches representing each of the actual control switches of the camera as illustrated in FIG. **20**. Utilizing an interface device such as a "mouse", the operator can "click" on any of the virtual control switches to activate the corresponding function in the camera as if the actual button or switch on the camera were being depressed.

As it may be desirable to have the computer operator remain at the computer instead of using the viewfinder **20** to frame a subject image, a virtual viewfinder is provided by utilizing the CCD image sensor **94** to image the subject scene, either in a still image mode or a motion image mode, and supply a digital viewfinder image **238** to the computer monitor **236** for viewfinding purposes. For example, a working image is captured every second and supplied from the working memory **124** to the host computer **232** via the data communication port **136** under control of the microcontroller **120**. When the subject image is appropriate, the computer operator then activates the virtual shutter button displayed on the computer monitor **236** to cause image capture.

The computer operator can perform a variety of image processing functions on digital images downloaded from the camera. For example, image processing software can be utilized in the host computer **232** to perform zoom, pan and crop functions on any portion of a displayed image, attach special borders for special occasions, and print the edited images on a printer. Image data generated by the host computer **232** can be transferred back to the camera to update the image information files of film mode images stored in the base camera memory **126** or of hybrid mode and digital mode images contained in a memory card coupled to the interface connector **130**. In addition, data generated by the host computer can be transferred to the camera for writing on the magnetic layer of the photographic film by the magnetic head **108**. Accordingly, a computer operator can generate photo-finishing data on the host computer **232** and transfer the photo-finishing data directly to the photographic film in the camera, such that when the film is presented to a photo-finisher, the data can be retrieved from the photographic film and utilized in a photo-finishing operation. Still further, album images contained in the host computer **232** can be transferred to the camera for storage in the album image storage section **125** of the base camera memory **126**.

The utilization of the host computer **232** to perform editing operations provides the advantage of having more advanced processing power available to perform the editing operations and a larger monitor making it easier to view the edited images. However, the same editing functions can be included within the functions available to the camera operator. The camera operator can therefore perform image processing functions including zooming, cropping and panning utilize the camera control interface **74** in conjunction with a user interface displayed on the main display screen unit **36**. Similarly, data corresponding to the editing operation is stored on the photographic film by writing the editing data to the film with the magnetic head **108**.

The camera structure described above provides a number of distinct technical advantages. The provision of the album image storage section **125** in the internal base camera memory **126** provides a convenient and practical method of allowing the camera operator to store digital images that can be easily transported and displayed. The provision of the quick review switch **37** enables an camera operator to quickly review the last image captured, while at the same time conserving energy by allowing the main display screen **36** to remain deactivated until specifically required for the quick review. The provision of the data communication port allows the camera to be conveniently coupled to the host computer **232**, thereby allowing the host computer **232** to control the operation of the camera. In addition, the host computer **232** can transfer data, including album images, directly for storage in the main camera memory **126** or a memory card coupled to the interface connector **130**, and also transfer data to photographic film contained in the camera by writing the data to the photographic film with the magnetic head **108**. Still further, the camera operator interface **74** in operation with the main display screen unit **36** provides a convenient method of entering cartridge identification data into the camera, thereby allowing hybrid mode images stored on a memory card to be tagged with the cartridge identification code of a film cartridge containing corresponding photographic images.

The invention has been described with reference to certain preferred embodiments thereof. It will be understood, however, that modifications and variations are possible within the scope of the appended claims. For example, the

invention has been described with reference to an exemplary graphical user interface. It will be understood, however, that specifics of the user interface utilized to present and select camera functions can vary widely. In addition, modifications in the overall architecture of the camera are possible. For example, a single optical system can be utilized to provide scene light to both the CCD image sensor **94** and the image plane **100** of the film transport unit **60**.

Parts List

10 . . . main camera body
12 . . . sliding lens cover
14 . . . silver-halide optical system
16 . . . digital imaging optical system
18 . . . electronic flash unit
19 . . . masking device
20 . . . optical viewfinder
21 . . . optical system
22 . . . LCD status unit
23 . . . image capture mode selector switch
24 . . . shutter button
25 . . . zoom control switch
26 . . . picture taking mode selector switch
28 . . . flash mode selector switch
30 . . . timer mode selector switch
32 . . . image format selector switch
34 . . . hinged support element
36 . . . main screen display unit
37 . . . review switch
38 . . . main screen operator control unit
39 . . . display mode selection switch
40 . . . edit switch
42 . . . exit switch
44 . . . directional switch unit
46 . . . up directional switch
48 . . . right directional switch
50 . . . down directional switch
52 . . . left directional switch
54 . . . memory card door
56 . . . battery compartment door
58 . . . film chamber door
60 . . . film transport unit
62 . . . range finding module
64 . . . light sensor
68 . . . main camera controller
70 . . . analog subsystem unit
72 . . . digital subsystem unit
74 . . . camera operator interface
76 . . . power supply unit
77 . . . AA cells
78 . . . multi-element lens
79 . . . power adapter connector
80 . . . aperture/shutter mechanism
82 . . . zoom/focus mechanism
84 . . . multi-element lens
86 . . . blur filter
88 . . . telephoto drive mechanism
90 . . . aperture drive mechanism
92 . . . aperture
94 . . . image sensor
96 . . . film drive
98 . . . film chamber
100 . . . image plane
102 . . . winding spool
104 . . . film perforation sensor
106 . . . cartridge sensors
107 . . . cartridge identification sensor
108 . . . magnetic head
110 . . . vertical clock drive circuit
112 . . . horizontal clock drive circuit
114 . . . CDS circuit
116 . . . programmable gain amplifier
118 . . . A/D converter
120 . . . microcontroller
122 . . . application specific integrated circuit (ASIC)
124 . . . DRAM working memory
125 . . . album storage section
126 . . . base camera flash memory
127 . . . film mode image storage section
128 . . . read only memory (ROM)
130 . . . memory card interface connector
132 . . . LCD interface drive circuitry
134 . . . standard communications interface circuit
136 . . . data communications port
140 . . . microcontroller
142 . . . magnetics I/O
144 . . . motor drivers
150 . . . LCD power module
152 . . . analog subsystem module
154 . . . main power module
156 . . . LCD backlight power module
158 . . . digital subsystem power module
160 . . . lash charger and control module
162 . . . a flash capacitor
164 . . . flashtube
200 . . . icon group
202 . . . image display area
204 . . . a scroll bar
206 . . . function name display area
208 . . . function data entry area
210 . . . copy number icon
212 . . . image format icon
214 . . . title icon
216 . . . album icon
218 . . . magnification icon
220 . . . mask
222 . . . slide show icon
224 . . . utilities icon
226 . . . help icon
228 . . . delete icon
232 . . . host computer
233 . . . communications link
234 . . . remote computer
236 . . . monitor
238 . . . digital viewfinder image

What is claimed is:

1. A camera comprising:

a user activated shutter control;

a digital imaging device adapted to generate a digital image representative of a subject scene in response to activation of the shutter control;

a first memory for receiving and storing a last digital image of a plurality of digital images generated by the digital imaging device as a working image;

a second non-volatile memory for storing the plurality of digital images generated by the digital imaging device;

a display screen;

a control processor adapted to control an operation of the digital imaging device, the first memory, the second non-volatile memory and the display screen, and controlling first and second display modes; and

camera operator controls for selecting at least said first or second display modes;

wherein the control processor, in the first display mode, accesses the first memory and transfers the last digital image to the display screen for display;

wherein the control processor, in the second display mode, accesses a plurality of images from the second non-volatile memory and transfers the images to the display screen for display; and

wherein, in the first display mode, the control processor activates the display screen for a predetermined time period to display the image in the fixed memory, and then deactivates the display screen while continuing to enable the activation of the shutter control to generate a subsequent digital image.

2. A camera as claimed in claim **1**, wherein the control processor in the second display mode automatically accesses and displays a plurality of digital images, and wherein each subsequent one of the plurality of digital images replaces the preceding one of the plurality of digital images and is displayed for a fixed period of time.

3. A camera as claimed in claim **1**, further comprising photographic imaging device for imaging the subject scene onto a photographic film plane of the camera under control of the control processor.

4. A camera as claimed in claim **3**, wherein the control processor further includes a camera operator interface that includes an image mode selector for selecting one of a film imaging mode, a hybrid imaging mode and the digital imaging mode of operation.

5. A camera as claimed in claim **4**, wherein the photographic imaging device images the subject scene onto the photographic image plane in the film imaging mode and the hybrid imaging mode to generate a corresponding photographic film image on a photographic film located at the photographic imaging plane that corresponds with the digital image generated by the digital imaging device.

6. A camera as claimed in claim **5**, wherein the digital imaging device generates a plurality of digital images under control of the control processor, and wherein each subsequent one of the plurality of digital images replaces a preceding one of the plurality of digital images as the image stored in the first memory, whereby the image stored in the first memory is representative of the last subject scene imaged by the camera.

7. A camera as claimed in claim **5**, wherein the control processor further generates a film mode digital image in the film imaging mode of operation and stores the film mode digital image in a third internal fixed base camera memory of the camera.

8. A camera as claimed in claim **5**, further comprising a removable interface connection device for receiving a removable memory device; wherein the second non-volatile memory is comprised in a removable memory card coupled to the interface connection device.

9. A camera as claimed in claim **8**, wherein the control processor generates a hybrid mode digital image in the hybrid mode of operation and transfers the hybrid mode digital image to the removable memory interface connection means for storage on the memory card.

10. A camera as claimed in claim **9**, wherein the camera operator control includes a first control for selecting the first display mode, and a second control for selecting film images or hybrid images in the second display mode.

11. A camera as claimed in claim **1**, wherein the digital imaging device generates a plurality of digital images under control of the control processor, and wherein each subsequent one of the plurality of digital images replaces a preceding one of the plurality of digital images as the image stored in the first memory, whereby the image stored in the first memory is representative of the last subject scene imaged by the camera.

12. A camera as claimed in claim **4**, wherein the camera operator control includes a quick review switch, and wherein the control processor activates the display screen to display the image stored in the first memory only when the quick review switch is activated.

13. A camera as claimed in claim **1**, wherein images stored in the first memory are uncompressed and images stored in the second non-volatile memory are compressed.

14. A camera comprising:

an electronic image sensor;

an optical system positioned to project an imaged scene onto the electronic image sensor;

a user-activated shutter control;

a fixed memory coupled to an output of the electronic image sensor, wherein said fixed memory receives and stores a digital image generated by the electronic image sensor in response to an exposure signal;

a removable non-volatile memory for storing a plurality of digital images;

a display screen;

a control processor coupled to the display screen, the electronic image sensor, the fixed memory, (and) the removable non-volatile memory, and a user-activated shutter control;

a first power module for supplying power to at least the display screen, wherein the control processor generated a compressed digital image from the image from the electronic image sensor and transfers the compressed digital image to the removable non-volatile memory while retaining the last image in the fixed memory until a subsequent digital image is generated by the electronic image sensor in response to a subsequent exposure signal;

wherein the control processor generates a quick review image from the image stored in the fixed memory and supplies the quick review image to the display screen for display in response to an operation interface first display mode control;

wherein the control processor generates a sequence of digital images from the plurality of compressed digital images stored in the removable non-volatile memory and supplies the images to the display screen for display in response to an operator interface second display mode control; and wherein the second power module is activated to supply power to the display screen for a predetermined time period after the first display mode control is activated, and after said predetermined time period, the second power module is deactivated in order to deactivate the display screen while the first power module continues to supply power to at least the control processor and continues to enable the activation of the shutter control to generate a subsequent digital image.

15. A camera as claimed in claim **14**,

wherein the optical system further comprises a silver-halide optical system for selectively exposing a film plane of a photographic film transport unit of the camera to the imaged scene in response to the exposure signal.

16. A camera as claimed in claim **15**,

wherein the operator interface further includes an exposure switch for generating the exposure signal ; and

wherein the operator interface further includes an image mode selector for selecting one of a film imaging mode, a hybrid imaging mode and a digital imaging mode of operation.

17. A camera as claimed in claim **16**,

wherein the control processor controls the operation of the silver-halide optical system in the film imaging mode and the hybrid imaging mode to expose the film plane to the imaged scene.

18. A camera as claimed in claim **16**,

wherein the control processor generates a film mode digital image in the film imaging mode of operation and stores the film mode digital image in an internal fixed base camera memory of the camera.

19. A camera as claimed in claim **16**,

wherein the control processor activates the display screen to display the quick review image as long as the first display mode control is activated.

20. A camera as claimed in claim **14**, wherein the display screen comprises an LCD and an LCD backlight, said second power module controlling the LCD backlight for the LCD.

21. A camera comprising:

an optical viewfinder adapted to compose an image representative of a subject scene;

a user activated shutter control;

a digital imaging device adapted to generate a digital image representative of the subject scene in response to activation of the shutter control;

a first memory for receiving and storing a last digital image of a plurality of digital images generated by the digital imaging device as a working image;

a second non-volatile memory for storing the plurality of digital images generated by the digital imaging device;

a display screen;

a control processor adapted to control an operation of the digital imaging device, the first memory, the second non-volatile memory and the display screen, and controlling first and second display modes; and

camera operator controls for selecting at least said first or second display modes;

wherein the control processor, in the first display mode, accesses the first memory and transfers the last digital image to the display screen for display;

wherein the control processor, in the second display mode, accesses a plurality of images from the second non-volatile memory and transfers the images to the display screen for display; and

wherein the control processor deactivates the display screen while a user composes the image using the optical viewfinder, activates the screen for a predetermined time period to display the captured image, and then deactivates the display screen at the end of the predetermined time period while continuing to enable the activation of the shutter control to generate a subsequent digital image.

* * * * *

EXHIBIT 6

US006879342B1

(12) **United States Patent**
Miller et al.

(10) **Patent No.: US 6,879,342 B1**
(45) **Date of Patent: Apr. 12, 2005**

(54) **ELECTRONIC CAMERA WITH IMAGE REVIEW**

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(73) Assignee: **Eastman Kodak Company**, Rochester, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 973 days.

(21) Appl. No.: **09/598,125**

(22) Filed: **Jun. 21, 2000**

Related U.S. Application Data

(62) Division of application No. 08/769,573, filed on Dec. 19, 1996.

(51) **Int. Cl.**[7] **H04N 5/222**

(52) **U.S. Cl.** **348/333.05**; 348/333.02; 348/333.11; 348/231.99

(58) **Field of Search** 348/333.01, 333.02, 348/333.05, 333.11, 220.1, 239, 231.1, 231.99, 231.3

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,157,511 A * 10/1992 Kawai et al. 386/68
5,742,339 A * 4/1998 Wakui 348/231.9
5,861,918 A * 1/1999 Anderson et al. 348/231.9
6,097,431 A * 8/2000 Anderson et al. 348/231.7
6,249,316 B1 * 6/2001 Anderson 348/333.05

* cited by examiner

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(57) **ABSTRACT**

A camera comprising:

(a) means for capturing an image of a real world scene as an image signal;

(b) storage means for storing captured images and from which stored images can be read;

(c) a screen;

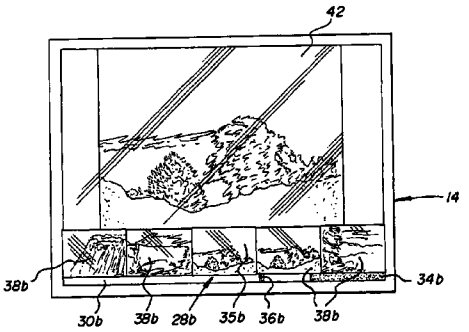
(d) a means for displaying on the screen a symbolic representation of the list of stored images and a user selected location within the list;

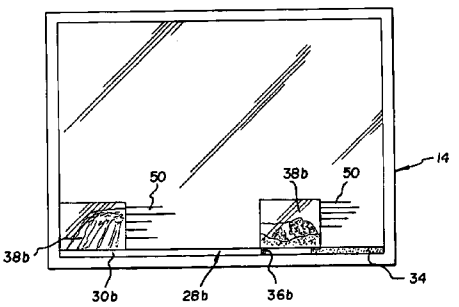
(e) a user interface which allows a user to select the location within the list; and

(f) means for displaying on the screen the image within the list corresponding to the selected location.

A method which can be executed by a camera such as the above, is also provided.

21 Claims, 7 Drawing Sheets





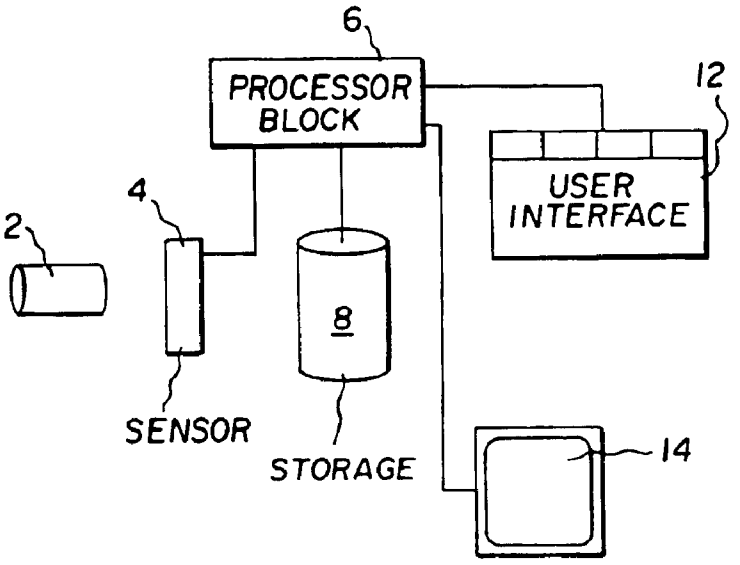

6
PROCESSOR BLOCK
12
USER INTERFACE
4
2
8
SENSOR
STORAGE
14

FIG. 1

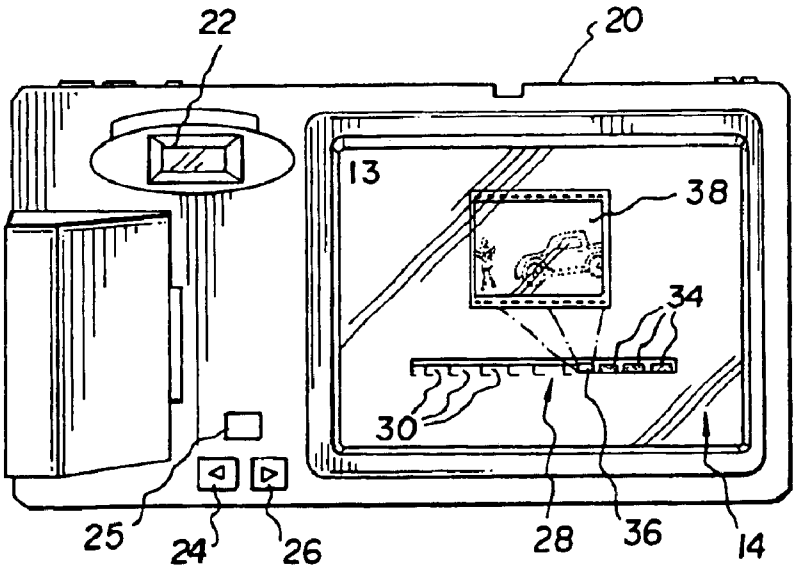

22
20
13
38
34
30
25
24
26
28
36
14

FIG. 2

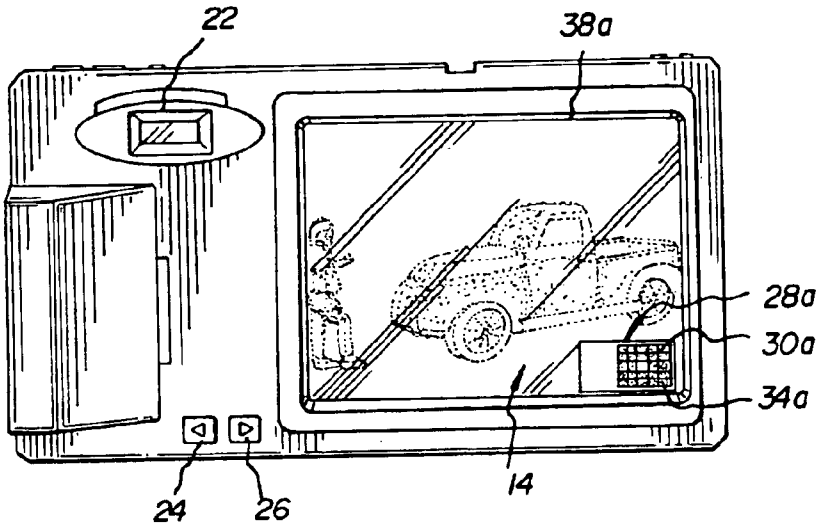


FIG. 3

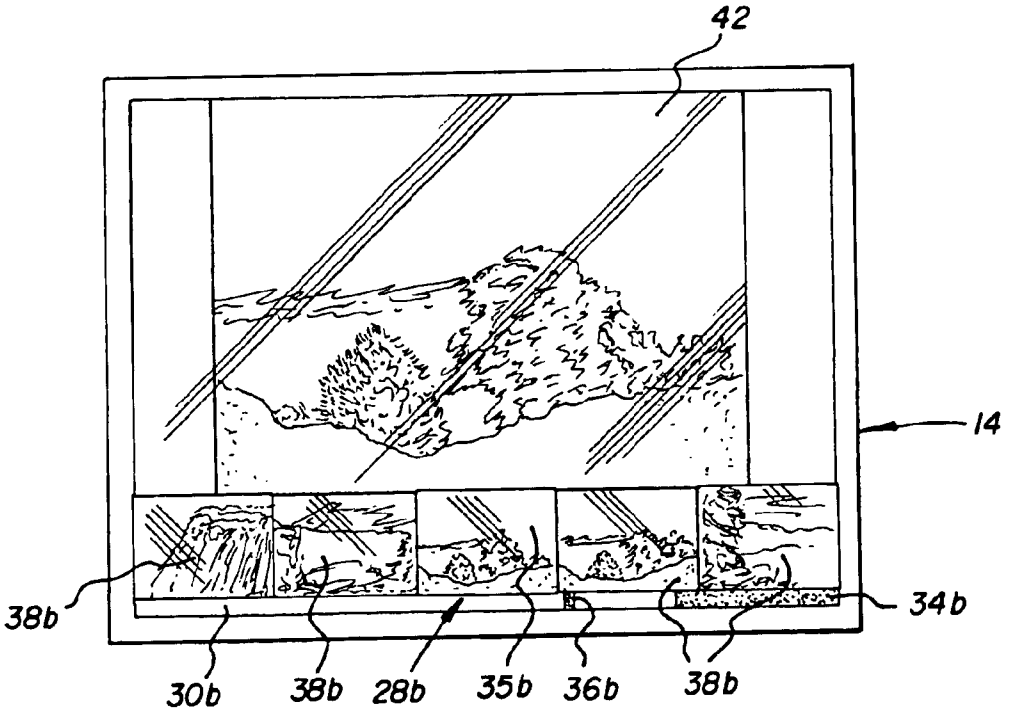


FIG. 5

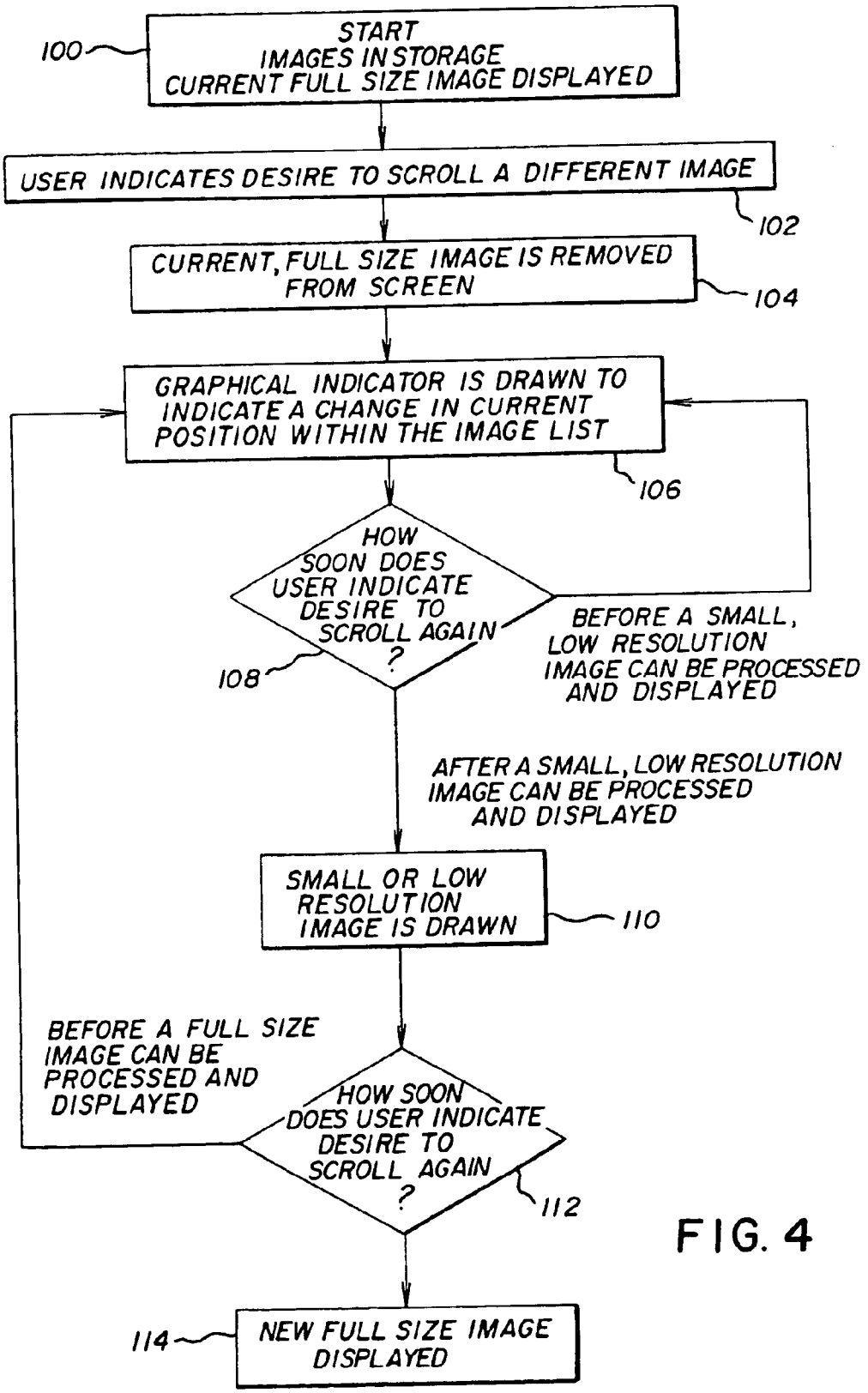

100
START
IMAGES IN STORAGE
CURRENT FULL SIZE IMAGE DISPLAYED
USER INDICATES DESIRE TO SCROLL A DIFFERENT IMAGE
102
CURRENT, FULL SIZE IMAGE IS REMOVED FROM SCREEN
104
GRAPHICAL INDICATOR IS DRAWN TO INDICATE A CHANGE IN CURRENT POSITION WITHIN THE IMAGE LIST
106
HOW SOON DOES USER INDICATE DESIRE TO SCROLL AGAIN ?
108
BEFORE A SMALL, LOW RESOLUTION IMAGE CAN BE PROCESSED AND DISPLAYED
AFTER A SMALL, LOW RESOLUTION IMAGE CAN BE PROCESSED AND DISPLAYED
SMALL OR LOW RESOLUTION IMAGE IS DRAWN
110
BEFORE A FULL SIZE IMAGE CAN BE PROCESSED AND DISPLAYED
HOW SOON DOES USER INDICATE DESIRE TO SCROLL AGAIN ?
112
114
NEW FULL SIZE IMAGE DISPLAYED

FIG. 4

FIG.6A

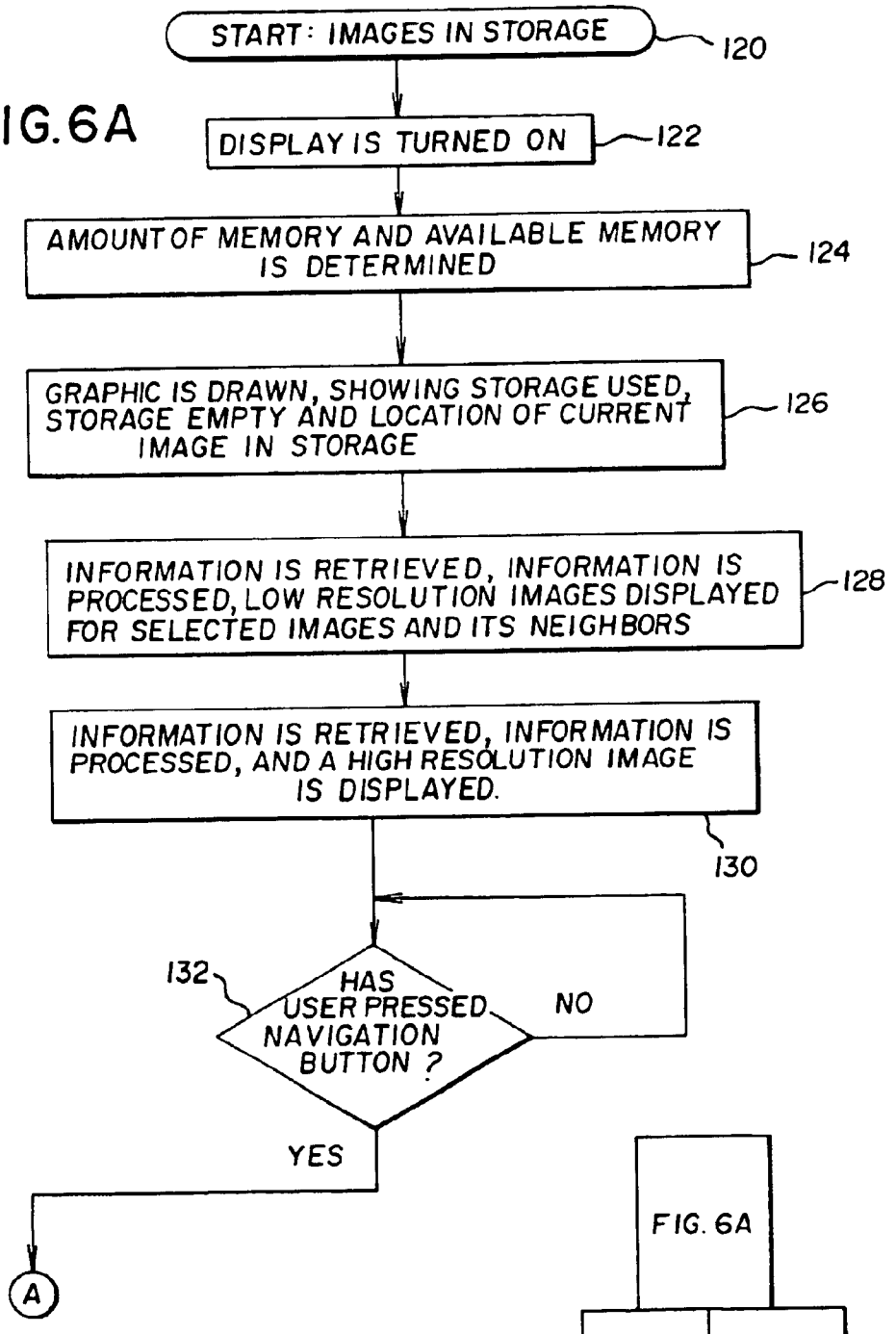

START: IMAGES IN STORAGE
120
DISPLAY IS TURNED ON
122
AMOUNT OF MEMORY AND AVAILABLE MEMORY IS DETERMINED
124
GRAPHIC IS DRAWN, SHOWING STORAGE USED, STORAGE EMPTY AND LOCATION OF CURRENT IMAGE IN STORAGE
126
INFORMATION IS RETRIEVED, INFORMATION IS PROCESSED, LOW RESOLUTION IMAGES DISPLAYED FOR SELECTED IMAGES AND ITS NEIGHBORS
128
INFORMATION IS RETRIEVED, INFORMATION IS PROCESSED, AND A HIGH RESOLUTION IMAGE IS DISPLAYED.
130
132
HAS USER PRESSED NAVIGATION BUTTON ?
NO
YES
A

FIG. 6A
FIG. 6B
FIG. 6C

FIG. 6

FIG. 6B

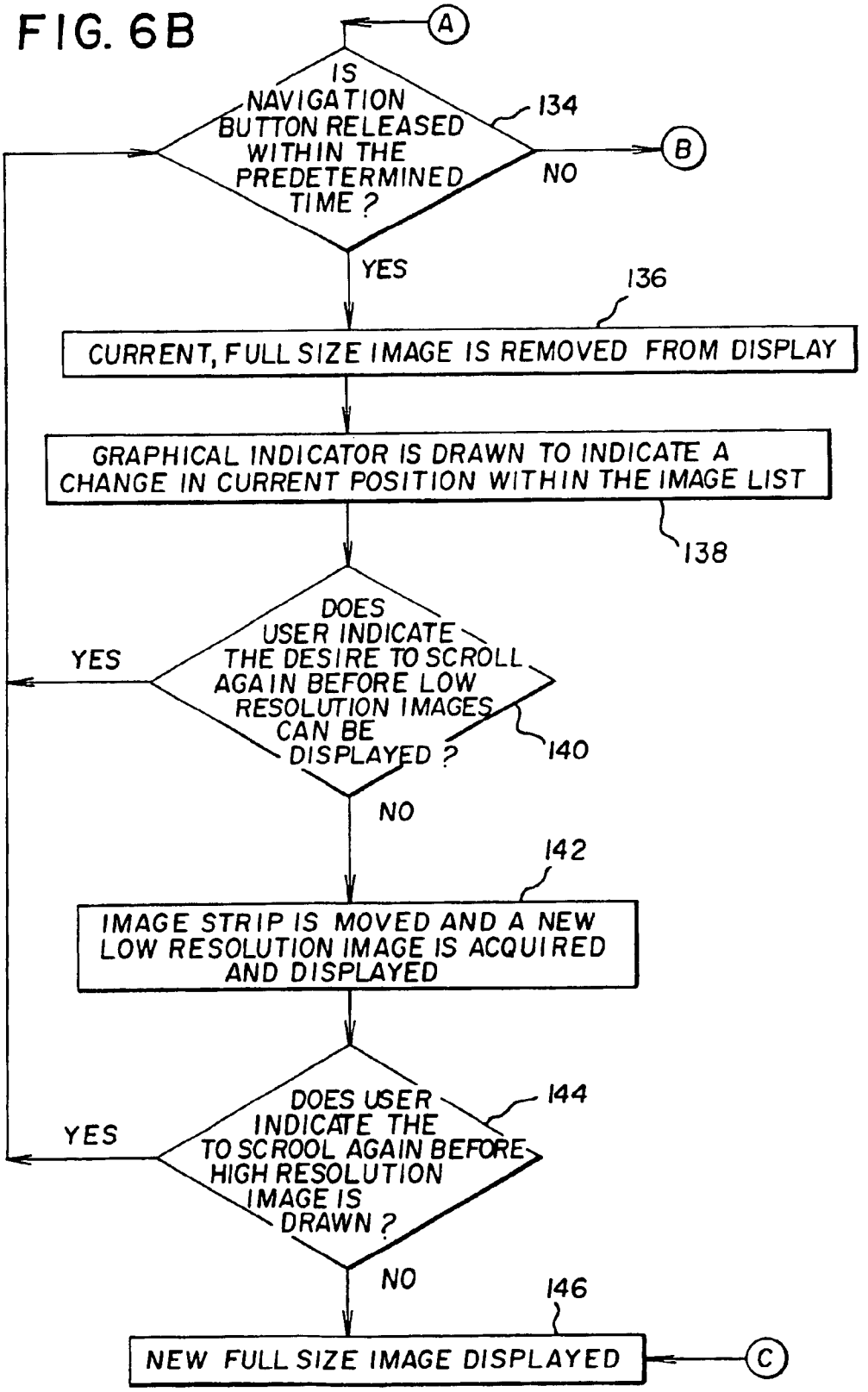
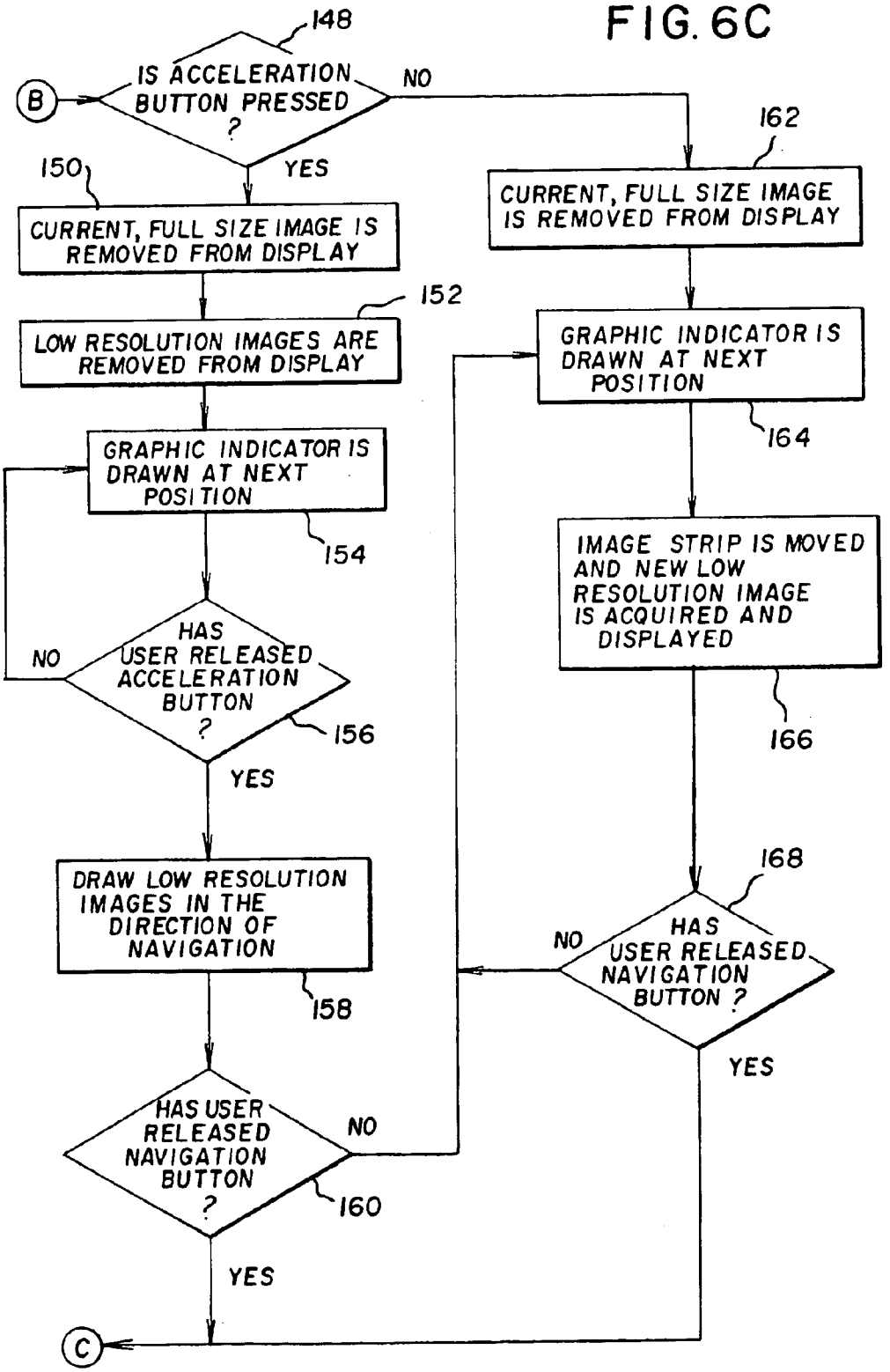

A
IS NAVIGATION BUTTON RELEASED WITHIN THE PREDETERMINED TIME ?
134
NO
B
YES
136
CURRENT, FULL SIZE IMAGE IS REMOVED FROM DISPLAY
GRAPHICAL INDICATOR IS DRAWN TO INDICATE A CHANGE IN CURRENT POSITION WITHIN THE IMAGE LIST
138
DOES USER INDICATE THE DESIRE TO SCROLL AGAIN BEFORE LOW RESOLUTION IMAGES CAN BE DISPLAYED ?
YES
140
NO
142
IMAGE STRIP IS MOVED AND A NEW LOW RESOLUTION IMAGE IS ACQUIRED AND DISPLAYED
DOES USER INDICATE THE TO SCROOL AGAIN BEFORE HIGH RESOLUTION IMAGE IS DRAWN ?
144
YES
NO
146
NEW FULL SIZE IMAGE DISPLAYED
C

FIG. 6C


148
IS ACCELERATION BUTTON PRESSED ?
B
NO
YES
150
CURRENT, FULL SIZE IMAGE IS REMOVED FROM DISPLAY
152
LOW RESOLUTION IMAGES ARE REMOVED FROM DISPLAY
GRAPHIC INDICATOR IS DRAWN AT NEXT POSITION
154
HAS USER RELEASED ACCELERATION BUTTON ?
NO
156
YES
DRAW LOW RESOLUTION IMAGES IN THE DIRECTION OF NAVIGATION
158
HAS USER RELEASED NAVIGATION BUTTON ?
NO
160
YES
C
162
CURRENT, FULL SIZE IMAGE IS REMOVED FROM DISPLAY
GRAPHIC INDICATOR IS DRAWN AT NEXT POSITION
164
IMAGE STRIP IS MOVED AND NEW LOW RESOLUTION IMAGE IS ACQUIRED AND DISPLAYED
166
168
HAS USER RELEASED NAVIGATION BUTTON ?
NO
YES

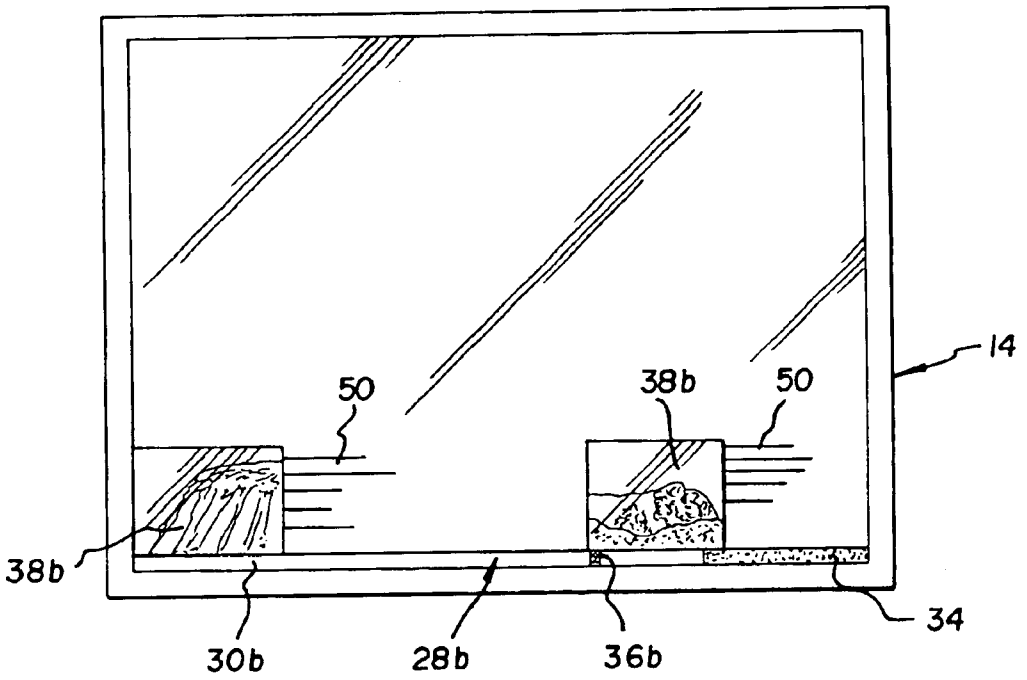


FIG. 7

ELECTRONIC CAMERA WITH IMAGE REVIEW

CROSS REFERENCE TO RELATED APPLICATIONS

This is a divisional application of Ser. No. 08/769,573, filed Dec. 19, 1996.

FIELD OF THE INVENTION

The invention relates generally to the field of photography, and in particular to electronic cameras.

BACKGROUND OF THE INVENTION

Traditional silver halide cameras typically display the number of the current frame to be exposed to the user. The user must use this information in conjunction with the number of frames available in the film canister to calculate the number of frames that remain to be exposed. All of this information is never provided to the user in a concise fashion and the number has to be read and understood. Recently introduced Advanced Photographic System ("APS") cameras will provide some assistance in this area by providing a number that corresponds to the number of frames remaining to be exposed. However, the user, will have no method for determining the number of frames that he or she has previously exposed. Software has receently become available which allows scrolling through images on a computer platform. For example, the recently available PICTURE DISK software from Eastman Kodak, which is provided to a customer on a diskette along with scanned images from a roll of film, presents a screen in a Microsoft Windows environment with thumbnails of the images, and a vertical scroll bar on the Windows screen which allows a user to scroll through the thumbnails.

The above problem is exacerbated in cameras that provide an electronic review feature. Such cameras typically have a storage medium on which to store captured images as image signals, and a screen on which any previously captured stored images can be reviewed. In such cameras it is desirable not only to indicate to the user the number of frames exposed and the number of frames remaining to be exposed, but also to indicate which frame is currently being viewed on the electronic display. The Casio QV-10 digital camera assists somewhat with this latter problem by numbering the image frames as they are taken and displaying this number over the image during image review. While this tells the user which frame is currently being viewed, the user has no direct way of determining the number of frames left to be exposed and only knows how many frames have been exposed by scrolling to the last image in the image list and reading the number of this image.

In addition, in an electronic digital camera such as the Casio QV-10, it is necessary for a user to review the stored images one by one to reach a particular one to be reviewed. For example, if the user is viewing image **1** and wishes to view image **20**, he or she must press a button to advance to the next image at which time image **2** is generated and brought to the screen after about a 2 second delay required for the camera electronics to read and display the stored image. The user must again press the advance button at which time image **3** is generated and brought to the screen after another 2 second delay. This process must be repeated 19 times by the user who wishes to view image **20**. This process requires better than 0.5 minute to complete. Such a method of scrolling through the images is therefore relatively time consuming and tedious.

It would be desirable then, to have an electronic camera which stores captured images and which allows a user to relatively rapidly review any desired stored image, and to do so without repetitive actions. It would further be desirable that the user can also readily ascertain the number of images stored and further also the space remaining for storage of further captured images.

SUMMARY OF THE INVENTION

The present invention, then, provides a camera comprising:

(a) means for capturing an image of a real world scene as an image signal;

(b) storage means for storing captured images and from which stored images can be read;

(c) a screen;

(d) a means for displaying on the screen a symbolic representation of the list of stored images and a user selected location within the list;

(e) a user interface which allows a user to select the location within the list; and

(f) means for displaying on the screen the image within the list corresponding to the selected location.

The present invention further provides a method for capturing, storing and displaying stored images, on a camera, comprising:

(a) capturing on the camera, images of real world scenes as image signals;

(b) storing the captured images in the camera;

(c) displaying on a screen on the camera, a symbolic representation of the list of stored images and a user selected location within the list; and

(d) displaying on the screen the image within the list corresponding to the selected location.

The present invention provides a simple means of allowing, in an electronic camera, a user to relatively quickly review any desired stored image, and to do so without repetitive actions. Additionally, the user can also readily ascertain the number of images stored and further also the space remaining for storage of further captured images (i.e. the number of exposures that remain to be taken).

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described with reference to the drawings, in which:

FIG. **1** is a schematic diagram of a camera of the present invention;

FIG. **2** is a back view of a camera of the present invention illustrating a particular output of the symbolic representation displaying means and image displaying means;

FIG. **3** is a view similar to FIG. **2** but with an alternative output of the symbolic representation displaying means and image displaying means;

FIG. **4** is a flowchart illustrating elements of the method of the present invention as executed on the camera of FIG. **2** or **3**;

FIG. **5** is a view of the screen of a camera of the present invention, showing a further alternative output of the symbolic representation displaying means and image displaying means;

FIG. **6** is a flowchart illustrating elements of the method of the present invention as executed on the camera of FIG. **5**; and

FIG. **7** is a view of the screen of a camera of the present invention, showing an output of an alternative image displaying means.

To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures.

DETAILED DESCRIPTION OF THE INVENTION

In the present invention, the symbolic representation displayed may, for example, be alphanumeric characters such as a list of numbers identifying each stored image as well as unexposed image frames. For example, the list of numbers may represent images numbered 1 to 24, which numbers are of different appearances (such as different color, texture, or font) depending on whether the image frame is exposed or not. Another example of a symbolic representation is a graphical representation, such as a bar along which a pointer is moved, or a rectangle divided into smaller regions each representing a captured image. In any event, the user interface may conveniently allow a user to scroll through the symbolic representation (such as pressing a button which moves the pointer on the bar) to the user selected location. However, the symbolic representation displays within the confines of the camera screen, a representation of all the stored images (that is, exposed image frames) and preferably also all the space remaining on which images can be stored (that is, unexposed image frames). To prevent an undue amount of time being required to generate the symbolic representation, it does not display the images themselves (either in the stored resolution or a lower resolution in which image features are visually identifiable).

Turning first to the schematic of FIG. **1**, the camera shown includes a lens **2** which directs light from real world scene onto a sensor **4**. Typically the light passes through known shutter and aperture mechanisms (not shown), before falling on sensor **4**. The shutter would be activated by a push button or similar user control. Sensor **4** is most typically a single array Charge Coupled Device ("CCD") sensor covered by a color filter array ("CFA"), or could be three CCD sensors with appropriate filters/mirrors (not shown) being provided to direct red, green, and blue light onto respective sensors. All of the camera elements in FIG. **1** will typically be mounted on/in a single housing (such as housing **20** of FIGS. **2** and **3**). A battery compartment (not shown) is typically provided to receive one or more batteries for power. All of these are conventional elements in electronic cameras. The camera is preferably portable, weighing no more than about 5 kg and preferably less than 2 kg (or even 1 kg), without batteries.

Processor block **6** includes appropriate circuitry including analog to digital converters, to convert the signal from sensor **4** to a digital signal for storage in storage device **8**, in a known manner. Storage device **8** can be any suitable digital signal storage device, including optical, magnetic (such as a disk drive) or solid state memory devices. The actual memory media used in storage device **8** is preferably removable but need not be. Captured images of real world scenes in the form of corresponding digital image signals, can therefore be stored in storage device **8** in a list ordered in the sequence in which the images were stored, and retrieved therefrom by processor block **6** for display on user viewing screen **14**. Screen **14** may be any suitable compact, low power consuming display, preferably a liquid crystal display ("LCD"). Features of the camera are controlled by a user through user interface **12**. Processor block **6** may further include a processor and other further necessary hardware and/or software for any apparatus or method of the present invention. Processor block **6** then, may act as the symbolic displaying means and image displaying means of the present invention.

As described above, a camera of the present invention includes a symbolic representation of the list of image frames (whether exposed or not) within the camera, and a user selected location within the list of images. Additionally, a small or low resolution representation of the image at the user selected location within the list may also be provided. The fact that only a small or low resolution image may be displayed, reduces time to retrieve the stored image at the user selected location, and allows faster movement through the list by a user. Turning particularly to FIGS. **1** and **2**, the back of the camera carries on housing **20**, and LCD screen, a viewfinder **22**, and user interface controls in the form of reverse and forward buttons **24**, **26** respectively. As captured images of real world scenes are stored in storage device **8** of the camera, a list of images are generated. The size of this list is limited by the storage capacity of storage device **8**, and is known. Therefore, the storage capacity of the camera can be represented as a list of sequenced slots into which images can be placed (that is, exposed or unexposed image frames). This graphical representation of the image frame list can be generated by processor block **6**. FIGS. **1** and **2** illustrate different forms of such a graphical representation. This is depicted as a film strip **28** in FIG. **1** and as an index print **28***a* in FIG. **2**. The single graphical representation **28** or **28***a* displays the list of captured images as small gray rectangles **30**. The unexposed image frames (space remaining in storage device **8**) are displayed as black rectangles **34** (FIG. **2**) or **34***a* (FIG. **3**). The user selected location is indicated by white rectangle **36** (FIG. **2**) or rectangel **36***a* (FIG. **3**), which will typically be positioned by a user on one of the exposed image frame rectangles **30** or **30***a* (which will turn white when selected). Of course, the foregoing regions of different appearance could be obtained, for example, by using other different colors than the gray, black white combination, or by using different textures or regions of other different appearance (such as different numbers representing each image frame), or any combination of the foregoing. Additionally, the user selected location may also be indicated by display of a frame number such as frame number "**13**" in shown in the upper left hand corner of screen **14** in FIG. **2**, and the lower left hand corner of screen **14** in FIG. **3**.

Processor block **6** also causes the image corresponding to the user selected location **36** within the graphical list representation **28** or index **28***a* (particularly, image frame "**13**" in FIGS. **1** and **2**), to be displayed on screen **14**. The displayed image **38** is preferably in the form of a smaller or lower resolution form of the larger, higher resolution image that is stored in the storage device **8**. This smaller or lower resolution image provides the user an indication of the image that is stored within the currently selected slot in the image list. In the case of FIG. **2**, this image is displayed as a reduced size image, while in FIG. **3** it is displayed as a larger size the same size as which the image will later be displayed, but at a lower resolution.

It is important to note that before the images can be displayed, they have to be retrieved from the memory of the camera and processed to provide a pleasing image. Completing this process for the entire image can require a significant amount of processing. The speed at which this process is completed will be dictated by the complexity of the process and by the power of the processing path in the camera. However, it is possible to use a number of tech-

niques to obtain only a small segment of the entire image and to process this small segment much more rapidly than the entire image can be processed, thus allowing a smaller or lower resolution version of the image to be processed and displayed much more quickly than the entire image can be processed and displayed. Therefore, displaying a small or low resolution representation of the image during scrolling can increase the perceived speed of scrolling.

Other additional features can be provided by processor block **6** so that the speed at which a user can scroll through a graphical list representation, such as representations **28** or **28***a* is further enhanced. For example, processor block **6** may, during scrolling, not display images corresponding to positions on the graphical representation **28** or **28***a* intermediate beginning and end scrolling positions. This can be accomplished simply by processor block **6** waiting a predetermined time (normally factory preset) after button **24** or **26** is pushed to see if it is pushed again (or is still being pushed), before retrieving a small or low resolution form of an image (such as image **38** or **38***a*) corresponding to the new user selected location. Alternatively, processor block **6** may start retrieving a form of the image corresponding to the new user selected location but terminate retrieval if during the time required for retrieval, the user selects another location.

As stated earlier, besides the advantage of providing the user with information as to how many images have been exposed, how many images remain to be exposed, and which image is currently being viewed, the camera described herein allows the user to scroll through images in a way that is perceived to be faster than simply scrolling through each of the full resolution images one at a time. The preferred method for scrolling through images using this camera is depicted in the flow chart in FIG. **4** and described below.

Referring particularly to FIG. **4**, as indicated therein, it will be assumed that a user has previously captured a number of images. The full size, full resolution stored image at the user selected location in the graphical representation **28** or **28***a* is displayed (**100**) on screen **14** by processor block **6**. When the user indicates (**102**), by pushing reverse or forward buttons **24**, **26**, that he or she wants to scroll to an image that corresponds to another location in the graphical representation, the image is instantly removed (**104**) from screen **14** and the graphical representation of the image list is drawn (**106**) to indicate the position of the new image in the image list. For example, looking at FIG. **2** if the user indicated that they wanted to scroll from the thirteenth to the twelfth image, the film strip **28** would be drawn with the twelfth image highlighted in white and the thirteenth image would be shown as gray. The number indicating the current image (the number **13** in FIG. **1**) would then be updated to indicate the change (e.g., the **13** would be changed to the number **12**). The camera would then begin retrieving a small or low resolution representation of the image to display it on the camera.

At this point in time, processor block **6** continues to monitor (**108**) how soon the user indicates that he wishes to scroll to a new location. If the user indicated that they wanted to move to a different image in the image list, before the camera could retrieve and display the small or low resolution representation of the image, the camera would simply redraw the graphic and number to indicate this change, and the camera would begin processing a small or low resolution representation of this new image (that is, return to step **106** in FIG. **4**). However, if the user waited beyond the predetermined time for the camera to complete the processing of the small or low resolution image, this image would be displayed (**110**) and the camera would begin to process (**112**) the full size, full resolution version of this image for display. Once again, the user can indicate that they want to move to a different image in the image list, at which time the image is removed and the graphic is redrawn. However, if the user does not indicate that he or she wishes to move to a different image in the image list, the full size, full resolution image replaces (**114**) the graphic and small image after it has been processed by the camera.

The progressive display of information to the user as described provides the user the opportunity to decide to continue to scroll before enough time has passed to allow the reduced resolution or full size image to be processed. By providing this capability, the user will be able to scroll to the image they desire to review more quickly than they would if they were forced to wait for the entire image to be processed.

A particularly preferred implementation of the present invention is further illustrated in FIG. **5**. In particular, in the embodiment of FIG. **5** processor block **6** causes to be displayed on screen **14**, a single graphic representation in the form of bar **28***b* showing the complete image frame list. The exposed image frames on bar **28***b* are represented by continuous light gray portion **30***b* of bar **28***b*, while unexposed image frames are represented by darker gray portion **34***b* of bar **28***b*. A sliding indicator **36***b* represents the user selected position within bar **28***b*. Portions **30***b* and **34***b* of bar **28***b*, and cursor **36***b*, while shown as different shades of gray in FIG. **5**, can all be of different colors, shadings or have other different features which makes them visually distinctive from one another. Processor block **6** can vary the position of indicator **36***b* under control of user operated reverse and forward buttons **24**, **26** respectively shown in FIG. **2**.

When indicator **36***b* is at rest (that is, the user has not pressed reverse or forward buttons **24**, **26** for some time), processor block **6** also displays on screen **14** a lower resolution version **35***b* of the stored full size and full resolution exposed image corresponding to the location of indicator **36***b* within bar **28***b*. Additionally, processor block **6** further displays lower resolution versions **38***b* of each of the two full size and full resolution images corresponding to positions on either side of indicator **36***b* on bar **28***b*. A larger resolution version, **42** of the selected image is also displayed. Version **42** may be the full resolution image stored in storage **8**, or may be a resolution intermediate the full stored resolution and the resolution of version **35***b*.

The user can then navigate backwards and forwards through the list of images in storage device by simply pressing a forward button **24** or reverse button **26**. The user will be able to scroll along through the list of images and then loop to the beginning of this list after passing through a screen that indicates beginning/ending of the strip. Graphical overlays will displayed on the screen to indicate the format of the type or format of the image being viewed.

If the user simply presses and releases forward or reverse buttons **24**, **26**, the next large image is displayed, the low resolution images move one image in the direction opposite to the direction indicated by the navigation button, and the position indicator moves to the right by a distance proportional to the amount of total memory used by the image. An acceleration button **25** can also be provided on the camera if a user wishes to increase the speed of scrolling beyond the speed provided when forward or reverse buttons **24**, **26** are pressed. The acceleration button **25** would be pressed after the forward or reverse buttons **24**, **26** are pressed.

The operation of the method of the present invention in which the display illustrated in FIG. **5** is generated, is

depicted in the flowchart in FIG. **6** and described below. It is assumed that there are previously captured images from sensor **4**, already stored in storage device **8**.

The start-up sequence when the screen **14** is first turned on, is illustrated in steps **120–130**. The amount of total memory and available memory is first determined **(124)**, and the graphic representation **28***b* is drawn **(126)**. The necessary information is retrieved **(128)** from storage device **8** to cause the lower resolution images **35***b* and **38***b* to be displayed on screen **14**. Additionally, the higher resolution image **42** is also displayed **(130)**.

When the user presses reverse or forward buttons **24**, **26** **(132)** and the button is released within a predetermined time **(134)**, the current full size image is removed from the display **(136)**, the graphical indicator is drawn to indicate a change in the current position within the image list **(138)**, the image strip is moved in the direction opposite the direction of the reverse or forward buttons and the low resolution image is then acquired and displayed **(142)**. The full size image is then acquired and displayed **(146)**. If the user presses the reverse or forward buttons **24**, **26** before the low resolution image is displayed **(140)** or before the new full size image is displayed **(144)**, the camera's current activity is interrupted and it behaves as if the reverse of forward button was just pressed **(134)**.

If the user presses and holds the reverse or forward buttons for longer than a predetermined time, and the user has not pressed the acceleration button **25** **(148)** the camera removes the current full size image from the display **(162)**, draws the graphic indicator at its next position **(164)**, moves the image strip and displays the new low resolution image **(166)**. The camera then repeats the steps **164** and **166** until the user releases the reverse or forward button. When the user releases the reverse or forward button, the new full size image that is represented by the center low resolution image is displayed **(146)**.

If the user presses and holds the reverse or forward button and then presses and holds the acceleration button **25** **(148)**, the full size image is removed from the display and steps **150** through **160** are completed. These steps are the same as described in steps **162** to **168** except the images in the image strip are not drawn until the user releases the acceleration button **25** **(156)**.

It may be that a user will desire to scroll through the image list represented by bar **28***b* at a rate which exceeds the ability of storage **8** and processor block **6** to retrieve and display the low resolution versions of all of images represented by the space on bar **28***b* over which sliding indicator **36***b* is moved. For example, this might be the case when the acceleration button is pressed. However, the user may still want to see at least some low resolution versions of the images. In this case, processor block **6** will acquire and display only interspersed ones of the low resolution images **38***b* in a manner as shown in FIG. **7**. For example, only every second, third, or fourth image might be retrieved and displayed on screen **14** (that is, the displayed images are separated in the image list by one, two, or three images). In addition, some visual indication can be provided on screen **14** to show the user that they are engaged in a rapid scrolling and that only interspersed low resolution images are being retrieved. For example, as low resolution images **38***b* are moved to the left in FIG. **7**, trailing lines **50** can be displayed to suggest rapid scrolling through the images. Other visual indications could be attached or displayed with the low resolution images **38***b* which indicates a faster or different rate or mode of review.

It will be appreciated that forward and reverse buttons **24**, **26** may generate other than discrete signals when pressed. For example, those buttons may generate signals which vary with the degree of pressure applied by a user.

Such signals may then be used by processor block **6** to vary the rate at which new low resolution images are acquired and displayed on screen **14**, such that the rate of acquisition and display is a function of pressure applied by the user. Thus, when a user presses forward or reverse buttons **24**, **26** harder, the rate of acquisition and display of the low resolution images is increased. If the desired rate of acquisition and retrieval, as indicated by the user's pressure on one of the buttons **24** or **26**, exceeds the rate at which storage **8** and processor block **6** allows for retrieval, then processor **6** may then cause only interspersed to be acquired and displayed such as in the manner described in connection with FIG. **7** (for example, only every second, third, or fourth image, may be displayed as pressure on buttons **24** or **26** is increased).

The present invention can also advantageously be applied to display devices for reviewing images electronically stored on a media. This is particularly true of other portable display devices which, like the camera described above, will often have limited processing power and storage space. Such portable devices will generally weigh less than about 5 kg and preferably less than about 2 kg (and even less than 1 kg), without batteries. In such a device, the image capturing means (particularly, lens **2**, sensor **4**, and the hardware and/or software components of processor block **6** which convert the signal from sensor **4** to a digital electrical signal) can be eliminated and the storage means can be replaced by a media reader for reading images stored on the media. The other features of such a portable device can be the same as for the cameras described above, although viewfinder **22** (FIGS. **2** and **3**) can also be eliminated.

In such a device, the media reader will preferably use a removable media using any suitable media, such as optical, magnetic or solid state memory media described above. Optionally, the media reader could be a storage device such as storage device **8**, which also can store image signals on the storage media. Such image signals might be received from a remote source (such as over a telephone line, network interface, radio link, or other communications link). In this case then, the portable display device would be as illustrated in FIGS. **1** to **5**, except lens **2** is deleted and sensor **4** is replaced by a suitable interface module (such as a modem, network interface or other communications hardware) with processor block **6** including any further necessary hardware and/or software. Such a display device may incorporate all other features of the camera describe above, and execute the methods described above for displaying stored images.

The invention has been described with reference to a preferred embodiment. However, it will be appreciated that variations and modifications can be effected by a person of ordinary skill in the art without departing from the scope of the invention.

PARTS LIST

2 Time Image
4 Sensor
6 Processor Block
8 Storage Device
12 User Interface
14 User Viewing Screen
20 Housing
22 Viewfinder
24 Reverse Button
26 Forward Button

28 Film Strip
28*a* Index Print
28*b* Bar
30 Gray Rectangles
30*a* Gray Rectangles
30*b* Light Gray Portion
34 Black Rectangles
34*a* Black Rectangles
34*b* Darker Gray Portion
35*b* Lower Resolution Version Of Image
36 Selected Location
36*b* Sliding Indicator
38 Displayed Image
38*a* Displayed Image
38*b* Lower Resolution Versions
42 Larger Resolution Version
50 Trailing Lines

What is claimed is:

1. A camera comprising:

(a) means for capturing images of scenes as image signals;

(b) storage means for storing the captured image signals;

(c) a screen;

(d) means for displaying on the screen a graphical representation of a list of the stored captured images, wherein the graphical representation does not include captured image data;

(e) a user interface including an adjustable indicator arranged so that a user can select a particular graphical representation from the displayed graphical list corresponding to a desired captured image; and

(f) means responsive to the selected particular graphical representation for causing the corresponding captured image signals to be applied to the screen for displaying on the screen the desired captured image, wherein the image displaying means requires a predetermined retrieval time to display an image, and wherein if during a retrieval time a user selects another graphical representation, the retrieval is terminated.

2. A camera according to claim **1** wherein the graphical displaying means additionally displays a graphical representation of space remaining within the storage means.

3. A camera according to claim **1** wherein the user interface allows a user to vary the position of the adjustable indicator on the screen so as to scroll through the graphical representation.

4. A camera according to claim **3** wherein the image displaying means allows scrolling without displaying images intermediate beginning and end scrolling positions on the graphical representation.

5. A camera according to claim **1** wherein the image displaying means only displays the captured image corresponding to the selected graphical representation provided a user does not select another graphical representation within a predetermined time.

6. A camera according to claim **1** wherein the image displaying means further includes means for initially displaying low resolution versions of the captured images which respectively correspond to the graphical representations on the list of stored images, and additionally causes a higher resolution version of the captured image corresponding to the selected graphical representation to be displayed on the screen provided a user does not select another graphical representation within a time required to display the low resolution version.

7. A camera according to claim **1** wherein the graphical representation of the list is a bar on the screen.

8. A camera according to claim **2** wherein the display means displays a graphic representation for both the list of stored images and space remaining as part of a single presentation which exhibits areas of different color or texture indicative of relative storage space occupied by the stored captured image signals and space remaining.

9. A camera comprising:

(a) means for capturing images of scenes as image signals;

(b) storage means for storing the captured image signals, the captured_image_signals being listed in the order in which the captured image signals were stored;

(c) a screen;

(d) means for displaying on the screen a graphical representation of the listed order of the stored captured images and moveable low resolution images corresponding to some of the captured images, wherein the graphical representation does not include captured image data;

(e) a user interface including means for changing the displayed low resolution images from the listed order of captured images and an adjustable indicator arranged so that a user can select a particular graphical representation from the displayed graphical list corresponding to a desired captured image; and

(f) means for causing a high resolution image from the corresponding captured image signals of the selected graphical representation to be applied to the screen for displaying on the screen the desired high resolution captured image, wherein the image displaying means requires a predetermined retrieval time to display an image, and wherein if during a retrieval time a user selects another graphical representation, the retrieval is terminated.

10. A camera according to claim **9** wherein the graphical displaying means additionally displays a graphical representation of space remaining within the storage means.

11. A camera according to claim **9** wherein the user interface allows a user to vary the position of the adjustable indicator on the screen so as to scroll through the graphical representation.

12. A camera according to claim **11** wherein the image displaying means allows scrolling without displaying images intermediate beginning and end scrolling positions on the graphical representation.

13. A camera according to claim **9** wherein the image displaying means only displays the high resolution captured image corresponding to the selected graphical representation provided a user does not select another graphical representation within a predetermined time.

14. A camera according to claim **9** wherein the image displaying means causes a higher resolution version of the selected image to be displayed only provided a user does not select another location within a time required to display the low resolution version.

15. A camera comprising:

(a) means for capturing images of scenes as image signals;

(b) storage means for storing the captured image signals, the captured_image_signals being listed in the order in which the captured image signals were stored;

(c) a screen;

(d) means for displaying on the screen a graphical representation of the listed order of the stored captured images and moveable low resolution images corre-

sponding to some of the captured images, wherein the graphical representation does not include captured image data;

(e) a user interface including means for changing the displayed low resolution images from the listed order of captured images and an adjustable indicator arranged so that a user can select a particular graphical representation from the displayed graphical list corresponding to a desired captured image, wherein the adjustable indicator is movable at varying rates, and wherein the display means causes an additional visual indication to be displayed on the screen when the faster rate is selected; and

(f) means for causing a high resolution image from the corresponding captured image signals of the selected graphical representation to be applied to the screen for displaying on the screen the desired high resolution captured image.

16. A camera according to claim **15** wherein the graphical displaying means additionally displays a graphical representation of space remaining within the storage means.

17. A camera according to claim **15** wherein the user interface allows a user to vary the position of the adjustable indicator on the screen so as to scroll through the graphical representation.

18. A camera according to claim **17** wherein the image displaying means allows scrolling without displaying images intermediate beginning and end scrolling positions on the graphical representation.

19. A camera according to claim **15** wherein the image displaying means requires a predetermined retrieval time to display an image, and wherein if during a retrieval time a user selects another graphical representation, the retrieval is terminated.

20. A camera according to claim **15** wherein the image displaying means only displays the high resolution captured image corresponding to the selected graphical representation provided a user does not select another graphical representation within a predetermined time.

21. A camera according to claim **15** wherein the image displaying means causes a higher resolution version of the selected image to be displayed only provided a user does not select another location within a time required to display the low resolution version.

* * * * *

EXHIBIT 7

US007210161B2

(12) **United States Patent**
Ward et al.

(10) **Patent No.: US 7,210,161 B2**
(45) **Date of Patent: *Apr. 24, 2007**

(54) **AUTOMATICALLY TRANSMITTING IMAGES FROM AN ELECTRONIC CAMERA TO A SERVICE PROVIDER USING A NETWORK CONFIGURATION FILE**

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(73) Assignee: **Eastman Kodak Company**, Rochester, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 917 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **09/855,375**

(22) Filed: **May 15, 2001**

(65) **Prior Publication Data**

US 2001/0022618 A1 Sep. 20, 2001

Related U.S. Application Data

(63) Continuation of application No. 09/004,046, filed on Jan. 7, 1998, now Pat. No. 6,784,924.

(60) Provisional application No. 60/037,962, filed on Feb. 20, 1997.

(51) **Int. Cl.**
H04N 7/173 (2006.01)
H04N 5/76 (2006.01)

(52) **U.S. Cl.** **725/105**; 348/231.3

(58) **Field of Classification Search** 348/207.99, 348/207.1, 207.2, 220.1, 14.01, 14.02, 14.03, 348/14.07, 14.08, 231.99, 231.3; 709/203; 725/105

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,230,015	A *	7/1993	Yokodate et al.	348/14.12
5,434,618	A *	7/1995	Hayashi et al.	348/231.2
5,737,491	A *	4/1998	Allen et al.	704/270
5,806,005	A *	9/1998	Hull et al.	455/566
6,167,469	A *	12/2000	Safai et al.	710/62
6,226,362	B1 *	5/2001	Gerszberg et al.	379/88.13
6,353,848	B1 *	3/2002	Morris	709/203
6,571,271	B1 *	5/2003	Savitzky et al.	709/200

* cited by examiner

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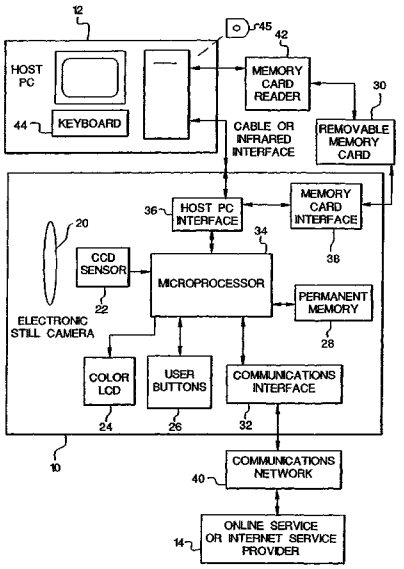
(74) *Attorney, Agent, or Firm*—Pamela R. Crocker

(57) **ABSTRACT**

A network configuration file is generated at a host computer and downloaded to a digital camera. This file contains instruction information for communicating with a selected destination via a communications interface. The digital camera includes a "send" button or LCD icon which allows the user to easily transmit one or more images via a wired or wireless communications interface to a desired destination, which among other possibilities may be an Internet Service Provider or a digital photofinishing center. When the user selects this option, the communications port settings, user account specifics, and destination connection commands are read from the network configuration file on the removable memory card. Examples of these settings include serial port baud rate, parity, and stop bits, as well as account name and password.

11 Claims, 4 Drawing Sheets



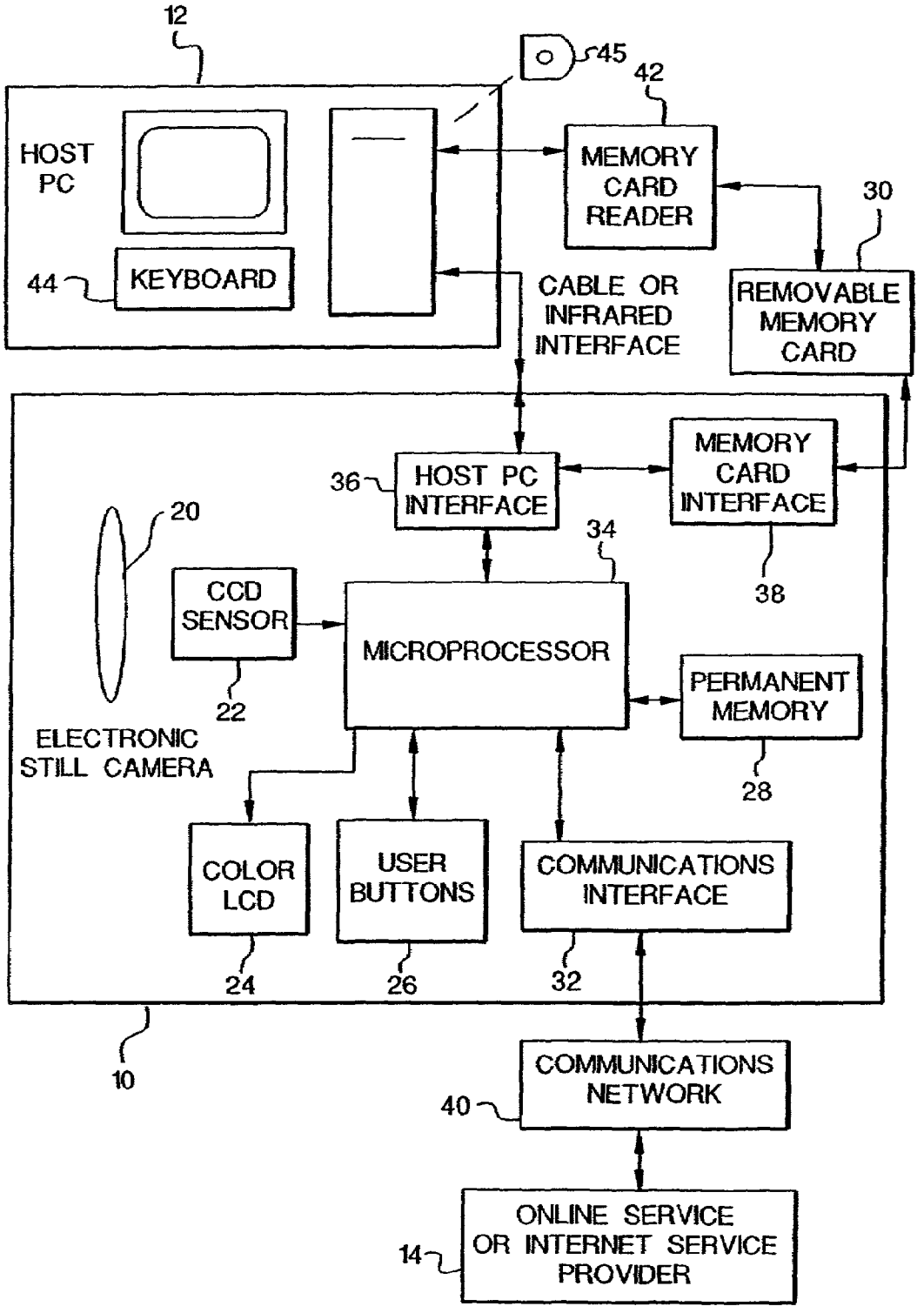

12
45
42
HOST PC
MEMORY CARD READER
30
44
KEYBOARD
CABLE OR INFRARED INTERFACE
REMOVABLE MEMORY CARD
36
HOST PC INTERFACE
MEMORY CARD INTERFACE
20
34
CCD SENSOR
MICROPROCESSOR
38
PERMANENT MEMORY
22
ELECTRONIC STILL CAMERA
28
COLOR LCD
USER BUTTONS
COMMUNICATIONS INTERFACE
24
26
32
10
COMMUNICATIONS NETWORK
40
ONLINE SERVICE OR INTERNET SERVICE PROVIDER
14

FIG. 1

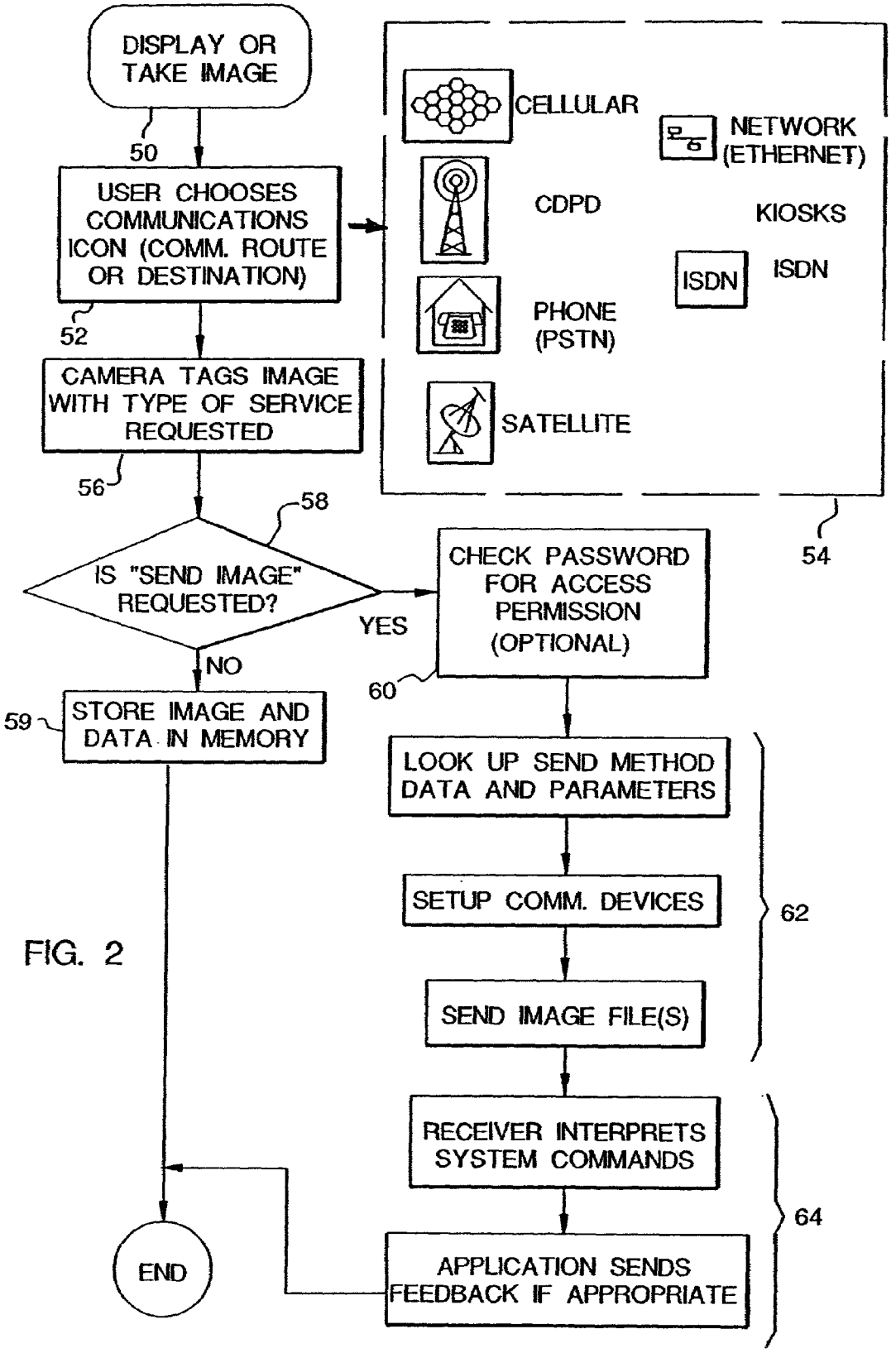

DISPLAY OR TAKE IMAGE
50
USER CHOOSES COMMUNICATIONS ICON (COMM. ROUTE OR DESTINATION)
52
CAMERA TAGS IMAGE WITH TYPE OF SERVICE REQUESTED
56
58
IS "SEND IMAGE" REQUESTED?
YES
NO
CHECK PASSWORD FOR ACCESS PERMISSION (OPTIONAL)
60
STORE IMAGE AND DATA IN MEMORY
59
LOOK UP SEND METHOD DATA AND PARAMETERS
SETUP COMM. DEVICES
SEND IMAGE FILE(S)
62
RECEIVER INTERPRETS SYSTEM COMMANDS
APPLICATION SENDS FEEDBACK IF APPROPRIATE
64
END
CELLULAR
NETWORK (ETHERNET)
CDPD
KIOSKS
ISDN
ISDN
PHONE (PSTN)
SATELLITE
54

FIG. 2

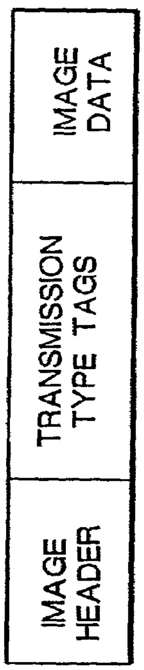


FIG. 3

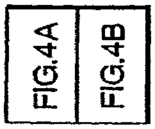


FIG. 4

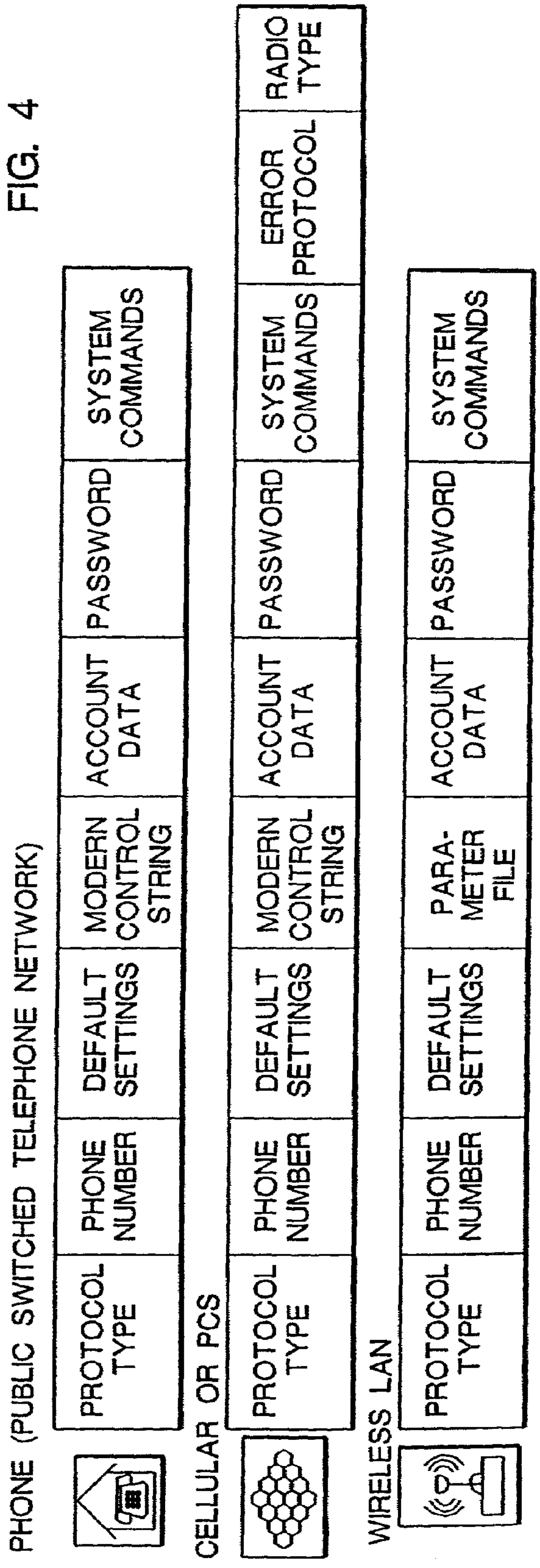


FIG. 4A

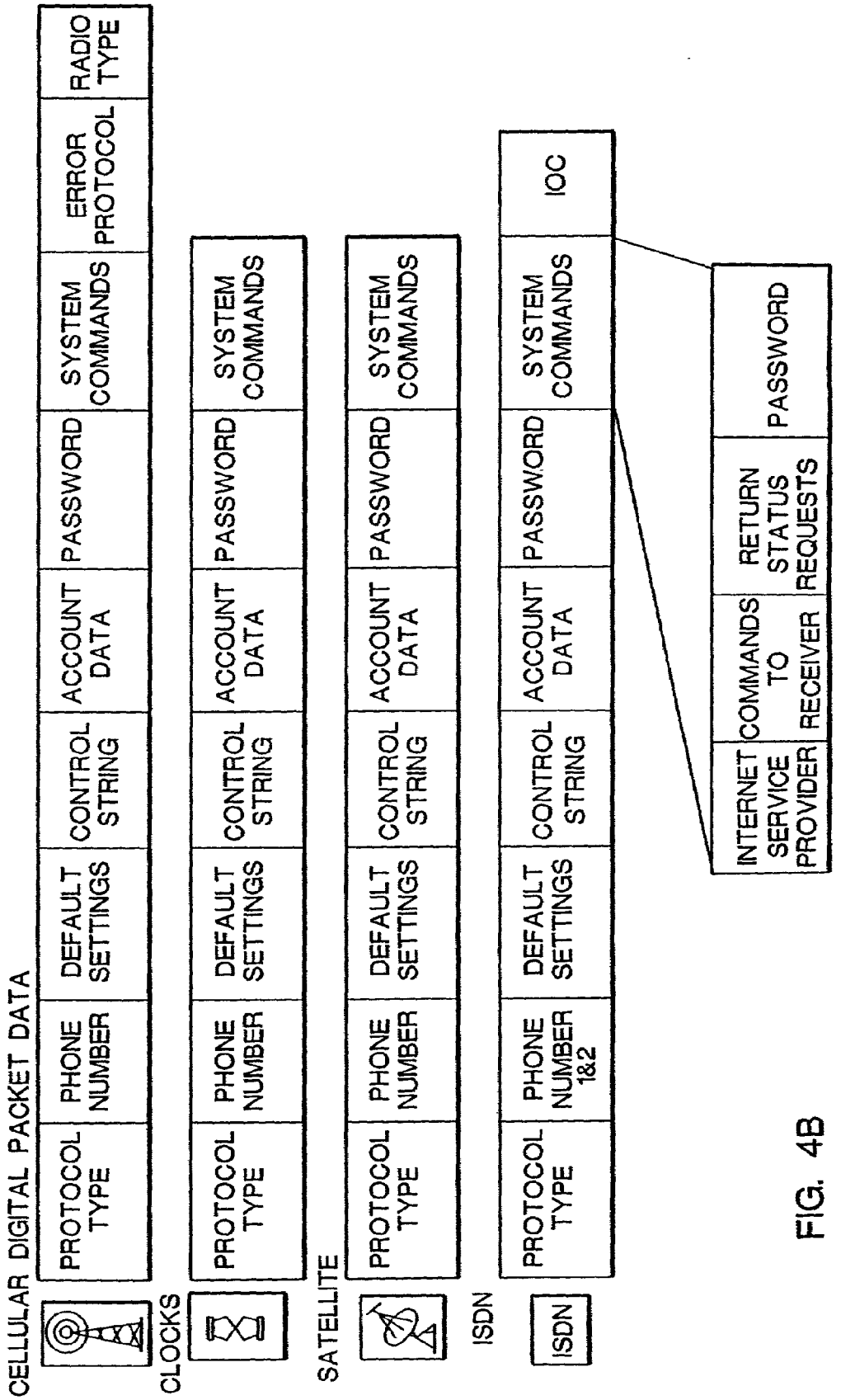

CELLULAR DIGITAL PACKET DATA
PROTOCOL TYPE
PHONE NUMBER
DEFAULT SETTINGS
CONTROL STRING
ACCOUNT DATA
PASSWORD
SYSTEM COMMANDS
ERROR PROTOCOL
RADIO TYPE
CLOCKS
PROTOCOL TYPE
PHONE NUMBER
DEFAULT SETTINGS
CONTROL STRING
ACCOUNT DATA
PASSWORD
SYSTEM COMMANDS
SATELLITE
PROTOCOL TYPE
PHONE NUMBER
DEFAULT SETTINGS
CONTROL STRING
ACCOUNT DATA
PASSWORD
SYSTEM COMMANDS
ISDN
PROTOCOL TYPE
PHONE NUMBER 1&2
DEFAULT SETTINGS
CONTROL STRING
ACCOUNT DATA
PASSWORD
SYSTEM COMMANDS
IOC
ISDN
INTERNET SERVICE PROVIDER
COMMANDS TO RECEIVER
RETURN STATUS REQUESTS
PASSWORD

FIG. 4B

AUTOMATICALLY TRANSMITTING IMAGES FROM AN ELECTRONIC CAMERA TO A SERVICE PROVIDER USING A NETWORK CONFIGURATION FILE

CROSS REFERENCE TO RELATED APPLICATION

Reference is made to and priority claimed from U.S. Provisional Application Ser. No. 60/037,962, filed Feb. 20, 1997, entitled NETWORK CONFIGURATION FILE FOR AUTOMATICALLY TRANSMITTING IMAGES FROM AN ELECTRONIC STILL CAMERA.

CROSS-REFERENCE TO RELATED APPLICATION(S)

This is a continuation of application Ser. No. 09/004,046 filed Jan. 7, 1998 now U.S. Pat. No. 6,784,924 entitled "Network Configuration File For Automatically Transmitting Images From An Electronic Still Camera".

FIELD OF THE INVENTION

The invention relates generally to the field of photography, and in particular to electronic photography. More specifically, the invention relates to a digital camera that interfaces with a host computer.

BACKGROUND OF THE INVENTION

Digital cameras, such as the Kodak Digital Science DC25™ camera, allow images to be utilized on a home computer (PC) and to be incorporated into e-mail documents and personal home pages on the World Wide Web. Presently, images must be copied to the PC and transmitted as e-mail, for example using an online service or an Internet Service Provider (ISP), via a modem from the user's PC. It would be desirable to be able to transmit pictures directly from the digital camera instead of first transferring the pictures to a PC. For instance, on a vacation trip, it is desirable to immediately share pictures with friends or relatives via e-mail or Internet access. It is also desirable to transmit pictures from a location without PC access in order to free up camera storage to take additional pictures. There are a wide variety of connection means to online services such as America On Line, ISPs, and bulletin board services. Each of these services typically requires an account name and password, as well as local telephone access numbers, and specific communications settings. It would be difficult to provide an easy-to-use means with buttons or menus on a small digital camera to input and/or modify all of these required settings.

SUMMARY OF THE INVENTION

The present invention is directed to overcoming one or more of the problems set forth above. Briefly summarized, according to one aspect of the present invention, a network configuration file is generated at a host computer and downloaded to a digital camera. This file contains instruction information for communicating with a selected destination via a communications interface. The digital camera includes a "send" button or LCD icon which allows the user to easily transmit one or more images via a wired or wireless communications interface to a desired destination, which among other possibilities may be an Internet Service Provider or a digital photofinishing center. When the user selects this option, the communications port settings, user account specifics, and destination connection commands are read from the network configuration file. Examples of these settings include serial port baud rate, parity, and stop bits, as well as account name and password.

In addition, information about which image or images to transmit is entered using the user buttons on the digital camera. This information is used to automatically establish a connection, log-in to the desired destination, and to transmit the image. The transmission may occur immediately after the pictures are taken, for example if the camera has a built-in cellular phone modem, or at a later time, when the camera is connected to a separate unit (such as a dock, kiosk, PC, etc.) equipped with a modem. In the latter case, a "utilization file" is created to provide information on which images should be transmitted to which account.

These and other aspects, objects, features and advantages of the present invention will be more clearly understood and appreciated from a review of the following detailed description of the preferred embodiments and appended claims, and by reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a system block diagram of the invention.

FIG. **2** is a diagram showing the steps used to automatically transmit images using the network configuration file.

FIG. **3** is a diagram of an image file.

FIG. **4** is a diagram showing several versions of the network configuration file.

DETAILED DESCRIPTION OF THE INVENTION

Because imaging systems and devices are well known, the present description will be directed in particular to elements forming part of, or cooperating more directly with, apparatus in accordance with the present invention. Elements not specifically shown or described herein may be selected from those known in the art. Some aspects of the present description may be implemented in software. Unless otherwise specified, all software implementation is conventional and within the ordinary skill in the programming arts.

A system block diagram of the invention is shown in FIG. **1** including an electronic still camera **10**, a host computer (PC) **12** and a service provider **14**. The camera includes an optical section **20** for imaging a scene upon a CCD sensor **22** and generating an image signal, a liquid crystal display (LCD) **24** for displaying images and other information, a number of user input buttons **26**, both permanent memory **28** and removable memory **30**, and an internal communications interface **32** (e.g., modem). This interface may connect to a variety of known networks, such as a public switched telephone network (PSTN), ISDN, an RF cellular phone network, or Ethernet. The camera **10** also includes a microprocessor **34** for generally controlling the camera functions, as well as the interchange of data with the host PC **12** and the memory card **30** through a host PC interface **36** and a memory card interface **38**, respectively. Besides the host PC **12**, the system includes a network connection **40** to the online service or ISP (Internet Service Provider) **14**. Alternately, the network **40** can connect to the user's home PC **12**.

When the camera **10** is first purchased (or at any time thereafter), it is connected to the PC **12** via the host PC **36** interface and a software application (stored on a disc **45**) running on the host PC **12** will enable the user to specify the

name of a destination ISP or online service and to input from the host PC keyboard **44** the appropriate communication settings and account information. This information generates a network configuration file, which then can then be downloaded to the camera **10** through the host PC interface **36**, which may be a wired or infrared (e.g., IrDA) interface, and written to the camera's internal memory **28** and/or the removable memory card **30**. Alternatively, a host PC equipped with a memory card reader/writer **42** can write the information directly to the card **30** without connecting the camera through its host PC interface **36**. Also, this information could be predetermined by the user and stored in a "preferences" file on the host PC **12** and then transferred to the camera **10** from this file without further intervention by the user. Multiple sets of destination services can be stored on the memory card **30**. Typically, keyword or graphic descriptors (e.g., icons) accompany the information in the network configuration file about destination services to enable easy access by the camera user.

The steps used to automatically transmit images using the network configuration file are shown in FIG. **2**. After disconnecting the camera from the host PC, the user operates the camera to take pictures (step **50**). This is typically done at a remote location, for example while traveling to another city. As the user takes or reviews images on the image LCD display, the decision can be made to transmit one or more images (step **52**). This is done by choosing one of the keywords or icons in a menu **54** shown in FIG. **2**, which are displayed on the LCD **24** and selected, e.g., through the user buttons **26**. (Note that a camera will typically only include a subset (only those desired by the user) of all the different services shown.) The selected image files may be tagged with a code (step **56**) indicating which service is requested, as shown in FIG. **3**. (Alternately, an "image utilization" file can be created in the camera storing a list of images to be transmitted by a particular method, as described in the cross-referenced copending patent application (U.S. Ser. No. 60/037,963). As described in that patent application, the details of an order, e.g., number of print copies to be made from an image and the size of the prints and/or a list of images to be e-mailed to various recipients, is written into the "utilization" file, which identifies the order and includes pointers to the image files that store the images required to "fulfill" the order. The "utilization" file is stored in the internal memory **28** or the memory card **30**.)

Next, the system determines whether a request exists to send an image (step **58**). If no request is present, the image and associated data is stored in either permanent memory **28** or the memory card **30** (step **59**). (Typically, all images are initially saved in memory whether eventually sent or not.) Otherwise, if there is a request to send an image, the user ensures that the camera is connected to the appropriate service (wired telephone line, cellular phone, kiosk, etc.) and pushes a "send" button in the user button section **26**, or selects a "send" menu option on the LCD **24**. The camera then utilizes the appropriate network configuration file, shown in FIG. **4**. Each network configuration file contains items such as the protocol type, phone number, etc., as described in Appendix I. The user password may be checked against the password in the network configuration file to ensure that the user is authorized to connect the camera to the desired service (step **60**). Alternately, the stored password in the appropriate configuration file can be used. Next, the camera uses the parameters in the configuration file to establish communications with the service and send one or more image files as selected by the user (steps **62**). The service receiver interprets the system commands issued by the camera from the network configuration file list and sends appropriate feedback (such as "transfer in progress" and "transfer complete") which are interpreted by the camera and displayed on the LCD **24** (steps **64**).

For example, when the camera uses a normal wired telephone (Public Switched Telephone Network) connection (i.e., network **40**) to the camera's internal modem **32**, after the user selects the images to be sent and presses the "send" button, the camera performs the following steps without user intervention:

1) Read the appropriate connection parameters from the network configuration file (on the memory card **30** or internal camera memory **28**), dial the phone and establish the connection to the destination service **14**.
2) Read the user's account name and password and transmit these to "log-on" to the service **14**.
3) Using the appropriate communications protocol (FTP, mailto, etc.), transmit the selected image or images to the destination service **14**.

The invention has been described with reference to a preferred embodiment. However, it will be appreciated that variations and modifications can be effected by a person of ordinary skill in the art without departing from the scope of the invention.

APPENDIX I

These are descriptions of the tags listed in the previous drawing:

Protocol Type

Each communication method has its own protocol, or rules to communicate. This tag identifies that protocol and where to find it. For example, the Network may use TCP/IP and a modem may use XModem.

Phone Number

This is the number of the receiving service. If internet access is requested, this could be the number of the Internet Service Provider. For ISDN, some systems require two phone numbers, dialed and connected to in sequence.

Default Settings

Standard settings that make the communications device compatible with the imaging device.

Modem Control String

Modem and communications devices have a command language that can set them up before they are used. For example, modems have many options controlled by command strings including volume level, the amount of time the carrier is allowed to fail before the system hangs up, and so on.

Account Data

This can be internet account data, charge number data, phone card data, billing address, and data related to the commerce part of the transmission.

Password

Any password needed to get into the communications system. Other passwords to get into the remote application or destination are located in the System Commands section.

System Commands

These are commands that control the end destination.

Error Protocol

In cellular and some other wireless communications, error protocols are used to increase the robustness of the link. For example, MNP10 or ETC may be used for cellular links.

Radio Type

The type of radio used for this communications feature may be identified here. Some cell phones have modems built in, others will have protocols for many communications functions built in. The radio type will make the imaging device adapt to the correct interface.

IOC

ISDN Ordering Code identifies what features are available on the ISDN line provided by the teleco. It is used to establish the feature set for that communications link.

Internet Service Provider

This identifies the actual service provider and any specific information or sequence of information that the service wants to see during connection and logoff. It also tells the device how to handle the return messages, like "time used" that are returned by the server.

Commands to Receiver

This may be a list of commands to control the receiving application. For example, a command to print one of the images and save the data to a particular file on a PC may be embedded here.

Return Status Requests

This tag can set up the ability of the application to tell if an error has occurred, or what the status of the application might be. The data here will help the device decide if it should continue communicating and a set user interface response can be developed around this feedback.

What is claimed is:

1. A method of transferring one of more images from an electronic camera to a service provider, the camera including optics and an image sensor for generating an image signal, a display for displaying images, a plurality of user inputs, a first digital memory for storing digital images, a second digital memory for storing a network configuration file, and a communications interface, the method comprising the steps of:

(a) storing the network configuration file for the service provider in the second digital memory;

(b) subsequently using the optics and image sensor to generate a plurality of image signals which are stored as a plurality of digital images in the first digital memory;

(c) viewing at least one of the plurality of digital images on the display of the electronic camera;

(d) using at least one of the plurality of user inputs to select at least one digital image for transfer to the service provider;

(e) using at least one of the plurality of user inputs to initiate transfer of the selected at least one digital image to the service provider;

(f) using the network configuration file, the electronic camera automatically establishing communications with the service provider and transferring the selected digital image(s) from the electronic camera to the service provider using the communications interface;

(g) transferring from the service provider to the electronic camera, feedback indicating the status of the transfer process; and

(h) displaying the status on the display of the electronic camera.

2. The method as claimed in claim **1** wherein the network configuration file includes a protocol type identifier.

3. The method as claimed in claim **2** wherein protocol type identifier identifies a TCP/IP protocol.

4. The method as claimed in claim **1** wherein the network configuration file includes account data.

5. A method of transferring one or more digital images from an electronic camera to a service, the camera including optics and an image sensor for generating an image signal, a display for displaying images, a plurality of user inputs, a first digital memory for storing digital images, a second digital memory for storing a network configuration file, and a communications interface, the method comprising:

(a) storing the network configuration file for the service in the second digital memory, wherein the network configuration file includes a protocol type identifier identifying a TCP/IP protocol;

(b) subsequently using the optics and image sensor to generate a plurality of image signals which are stored in the first digital memory as a plurality of digital images representative of the plurality of image signals;

(c) displaying a representation of at least one of the plurality of digital images on the display of the electronic camera;

(d) selecting at least one digital image for transfer to the service in response to the use of at least one of the plurality of user inputs;

(e) initiating transfer of the selected at least one digital image to the service in response to use of at least one of the plurality of user inputs; and

(f) using the network configuration file to automatically establish communications with the service and to transfer the selected at least one digital image from the electronic camera to the service using the communications interface.

6. The method of claim **5** further including:

(g) receiving feedback indicating the status of the transfer process from the service; and

(h) displaying the status on the display of the electronic camera.

7. The method of claim **5** wherein the network configuration file includes account data.

8. The method of claim **5** wherein the network configuration file is generated at least in part by a host device.

9. A method of transferring one or more digital images from an electronic camera to a service, the camera including optics and an image sensor for generating an image signal, a display for displaying images, a plurality of user inputs, a first digital memory for storing digital images, a second digital memory for storing a network configuration file, and a communications interface, the method comprising:

(a) storing the network configuration file for the service in the second digital memory;

(b) subsequently using the optics and image sensor to generate a plurality of image signals which are stored in the first digital memory as a plurality of digital images representative of the plurality of image signals;

(c) displaying a representation of at least one of the plurality of digital images on the display of the electronic camera;

(d) selecting at least one digital image for transfer to the service in response to the use of at least one of the plurality of user inputs;

(e) initiating transfer of the selected at least one digital image to the service in response to use of at least one of the plurality of user inputs;

(f) using the network configuration file to automatically establish communications with the service and to transfer the selected at least one digital image from the

electronic camera to the service using the communications interface;

(g) receiving information indicating the status of the transferring at least one digital image from the electronic camera to the service; and

(h) displaying an indication of the status.

10. The method of claim **9** wherein the network configuration file includes account data.

11. The method of claim **10** wherein the network configuration file is generated at least in part by a host device.

* * * * *

EXHIBIT 8

US007453605B2

(12) **United States Patent**
Parulski et al.

(10) **Patent No.: US 7,453,605 B2**
(45) **Date of Patent: Nov. 18, 2008**

(54) **CAPTURING DIGITAL IMAGES TO BE TRANSFERRED TO AN E-MAIL ADDRESS**

(75) Inventors: **Kenneth A. Parulski**, Rochester, NY (US); **Joseph Ward**, Hilton, NY (US); **Michael C. Hopwood**, Mountain View, CA (US)

(73) Assignee: **Eastman Kodak Company**, Rochester, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 663 days.

(21) Appl. No.: **11/174,370**

(22) Filed: **Jul. 1, 2005**

(65) **Prior Publication Data**

US 2005/0243189 A1 Nov. 3, 2005

Related U.S. Application Data

(63) Continuation of application No. 09/821,152, filed on Mar. 29, 2001, now Pat. No. 7,034,871, which is a continuation of application No. 08/977,382, filed on Nov. 24, 1997, now Pat. No. 6,573,927.

(51) **Int. Cl.**
H04N 5/76 (2006.01)

(52) **U.S. Cl.** **358/402**; 348/231.2; 348/231.3

(58) **Field of Classification Search** 358/402, 358/1.9, 1.15, 1.16, 906, 505, 474; 396/319; 348/231.99, 231.2, 231.3, 231.7, 231.9, 231.1, 348/14.12, 64, 14.06, 207.1, 231.6, 552; 347/2

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,241,659 A 8/1993 Parulski et al.
5,546,145 A * 8/1996 Bernardi et al. 396/319
5,806,005 A * 9/1998 Hull et al. 348/14.12
6,111,604 A * 8/2000 Hashimoto et al. 348/552
6,167,469 A * 12/2000 Safai et al. 348/64
6,226,362 B1 * 5/2001 Gerszberg et al. 348/14.06

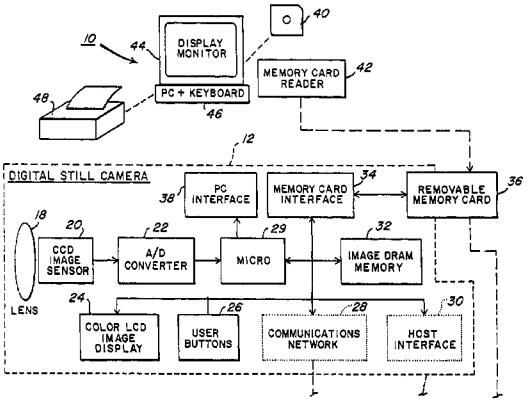
(Continued)

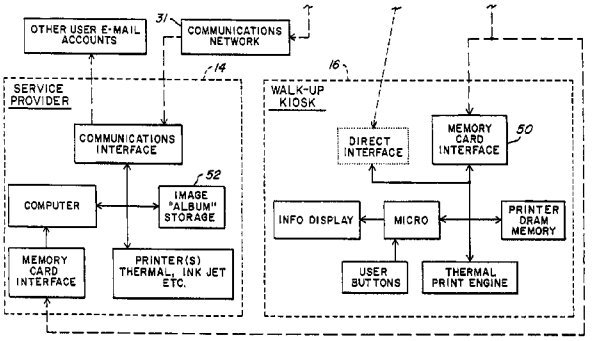
Primary Examiner—David K. Mooe
Assistant Examiner—Henry Dahbour
(74) *Attorney, Agent, or Firm*—Pamela R. Crocker

(57) **ABSTRACT**

An electronic still camera for capturing images to be transferred to at least one e-mail address is disclosed. The electronic still camera includes an image sensor for capturing a plurality of images of scenes and for producing image signals representative of the corresponding scenes; an analog-to-digital converter for digitizing the image signals to produce digital images; and a removable memory card for storing a plurality of digital image files corresponding to the digital images. The electronic still camera also includes an internal memory for storing at least one digital image to be displayed and a plurality of e-mail addresses; a processor for controlling the transfer of the digital images from the removable memory card to the internal memory and for producing a utilization file; and a display coupled to the internal memory for displaying at least one digital image. The electronic still camera further includes a user interface for selecting at least one e-mail address and for scrolling through the plurality of digital images stored on the removable memory card in order to display and select particular digital images to be transferred to the selected at least one e-mail address, wherein the utilization file includes the at least one selected e-mail address and the name of at least one digital image file to be transferred to the at least one selected e-mail address and the processor stores the utilization file on the removable memory card separate from the digital image files.

20 Claims, 5 Drawing Sheets





U.S. PATENT DOCUMENTS

6,344,875	B1 *	2/2002	Hashimoto et al.	348/207.1
6,427,078	B1 *	7/2002	Wilska et al.	348/231.99
6,642,959	B1 *	11/2003	Arai	348/231.3
6,683,649	B1 *	1/2004	Anderson	348/231.6
6,784,924	B2 *	8/2004	Ward et al.	348/207.1
6,812,962	B1 *	11/2004	Fredlund et al.	348/231.2
7,034,871	B2 *	4/2006	Parulski et al.	348/231.3

* cited by examiner

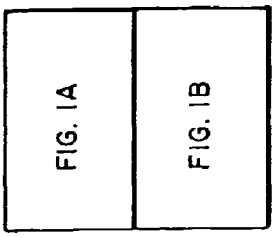


FIG. 1A
FIG. 1B

FIG. 1

FIG. 1A
DIGITAL STILL CAMERA
12
REMOVABLE MEMORY CARD
36
MEMORY CARD READER
42
MEMORY CARD INTERFACE
34
IMAGE DRAM MEMORY
32
HOST INTERFACE
30
COMMUNICATIONS NETWORK
28
PC INTERFACE
38
MICRO
29
USER BUTTONS
26
A/D CONVERTER
22
COLOR LCD IMAGE DISPLAY
24
CCD IMAGE SENSOR
20
LENS
18
DISPLAY MONITOR
PC + KEYBOARD
46
40
44
10
48

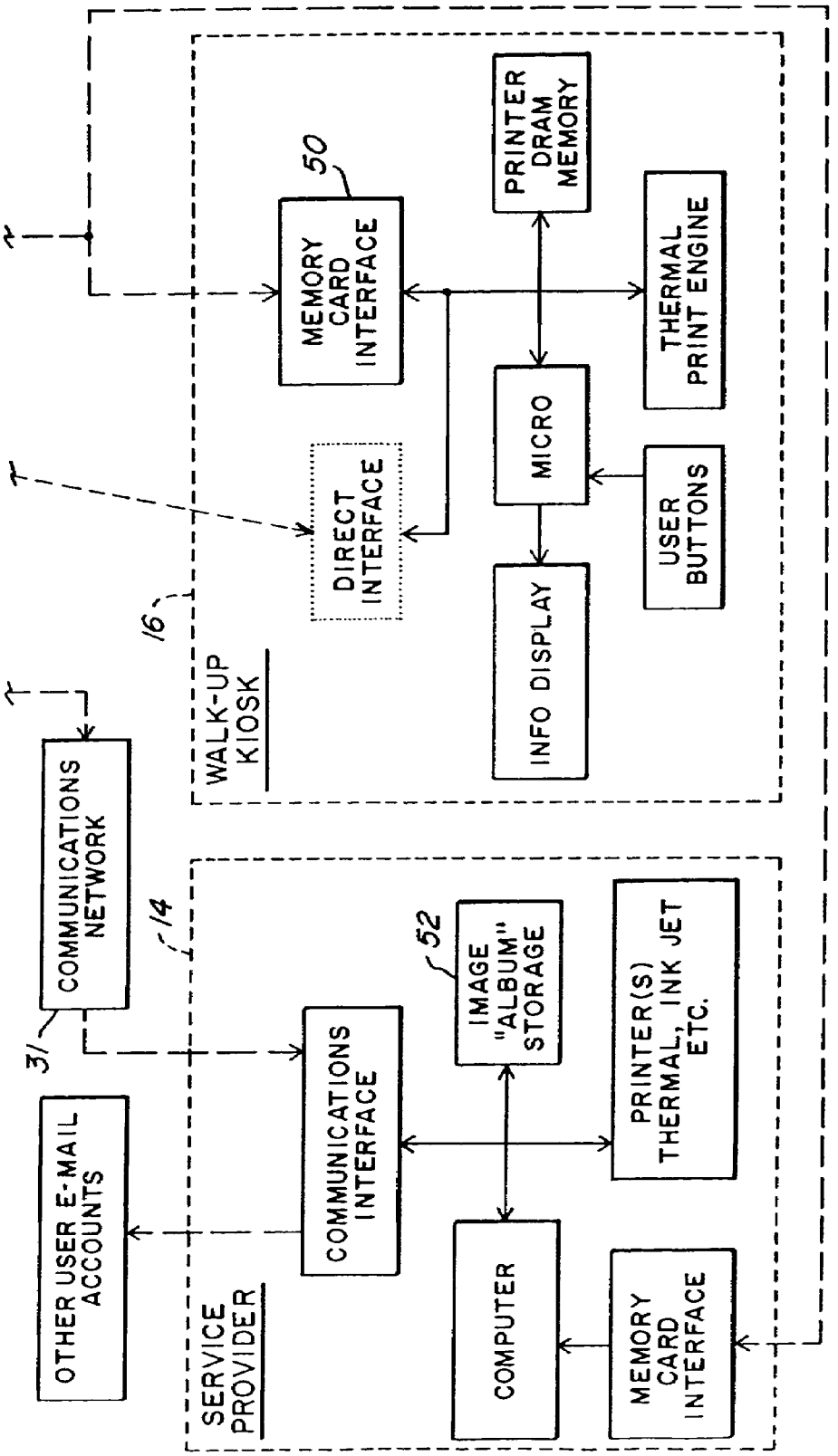

WALK-UP KIOSK
16
MEMORY CARD INTERFACE
50
PRINTER DRAM MEMORY
THERMAL PRINT ENGINE
MICRO
USER BUTTONS
INFO DISPLAY
DIRECT INTERFACE
COMMUNICATIONS NETWORK
31
SERVICE PROVIDER
14
COMMUNICATIONS INTERFACE
IMAGE "ALBUM" STORAGE
52
PRINTER(S) THERMAL, INK JET ETC.
OTHER USER E-MAIL ACCOUNTS
COMPUTER
MEMORY CARD INTERFACE

FIG. 1B

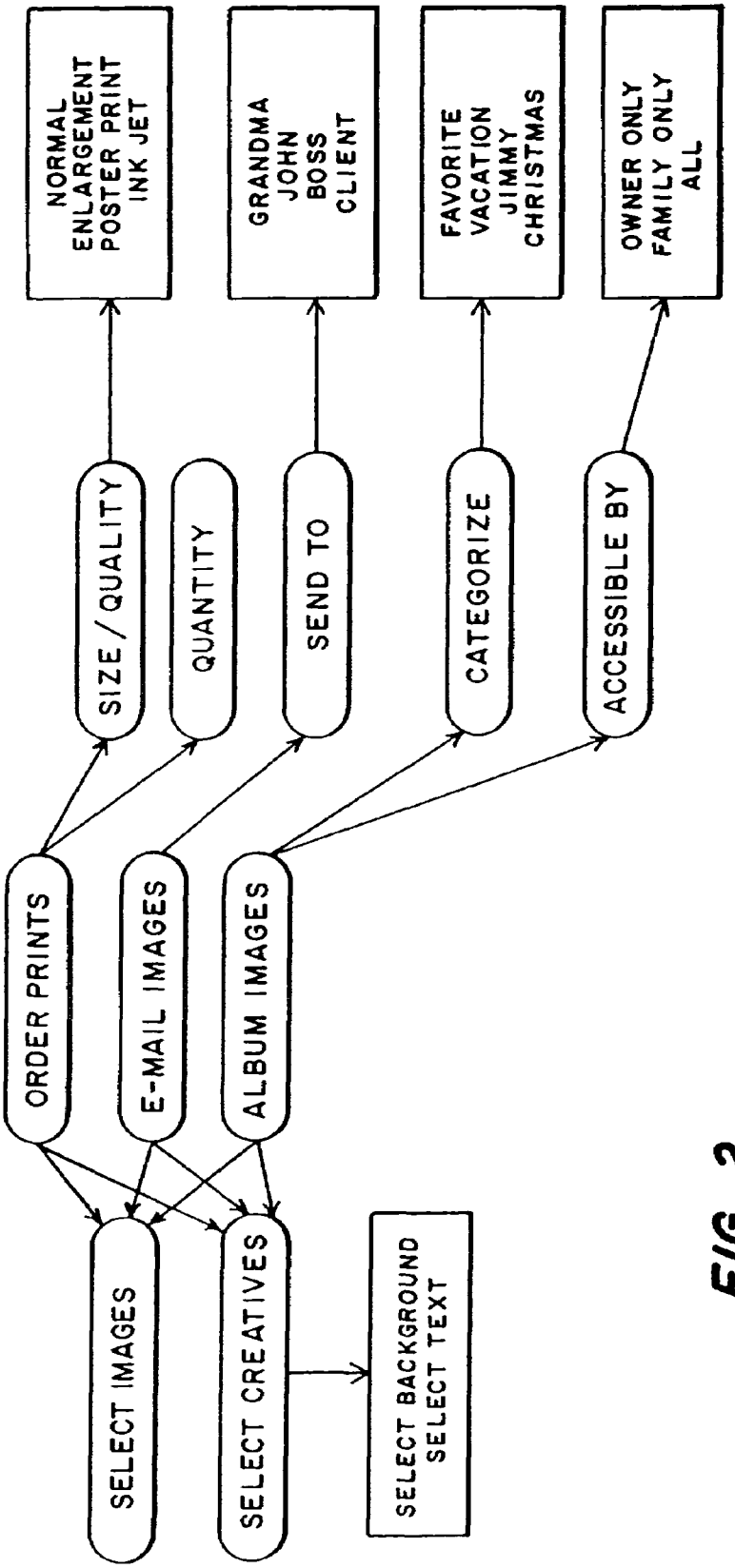

ORDER PRINTS
E-MAIL IMAGES
ALBUM IMAGES
SIZE / QUALITY
QUANTITY
SEND TO
CATEGORIZE
ACCESSIBLE BY
NORMAL
ENLARGEMENT
POSTER PRINT
INK JET
GRANDMA
JOHN
BOSS
CLIENT
FAVORITE
VACATION
JIMMY
CHRISTMAS
OWNER ONLY
FAMILY ONLY
ALL
SELECT IMAGES
SELECT CREATIVES
SELECT BACKGROUND
SELECT TEXT

FIG. 2

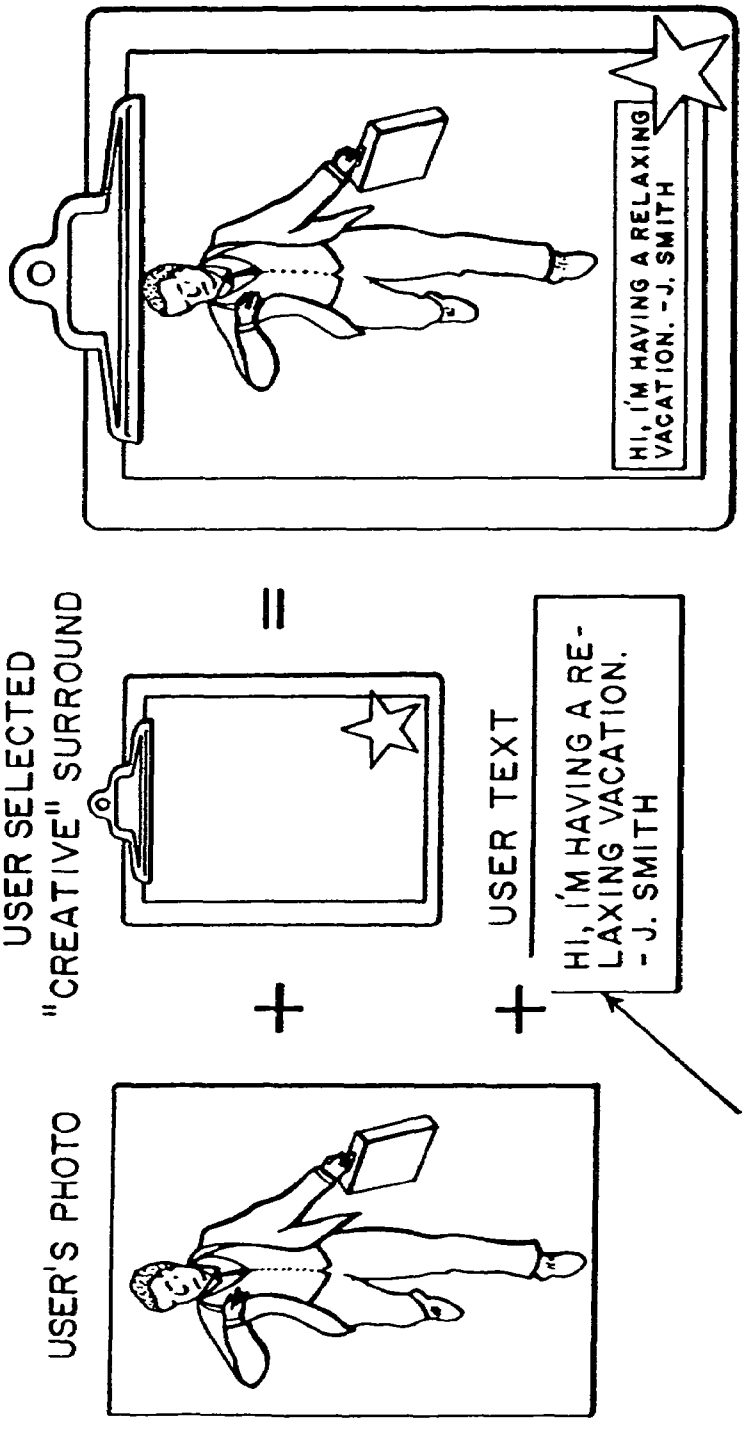

HI, I'M HAVING A RELAXING VACATION. - J. SMITH
USER SELECTED "CREATIVE" SURROUND
=
USER TEXT
HI, I'M HAVING A RE-LAXING VACATION. - J. SMITH
+
+
USER'S PHOTO
INPUT VIA HOST PC, SELECT VIA CAMERA UI

FIG. 3

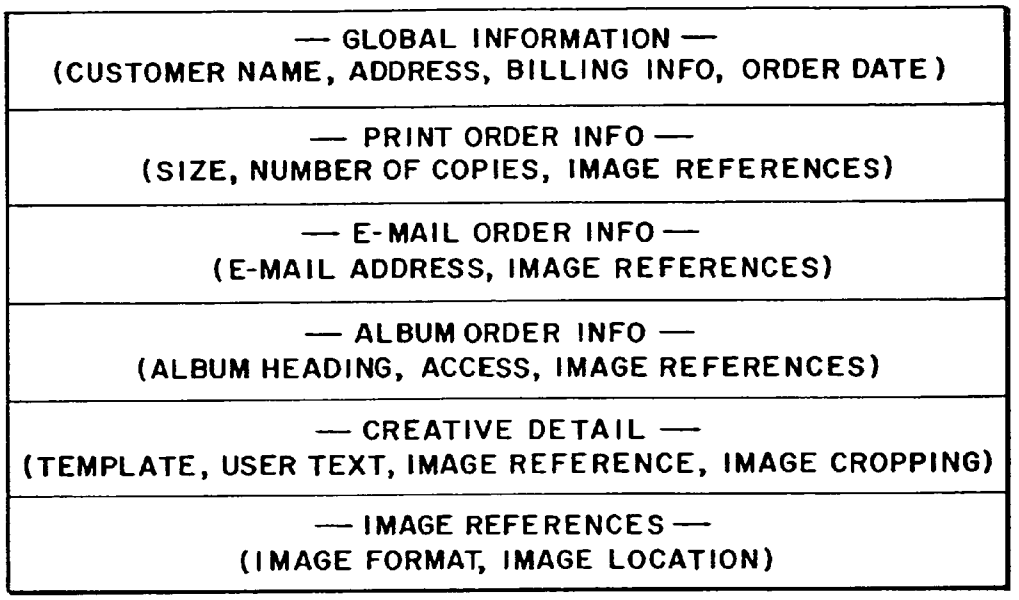

— GLOBAL INFORMATION —
(CUSTOMER NAME, ADDRESS, BILLING INFO, ORDER DATE)
— PRINT ORDER INFO —
(SIZE, NUMBER OF COPIES, IMAGE REFERENCES)
— E-MAIL ORDER INFO —
(E-MAIL ADDRESS, IMAGE REFERENCES)
— ALBUM ORDER INFO —
(ALBUM HEADING, ACCESS, IMAGE REFERENCES)
— CREATIVE DETAIL —
(TEMPLATE, USER TEXT, IMAGE REFERENCE, IMAGE CROPPING)
— IMAGE REFERENCES —
(IMAGE FORMAT, IMAGE LOCATION)

FIG. 4

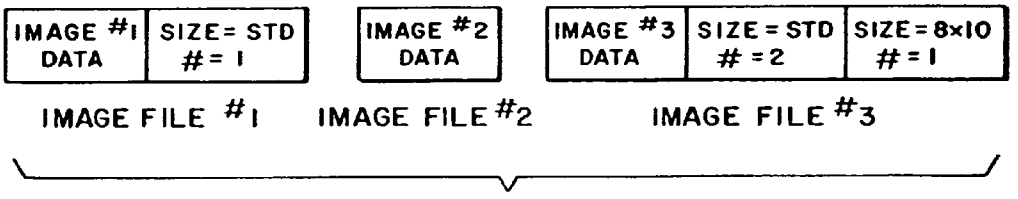


IMAGE #1 DATA
SIZE = STD #= 1
IMAGE #2 DATA
IMAGE #3 DATA
SIZE = STD #= 2
SIZE = 8×10 #= 1
IMAGE FILE #1
IMAGE FILE #2
IMAGE FILE #3

FIG. 5

CAPTURING DIGITAL IMAGES TO BE TRANSFERRED TO AN E-MAIL ADDRESS

CROSS-REFERENCE TO RELATED APPLICATION(S)

This application is a Continuation Application of U.S. Ser. No. 09/821,152, filed Mar. 29, 2001 now U.S. Pat. No. 7,034,871, by Kenneth A. Parulski et al., entitled Electronic Still Camera for Capturing Digital Images to be Transferred to an E-Mail Address, which is a Continuation of U.S. Ser. No. 08/977,382, filed Nov. 24, 1997 now issued as U.S. Pat. No. 6,573,927 on Jun. 3, 2003.

FIELD OF THE INVENTION

The invention relates generally to the field of photography, and in particular to electronic photography. More specifically, the invention relates to an electronic camera that can be interfaced with a host computer.

BACKGROUND OF THE INVENTION

Digital cameras, such as the Kodak Digital Science DC25™ camera, allow images to be utilized on a home computer (PC) and to be incorporated into e-mail documents and personal home pages on the World Wide Web. Presently, if a print is desired, each image must first be copied to the PC and then individually printed. The user is required to manually select each image to be printed, and manually decide how big each print should be and how many prints to make of each image.

In addition, it is possible for users to electronically send images to others using software, such as the Kodak Digital Science Picture Postcard Software™. However, this again requires the user to manually download each image to the host computer, select each image to be transmitted, and create a new "Postcard" for each image to be sent. Users can also create "albums" of photos on their computers using software such as the Family Album Creator™ by Creative Wonders, Inc. Again, however, this is a manual process that requires each image to be downloaded to the computer, individually selected, and added to the album.

In U.S. Pat. No. 5,241,659, reprint information can be generated at the time a PhotoCD disc is played back. This patent describes an EEPROM card that can be inserted into a PhotoCD player. As shown in FIGS. **3**, **5**, and **6** of this patent, the EEPROM card can contain reprint order information and "album disc" information input by the player operator. However, this information is not generated at the time of picture taking, and is not stored on the same media as the images. Moreover, the reprint information does not include information useful to the service provider, such as user account, charge card, and mailing address.

What is needed is a way for camera users to quickly and easily compose "print orders" and "transmission orders" and/or "electronic albuming" orders, at the time they capture their images.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide an electronic still camera for capturing images to be transferred to at least one e-mail address, the electronic still camera comprising:

(a) an image sensor for capturing a plurality of images of scenes and for producing image signals representative of the corresponding scenes;

(b) an analog-to-digital converter for digitizing the image signals to produce digital images;

(c) a removable memory card for storing a plurality of digital image files corresponding to the digital images;

(d) an internal memory for storing at least one digital image to be displayed and a plurality of e-mail addresses;

(e) a processor for controlling the transfer of the digital images from the removable memory card to the internal memory and for producing a utilization file;

(f) a display coupled to the internal memory for displaying at least one digital image; and

(g) a user interface for selecting at least one e-mail address and for scrolling through the plurality of digital images stored on the removable memory card in order to display and select particular digital images to be transferred to the selected at least one e-mail address, wherein the utilization file includes the at least one selected e-mail address and the name of at least one digital image file to be transferred to the at least one selected e-mail address and the processor stores the utilization file on the removable memory card separate from the digital image files.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of the system according to the invention;

FIG. **2** is a diagram of downstream services available in the system shown in FIG. **1**;

FIG. **3** is an illustration of one example of a creative background added to an image;

FIG. **4** is a diagram of the organization of a utilization file; and

FIG. **5** is a diagram of another organization of a utilization file together with each image file.

DETAILED DESCRIPTION OF THE INVENTION

Because imaging systems and devices are well known, the present description will be directed in particular to elements forming part of, or cooperating more directly with, apparatus in accordance with the present invention. Elements not specifically shown or described herein may be selected from those known in the art. Some aspects of the present description may be implemented in software. Unless otherwise specified, all software implementation is conventional and within the ordinary skill in the programming arts.

A system block diagram of the invention is shown in FIG. **1**, and includes a user's host computer (PC) **10**, a digital camera **12**, equipment located at a "downstream" service provider **14**, and equipment at a walk-up kiosk **16**. The camera **12** includes an optical section **18** for imaging a scene upon an image sensor **20** and generating an image signal, an A/D converter **22** for digitizing the image signal, a liquid crystal display (LCD screen) **24** for displaying images and other information, a number of user input buttons **26**, and both internal memory **32** and a removable memory card **36** for storing captured images. The camera **12** may optionally include an internal communications interface **28** (e.g., modem). A microprocessor **29** generally controls the operation of the camera **12**, and interchanges data through a memory card interface **34** with the memory card **36**, through a PC interface **38** with the host computer **10**, through a host interface **30** directly with the kiosk **16**, and through the communications interface **28** and a communications network **31** with the service provider **14**.

When the camera **12** is purchased, it is provided with a software application (located on a disc **40**) for running on the

user's host PC **10** that enables the user to specify the name(s) of downstream service providers, network addresses (friends, family or business associates) and related account information such as billing information (e.g., charge card number, mailing addresses). The user can also select, through the software application, one or more "creative backgrounds" offered by the service provider (such as a postcard border) and enter one or more text messages, (such as "Hi, I'm having a relaxing vacation, John Smith"), as will be described in connection with FIG. **3**. All of this information can then be downloaded, via a memory card reader **42** on the host PC **10**, to the removable memory card **36**, which can be subsequently inserted into the camera **12**. Alternatively, the information can be downloaded to the camera **12** via the host PC interface **38** and written to the camera's internal memory **32** or the removable memory card **36** in the camera. Typically, keyword descriptors accompany the information to enable easy access by the camera user.

After placing the memory card **36** in the camera **12** (or disconnecting the camera **12** from the host PC **10**), the user can operate the camera **12** to take numerous pictures, which are stored either in the internal memory **32** or in the memory card **36** (or in both). After taking pictures, the user reviews the images on the LCD screen **24**, using the buttons **26** to scroll through the images. The user can then select the desired "downstream services" (printing, e-mailing, and/or albuming) and compose the order using the options listed in FIG. **2**. These services and options are accessed from the memory card **36** and, for example, the keyword descriptors are assembled in a menu and displayed on the LCD screen **24**. Selections among these services and options are made, for example, by reference to the keyword descriptors and actuation of the user buttons **26**. The details of the order information is written into a "utilization" file generated by the camera **12** that identifies the order and includes pointers to the image files that store the images required to "fulfill" the order. The "utilization" file is stored in the internal memory **32** or the memory card **36**.

For printing, order composition involves selecting the quantity, print size, and quality level (e.g., thermal or ink jet) of the images to be printed. For example, the user might choose one "standard" (4"×6" size) image of 2 different images, and 2 standard size images plus one "enlargement" (8"×10" size) image of their "favorite" vacation image. The print order information is provided in the utilization file that identifies the order and includes pointers to the image files that store the images required to "fulfill" the print order. In addition to "normal" type prints, the prints can be "creative" prints, using one of the creative backgrounds selected on the host computer and downloaded to the camera along with text. In this case, the "favorite" image might be surrounded with one of the border and captions provided via the host PC **10**, as shown in FIG. **3**.

The user can then take or mail the image memory card **36** containing the image files and order information (utilization file) to the print service provider **14**. The provider reads the information, fills the print order, and returns the print order either for pick-up by the user or by mail. The service provider **14** charges the user's credit card account (which can be stored in the print order information file) for the prints provided. Alternatively, the user can place the card **36** in a slot **50** of a "walk-up kiosk" **16** along with a credit card. The kiosk can then automatically produce the prints required while minimizing the amount of user interaction required. Finally, the user could place the card in a home printer **48**, and the printer could automatically produce the quantity of prints of each image required. In the last two cases, the size and quality of print types available might be limited to those available by the kiosk **16** or the home printer **48**.

Alternatively, the camera **12** could incorporate or be connected to a wired or wireless modem, such as the communications interface **28**. In this case, the print order information, and the image information needed to fulfill the print order, would be transmitted to the service provider **14** along with the account information through the communication network **31** (which could be a wired or wireless network). The service provider **14** would print the order and mail the prints back to the user.

Instead of, or in addition to, composing a print order, the user may choose to transmit one or more images to others. These images can include the "creative" images and/or text described above. The user selects the images and the person(s) who will receive them, from the group of addresses loaded into the camera **12** via the process described earlier (the software application running on the home PC **10**). The e-mail order information is provided in the utilization file that gives the e-mail address and includes pointers to the image files that store the images required to "fulfill" the e-mail order.

If the camera **12** includes a transmitter, e.g., a cellular connection in the communications interface **28**, the camera **12** could include and initiate a "send" command that the user would enable after completing the e-mail order. This command would automatically send the appropriate images to the appropriate user's e-mail accounts through the network **31** using the appropriate communications protocol (i.e., FTP, mailto). Alternatively, the camera **12** can be placed in a docking unit (not shown) containing the modem. The images can then be automatically transmitted to the service provider **14**, when the camera **12** is inserted into the dock. Alternatively, the memory card **36** could be removed from the camera **12** and placed in a kiosk, which would then transmit the images and bill the user's charge card.

Instead of, or in addition to, composing a print order and/or an e-mail order, the user may choose to transmit one or more images to their "electronic photo album" account, which could be maintained by the service provider **14** (or alternatively could be maintained on the user's home computer **10**) in an image "album" storage **52**. In this case, the user selects the images to be transferred to their photo album, and optionally selects what group of users might be allowed to view the images. The groups may include "Self only", "Self plus immediate family only", and "All" (i.e., family, friends) The information may include text, which may be input and selected as described in U.S. Pat. No. 5,633,678, "An Electronic Still Camera for Capturing and Categorizing Images", filed Dec. 20, 1995, and assigned to the assignee of the present application, the disclosure of which is herein incorporated by reference.

Instead of having the camera **12** communicate directly to the "downstream" service provider **14** over the communications network **31**, the communications network **31** from the camera **12** could alternatively be connected to an internet service provider (ISP) (not shown) such as AOL (America On Line), Earthlink, and Eznet. The "downstream" service provider **14** would then be connected to all ISPs via the internet, eliminating the need to maintain a separate communications network. The ISP would transfer the utilization file data and images needed to order prints and album images to the downstream service provider. The ISP could itself handle e-mailing of images to other users, using the data and images in the utilization file.

The utilization order information is provided in the utilization file. The general file organization is shown in FIG. **4**, and a detailed example of the file contents of an elaborate

utilization file is given in Appendix I. This file may be encrypted to prevent unauthorized use of the sensitive information, such as the user's credit card number. Referring to Appendix I, a Global information section (lines **2-26**) provides the customer information (name, address, credit card), as well as the time the order was placed, and whether it has been processed or not.

The file may contain one or more Print Order sections. For example, lines **28-37** describe a print order of "standard" size (4"×6") prints of the images made on a silver halide based CRT printer. Line **34** indicates that two copies of the image referenced in line **33** will be printed, while only one copy of the images referenced in lines **35-36** is printed. A second print order section (lines **39-55**) indicates a large size print (24"×36") should be made on a silver halide printer and mounted in particular in a walnut frame. This printer should be sent via UPS to the address shown in lines **47-52**. The image is the composite shown in FIG. **3**, which is described in the CreativeDetail section (lines **76-90**).

An e-mail order section (lines **57-65**) provides the e-mail address and a list of images that should be sent to this address. An album order section (lines **67-72**) provides a means for adding images to the users on-line photo album. The user can classify the images under a particular heading (e.g., "vacation" images) and indicate who is allowed to access the images via the internet.

A Creative Detail section (lines **74-90**) defines each creative image, such as the image in FIG. **3**. It also describes user defined text (line **81**). Multiple templates and user text options may be downloaded from the host computer to a memory card **36** that is then inserted into the camera **12**, prior to taking pictures. The template (background) may be an identification code that is only added, for example, during printing. In this case, the template is not viewed when the image is displayed on the camera **12**. Alternatively, a low resolution version of the templates desired by the user can be stored in the camera **12**, so that the user can preview the final composite image. A high resolution version of the template can be used by the service provider to print the final composite image. The user may decide to crop and rotate the image (lines **86-87**) prior to inserting it into the creative background.

Finally, an image detail section (**92-102**) describes the file type (e.g., FlashPix, JPEG, TIFF) and location of each image. In this example, the three images are all FlashPix images located on the memory card "Local Card" in the "vacation" folder.

Most of the information in GlobalInfo and CreativeDetail sections of the digital camera utilization file, for example the addresses and creative text, is downloaded from the host computer to the camera prior to picture taking. After reviewing the images, the user uses the image LCD and user interface to select which images to print, e-mail, and album. The print size, e-mail, albuming, and creative options are offered by pull-down menus that match the options provided by the service providers they have selected on the computer and downloaded to the camera **12** (via the memory card **36**). The full utilization file (i.e., Print order, e-mail order) is then created by the camera based on the user selections.

A much simpler print utilization file is shown in Appendix II. In this case, the camera **12** simply allows a print order to be created. The memory card **36** containing the images and the simple utilization file is then inserted into the home PC **10**, the home printer, or the walk-up kiosk **16** or sent to a service provider via a communications interface. The proper number of each selected image is then automatically printed, without further user intervention.

Instead of providing the utilization information for multiple images in a single utilization file, other embodiments are possible. For example, the camera may create three utilization files, one containing the information needed to produce a print order, a second containing information needed to provide electronic albuming, and a third containing e-mail order information. Alternatively, the utilization information may be provided with each image file, as shown in FIG. **5**. In this embodiment, the print order information describing the number and size of each image to be printed is included in tags provided within each image file. For example, image file #1 contains the image data and a tag indicating that the user has requested one standard size print. Image file #2 does not contain a print tag (or alternatively could include a tag with the number of prints set equal to zero) so no prints will be made of image #2. Image file #3 includes a first print tag indicating that the user has requested two standard size prints, and a second tag indicating that the user has also requested a single 8"×10" size enlargement.

The invention has been described with reference to a preferred embodiment. However, it will be appreciated that variations and modifications can be effected by a person of ordinary skill in the art without departing from the scope of the invention.

APPENDIX I: DIGITAL CAMERA UTILIZATION FILE

```
1   00000000 UTILIZATION ORDER SPECIFICATION
    (Non-zero initial number identifies encryption key)
2   %Section: GlobalInfo
3       %Section: ConsumerInfo (Provides info on camera owner and
        default mailing address)
4           %Name: ~Smith~~John~~W~
5           %Consumer ID: Njj1007
6           %Address: ~1 Picture Avenue~
7               ~Apartment 8b~
8               ~PO Box 123~
9               ~Anytown~
10              ~State~
11          %PostalCode: ~14650~
12          %CountryCode: USA
13          %Email: ~jdoe@kodak.com~
14          %PhoneDay: ~(716) 555-1111~
15          %PhoneNight: ~(716) 555-2222~
16          %CreditCardExpDate: 1996 03 24
```

-continued

```
            %CreditCardNumber: 3030445643345
            %CreditCardType: AmericanExpress
        %EndSection: ConsumerInfo

        %Section: OrderInfo (Provides information on when utilization file was created)
            %Date: 1996 2 28
            %Time: 14 22 29
            %Processed: 0 (1 Indicates that this utilization order was processed)
        %EndSection: OrderInfo
%EndSection: GlobalInfo

%Section: PrintOrder (Lists the images in a print order)
        %Section: FinishInfo
            %ImageOutputSize: 4 6 Inches (This example is for standard size prints)
            %MediaClass: AgX 20 EN34 Glossy
        %EndSeccion: FinishInfo
            %ImageRef: ImageDetail1 (Points to images defined below)
            %Quantity:2 (Optionally indicates number of copies, default = 1)
            %ImageRef: ImageDetail2
            %ImageRef: ImageDetail3
%EndSection: PrintOrder

%Section: PrintOrder
        %Section: FinishInfo
            %ImageOutputSize: 24 36 Inches (This example is for a large creative print)
            %MediaClass: AgX 20 EN34 Glossy
            %FrameType: F134 Walnut
        %EndSection: FinishInfo
        %Section: ShippingInfo (Instructions to ship to an address other than the one in
        GlobalInfo)
            %ShippingCarrier: UPS
            %Name: ~Good~~Johnny~~B~
            %Address: ~1 Song Street~
                ~Mytown~
                ~State~
            %PostalCode: ~00111~
            %CountryCode: USA
        %EndSection: ShippingInfo
        %ImageRef: CreativeDetail1 (Points to creative defined below)
%EndSection: PrintOrder

%Section: EmailOrder (Sends images via e-mail)
        %Section: AddressInfo (Instructions to ship to an address other than the one in
        GlobalInfo)
            %Name: ~Good~~Johnny~~B~
            %Email: ~jgood@localnet.net~
        %EndSection: AddressInfo
        %ImageRef: Creative Detail1 (Points to creative defined below)
        %ImageRef: ImageDetail2
        %ImageRef: Imagefletail3
%EndSection: EmailOrder

%Section: AlbumOrder (Add these images to on-line photo album)
        %AlbumHeading: ~Vacation images~ (Place images under "vacation"
        album heading)
        %AlbumViewing: All (gives access to all authorized album viewers)
        %ImageRef: CreativeDetail1 (Points to creative defined below)
        %ImageRef: ImageDetail2
%EndSection: AlbumOrder

%Section: CreativeDetail 1 (Describes each composite image)

        %LayoutRef: T12345 (Indicates template ID or template image file)
        %Section: PageInfo
            %PageRef: 0
            %Section: TextInfo (Indicates what text appears in the template)
                %TextNodeRef: 1
                %ConsumerText: ~Hi, I'm having a relaxing time on vacation. John Smith
            %EndSection: TextInfo
            %Section:ImageInfo (Indicates which images(s) appear in template)
                %ImageNodeRef: 2
                %ImageDetailRef: 1
                %CropRect: 256 0 768 1280 (Cropped image top, left, width, height)
                %Rotate: 90 (Indicates rotation in degrees clockwise)
            %EndSection: ImageInfo
        %EndSection: PageInfo
%EndSection: CreativeDetail

%Section: ImageData (Describes each image, may be referenced multiple times)
```

-continued

```
93        %Section: ImageDetail 1
94            %FileType: FlashPix Version 2.0
95            %ImageLocation: LocalCard~Vacation/Image4.FPX~
96        %Section: ImageDetail 2
97            %FileType: FlashPix Version 2.0
98            %ImageLocation: LocalCard~Vacation/Image7.FPX~
99        %Section: ImageDetail 3
100           %FileType: FlashPix Version 2.0
101           %ImageLocation: LocalCard~Vacation/Image10.FPX~
102   %EndSection: ImageData
```

APPENDIX II: SIMPLE PRINT ORDER UTILIZATION FILE

```
1     %Section:PrintOrder (Lists the images in a print order)
2         Image4.FPX 1 (One copy of image 4)
3         Image7.FPX 2 (Two copies of image 7)
4         Image10.FPX 1
5         Image12.FPX 4
6         Image13.FPX 1
7     %EndSection:PrintOrder
```

What is claimed is:

1. An electronic camera for capturing images to be transferred to at least one e-mail address, the electronic camera comprising:

(a) an image sensor for capturing a plurality of images;

(b) a first memory for storing the plurality of images;

(c) a second memory for storing a plurality of e-mail addresses;

(d) a processor for producing a utilization file;

(e) a display coupled to the first memory for displaying at least one of the plurality of stored images; and

(f) a user interface for selecting at least one e-mail address stored in the second memory and for scrolling through the plurality of images stored in the first memory in order to display and select at least one image to be transferred to the selected at least one e-mail address, wherein the utilization file identifies the at least one selected e-mail address and the at least one image to be transferred to the at least one selected e-mail address.

2. The electronic camera as claimed in claim **1** wherein the first memory is a removable memory card.

3. The electronic camera as claimed in claim **1** further including a communications interface which interfaces to a communications network for transferring the at least one selected image to the at least one selected e-mail address.

4. The electronic camera as claimed in claim **3** wherein the communications interface includes a transmitter.

5. The electronic camera as claimed in claim **4** wherein the transmitter provides a cellular connection.

6. The electronic camera as claimed in claim **4** wherein the electronic camera provides a send command to initiate transfer of the at least one selected image to the at least one selected e-mail address using the transmitter.

7. The electronic camera as claimed in claim **1** further including a separate docking unit having a modem for transferring the at least one selected image to the at least one selected e-mail address.

8. The electronic camera as claimed in claim **7** wherein the at least one selected image is transmitted to a service provider, and the service provider then transfers the at least one selected image to the at least one selected e-mail address.

9. The electronic camera as claimed in claim **1** wherein the plurality of images are stored in a corresponding plurality of digital image files.

10. The electronic camera as claimed in claim **9** wherein the digital image files are JPEG files.

11. The electronic camera as claimed in claim **1** wherein the utilization file identifies at least two digital images.

12. The electronic camera as claimed in claim **1** wherein the utilization file identifies the camera owner.

13. A method for capturing images to be transferred to at least one e-mail address, comprising:

(a) storing a plurality of e-mail addresses in a memory of an electronic camera;

(b) capturing a plurality of images of scenes with the electronic camera;

(c) storing the plurality of images in a memory of the electronic camera;

(d) providing a user interface in the electronic camera for selecting at least one e-mail address from the stored plurality of e-mail addresses and for scrolling through the plurality of stored images in order to display and select particular images to be transferred from the electronic camera to the selected at least one e-mail address;

(e) transferring the selected images to the selected at least one e-mail address.

14. The method as claimed in claim **13** wherein the plurality of e-mail addresses are transferred from a separate device to the electronic camera.

15. The method as claimed in claim **14** wherein the separate device is a PC.

16. The method as claimed in claim **13** further including interfacing to a communications network and transferring the selected images to the at least one selected e-mail address.

17. The method as claimed in claim **16** wherein the communications network includes a cellular transmitter.

18. The method as claimed in claim **13** wherein the selected images are transmitted to a service provider, and the service provider then transfers the selected images to the at least one selected e-mail address.

19. The method as claimed in claim **13** further including producing a utilization file that identifies the at least one selected e-mail address and the selected images.

20. The method as claimed in claim **13** wherein the plurality of images is stored in a corresponding plurality of JPEG image files.

* * * * *

EXHIBIT 9

US007742084B2

(12) **United States Patent**
Ward et al.

(10) **Patent No.: US 7,742,084 B2**
(45) **Date of Patent: *Jun. 22, 2010**

(54) **NETWORK CONFIGURATION FILE FOR AUTOMATICALLY TRANSMITTING IMAGES FROM AN ELECTRONIC STILL CAMERA**

(75) Inventors: **Joseph Ward**, Rochester, NY (US); **Kenneth A. Parulski**, Rochester, NY (US); **James D. Allen**, Rochester, NY (US)

(73) Assignee: **Eastman Kodak Company**, Rochester, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 258 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **11/692,224**

(22) Filed: **Mar. 28, 2007**

(65) **Prior Publication Data**

US 2007/0285523 A1 Dec. 13, 2007

Related U.S. Application Data

(60) Continuation of application No. 09/783,437, filed on Feb. 14, 2001, now Pat. No. 7,256,823, which is a division of application No. 09/004,046, filed on Jan. 7, 1998, now Pat. No. 6,784,924.

(60) Provisional application No. 60/037,962, filed on Feb. 20, 1997.

(51) **Int. Cl.**
H04N 5/76 (2006.01)

(52) **U.S. Cl.** **348/231.3**; 348/333.02

(58) **Field of Classification Search** 348/207.1, 348/333.01–333.11

See application file for complete search history.

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

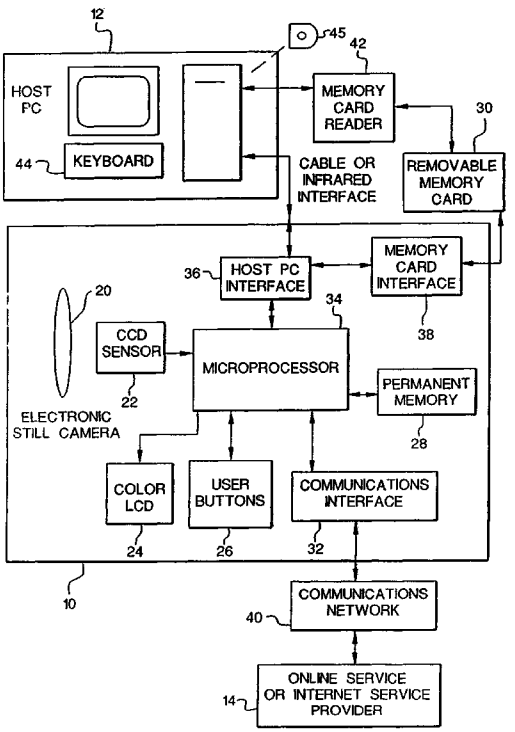
JP 1994-268582 9/1994

Primary Examiner—Tuan Ho
(74) *Attorney, Agent, or Firm*—Thomas J. Strouse; Peyton C. Watkins

(57) **ABSTRACT**

A network configuration file is generated at a host computer and downloaded to a digital camera. This file contains instruction information for communicating with a selected destination via a communications interface. The digital camera includes a "send" button or LCD icon which allows the user to easily transmit one or more images via a wired or wireless communications interface to a desired destination, which among other possibilities may be an Internet Service Provider or a digital photofinishing center. When the user selects this option, the communications port settings, user account specifics, and destination connection commands are read from the network configuration file on the removable memory card. Examples of these settings include serial port baud rate, parity, and stop bits, as well as account name and password.

11 Claims, 4 Drawing Sheets



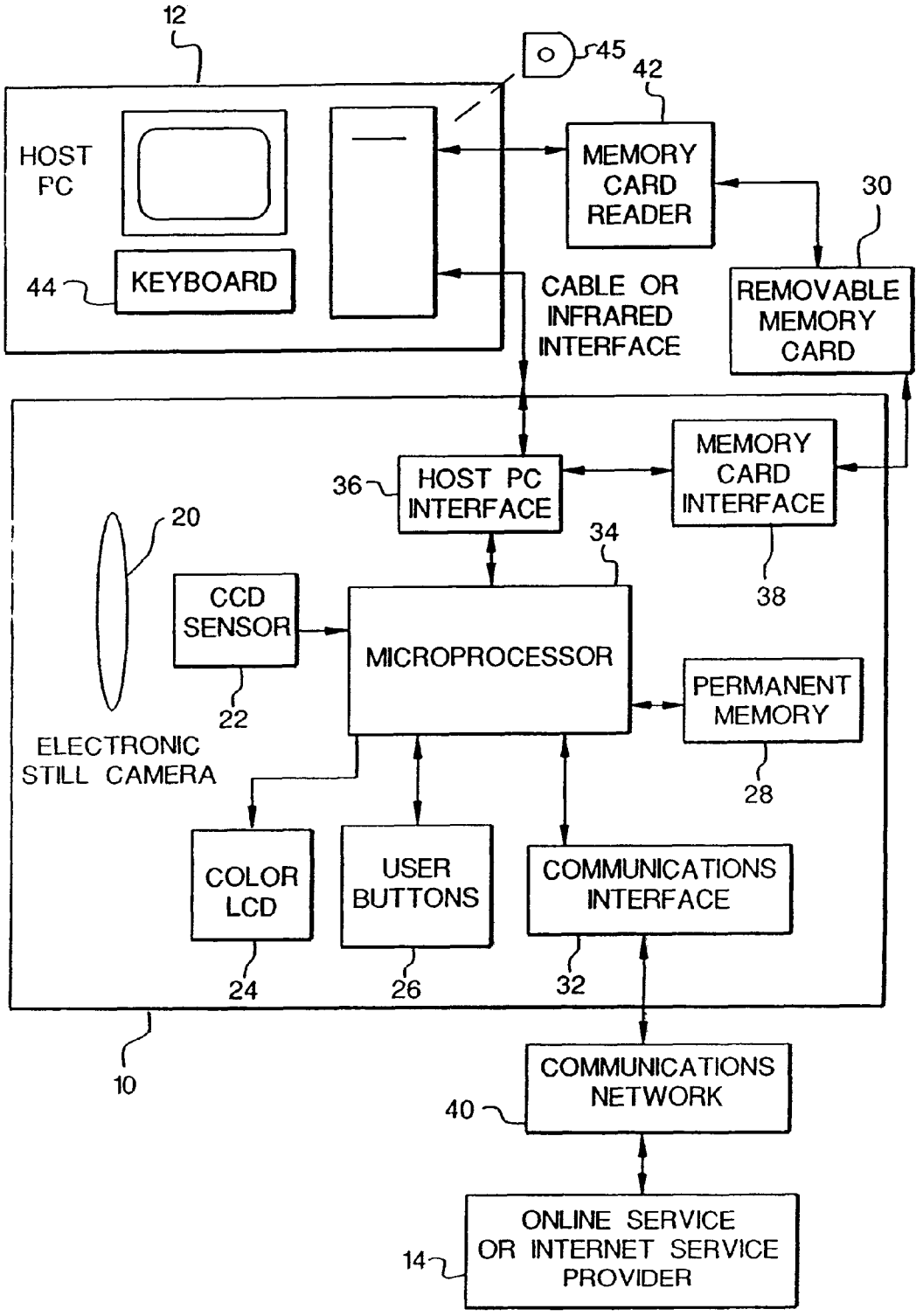

12
45
42
HOST PC
MEMORY CARD READER
30
44
KEYBOARD
CABLE OR INFRARED INTERFACE
REMOVABLE MEMORY CARD
MEMORY CARD INTERFACE
36
HOST PC INTERFACE
20
34
38
CCD SENSOR
MICROPROCESSOR
PERMANENT MEMORY
22
ELECTRONIC STILL CAMERA
28
COLOR LCD
USER BUTTONS
COMMUNICATIONS INTERFACE
24
26
32
10
COMMUNICATIONS NETWORK
40
ONLINE SERVICE OR INTERNET SERVICE PROVIDER
14

FIG. 1

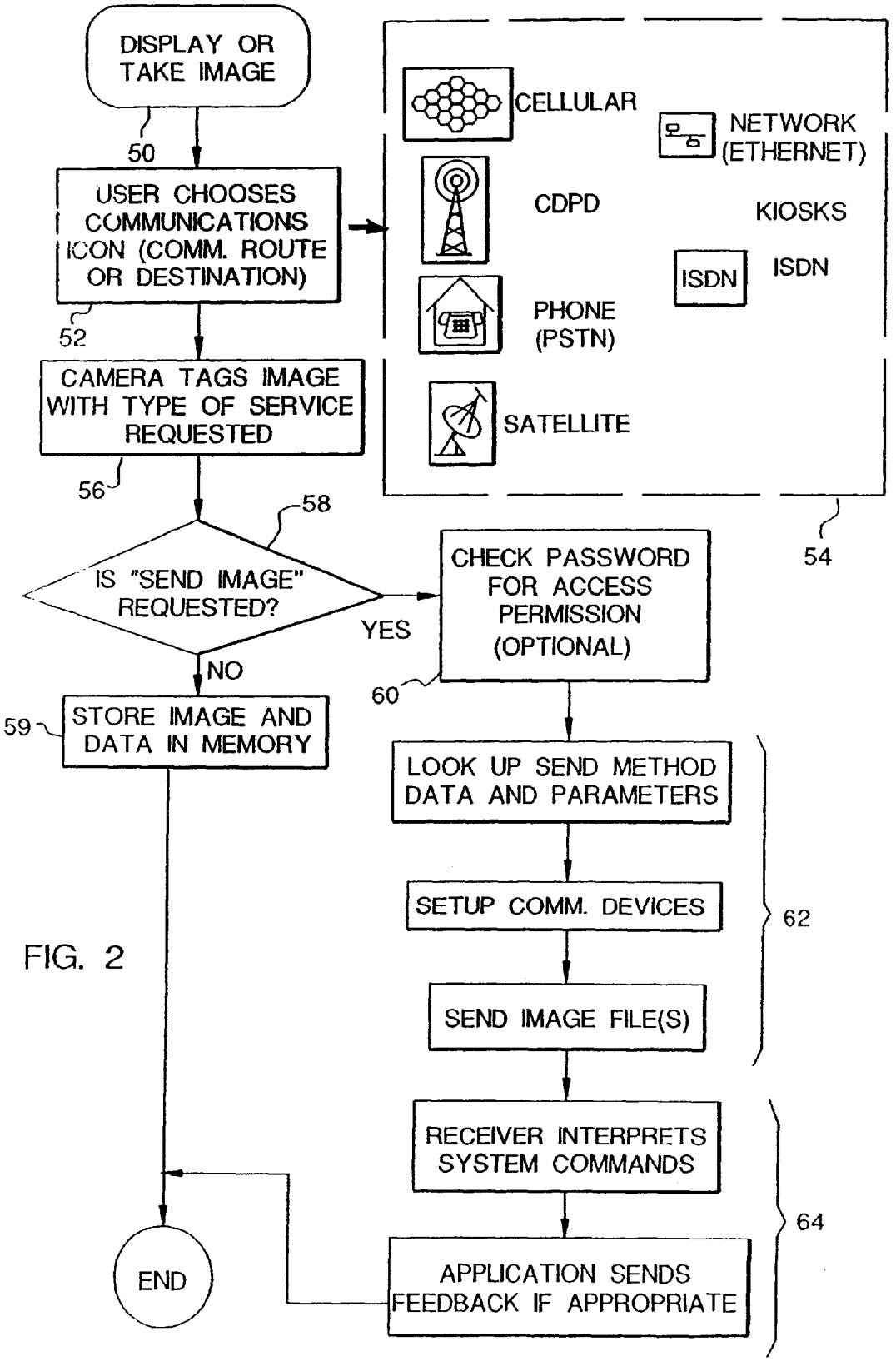

DISPLAY OR TAKE IMAGE
50
USER CHOOSES COMMUNICATIONS ICON (COMM. ROUTE OR DESTINATION)
52
CAMERA TAGS IMAGE WITH TYPE OF SERVICE REQUESTED
56
58
IS "SEND IMAGE" REQUESTED?
YES
NO
CHECK PASSWORD FOR ACCESS PERMISSION (OPTIONAL)
60
59
STORE IMAGE AND DATA IN MEMORY
LOOK UP SEND METHOD DATA AND PARAMETERS
SETUP COMM. DEVICES
SEND IMAGE FILE(S)
62
RECEIVER INTERPRETS SYSTEM COMMANDS
APPLICATION SENDS FEEDBACK IF APPROPRIATE
64
END
CELLULAR
NETWORK (ETHERNET)
CDPD
KIOSKS
ISDN
ISDN
PHONE (PSTN)
SATELLITE
54

FIG. 2

FIG. 3

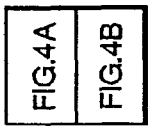
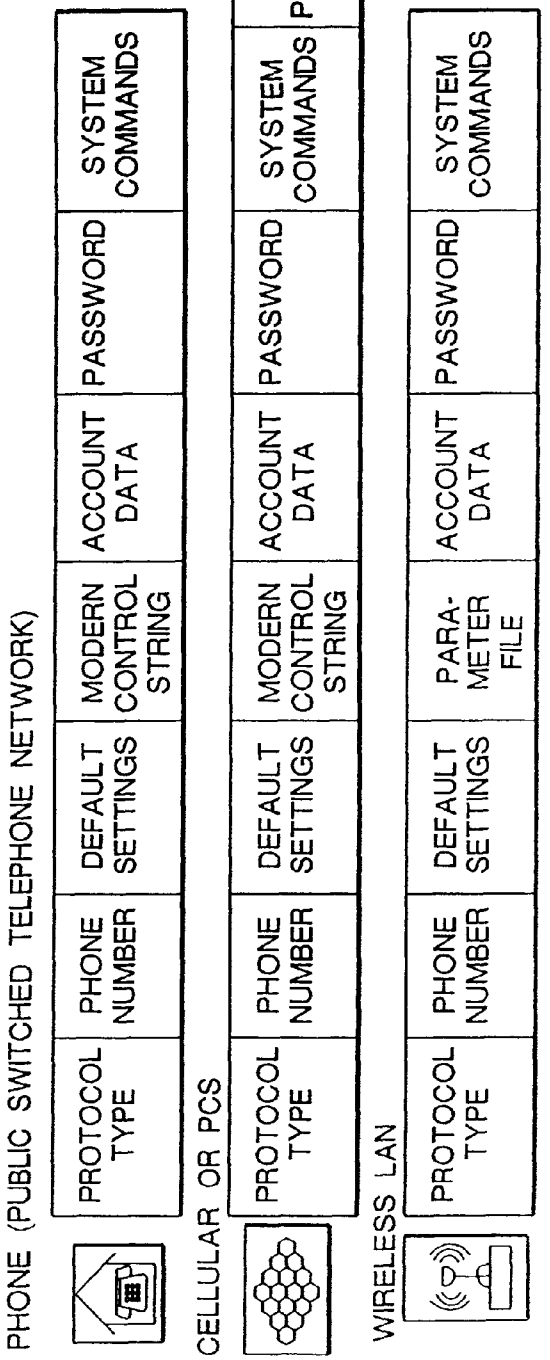


FIG. 4

FIG. 4A



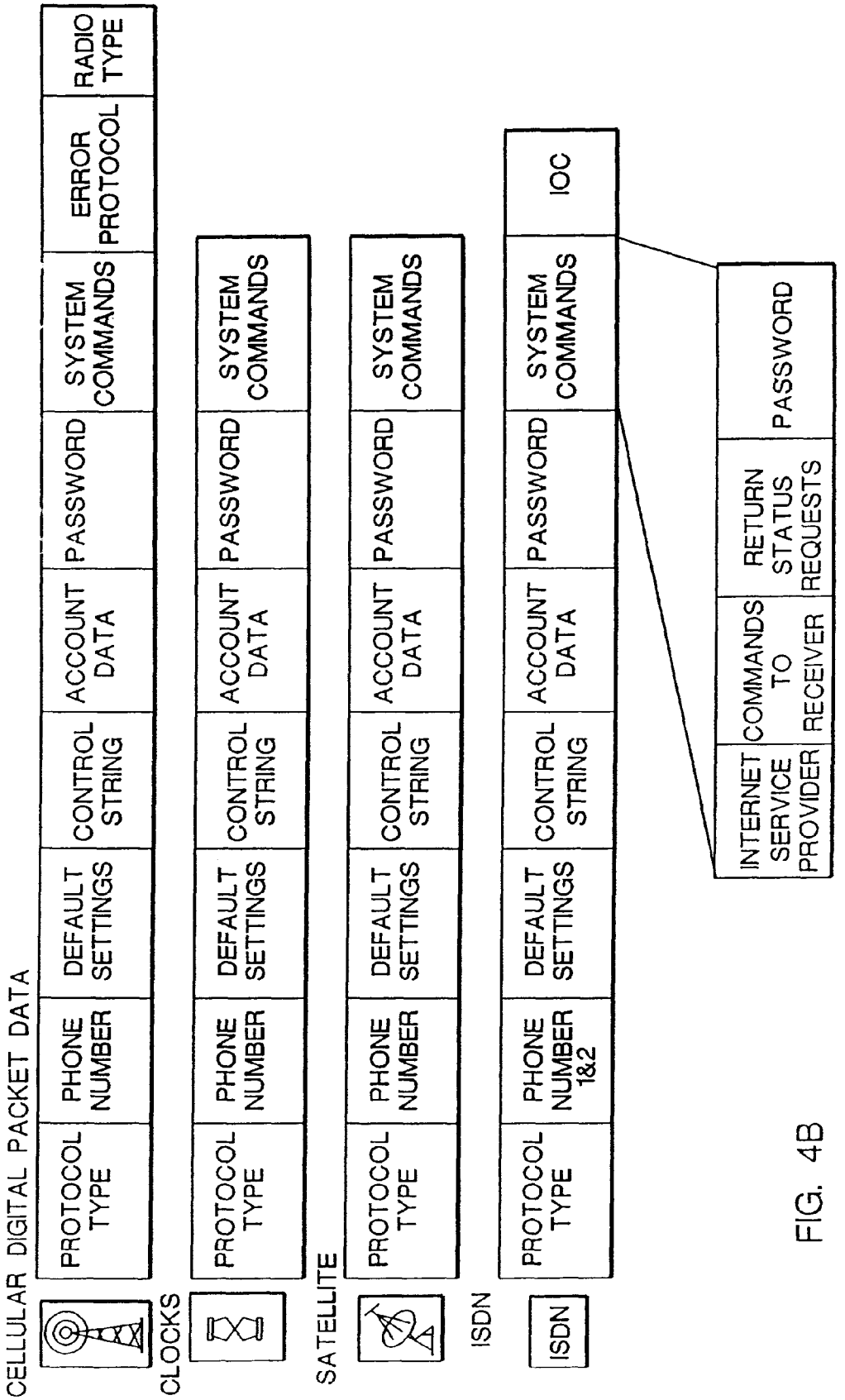

CELLULAR DIGITAL PACKET DATA
PROTOCOL TYPE
PHONE NUMBER
DEFAULT SETTINGS
CONTROL STRING
ACCOUNT DATA
PASSWORD
SYSTEM COMMANDS
ERROR PROTOCOL
RADIO TYPE
CLOCKS
PROTOCOL TYPE
PHONE NUMBER
DEFAULT SETTINGS
CONTROL STRING
ACCOUNT DATA
PASSWORD
SYSTEM COMMANDS
SATELLITE
PROTOCOL TYPE
PHONE NUMBER
DEFAULT SETTINGS
CONTROL STRING
ACCOUNT DATA
PASSWORD
SYSTEM COMMANDS
ISDN
ISDN
PROTOCOL TYPE
PHONE NUMBER 1&2
DEFAULT SETTINGS
CONTROL STRING
ACCOUNT DATA
PASSWORD
SYSTEM COMMANDS
IOC
INTERNET SERVICE PROVIDER
COMMANDS TO RECEIVER
RETURN STATUS REQUESTS
PASSWORD

FIG. 4B

NETWORK CONFIGURATION FILE FOR AUTOMATICALLY TRANSMITTING IMAGES FROM AN ELECTRONIC STILL CAMERA

CROSS-REFERENCE TO RELATED APPLICATION(S)

This is a continuation of U.S. Ser. No. 09/783,437 filed Feb. 14, 2001 (which issued as U.S. Pat. No. 7,256,823 on Aug. 14, 2007, which is now Reissue application Ser. No. 12/540,610) which is a divisional of U.S. Ser. No. 09/004,046 filed Jan. 7, 1998 (now U.S. Pat. No. 6,784,924 which issued on Aug. 31, 2004) which claims the benefit of U.S. Provisional Application No. 60/037,962 filed Feb. 20, 1997.

FIELD OF THE INVENTION

The invention relates generally to the field of photography, and in particular to electronic photography. More specifically, the invention relates to a digital camera that interfaces with a host computer.

BACKGROUND OF THE INVENTION

Digital cameras, such as the Kodak Digital Science DC25™ camera, allow images to be utilized on a home computer (PC) and to be incorporated into e-mail documents and personal home pages on the World Wide Web. Presently, images must be copied to the PC and transmitted as e-mail, for example using an online service or an Internet Service Provider (ISP), via a modem from the user's PC. It would be desirable to be able to transmit pictures directly from the digital camera instead of first transferring the pictures to a PC. For instance, on a vacation trip, it is desirable to immediately share pictures with friends or relatives via e-mail or Internet access. It is also desirable to transmit pictures from a location without PC access in order to free up camera storage to take additional pictures. There are a wide variety of connection means to online services such as America On Line, ISPs, and bulletin board services. Each of these services typically requires an account name and password, as well as local telephone access numbers, and specific communications settings. It would be difficult to provide an easy-to-use means with buttons or menus on a small digital camera to input and/or modify all of these required settings.

SUMMARY OF THE INVENTION

The present invention is directed to overcoming one or more of the problems set forth above. Briefly summarized, according to one aspect of the present invention, a network configuration file is generated at a host computer and downloaded to a digital camera. This file contains instruction information for communicating with a selected destination via a communications interface. The digital camera includes a "send" button or LCD icon which allows the user to easily transmit one or more images via a wired or wireless communications interface to a desired destination, which among other possibilities may be an Internet Service Provider or a digital photofinishing center. When the user selects this option, the communications port settings, user account specifics, and destination connection commands are read from the network configuration file. Examples of these settings include serial port baud rate, parity, and stop bits, as well as account name and password.

In addition, information about which image or images to transmit is entered using the user buttons on the digital camera. This information is used to automatically establish a connection, log-in to the desired destination, and to transmit the image. The transmission may occur immediately after the pictures are taken, for example if the camera has a built-in cellular phone modem, or at a later time, when the camera is connected to a separate unit (such as a dock, kiosk, PC, etc.) equipped with a modem. In the latter case, a "utilization file" is created to provide information on which images should be transmitted to which account.

These and other aspects, objects, features and advantages of the present invention will be more clearly understood and appreciated from a review of the following detailed description of the preferred embodiments and appended claims, and by reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a system block diagram of the invention.

FIG. **2** is a diagram showing the steps used to automatically transmit images using the network configuration file.

FIG. **3** is a diagram of an image file.

FIG. **4** is a diagram showing several versions of the network configuration file.

DETAILED DESCRIPTION OF THE INVENTION

Because imaging systems and devices are well known, the present description will be directed in particular to elements forming part of, or cooperating more directly with, apparatus in accordance with the present invention. Elements not specifically shown or described herein may be selected from those known in the art. Some aspects of the present description may be implemented in software. Unless otherwise specified, all software implementation is conventional and within the ordinary skill in the programming arts.

A system block diagram of the invention is shown in FIG. **1** including an electronic still camera **10**, a host computer (PC) **12** and a service provider **14**. The camera includes an optical section **20** for imaging a scene upon a CCD sensor **22** and generating an image signal, a liquid crystal display (LCD) **24** for displaying images and other information, a number of user input buttons **26**, both permanent memory **28** and removable memory **30**, and an internal communications interface **32** (e.g., modem). This interface may connect to a variety of known networks, such as a public switched telephone network (PSTN), ISDN, an RF cellular phone network, or Ethernet. The camera **10** also includes a microprocessor **34** for generally controlling the camera functions, as well as the interchange of data with the host PC **12** and the memory card **30** through a host PC interface **36** and a memory card interface **38**, respectively. Besides the host PC **12**, the system includes a network connection **40** to the online service or ISP (Internet Service Provider) **14**. Alternately, the network **40** can connect to the user's home PC **12**.

When the camera **10** is first purchased (or at any time thereafter), it is connected to the PC **12** via the host PC **36** interface and a software application (stored on a disc **45**) running on the host PC **12** will enable the user to specify the name of a destination ISP or online service and to input from the host PC keyboard **44** the appropriate communication settings and account information. This information generates a network configuration file, which then can then be downloaded to the camera **10** through the host PC interface **36**, which may be a wired or infrared (e.g., IrDA) interface, and written to the camera's internal memory **28** and/or the removable memory card **30**. Alternatively, a host PC equipped with a memory card reader/writer **42** can write the information

directly to the card **30** without connecting the camera through its host PC interface **36**. Also, this information could be predetermined by the user and stored in a "preferences" file on the host PC **12** and then transferred to the camera **10** from this file without further intervention by the user. Multiple sets of destination services can be stored on the memory card **30**. Typically, keyword or graphic descriptors (e.g., icons) accompany the information in the network configuration file about destination services to enable easy access by the camera user.

The steps used to automatically transmit images using the network configuration file are shown in FIG. **2**. After disconnecting the camera from the host PC, the user operates the camera to take pictures (step **50**). This is typically done at a remote location, for example while traveling to another city. As the user takes or reviews images on the image LCD display, the decision can be made to transmit one or more images (step **52**). This is done by choosing one of the keywords or icons in a menu **54** shown in FIG. **2**, which are displayed on the LCD **24** and selected, e.g., through the user buttons **26**. (Note that a camera will typically only include a subset (only those desired by the user) of all the different services shown.) The selected image files may be tagged with a code (step **56**) indicating which service is requested, as shown in FIG. **3**. (Alternately, an "image utilization" file can be created in the camera storing a list of images to be transmitted by a particular method, as described in the cross-referenced copending patent application (U.S. Ser. No. 60/037,963). As described in that patent application, the details of an order, e.g., number of print copies to be made from an image and the size of the prints and/or a list of images to be e-mailed to various recipients, is written into the "utilization" file, which identifies the order and includes pointers to the image files that store the images required to "fulfill" the order. The "utilization" file is stored in the internal memory **28** or the memory card **30**.)

Next, the system determines whether a request exists to send an image (step **58**). If no request is present, the image and associated data is stored in either permanent memory **28** or the memory card **30** (step **59**). (Typically, all images are initially saved in memory whether eventually sent or not.) Otherwise, if there is a request to send an image, the user ensures that the camera is connected to the appropriate service (wired telephone line, cellular phone, kiosk, etc.) and pushes a "send" button in the user button section **26**, or selects a "send" menu option on the LCD **24**. The camera then utilizes the appropriate network configuration file, shown in FIG. **4**. Each network configuration file contains items such as the protocol type, phone number, etc., as described in Appendix I. The user password may be checked against the password in the network configuration file to ensure that the user is authorized to connect the camera to the desired service (step **60**). Alternately, the stored password in the appropriate configuration file can be used. Next, the camera uses the parameters in the configuration file to establish communications with the service and send one or more image files as selected by the user (steps **62**). The service receiver interprets the system commands issued by the camera from the network configuration file list and sends appropriate feedback (such as "transfer in progress" and "transfer complete") which are interpreted by the camera and displayed on the LCD **24** (steps **64**).

For example, when the camera uses a normal wired telephone (Public Switched Telephone Network) connection (i.e., network **40**) to the camera's internal modem **32**, after the user selects the images to be sent and presses the "send" button, the camera performs the following steps without user intervention:

1) Read the appropriate connection parameters from the network configuration file (on the memory card **30** or internal camera memory **28**), dial the phone and establish the connection to the destination service **14**.
2) Read the user's account name and password and transmit these to "log-on" to the service **14**.
3) Using the appropriate communications protocol (FTP, mailto, etc.), transmit the selected image or images to the destination service **14**.

The invention has been described with reference to a preferred embodiment. However, it will be appreciated that variations and modifications can be effected by a person of ordinary skill in the art without departing from the scope of the invention.

APPENDIX I

These are descriptions of the tags listed in the previous drawing:

Protocol Type

Each communication method has its own protocol, or rules to communicate. This tag identifies that protocol and where to find it. For example, the Network may use TCP/IP and a modem may use XModem.

Phone Number

This is the number of the receiving service. If internet access is requested, this could be the number of the Internet Service Provider. For ISDN, some systems require two phone numbers, dialed and connected to in sequence.

Default Settings

Standard settings that make the communications device compatible with the imaging device.

Modem Control String

Modem and communications devices have a command language that can set them up before they are used. For example, modems have many options controlled by command strings including volume level, the amount of time the carrier is allowed to fail before the system hangs up, and so on.

Account Data

This can be internet account data, charge number data, phone card data, billing address, and data related to the commerce part of the transmission.

Password

Any password needed to get into the communications system. Other passwords to get into the remote application or destination are located in the System Commands section.

System Commands

These are commands that control the end destination.

Error Protocol

In cellular and some other wireless communications, error protocols are used to increase the robustness of the link. For example, MNP **10** or ETC may be used for cellular links.

Radio Type

The type of radio used for this communications feature may be identified here. Some cell phones have modems built in, others will have protocols for many communications functions built in. The radio type will make the imaging device adapt to the correct interface.

IOC

ISDN Ordering Code identifies what features are available on the ISDN line provided by the teleco. It is used to establish the feature set for that communications link.

Internet Service Provider

This identifies the actual service provider and any specific information or sequence of information that the service wants to see during connection and logoff. It also tells the device how to handle the return messages, like "time used" that are returned by the server.

Commands to Receiver

This may be a list of commands to control the receiving application. For example, a command to print one of the images and save the data to a particular file on a PC may be embedded here.

Return Status Requests

This tag can set up the ability of the application to tell if an error has occurred, or what the status of the application might be. The data here will help the device decide if it should continue communicating and a set user interface response can be developed around this feedback.

What is claimed is:

1. An electronic camera comprising:

a communication interface;

a sensor for capturing images;

a first memory for storing images;

a second memory for storing information for communicating with a plurality of destinations via the communications interface; and

a user interface for selecting an image destination and for commanding the camera to send the images to the selected destination via the communications interface using the information, and wherein the user interface displays a plurality of descriptive icons representative of the plurality of destinations and selection is made by reference to at least one of the icons.

2. The camera of claim **1**, wherein both first and second memories are memory locations on the same removable memory card.

3. The camera of claim **1**, wherein the second memory permanently resides in the camera and can be loaded with a network configuration file from a host PC.

4. The camera of claim **3**, wherein the network configuration file further includes information to enable connection to an identified Internet Service Provider.

5. The camera of claim **1**, wherein the communications interface connects to PSTN (Public Switched Telephone Network).

6. The camera of claim **1**, wherein the communications interface connects to ISDN.

7. The camera of claim **1**, wherein the communications interface connects to an RF cellular phone network.

8. The camera of claim **1**, wherein the communications interface connects to a data network.

9. The camera of claim **8**, wherein the data network is an Ethernet.

10. The camera of claim **1**, wherein the communications interface is located internal to the camera.

11. The camera of claim **1**, wherein the user interface displays a feedback indicating the status of the image transfer.

* * * * *

EXHIBIT 10

US007936391B2

(12) **United States Patent**
Ward et al.

(10) **Patent No.: US 7,936,391 B2**
(45) **Date of Patent: *May 3, 2011**

(54) **DIGITAL CAMERA WITH COMMUNICATIONS INTERFACE FOR SELECTIVELY TRANSMITTING IMAGES OVER A CELLULAR PHONE NETWORK AND A WIRELESS LAN NETWORK TO A DESTINATION**

(75) Inventors: **Joseph Ward**, Rochester, NY (US); **Kenneth A. Parulski**, Rochester, NY (US); **James D. Allen**, Rochester, NY (US)

(73) Assignee: **Eastman Kodak Company**, Rochester, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/625,692**

(22) Filed: **Nov. 25, 2009**

(65) **Prior Publication Data**

US 2010/0073489 A1 Mar. 25, 2010

Related U.S. Application Data

(60) Continuation of application No. 11/692,224, filed on Mar. 28, 2007, now Pat. No. 7,742,084, which is a continuation of application No. 09/783,437, filed on Feb. 14, 2001, now Pat. No. 7,256,823, which is a division of application No. 09/004,046, filed on Jan. 7, 1998, now Pat. No. 6,784,924.

(60) Provisional application No. 60/037,962, filed on Feb. 20, 1997.

(51) **Int. Cl.**
H04N 5/222 (2006.01)

(52) **U.S. Cl.** **348/333.02**

(58) **Field of Classification Search** 348/231.2–231.3, 348/211.2–211.4, 333.01–333.02
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,434,618 A 7/1995 Hayashi et al.
5,737,491 A 4/1998 Allen et al.
(Continued)

FOREIGN PATENT DOCUMENTS

JP 1994-268582 9/1994

OTHER PUBLICATIONS

Sharp Zaurus Infoweb/Wildbird registration handbook, pp. 1-29 (English Translation included).

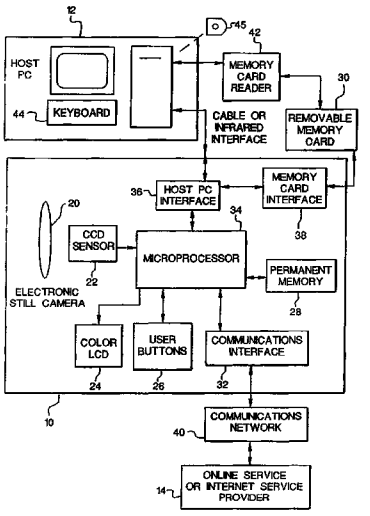
(Continued)

Primary Examiner — Tuan Ho
(74) *Attorney, Agent, or Firm* — Peyton C. Watkins

(57) **ABSTRACT**

Digital camera includes an image sensor receiving incident light of a scene, the digital camera captures an image corresponding to the incident light; display displays the plurality of captured images and displays a menu of destinations; at least one user input for selection of at least one image from the plurality of captured images and a destination from the menu of destinations displayed on the display; communications interface transmits the at least one selected image to the selected destination over one of a plurality of networks, the plurality of networks including at least two different types of wireless networks; memory; and processor coupled to the image sensor, the display, the at least one user input, the communications interface, and the memory, the processor controlling the transmission of the at least one selected image to the selected destination using either one of the at least two different types of wireless networks.

18 Claims, 4 Drawing Sheets



U.S. PATENT DOCUMENTS

5,806,005	A		9/1998	Hull et al.
5,825,432	A	*	10/1998	Yonezawa 348/563
6,111,604	A	*	8/2000	Hashimoto et al. 348/220.1
6,209,048	B1		3/2001	Wolff
6,226,362	B1		5/2001	Gerszberg et al.
6,571,271	B1		5/2003	Savitzky et al.
7,034,871	B2	*	4/2006	Parulski et al. 348/231.3

OTHER PUBLICATIONS

Sharp MI-10 Zaurus Camera Document, 3 pages (English translation included).

Sharp Zaurus MI-10 Users Manual, pp. 1-104 (English translation included).

* cited by examiner

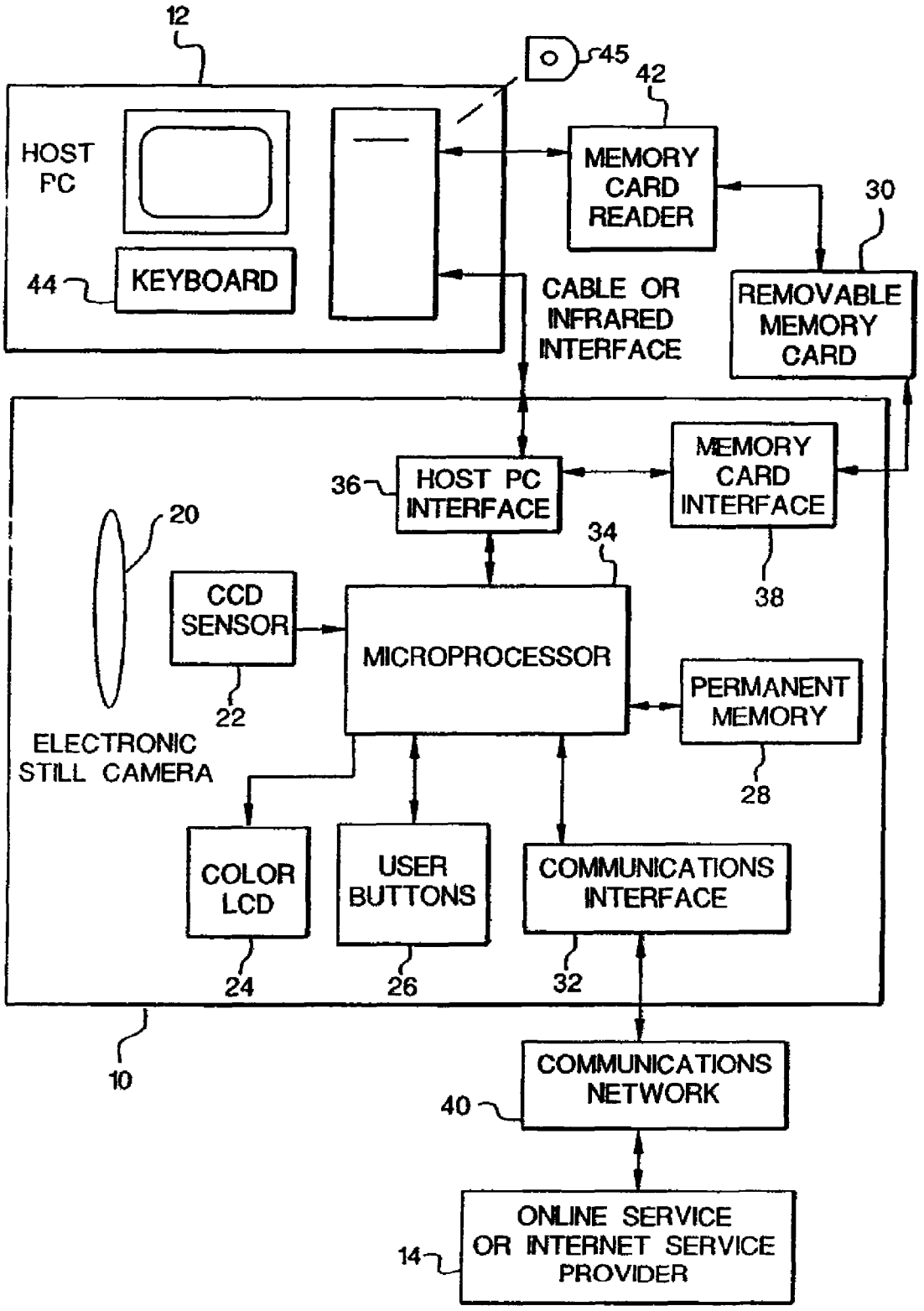

12
45
42
HOST PC
MEMORY CARD READER
30
44
KEYBOARD
CABLE OR INFRARED INTERFACE
REMOVABLE MEMORY CARD
36
HOST PC INTERFACE
MEMORY CARD INTERFACE
20
34
CCD SENSOR
MICROPROCESSOR
38
PERMANENT MEMORY
22
ELECTRONIC STILL CAMERA
28
COLOR LCD
USER BUTTONS
COMMUNICATIONS INTERFACE
24
26
32
10
COMMUNICATIONS NETWORK
40
ONLINE SERVICE OR INTERNET SERVICE PROVIDER
14

FIG. 1

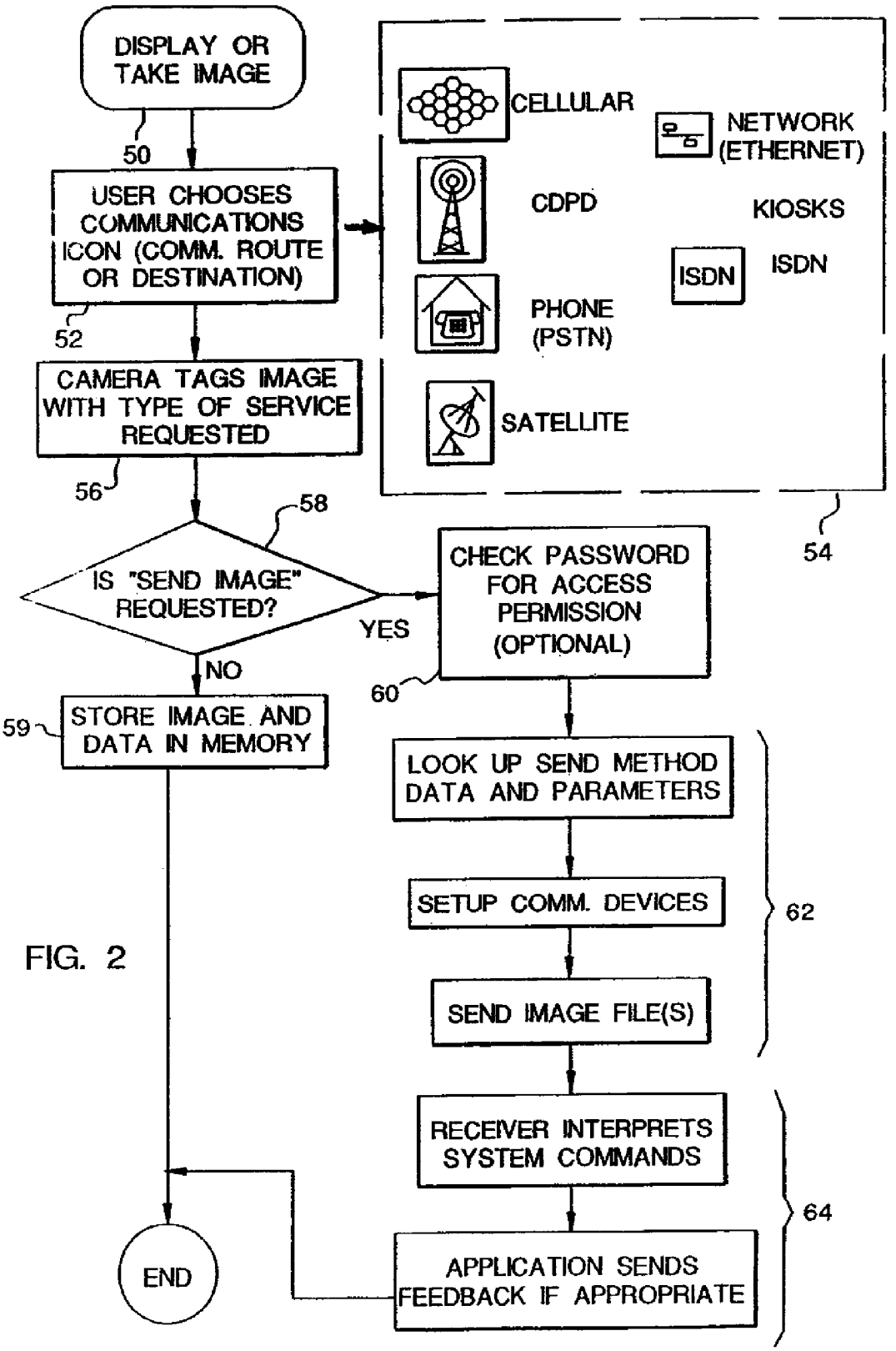

DISPLAY OR TAKE IMAGE
50
USER CHOOSES COMMUNICATIONS ICON (COMM. ROUTE OR DESTINATION)
52
CAMERA TAGS IMAGE WITH TYPE OF SERVICE REQUESTED
56
58
IS "SEND IMAGE" REQUESTED?
YES
NO
CHECK PASSWORD FOR ACCESS PERMISSION (OPTIONAL)
60
59
STORE IMAGE AND DATA IN MEMORY
LOOK UP SEND METHOD DATA AND PARAMETERS
SETUP COMM. DEVICES
SEND IMAGE FILE(S)
62
RECEIVER INTERPRETS SYSTEM COMMANDS
APPLICATION SENDS FEEDBACK IF APPROPRIATE
64
END
CELLULAR
NETWORK (ETHERNET)
CDPD
KIOSKS
ISDN
ISDN
PHONE (PSTN)
SATELLITE
54

FIG. 2

FIG. 3

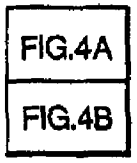
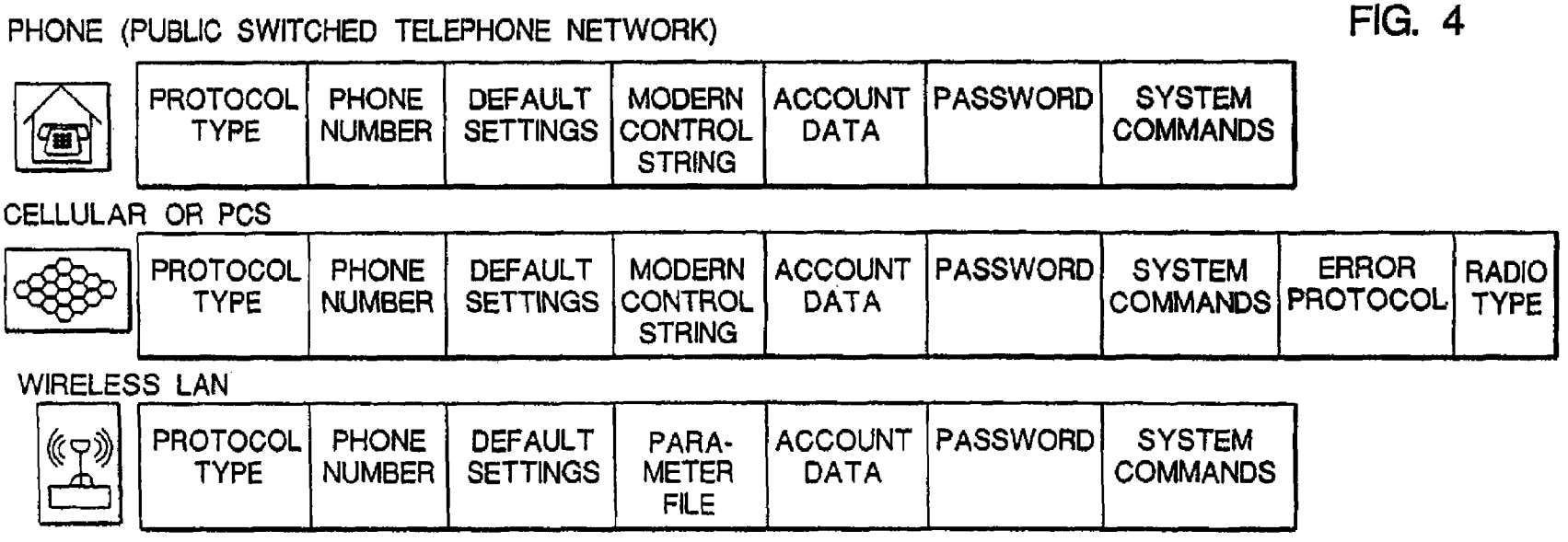


FIG. 4

FIG. 4A



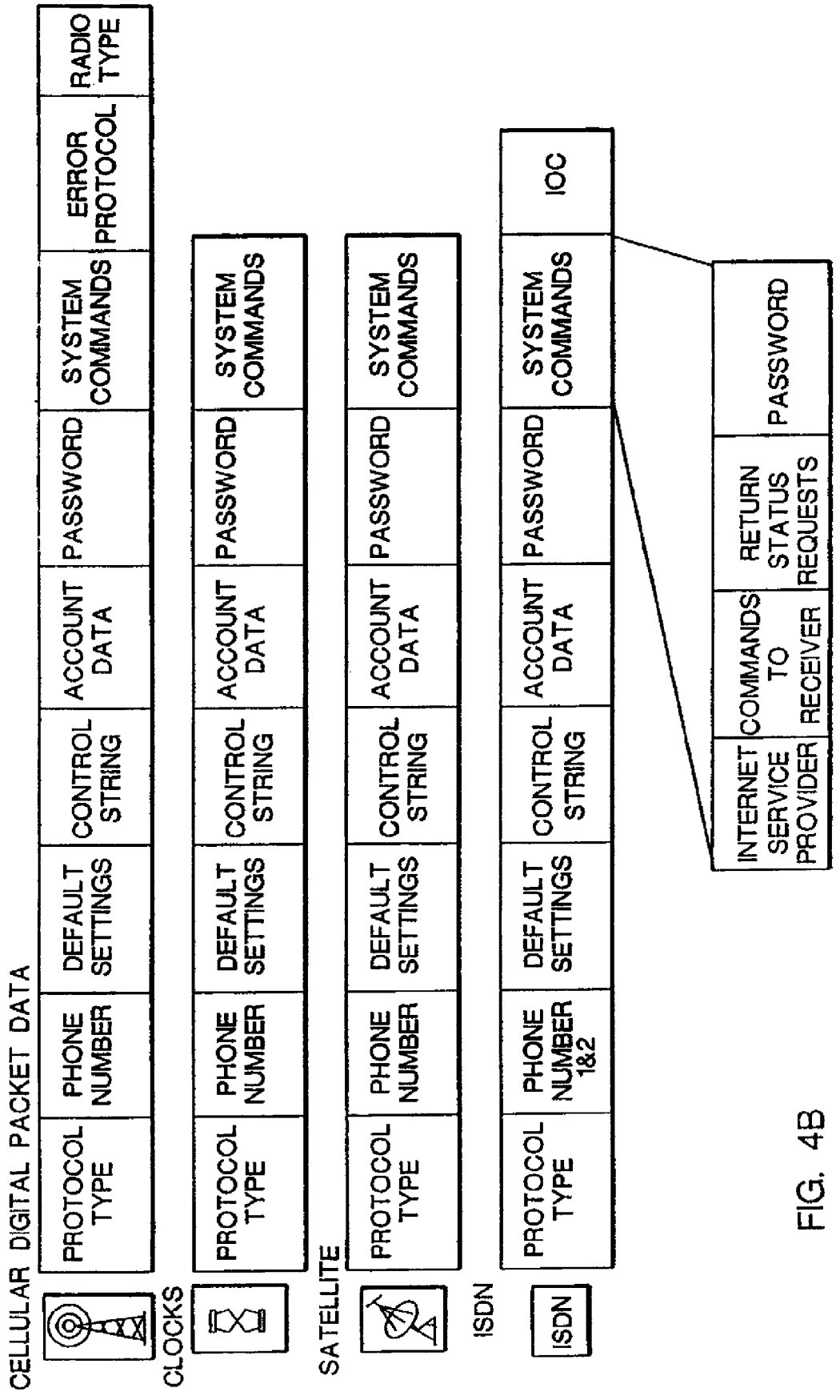

CELLULAR DIGITAL PACKET DATA
PROTOCOL TYPE
PHONE NUMBER
DEFAULT SETTINGS
CONTROL STRING
ACCOUNT DATA
PASSWORD
SYSTEM COMMANDS
ERROR PROTOCOL
RADIO TYPE
CLOCKS
SATELLITE
ISDN
IOC
INTERNET SERVICE PROVIDER
COMMANDS TO RECEIVER
RETURN STATUS REQUESTS
PASSWORD

FIG. 4B

DIGITAL CAMERA WITH COMMUNICATIONS INTERFACE FOR SELECTIVELY TRANSMITTING IMAGES OVER A CELLULAR PHONE NETWORK AND A WIRELESS LAN NETWORK TO A DESTINATION

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation of U.S. Ser. No. 11/692,224 filed Mar. 28, 2007, now U.S. Pat. No. 7,742,084, which is a continuation of U.S. Ser. No. 09/783,437 filed Feb. 14, 2001 (which issued as U.S. Pat. No. 7,256,823 on Aug. 14, 2007, which is now Reissue application Ser. No. 12/540,610) which is a divisional of U.S. Ser. No. 09/004,046 filed Jan. 7, 1998 (now U.S. Pat. No. 6,784,924 which issued on Aug. 31, 2004) which claims the benefit of U.S. Provisional Application No. 60/037,962 filed Feb. 20, 1997

FIELD OF THE INVENTION

The invention relates generally to the filed of photography, and in particular to electronic photography. More specifically, the invention relates to a digital camera that interfaces with a host computer.

BACKGROUND OF THE INVENTION

Digital cameras, such as the Kodak Digital Science DC25™ camera, allow images to be utilized on a home computer (PC) and to be incorporated into e-mail documents and personal home pages on the World Wide Web. Presently, images must be copied to the PC and transmitted as e-mail, for example using an online service or an Internet Service Provider (ISP), via a modem from the user's PC. It would be desirable to be able to transmit pictures directly from the digital camera instead of first transferring the pictures to a PC. For instance, on a vacation trip, it is desirable to immediately share pictures with friends or relatives via e-mail or Internet access. It is also desirable to transmit pictures from a location without PC access in order to free up camera storage to take additional pictures. There are a wide variety of connection means to online services such as America On Line, ISPs, and bulletin board services. Each of these services typically requires an account name and password, as well as local telephone access numbers, and specific communications settings. It would be difficult to provide an easy-to use means with buttons or menus on a small digital camera to input and/or modify all of these required settings.

SUMMARY OF THE INVENTION

The present invention is directed to overcoming one or more of the problems set forth above. Briefly summarized, according to one aspect of the present invention, the invention resides in a digital camera for capturing a plurality of images comprising an image sensor for receiving incident light of a scene, the digital camera capturing an image corresponding to the incident light of the scene; a display for displaying the plurality of captured images and for displaying a menu of destinations; at least one user input for selection of at least one image from the plurality of captured images and a destination from the menu of destinations displayed on the display; a communications interface for transmitting the at least one selected image to the selected destination over one of a plurality of networks, the plurality of networks including at least two different types of wireless networks; a memory; and a processor coupled to the image sensor, the display, the at least one user input, the communications interface, and the memory, the processor controlling the transmission of the at least one selected image to the selected destination using either one of the at least two different types of wireless networks.

These and other aspects, objects, features and advantages of the present invention will be more clearly understood and appreciated from a review of the following detailed description of the preferred embodiment and appended claims, and by reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a system block diagram of the invention.

FIG. **2** is a diagram showing the steps used to automatically transmit images using the network configuration file.

FIG. **3** is a diagram of an image file.

FIG. **4** is a diagram showing several versions of the network configuration file.

DETAILED DESCRIPTION OF THE INVENTION

Because imaging systems and devices are well known, the present description will be directed in particular to elements forming part of, or cooperating more directly with, apparatus in accordance with the present invention. Elements not specifically shown or described herein may be selected from those known in the art. Some aspects of the present description may be implemented in software. Unless otherwise specified, all software implementation is conventional and within the ordinary skill I the programming arts.

A system block diagram of the invention is shown in FIG. **1** including an electronic still camera **10**, a host computer (PC) **12** and a service provider **14**. The camera includes an optical section **20** for imaging a scene upon a CCD sensor **22** and generating an image signal, a liquid crystal display (LCD) **24** for displaying images and other information, a number of user input buttons **26**, both permanent memory **28** and removable memory **30**, and an internal communications interface (**32**) (e.g., modem). This interface may connect to a variety of known networks, such as a public switched telephone network (PSTN), ISDN, an RF cellular phone network, or Ethernet. The camera **10** also includes a microprocessor **34** for generally controlling the camera functions, as well as the interchange of data with the host PC **12** and the memory card **30** through a host PC interface **36** and a memory card interface **38**, respectively. Besides the host PC **12**, the system includes a network connection **40** to the online service or ISP (Internet Service Provider) **14**. Alternately, the network **40** can connect to the user's home PC **12**.

When the camera **10** is first purchased (or at any time thereafter), it is connected to the PC **12** via the host PC **36** interface and a software application (stored on a disc **45**) running on the host PC **12** will enable the user to specify the name of a destination ISP or online service and to input from the host PC keyboard **44** the appropriate communication settings and account information. This information generates a network configuration file, which then can then be downloaded to the camera **10** through the host PC interface **36**, which may be a wired or infrared (e.g., IrDA) interface, and written to the camera's internal memory **28** and/or the removable memory card **30**. Alternatively, a host PC equipped with a memory card reader/writer **42** can write the information directly to the card **30** without connecting the camera through its host PC interface **36**. Also, this information could be

predetermined by the user and stored in a "preferences" file on the host PC **12** and then transferred to the camera **10** from this file without further intervention by the user. Multiple sets of destination services can be stored on the memory card **30**. Typically, keyword or graphic descriptors (e.g., icons) accompany the information in the network configuration file about destination services to enable easy access by the camera user.

The steps used to automatically transmit images using the network configuration file are shown in FIG. **2**. After disconnecting the camera from the host PC, the user operates the camera to take pictures (step **50**). This is typically done at a remote location, for example while traveling to another city. As the user takes or reviews images on the image LCD display, the decision can be made to transmit one or more images (step **52**). This is done by choosing one of the keywords or icons in a menu **54** shown in FIG. **2**, which are displayed on the LCD **24** and selected, e.g., through the user buttons **26**. (Note that a camera will typically only include a subset (only those desired by the user) of all the different services shown.) The selected image files may be tagged with a code (step **56**) indicating which service is requested, as shown in FIG. **3**. (Alternately, an "image utilization" file can be created in the camera storing a list of images to be transmitted by a particular method, as described in the cross-referenced copending patent application (U.S. Ser. No. 60/037,963). As described in that patent application, the details of an order, e.g., number of print copies to be made from an image and the size of the prints and/or a list of images to be e-mailed to various recipients, is written into the "utilization" file, which identifies the order and includes pointers to the image files that store the images required to "fulfill" the order. The "utilization" file is stored in the internal memory **28** or the memory card **30**.)

Next, the system determines whether a request exists to send an image (step **58**). If no request is present, the image and associated data is stored in either permanent memory **28** or the memory card **30** (step **59**). (Typically, all images are initially saved in memory whether eventually sent or not.) Otherwise, if there is a request to send an image, the user ensures that the camera is connected to the appropriate service (wired telephone line, cellular phone, kiosk, etc.) and pushes a "send" button in the user button section **26**, or selects a "send" menu option on the LCD **24**. The camera then utilizes the appropriate network configuration file, shown in FIG. **4**. Each network configuration file contains items such as the protocol type, phone number, etc., as described in Appendix I. The user password may be checked against the password in the network configuration file to ensure that the user is authorized to connect the camera to the desired service (step **60**). Alternately, the stored password in the appropriate configuration file can be used. Next, the camera uses the parameters in the configuration file to establish communications with the service and send one or more image files as selected by the user (steps **62**). The service receiver interprets the system commands issued by the camera from the network configuration file list and sends appropriate feedback (such as "transfer in progress" and "transfer complete") which are interpreted by the camera and displayed on the LCD **24** (steps **64**).

For example, when the camera uses a normal wired telephone (Public Switched Telephone Network) connection (i.e., network **40**) to the camera's internal modem **32**, after the user selects the images to be sent and presses the "send" button, the camera performs the following steps without user intervention:

1) Read the appropriate connection parameters from the network configuration file (on the memory card **30** or internal camera memory **28**), dial the phone and establish the connection to the destination service **14**.
2) Read the user's account name and password and transmit these to "log-on" to the service **14**.
3) Using the appropriate communications protocol (FTP, mailto, etc.), transmit the selected image or images to the destination service **14**.

The invention has been described with reference to a preferred embodiment. However, it will be appreciated that variation and modifications can be effected by a person of ordinary skill in the art without departing from the scope of the invention.

APPENDIX I

These are descriptions of the tags listed in the previous drawing:

Protocol Type

Each communication method has its own protocol, or rules to communicate. This tag identifies that protocol and where to find it. For example, the Network may use TCP/IP and a modem may use XModem.

Phone Number

This is the number of the receiving service. If internet access is requested, this could be the number of the Internet Service Provider. For ISDN, some systems require two phone numbers, dialed and connected to in sequence.

Default Settings

Standard settings that make the communications device compatible with the imaging device.

Modem Control String

Modem and communications devices have a command language that can set them up before they are used. For example, modems have many options controlled by command strings including volume level, the amount of time the carrier is allowed to fail before the system hangs up, and so on.

Account Data

This can be internet account data, charge number data, phone card data, billing address, and data related to the commerce part of the transmission.

Password

Any password needed to get into the communications system. Other passwords to get into the remote application or destination are located in the System Commands section.

System Commands

These are commands that control the end destination.

Error Protocol

In cellular and some other wireless communications, error protocols are used to increase the robustness of the link. For example, MNP10 or ETC may be used for cellular links.

Radio Type

The type of radio used for this communications feature may be identified here. Some cell phones have modems built in, others will have protocols for many communications functions built in. The radio type will make the imaging device adapt to the correct interface.

IOC

ISDN Ordering Code identifies what features are available on the ISDN line provided by the teleco. It is used to establish the feature set for that communications link.

Internet Service Provider

This identifies the actual service provider and any specific information or sequence of information that the service wants to see during connection and logoff. It also tells the device how to handle the return messages, like "time used" that are returned by the server.

Commands to Receiver

This may be a list of commands to control the receiving application. For example, a command to print one of the images and save the data to a particular file on a PC may be embedded here.

Return Status Requests

This tag can set up the ability of the application to tell if an error has occurred, or what the status of the application might be. The data here will help the device decide if it should continue communicating and a set user interface response can be developed around this feedback.

The invention claimed is:

1. A digital camera for capturing a plurality of images comprising:

an image sensor for receiving incident light of a scene, the digital camera capturing an image corresponding to the incident light of the scene;

a display for displaying the plurality of captured images and for displaying a menu of destinations;

at least one user input for selection of at least one image from the plurality of captured images and a destination from the menu of destinations displayed on the display;

a communications interface for transmitting the at least one selected image to the selected destination over one of a plurality of networks, the plurality of networks including at least two different types of wireless networks;

a memory; and

a processor coupled to the image sensor, the display, the at least one user input, the communications interface, and the memory, the processor controlling the transmission of the at least one selected image to the selected destination using either one of the at least two different types of wireless networks.

2. The digital camera of claim **1**, wherein the at least two different types of wireless networks include a cellular phone network and a wireless LAN.

3. The digital camera of claim **2**, wherein the image sensor, the display, the at least one user input, and the communications interface are directly coupled to the processor, and the memory is coupled to the processor via a memory interface, and wherein the memory stores first information used by the processor to control the communications interface to enable transmission over the cellular phone network, and stores second information used by the processor to control the communications interface to enable transmission over the wireless LAN.

4. The digital camera of claim **3**, wherein the first information is stored in a first configuration file and the second information is stored in a second configuration file.

5. The digital camera of claim **4**, wherein the first and second configuration files are generated by a separate device, and transferred from the separate device to the memory of the digital camera.

6. The digital camera of claim **5**, wherein the separate device is a computer.

7. The digital camera of claim **1**, wherein the memory is an internal memory.

8. The digital camera of claim **1**, wherein the memory is a removable memory card.

9. The digital camera of claim **3**, wherein the first information includes a phone number associated with the selected destination.

10. The digital camera of claim **3**, wherein the first and second information include account data.

11. A digital camera for capturing a plurality of images comprising:

an image sensor for receiving incident light of a scene, the digital camera capturing an image corresponding to the incident light of the scene;

a display for displaying the plurality of captured images;

at least one user input for selection of at least one image from the plurality of captured images;

a communications interface for transmitting the at least one selected image over one of a plurality of networks, the plurality of networks including a cellular phone network and a wireless LAN;

a processor coupled to the image sensor, the display, the at least one user input, and the communications interface, the processor controlling the transmission of the at least one selected image to a destination;

a memory coupled to the processor for storing first information used by the processor to control the communications interface to transmit to the destination over the cellular phone network when the camera is connected to the cellular phone network, and for storing second information used by the processor to control the communications interface to transmit to the destination over the wireless LAN when the camera is connected to the wireless LAN.

12. The digital camera of claim **11**, wherein the first information is stored in a first configuration file and the second information is stored in a second configuration file.

13. The digital camera of claim **12**, wherein the first and second configuration files are generated by a separate device, and transferred from the separate device to said memory of said digital camera.

14. The digital camera of claim **13**, wherein the separate device is a computer.

15. The digital camera of claim **11**, wherein the memory is an internal memory.

16. The digital camera of claim **11**, wherein the memory is a removable memory card coupled to the processor via a memory card interface, and wherein the image sensor, the display, the at least one user input, and the communications interface are directly coupled to the processor.

17. The digital camera of claim **11**, wherein the first information includes a phone number associated with the destination.

18. The digital camera of claim **11**, wherein the first and second information include account data.

* * * * *

EXHIBIT 11

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SUPERIOR COURT OF CALIFORNIA

COUNTY OF SANTA CLARA

110CV181091

APPLE INC., Plaintiff, v. EASTMAN KODAK COMPANY Defendant.	Case No. UNLIMITED CIVIL CASE COMPLAINT FOR BREACH OF CONTRACT, CONVERSION, DECLARATION OF OWNERSHIP, UNFAIR COMPETITION, AND BREACH OF CONFIDENCE **JURY TRIAL DEMANDED**

COMPLAINT

1. This is a civil action brought by Plaintiff Apple Inc. ("Apple") to enjoin Kodak from further profiting from Apple's intellectual property and to recover economic damages and intellectual property from Defendant Eastman Kodak Company ("Kodak") as a result of Kodak's breach of contract under Cal. Civ. Code § 3300 et seq.; Kodak's conversion; Kodak's acts of unfair competition under the common law and Cal. Bus. & Prof. Code § 17200 and 17500 et seq.; and Kodak's breach of confidence.

2. As the paragraphs below detail, in the early 1990s Apple developed a digital camera architecture involving an LCD viewfinder for live motion preview of images. During this period, Apple approached Kodak about potentially working with Apple to commercialize this digital camera architecture. Apple revealed confidential details of its digital camera development

program to Kodak. In breach of contractual and common law obligations—and unbeknownst to Apple until recently—Kodak wrongfully took this information and claimed it as Kodak's own in applying for and obtaining one or more United States patents. Kodak subsequently engaged in an aggressive licensing campaign supported by at least one such patent, earning Kodak over $1 billion.

3. In support of its complaint, Apple alleges as follows:

PARTIES

4. Apple is a corporation organized under the laws of California with its principal place of business located at 1 Infinite Loop, Cupertino, California 95014.

On information and belief, Kodak is a corporation organized under the laws of New Jersey with its principal place of business located at 343 State Street, Rochester, New York 14650.

JURISDICTION

5. This is an action arising under the laws of the State of California, including Cal. Civ. Code § 3300 *et seq.* and Cal. Bus. & Prof. Code § 17200 and 17500 *et seq.* The damages sustained by Apple are in excess of the jurisdictional minimum of this Court.

6. Personal jurisdiction exists over Kodak because, as set forth below, Kodak has committed acts in this State that are the subject of Apple's claims herein and has injured Apple. Kodak has specifically availed itself of the laws of California in doing so.

VENUE

7. Venue over Apple's claims is proper in this district pursuant to the California Code of Civil Procedure § 395(a) because Kodak conducts business in Santa Clara County, Apple is located in Santa Clara County, and many of the acts complained of occurred in Santa Clara County.

BACKGROUND FACTS COMMON TO ALL CAUSES OF ACTION

I. Introduction

8. Apple is a leading designer and manufacturer of personal computers, portable digital media players, and mobile communications devices. Apple's personal digital media and communications products, such as the iPhone, the iPod line of digital media players, and the iPad, are groundbreaking products that revolutionized their respective industries, enjoy

enormous commercial success and popular acclaim, and continue to lead their fields in innovation, performance, and ease of use. Apple's product portfolio also includes its industry-leading line of Macintosh desktop and notebook computers, including the iMac and MacBook products such as the MacBook Pro and ultra-light MacBook Air, and its portfolio of software, such as the Mac OS X operating system that comes pre-installed on every Macintosh computer.

9. Apple's history of launching technically innovative and commercially successful products stems from its ongoing commitment to research and development ("R&D"). For decades Apple has made substantial investments in R&D in a wide variety of technical fields, including digital camera technology, computer hardware and software, graphical and touch-based user interfaces, digital media players, digital imaging, and personal communications. Substantially all of this R&D has been conducted by employees located at the company headquarters in Cupertino, Santa Clara County, California. The U.S. Patent and Trademark Office has awarded Apple patent protection for many of Apple's innovations, including patents relating to digital cameras, and Apple continues to seek and obtain patent protection for its recent and ongoing innovations.

10. On information and belief, Kodak is a company engaged in the business of selling, inter alia, digital cameras and accessories. Kodak sells many of these products and services in Santa Clara County. But like its other operations, Kodak's sales and profits from the sale of these devices has declined substantially. Kodak has earned an annual profit only once since 2004. In 2009, Kodak's net loss amounted to $210 million, and in 2008, its sales shrunk 19%. Kodak hired a new CEO in 2005, who turned to an aggressive patent litigation strategy as a means to generate cash for the company's operations. One patent to which Kodak has turned to make up for its inability to compete in the marketplace is U.S. Patent No. 6,292,218 (the "'218 patent"), which claims a digital camera capable of capturing an image while previewing the scene to be captured on an LCD screen. Within the last two years, Kodak has filed a number of patent infringement actions based in part on the '218 patent, and has claimed to have received over one billion dollars in settlement of those litigations.

11. In furtherance of its litigation strategy, on January 14, 2010, Kodak requested that the U.S. International Trade Commission ("ITC") institute an investigation to determine whether Apple's iPhone products—which contain a digital camera—violated Section 337 of the Tariff Act of 1930 by reason of Apple's purported infringement of the '218 patent. That complaint resulted in the institution of Investigation No. 337-TA-703 ("the 703 Investigation"). As part of that complaint, Kodak requested an order that would prohibit importation of all of Apple's current iPhone products into the United States, and enjoin Apple from selling any such products already in the United States. Kodak also filed a complaint asserting the '218 patent (along with another Kodak patent) in the United States District Court for the Western District of New York (Civil Action No. 6:10-CV-06021)("the '021 case") seeking monetary damages based on Apple's alleged infringement of the '218 patent. Given the potential economic severity of Kodak's requested relief, in early 2010, Apple launched an extensive internal investigation into Apple's prior relationship with Kodak in the 1990s to determine what Apple disclosed to Kodak concerning the development of digital camera technology. Apple's investigation, summarized in sections II-IV below, revealed that Apple is the rightful owner of the '218 patent pursuant to disclosures made by Apple to Kodak and contracts made between the parties in the early 1990s. Indeed, Apple disclosed the architecture for its confidential digital camera technology to Kodak subject to non-disclosure agreements, which also provided that any improvements Kodak made to Apple's disclosures remain the property of Apple. By using Apple's disclosures to draft and prosecute the '218 patent and claim ownership thereof, Kodak is in breach of its agreements with Apple, has unlawfully converted Apple's intellectual property for Kodak's use, and has improperly reaped substantial benefits from such conversion. Kodak has also breached its duty of confidence owed to Apple and has engaged in unfair competition.

II. Apple and the Relevant Technology

12. By the early 1990s, Apple was already researching a variety of digital camera technologies within its Advanced Technology Group. In 1992, the typical consumer camera user was a film camera that needed to be held up to the user's face in order to capture an image. Apple developed prototypes and completed user studies to explore possible digital camera

implementations. This research sparked enough interest within Apple that Apple began investigating whether the research could be developed into a viable product. Apple employee Eric Zarakov and his team eventually developed a set of features and an architecture for a digital camera.

13. The camera architecture was developed around the central concept of a digital still camera with an LCD viewfinder for live color preview, including sound annotations for still images, review and playback of images and sounds, and easy transfer of the images to a computer or other digital device.

14. As early as February 1992, Apple had built a working prototype to demonstrate the experience of using a color display as a live viewfinder and review tool.

15. During Apple's development of the digital camera architecture, Apple sought potential original equipment manufacturer ("OEM") to work with Apple to commercialize and manufacture the camera. Because Apple's core expertise was in computers and digital processing, Apple looked for OEMs with experience producing sensors, lens systems, and displays it could use to implement the architecture Apple had designed. Kodak was one such potential OEM.

III. The Relationship Between Apple and Kodak

16. Apple formalized an agreement with Kodak in early 1990. Apple and Kodak explored how the two companies could work together on various projects, including the commercialization of Apple's digital cameras. Apple was considering whether Kodak could supply certain components for its digital camera. In 1991 and 1992, representatives from Apple and Kodak met to discuss digital camera technology. Named inventors of the '218 patent, Timothy Tredwell and Kenneth Parulski, each attended at least one such meeting each.

17. One such meeting occurred on November 17 and 18, 1992, in Rochester, New York. Apple and Kodak met to discuss more specifically what Kodak could offer as part of Apple's development of Apple's proposed digital camera architecture. Apple employees Eric Anderson, Eric Zarakov, and Scott Fullam attended that meeting. A named inventor of the '218 patent, Timothy Tredwell, among others, attended the meeting for Kodak. At that meeting, Apple

presented to Kodak the confidential architecture and design of Apple's digital camera, and Kodak presented to Apple information about Kodak's lenses and CCDs. Members of Apple's digital camera project team met with members of Kodak's imaging department, and Apple disclosed to Kodak's imaging department the architecture for a digital still camera with live color preview. Apple also disclosed the use of a high-powered, multitasking processor.

18. Apple's disclosures to Kodak at the November 17–18, 1992 meeting are confirmed in contemporaneous documents. For example, Mr. Zarakov of Apple sent a letter to David Lewis of Kodak on January 25, 1993 in order to commemorate the details of Apple's disclosure to Kodak. Specifically, Mr. Zarakov described that Apple disclosed a digital signal processor as a microprocessor, as well as certain video subsystem architectures. In a voicemail transcribed at the time it was received, Mr. Lewis of Kodak acknowledged receipt of Mr. Zarakov's letter without disputing Mr. Zarakov's description of what Apple disclosed.

19. Apple made another presentation to Kodak on February 19, 1993, specifying details such as the resolution and color filter pattern of the CCD and the LCD display. The February 1993 presentation also further memorialized the processing of still images disclosed by Apple to Kodak at the November 17–18, 1992 meeting and as described in a November 24, 1992 technical overview presentation.

20. In parallel with the February 19, 1993 presentation, Mr. Fullam drafted several block diagrams showing the components of Apple's camera architecture that supported still image capture and live color viewfinder. Those block diagrams further evidence the state of the development project at Apple in February 1993.

21. Kodak worked together with Apple to develop the Apple QuickTake 100 camera, released in early 1994. That camera did not include Apple's live color preview architecture, but the digital imaging personnel at Apple continued to develop a digital still camera with live color preview. The core aspects of the live color preview camera architecture were incorporated into next-generation camera projects. These camera projects were also proposed by Apple to third parties, including Sanyo, and were ultimately developed by Apple in co-operation with Kodak.

22. In 1996, Apple's digital camera projects and certain of Apple's digital camera intellectual property and personnel were transferred to a company called FlashPoint. Apple's camera architecture, comprising a digital still camera with live color preview, was incorporated into a number of cameras using Apple's concept that were jointly developed by Kodak and FlashPoint, and sold by Kodak, including the Kodak DC-220, DC-260, DC-265, and DC-290.

23. During this period of cooperation, unbeknownst to Apple, Kodak was secretly taking Apple's innovations and claiming them as Kodak's own in at least one patent application filed with the U.S. Patent and Trademark Office. That application, which ultimately issued as the '218 patent, describes and appears to be based upon technology included in the confidential, proprietary disclosures Apple made to Kodak in the 1992-1993 time period.

IV. The Agreements Between Apple and Kodak

24. Both Apple and Kodak understood that the discussions between them included the exchange of confidential information, and that each party would protect and respect the confidential information of the other, neither disclosing it to anyone else nor misusing the information for its own benefit. Indeed, the disclosures described above that were made by Apple to Kodak were made subject to non-disclosure agreements. The non-disclosure agreements contain provisions that any patentable improvements made to information disclosed under the non-disclosure agreement belong to the discloser and *not* the party who made the improvement. One such agreement signed by Kodak and Apple was dated December 20, 1994—ten days prior to the filing of the application that led to the '218 Patent.

25. The 1994 agreement governed the parties' rights, both with regard to past and future work and specifies that any derivative work belongs to the company that made the original disclosure upon which the derivative work was based.

26. Another agreement is a confidentiality agreement between Apple and Kodak dated February 28, 1991—the same date that Apple and Kodak met to discuss, among other things, low-cost digital cameras. This agreement likewise has a provision specifying that any derivatives of information disclosed remain the property of the discloser. The five-year term of this agreement extends beyond the filing date of the application that led to the '218 Patent. Thus,

under the 1991 agreement, Apple owns any patent derived from confidential information provided by Apple.

27. There is no doubt that Apple considered its proprietary digital camera designs to be confidential. Mr. Zarakov wrote Mr. Lewis to notify him of that fact. Included with that letter were three figures reflecting various proprietary architectures disclosed to Kodak. There is also no doubt that Kodak had notice of that fact and agreed to it. As explained above, Mr. Lewis left a voicemail for Mr. Zarakov acknowledging receipt of a letter from Apple informing Kodak that Apple considered its architecture to be confidential.

28. Apple satisfied its confidentiality and other obligations under its agreements with Kodak.

V. Kodak's Wrongful Acts

29. Apple revealed its confidential information to Kodak in confidence, which Kodak unlawfully used to prepare its application for the '218 patent. The purpose of the patent system is to encourage innovation by conferring on the patent holder a limited right to control who can use its invention. Part of that control includes the ability to exclude others from using the patented invention, as well as the ability to issue exclusive or nonexclusive licenses to the patented invention, which can be extremely lucrative, as it has been for Kodak based on its litigation efforts related to the '218 patent.

30. Kodak's agreements that any derivatives based on Apple's disclosures remain Apple's property makes Apple the rightful owner of the '218 patent. Moreover, Kodak's agreement to assign ownership to Apple on derivatives of Apple's disclosures gives Apple equitable rights in the '218 Patent. Additionally, Kodak's use of Apple's confidential information and its failure to disclose and assign its rights to the '218 patent to Apple constitute breaches of the parties' agreements and has unjustly enriched Kodak. Kodak has also unlawfully converted Apple's intellectual property into its own property, has breached its duty of confidence with Apple, and has committed acts of unfair competition.

31. As explained above, Kodak has recently enjoyed litigation settlements and royalties for the '218 patent that amount to over $1 billion. Kodak has further been unjustly

enriched at least in these amounts, and Apple has suffered and will continue to suffer actual damages by Kodak's unlawful assertion of ownership rights in the '218 patent. Indeed, Kodak has gone so far as to assert the '218 patent against Apple, thereby forcing Apple to incur attorneys' fees and other expenses in defending itself.

VI. Statutes of Limitations

32. The causes of action alleged below carry either a two, three, or four-year statute of limitations, placing the operative date in August of 2008, 2007, or 2006.

33. California uses the "discovery rule" to determine when a cause of action accrues for purposes determining the statute of limitations. A claim accrues when the plaintiff discovers, or could have discovered through reasonable diligence, the injury and its cause.

34. Apple did not discover, and could not have discovered through reasonable diligence, Kodak's wrongful acts prior to August of 2008. Indeed, Kodak's very failure to disclose to Apple its improvements on Apple's technology prevented Apple from having any knowledge of Kodak's wrongful acts; Kodak secretly pursued the '218 patent without informing Apple of its activities.

35. Kodak holds thousands of patents, and Apple could not have discovered through reasonable diligence prior to August 2008 that any one of those patents might implicate Apple's rights arising out of the parties' relationship in the early 1990s. In California, a plaintiff is under no duty to continuously monitor a defendant's activities to determine if a cause of action exists. Moreover, the '218 patent did not issue until 2001, some eight years after the parties' relationship had grown stale.

36. Kodak and Apple had additional discussions in the 2007-2008 time frame, but, again, at no time during that period did Kodak assert or otherwise identify the '218 patent. Thus, Apple could not have discovered the wrongful acts committed by Kodak until after October 2008, when Kodak first brought the '218 patent to Apple's attention.

FIRST CAUSE OF ACTION
(Breach of Contract)

37. Apple incorporates by reference paragraphs 1 through 36 as though fully set forth herein.

38. Apple and Kodak entered into various contracts, including contracts dated February 28, 1991 and December 20, 1994. Kodak committed significant acts in violation of these various contracts, and Kodak failed to perform other significant acts that the various contracts required Kodak to do. For example, Kodak breached the 1991 agreement in multiple ways, including: 1) by unlawfully using Apple's confidential information without Apple's consent, 2) by unlawfully claiming ownership of the '218 patent, and 3) by failing to grant Apple a royalty-free license to the '218 patent and/or acknowledging Apple's ownership of the '218 patent. Kodak likewise breached the 1994 agreement in multiple ways, including: 1) by unlawfully using Apple's confidential information without Apple's consent, 2) by claiming ownership of the '218 patent, 3) by failing to disclose to Apple Kodak's derivative work, and 4) by failing to assign to Apple Kodak's rights to the '218 patent.

39. At no time was Kodak excused from having to perform all of the significant acts that the contracts required, nor was Kodak permitted to commit acts in violation of the contracts. Likewise, Apple has satisfied its obligations under its various agreements with Kodak.

40. Apple has been and continues to be harmed significantly from Kodak's breach of contract.

SECOND CAUSE OF ACTION
(Conversion)

41. Apple incorporates by reference paragraphs 1 through 36 as though fully set forth herein.

42. Apple had ownership rights to the intellectual property it disclosed to Kodak in the early 1990s concerning digital camera technology, and to all improvements thereon. Kodak received Apple's intellectual property and made improvements to it in filing and prosecuting the applications that led to the '218 patent. Kodak intentionally took possession of Apple's

intellectual property for a significant period of time, and in claiming ownership to the '218 patent, prevented Apple from having access to its intellectual property.

43. Apple did not consent to Kodak's use, possession, or ownership of Apple's intellectual property and improvements thereon.

44. Apple has been and continues to be harmed significantly from Kodak's unlawful conversion of Apple's property.

45. Kodak's conduct was the legal cause of Apple's harm.

THIRD CAUSE OF ACTION
(Declaration of Ownership)

46. Apple incorporates by reference paragraphs 1 through 36 as though fully set forth herein.

47. California Code of Civil Procedure § 1060 provides that "[a]ny person interested under a written instrument, . . . or under a contract, or who desires a declaration of his or her rights or duties . . . in respect to, in, over or upon property, . . . may, in cases of actual controversy relating to the legal rights and duties of the respective parties, bring an original action or cross-complaint in the superior court for a declaration of his or her rights."

48. Apple requests that, based on the actions described herein, Apple be declared the rightful owner of the '218 patent.

FOURTH CAUSE OF ACTION
(Unfair Competition)

49. Apple incorporates by reference paragraphs 1 through 36 as though fully set forth herein.

50. Kodak has engaged in unfair competition under the California Business and Professions Code § 17200 and 17500 *et seq.*, which provide that "unfair competition shall mean and include any unlawful, unfair or fraudulent business act or practice."

51. California Businesses and Professions Code § 17203 further provides that "[a]ny person who engages, has engaged, or proposes to engage in unfair competition may be

enjoined in any court of competent jurisdiction. The court may make such orders or judgments . . . as may be necessary to prevent the use or employment by any person of any practice which constitutes unfair competition, as defined in this chapter, or as may be necessary to restore to any person in interest any money or property, real or personal, which may have been acquired by means of such unfair competition."

52. The acts described in paragraphs 1 through 36 of this Complaint constitute unlawful, unfair, and/or fraudulent business acts or practices on the part of Kodak.

(Unfair Business Acts)

53. Given the exclusionary power that a patent conveys, Kodak's actions have had a direct, discernible and anticompetitive impact on competition; that said anticompetitive conduct included, *inter alia*, Kodak's unfair demand for the royalties that Kodak has exclusively extracted from competitors in the marketplace for access to the '218 patent; in addition, Kodak has unfairly asserted a right and an ability to exclude others, including Apple, from practicing the disclosed invention. The above mentioned conduct, which has occurred as a result of Kodak's unfair use of the information disclosed to Kodak by Apple in confidence, has significantly threatened and harmed competition, and has therefore engaged in unfair conduct which constitutes unfair competition under § 17200 et seq. of the Business & Professions Code of the State of California.

(Unlawful Business Acts)

54. Apple invested substantial sums of money in the research and development of digital camera technology. Apple disclosed that technology to Kodak in confidence and pursuant to non-disclosure agreements, with the hopes of a possible joint development of digital camera projects. Kodak was prohibited from using Apple's technology or any improvements thereon, and from claiming ownership of Apple's technology or any improvements thereon. Kodak was further required to disclose to Apple any derivative works, and to assign to Apple the rights to any such derivative works. Rather than abiding its contractual obligations, Kodak instead used Apple's disclosure to prosecute an application for a U.S. patent, and claimed Apple's technology as its own. By doing so, Kodak has earned over a billion of dollars in litigation

settlements and royalties. In addition, and by reason of said conduct, Kodak violated one or more of the following statutes and regulations: 35 U.S.C. §§ 115 and 116; and 37 CFR 1.56 and 19 CFR 210.4, and has therefore engaged in unlawful conduct which constitutes unfair competition under §§ 17200 et seq. of the Business & Professions Code of the State of California.

55. Apple has been and continues to be harmed significantly from Kodak's wrongful acts.

(Common Law Unfair Competition)

56. That by reason of the facts and circumstances mentioned above, Kodak has engaged in common law unfair competition; rather than abiding its contractual obligations, Kodak unlawfully used Apple's disclosures to prosecute an application for a U.S. patent and thereby passed off Apple's technology as its own.

FIFTH CAUSE OF ACTION
(Breach of Confidence)

57. Apple incorporates by reference paragraphs 1 through 36 as though fully set forth herein.

58. The acts described in paragraphs 1 through 36 of this complaint constitute a breach of confidence by Kodak against Apple under the common law of the State of California.

59. Under the common law of California, a breach of confidence claim arises when (1) an idea, whether or not protectable, is offered to another in confidence, (2) is voluntarily received in confidence with the understanding that it is not to be disclosed, and (3) is not to be used by the receiving party beyond the limits of the confidence without express permission provided.

60. The information that Apple disclosed to Kodak, as described above, was highly confidential in nature. Apple took steps to protect the confidentiality of this information, including by entering into non-disclosure agreements with Kodak. Apple disclosed the information to Kodak in confidence, pursuant to the non-disclosure agreements. Pursuant to these agreements, Kodak had a duty of confidence not to use the information that Apple disclosed, and to disclose to Apple any works derived from Apple's disclosure.

61. Kodak breached its duty of confidence in using Apple's confidential information to conceive the alleged invention claimed in the '218 patent. Kodak took Apple's confidential information, improved upon it, and engaged in a lengthy application process before the U.S. Patent & Trademark Office in pursuit of the '218 patent. In so doing, Kodak unlawfully disclosed Apple's confidential information to the Patent Office and to the public.

62. Apple has been and continues to be harmed significantly from Kodak's breach of confidence.

PRAYER FOR RELIEF

WHEREFORE, Apple requests that this Court enter judgment against Kodak and grant Apple the following relief:

1. A judicial determination that Apple is the owner in equity and law of the '218 patent under Cal. Civ. Code § 3380 and other applicable laws;

2. An order of specific performance requiring Kodak to assign its rights to the '218 patent to Apple.

3. Restitution of all amounts which Kodak has received as a result of claiming ownership of the '218 patent;

4. An injunction permanently enjoining Kodak's use of the '218 patent and any other property or work that Kodak derived from Apple's disclosures;

5. An injunction permanently enjoining Kodak from seeking to enforce the '218 patent or any other wrongfully obtained intellectual property right against Apple in any forum, including the United States International Trade Commission and the United States District Courts.

6. An award of punitive damages;

7. A trial by jury;

8. Attorneys' fees, costs, and expenses, including costs incurred as a result of the ITC investigation instituted against Apple at Kodak's request; and

9. For such other and further relief and damages as the Court deems proper.

Dated: August 25, 2010

WEIL, GOTSHAL & MANGES LLP

By: _____

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APPLE INC.

EXHIBIT 12

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March 16, 2012

By E-Mail

Brian D. Glueckstein
Sullivan & Cromwell LLP
125 Broad Street
New York, NY 10004-2498

Re: Apple's claims of ownership to patents assigned to Kodak

Dear Brian:

I write in response to Kodak's request for additional information regarding Apple's claims of ownership of patents presently assigned to Kodak. In an effort to move towards a fair and prompt resolution of these claims, we provide the preliminary information below based on our investigation to date.

Based on the information presently known to us, Apple intends to pursue claims with respect to the following patents assigned to Kodak:

5,493,335
5,828,406
6,147,703
6,292,218
6,441,854
6,879,342
7,210,161
7,453,605
7,742,084
7,936,391

Apple's ownership claims will be pursued based on at least the following causes of action: correction of inventorship, breach of contract, conversion, unfair competition, deceptive business practices, and/or breach of confidence. Apple seeks both monetary and injunctive relief,

including but not limited to damages for harm to Apple and recovery of funds improperly received by Kodak, declarations of correction of inventorship and ownership, and any other appropriate relief.

As you know, Apple has sought several times to move forward with litigation of its ownership claims but has been blocked from doing so by Kodak. Apple has thus been unable to further explain and develop its ownership claims within the context of the parties' litigations, and looks forward to the opportunity to do so. The information provided above is therefore preliminary and subject to further refinement, including but not limited to when Apple is afforded the opportunity to take discovery of Kodak with respect to these claims.

Apple's identification of these patents and causes of action should not be viewed or construed as an assertion of such claims for purposes of 11 U.S.C. § 362 or otherwise. We are merely providing this information in response to Kodak's informal request. Moreover, by this letter, Apple does not waive, and in fact preserves, all of its rights and remedies, including without limitation its jury trial rights and its rights to have any disputes with Apple adjudicated by a district court.

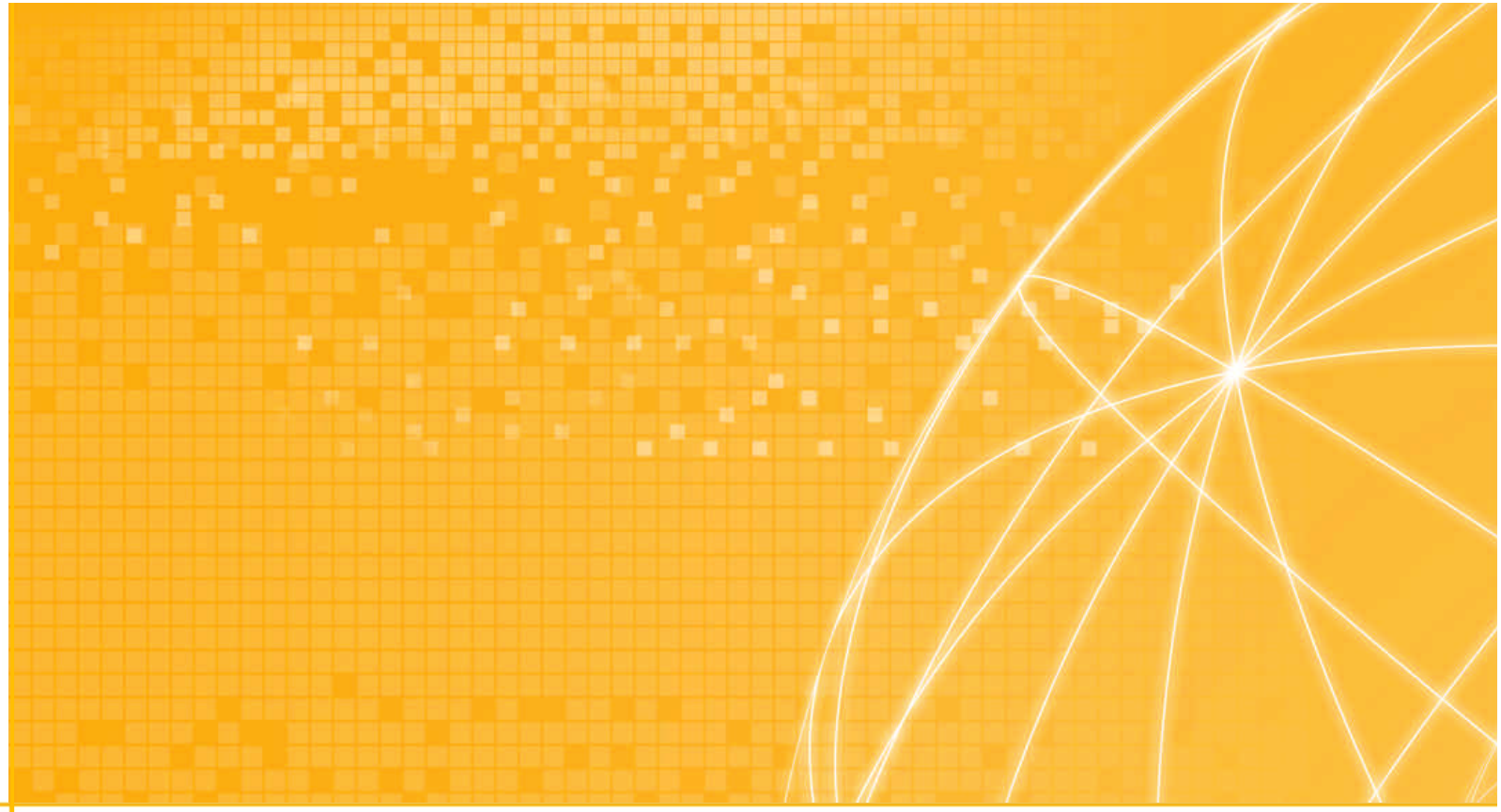
We trust that our voluntary identification of these details regarding Apple's ownership claims should be more than sufficient to allow the parties to discuss an appropriate path forward to adjudicate them. Please let me know if you have any questions or concerns.

Sincerely,

/s/ Marcus E. Sernel P.C.

Marcus E. Sernel, P.C.

EXHIBIT 13



Kodak

Business Segment Review

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