

# **EXHIBIT A**



US005493335A

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Parulski et al.

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

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[51] Int. Cl.<sup>6</sup> 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

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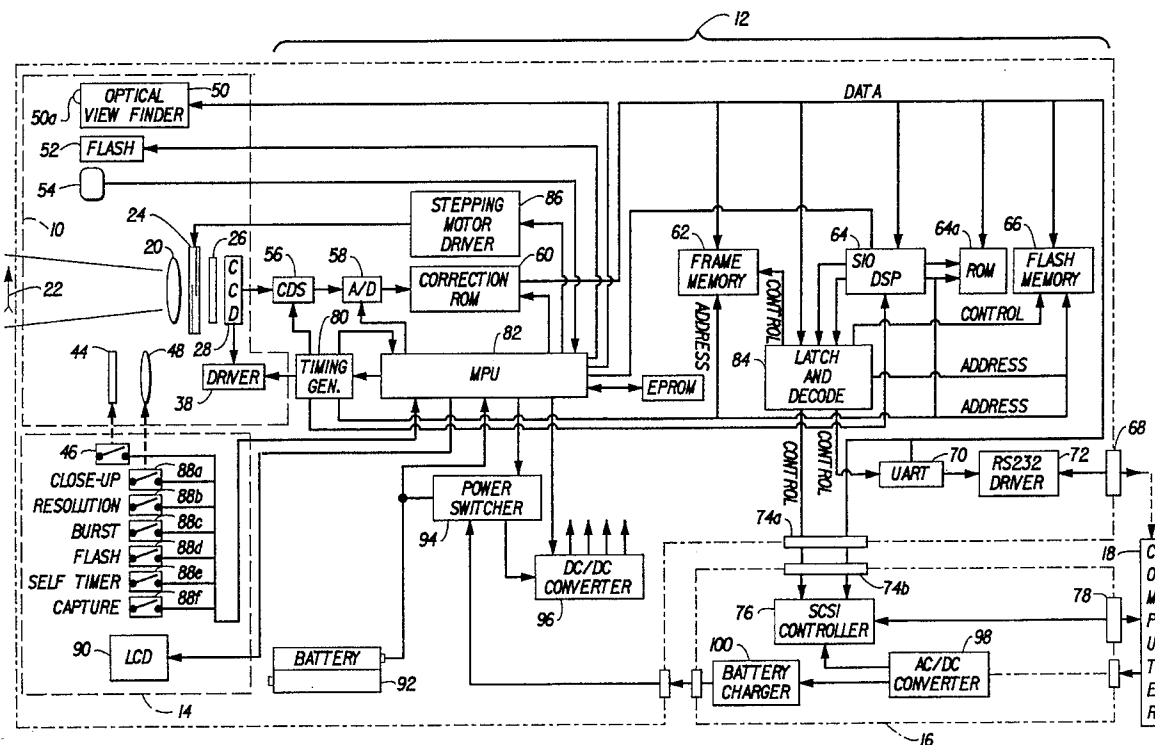
"Popular Science", Sep. 1992, p. 65.

Primary Examiner—James J. Groody  
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 sub-sampled 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



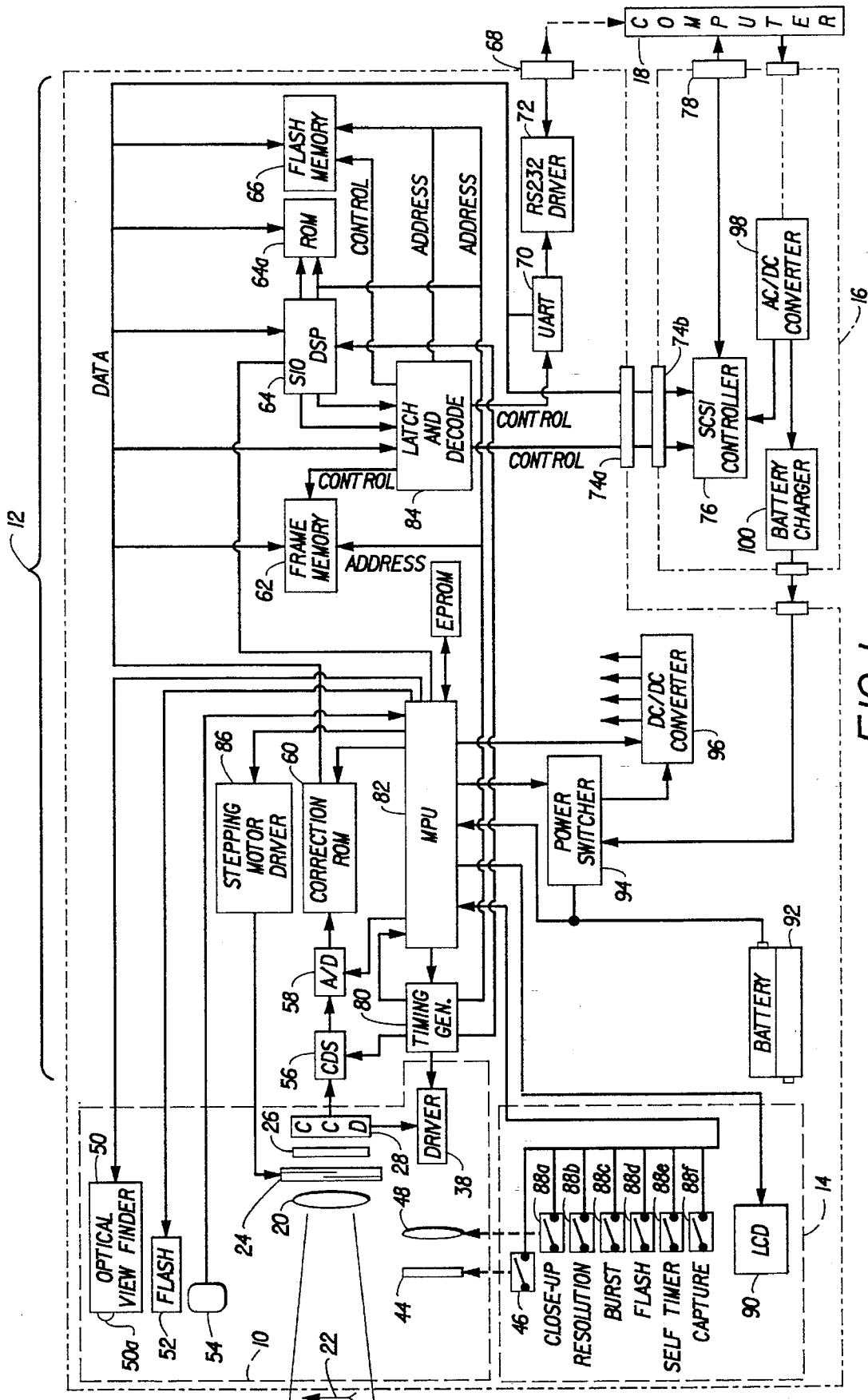


FIG. 1

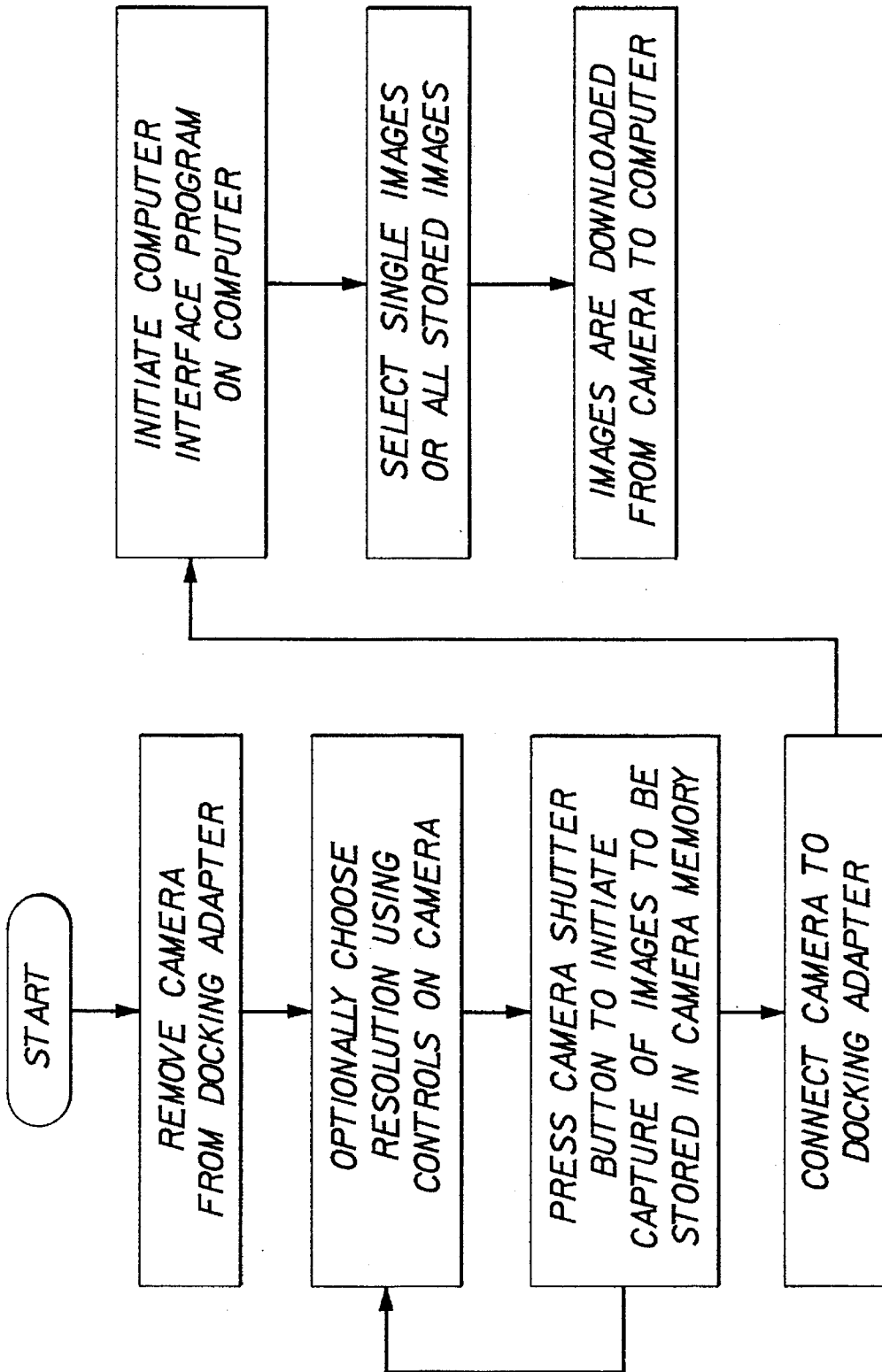


FIG.2

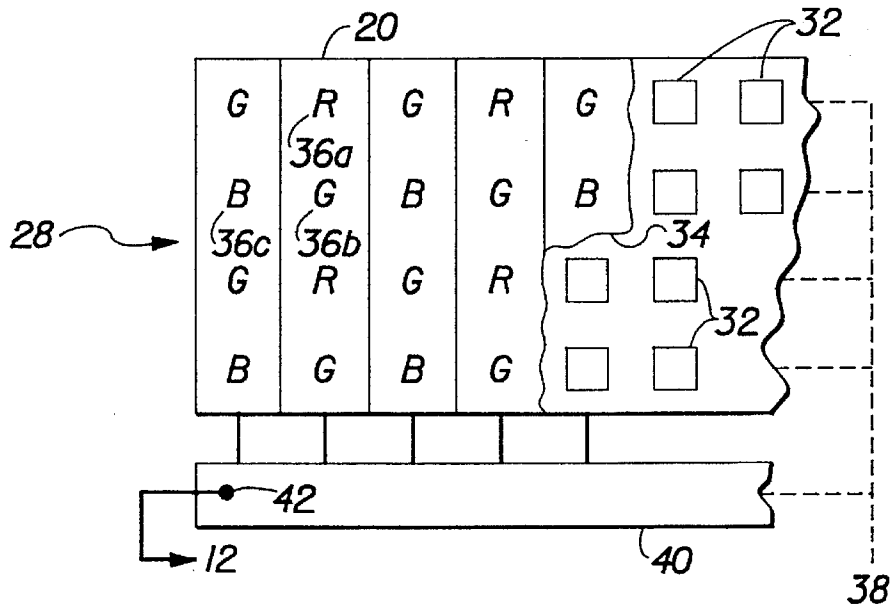


FIG. 3

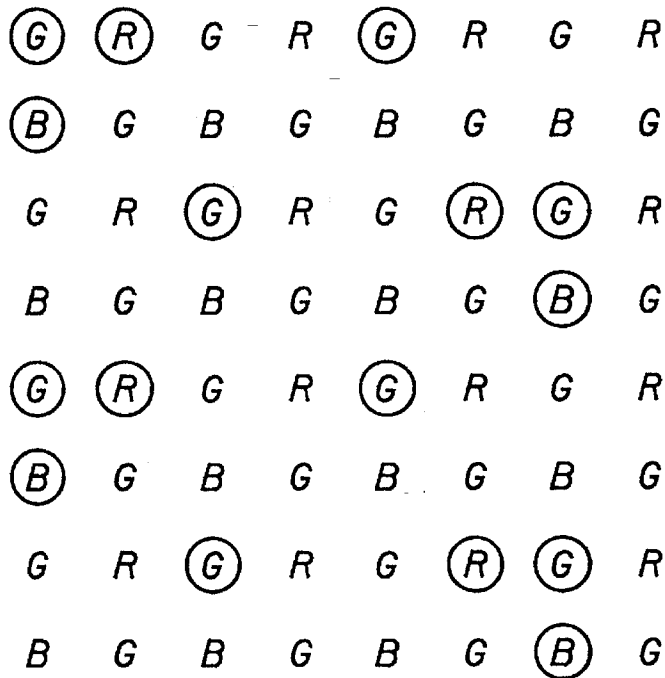


FIG. 4

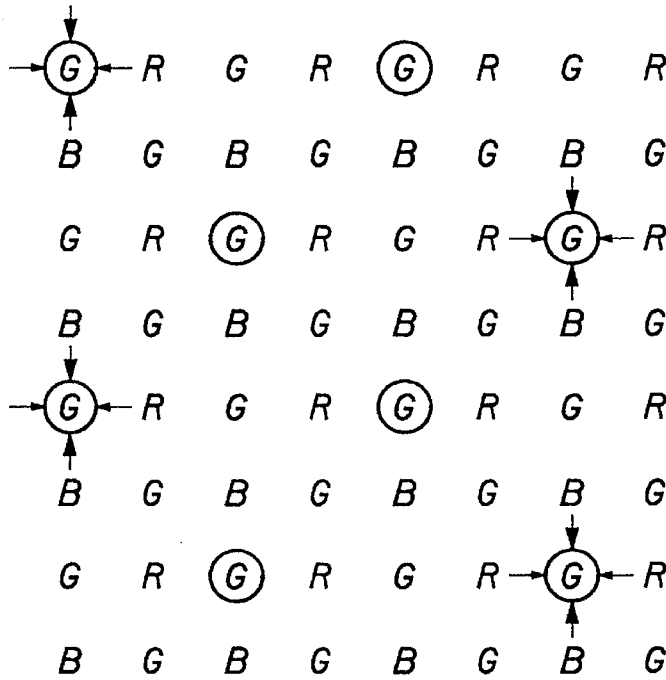


FIG. 5

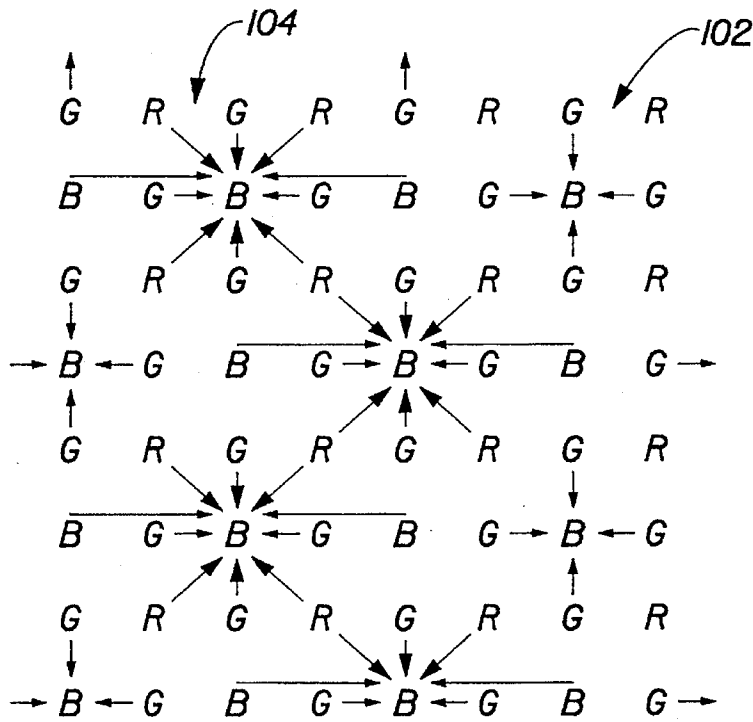


FIG. 6

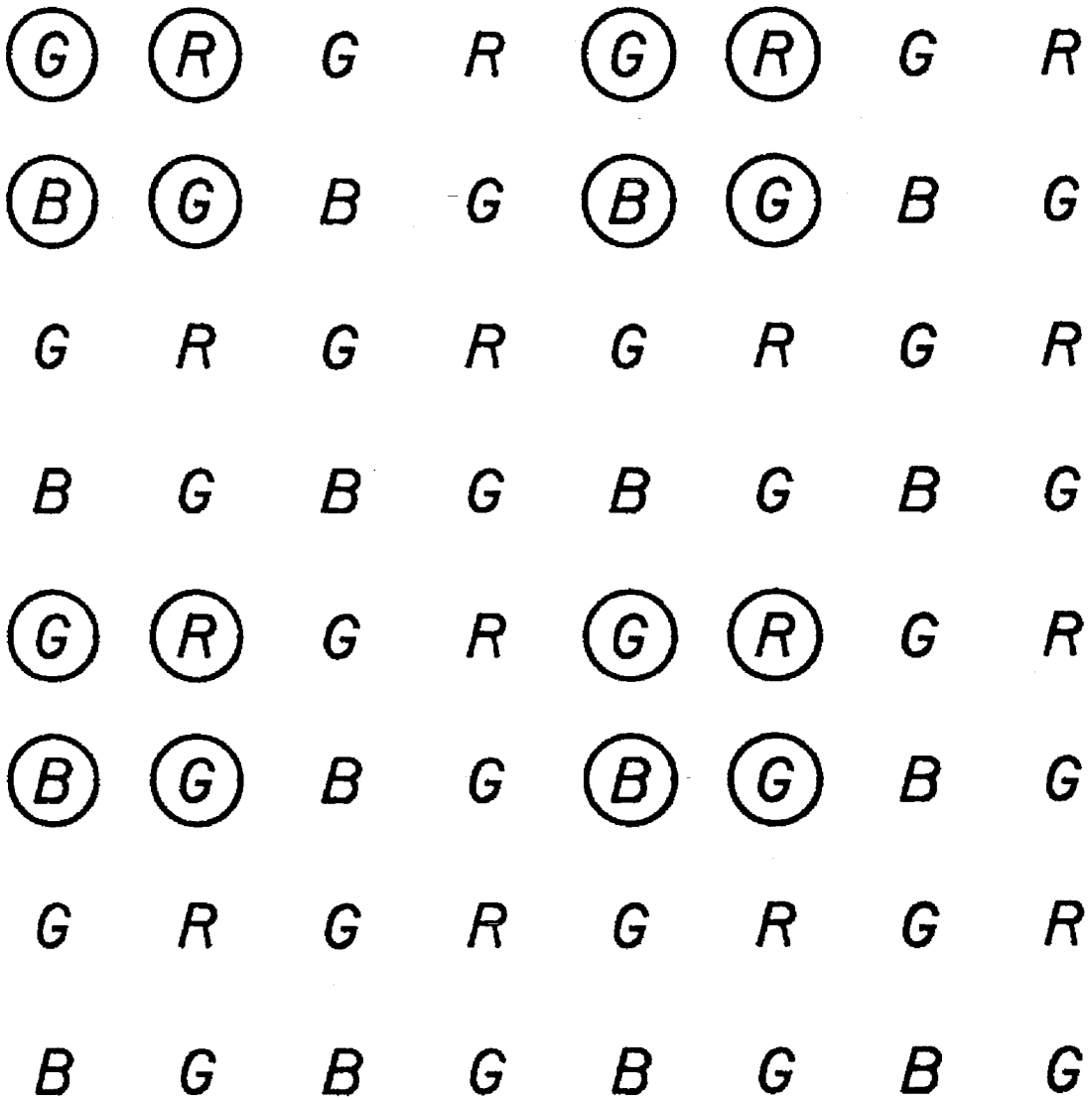


FIG. 7

# 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 36a, 36b, and 36c 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 36b, are arranged horizontally and vertically in a checker-board pattern, and the chrominance pixels, i.e., corresponding to the red and blue color elements 36a and 36c, 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 74a and 74b 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 50a 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 88a moves the close-up lens 48 into position, a switch 88b 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 88c activates a low resolution "burst" mode in which several pictures are rapidly taken, a switch 88d activates the flash unit 52, and a switch 88e activates a self-timer delay mode. A capture switch 88f 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 88f 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 36a, 36b, 36c 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 64a, 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 88b 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 88b 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 88b, with the burst mode enabled by actuation of the switch 88c, 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 form 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 88c 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

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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 horizon-

## 12

tally 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)

Table with 3 columns: Country, Patent Number, Date. Includes 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)

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Reexamination Request:

No. 90/010,630, Jul. 31, 2009
No. 90/010,910, Apr. 12, 2010

Reexamination Certificate for:

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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.

(Continued)

Primary Examiner—Linh M. Nguyen

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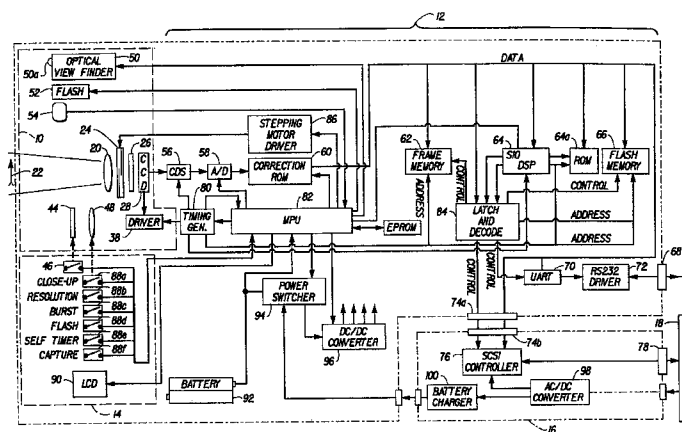
(Continued)

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Table with 3 columns: Country, Patent No., Date. Includes JP 63-064485 (3/1988), JP 63-286078 (11/1988)

(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 sub-sampled 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.



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**1**  
**EX PARTE**  
**REEXAMINATION CERTIFICATE**  
**ISSUED UNDER 35 U.S.C. 307**

NO AMENDMENTS HAVE BEEN MADE TO  
THE PATENT

**2**

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

The patentability of claims **1, 4** and **12** is confirmed.  
5 Claims **2, 3, 5-11, 13-15** were not reexamined.

\* \* \* \* \*



# **EXHIBIT B**



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**

(75) Inventors: **Kenneth A. Parulski**, Rochester;  
**Timothy J. Tredwell**, Fairport, both of NY (US)

(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.<sup>7</sup> ..... **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**

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*Primary Examiner*—Wendy R. Garber

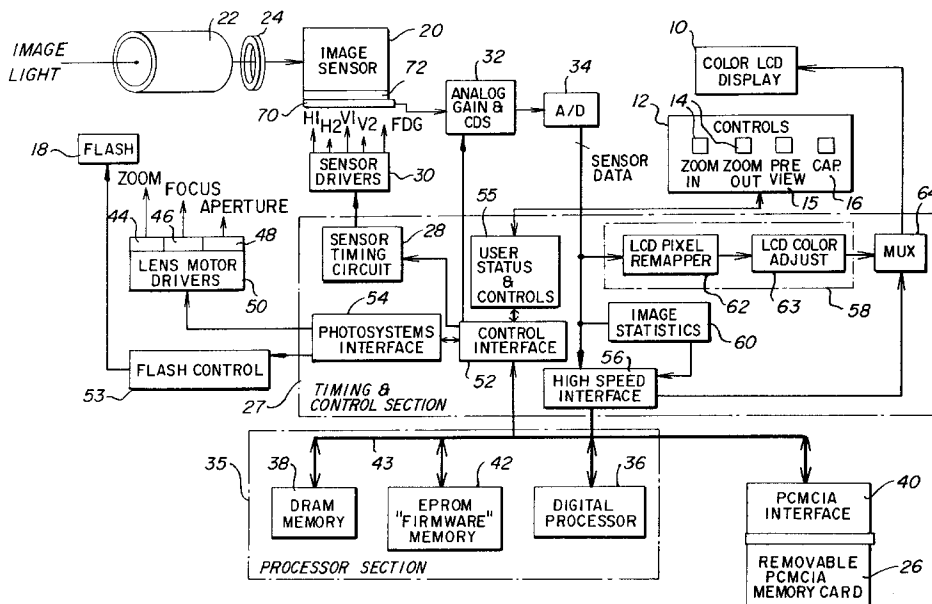
*Assistant Examiner*—Alicia M Harrington

(74) *Attorney, Agent, or Firm*—Pamela R. Crocker

(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**



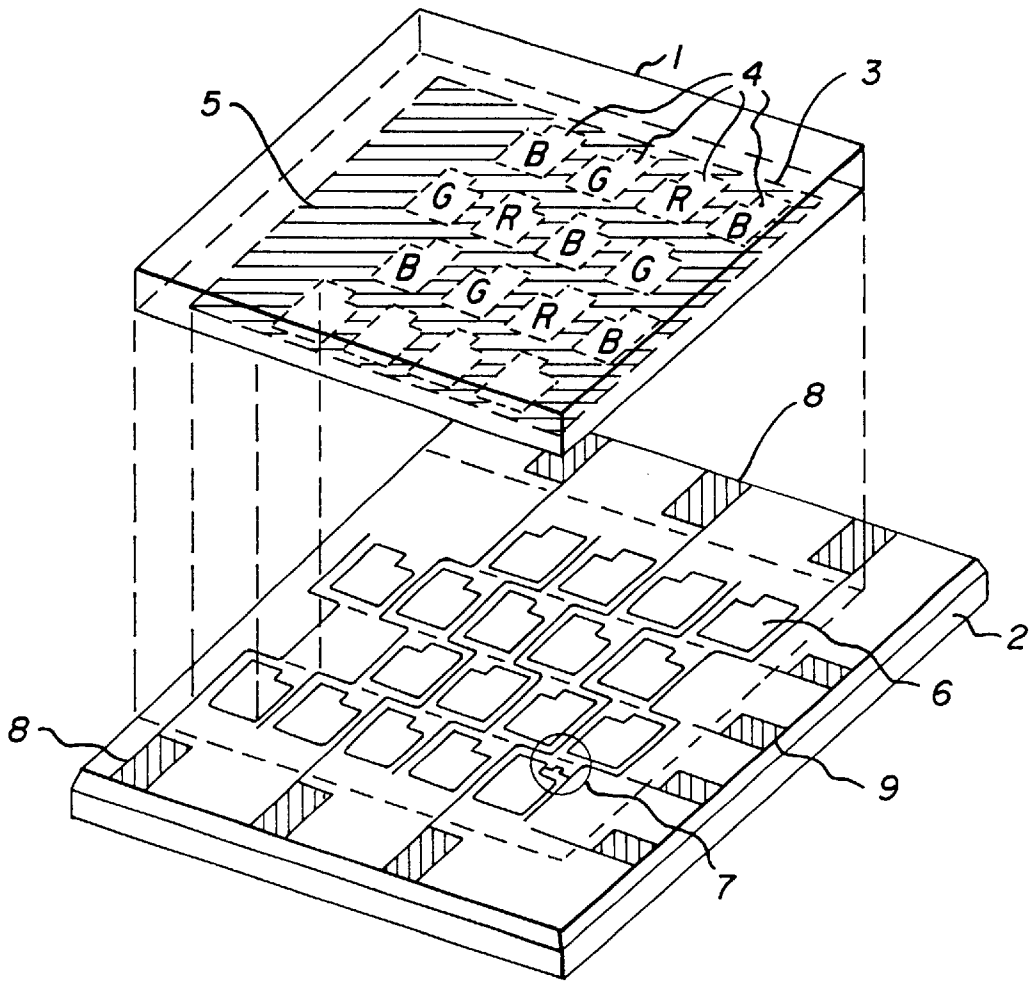


FIG. 1A

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

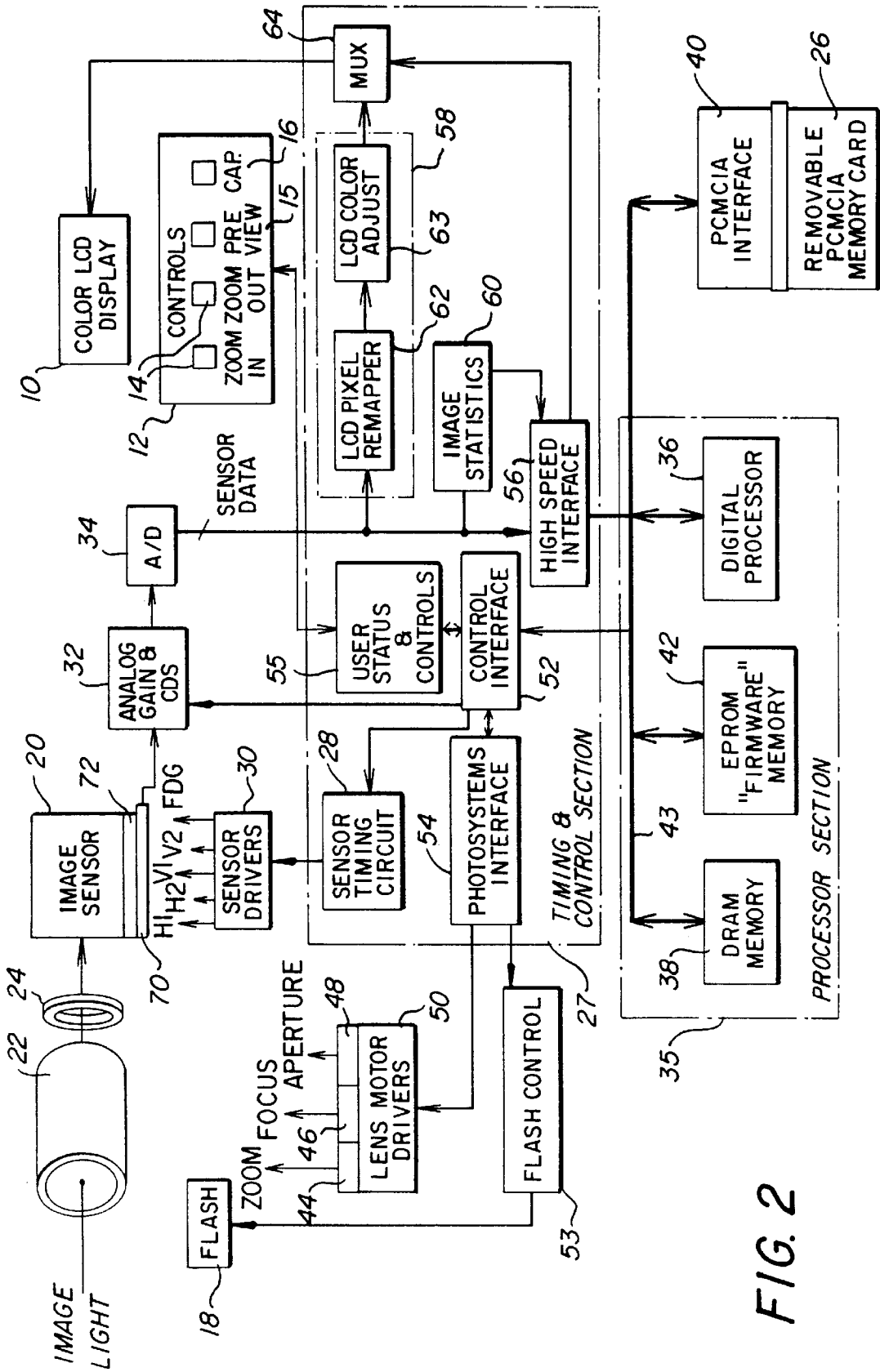


FIG. 2

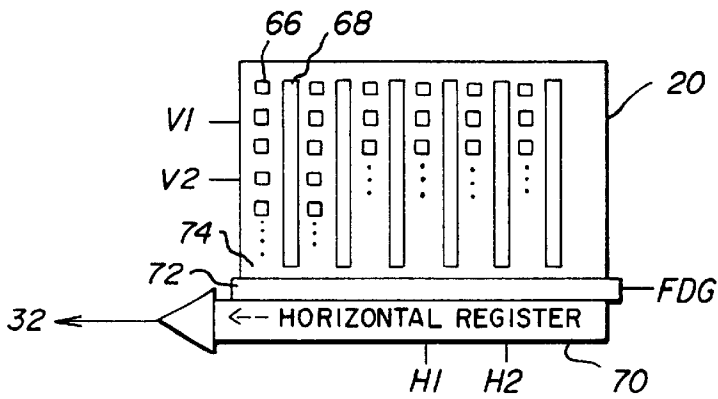
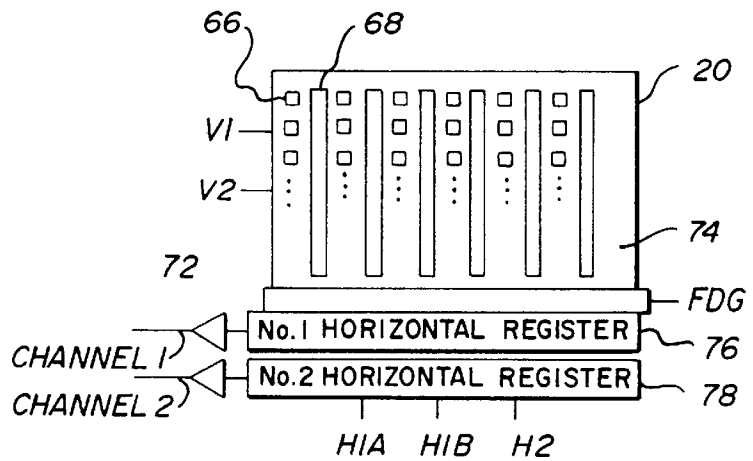


FIG. 3A

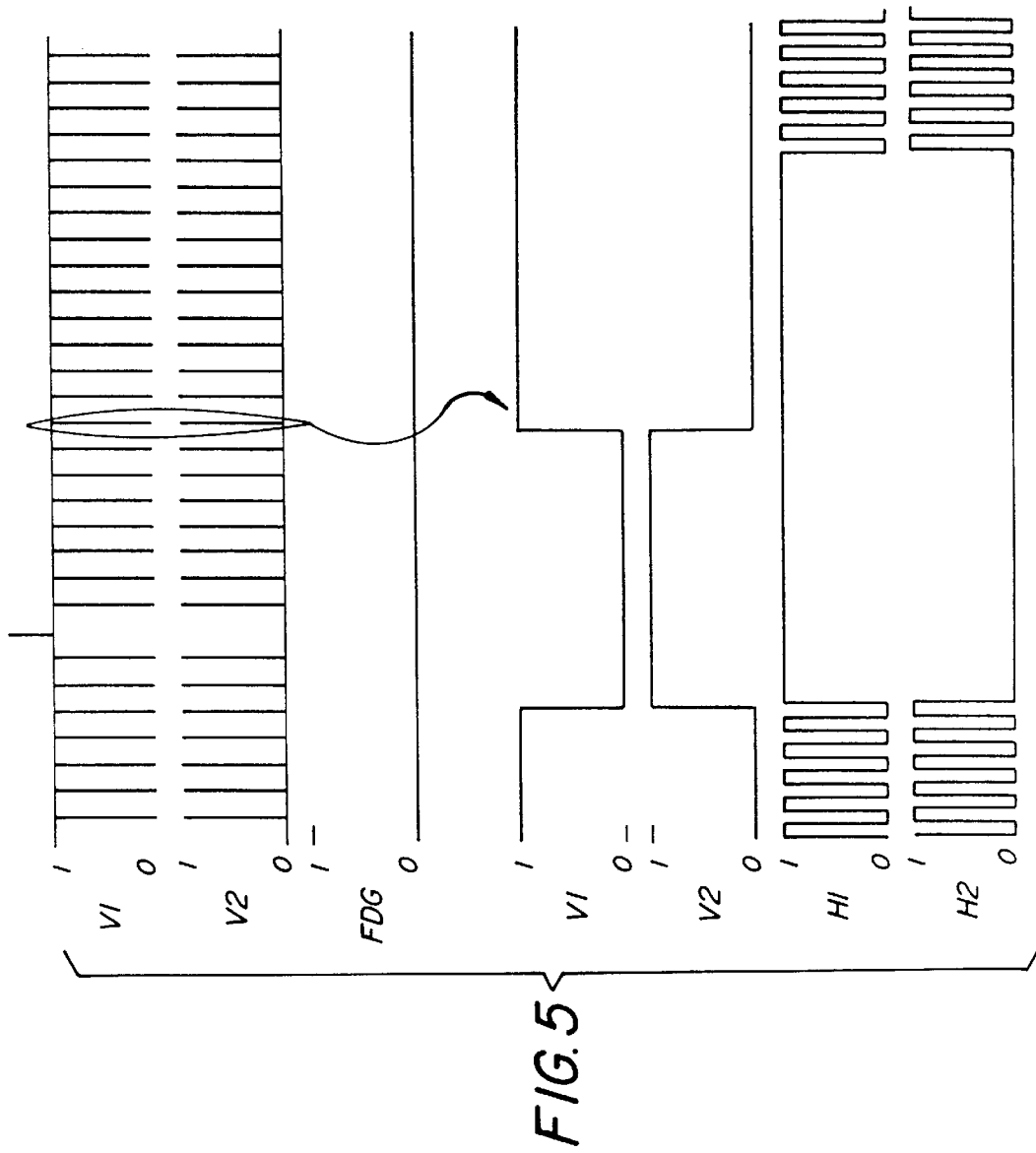
FIG. 3B



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



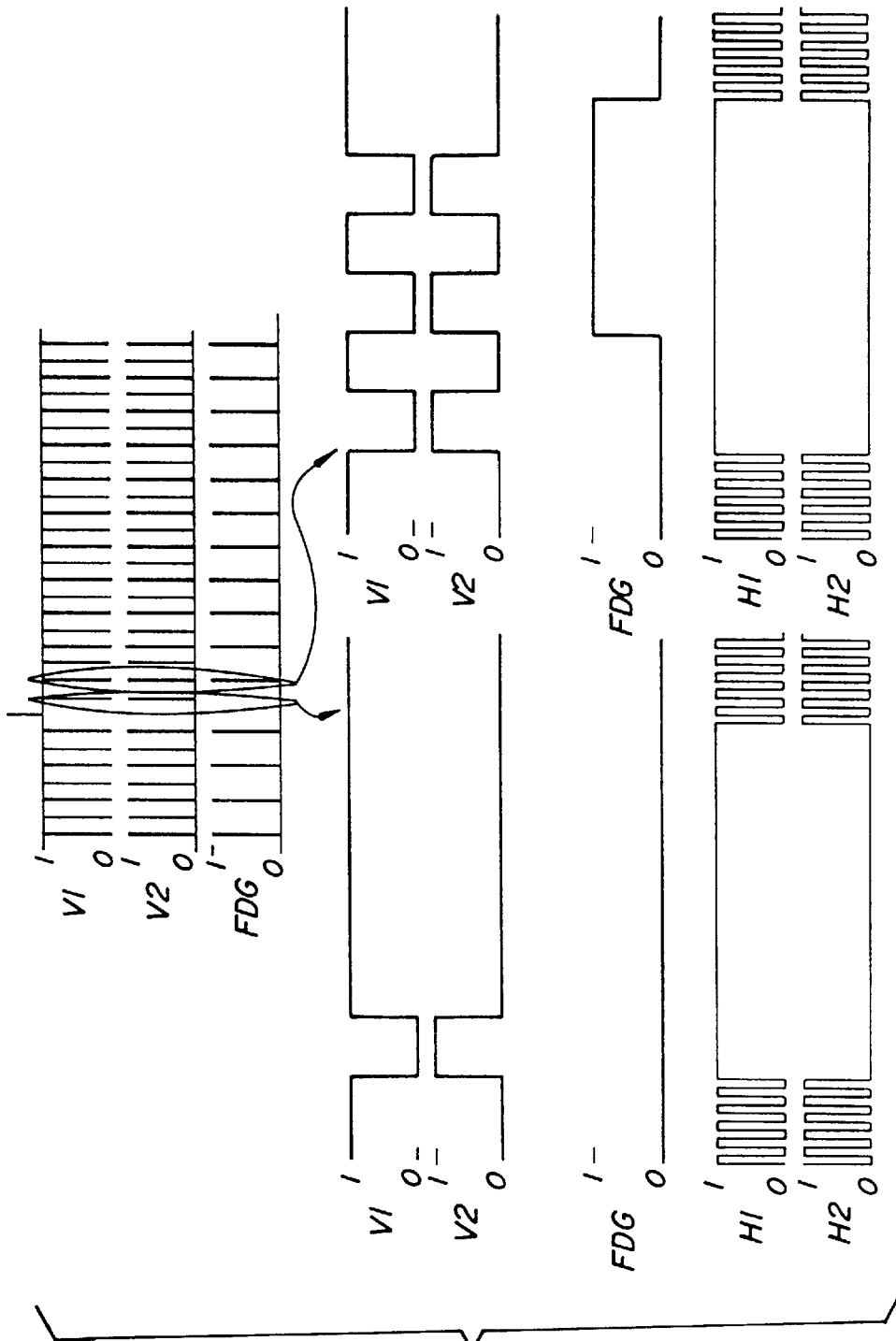
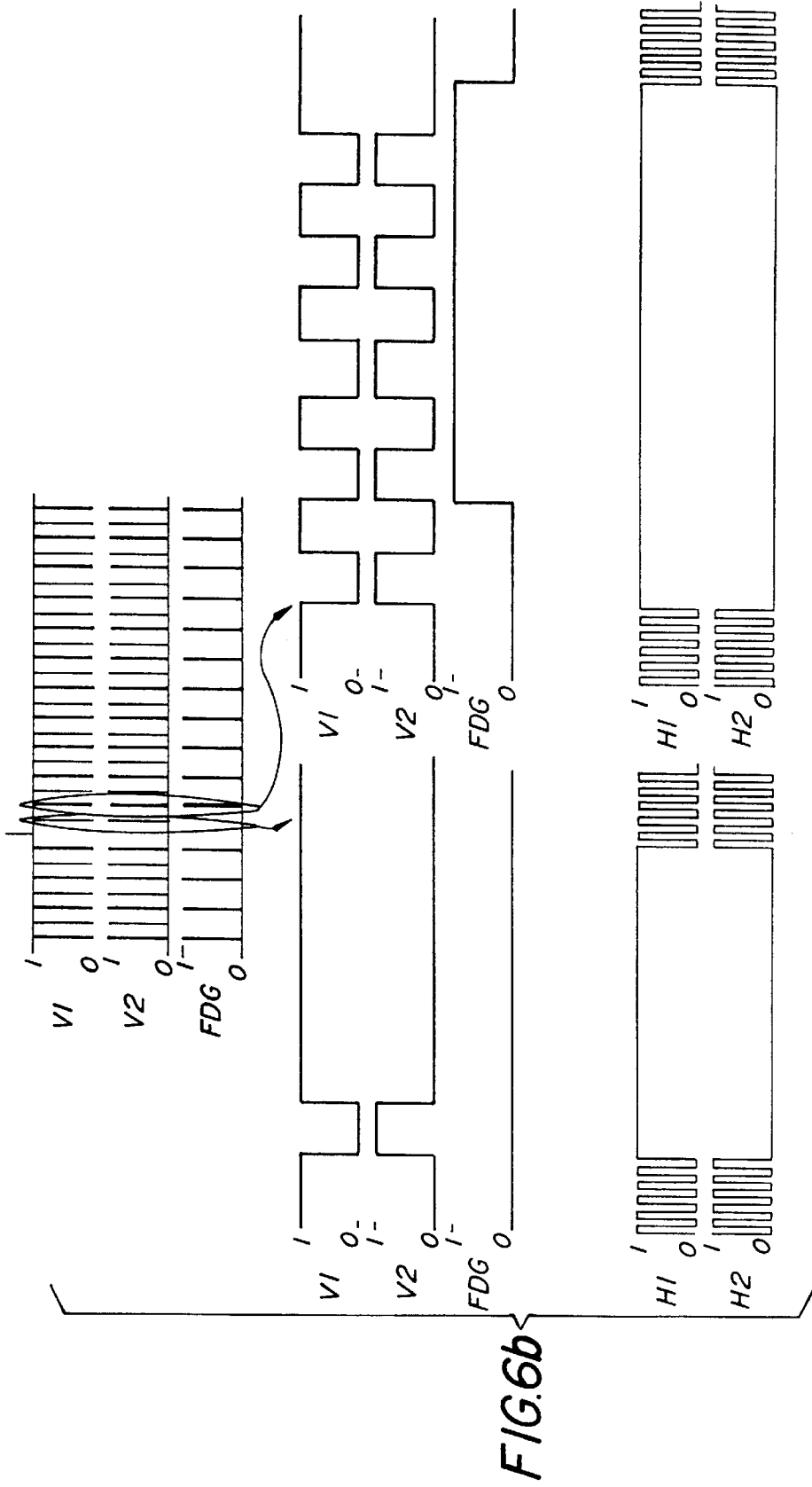


FIG. 6a





CCD LINES

LINE 1	G	R	G	R	G	R	G	R
LINE 2	B	G	B	G	B	G	B	G
LINE 3								
LINE 4								
LINE 5	G	R	G	R	G	R	G	R
LINE 6	B	G	B	G	B	G	B	G
LINE 7								
LINE 8								
LINE 9								
LINE 10								
LINE 11	G	R	G	R	G	R	G	R
LINE 12	B	G	B	G	B	G	B	G
LINE 13								
LINE 14								
LINE 15	G	R	G	R	G	R	G	R
LINE 16	B	G	B	G	B	G	B	G
LINE 17								
LINE 18								
LINE 19								
LINE 20								

ELIMINATED VIA  
"FAST DUMP"

*FIG. 7*

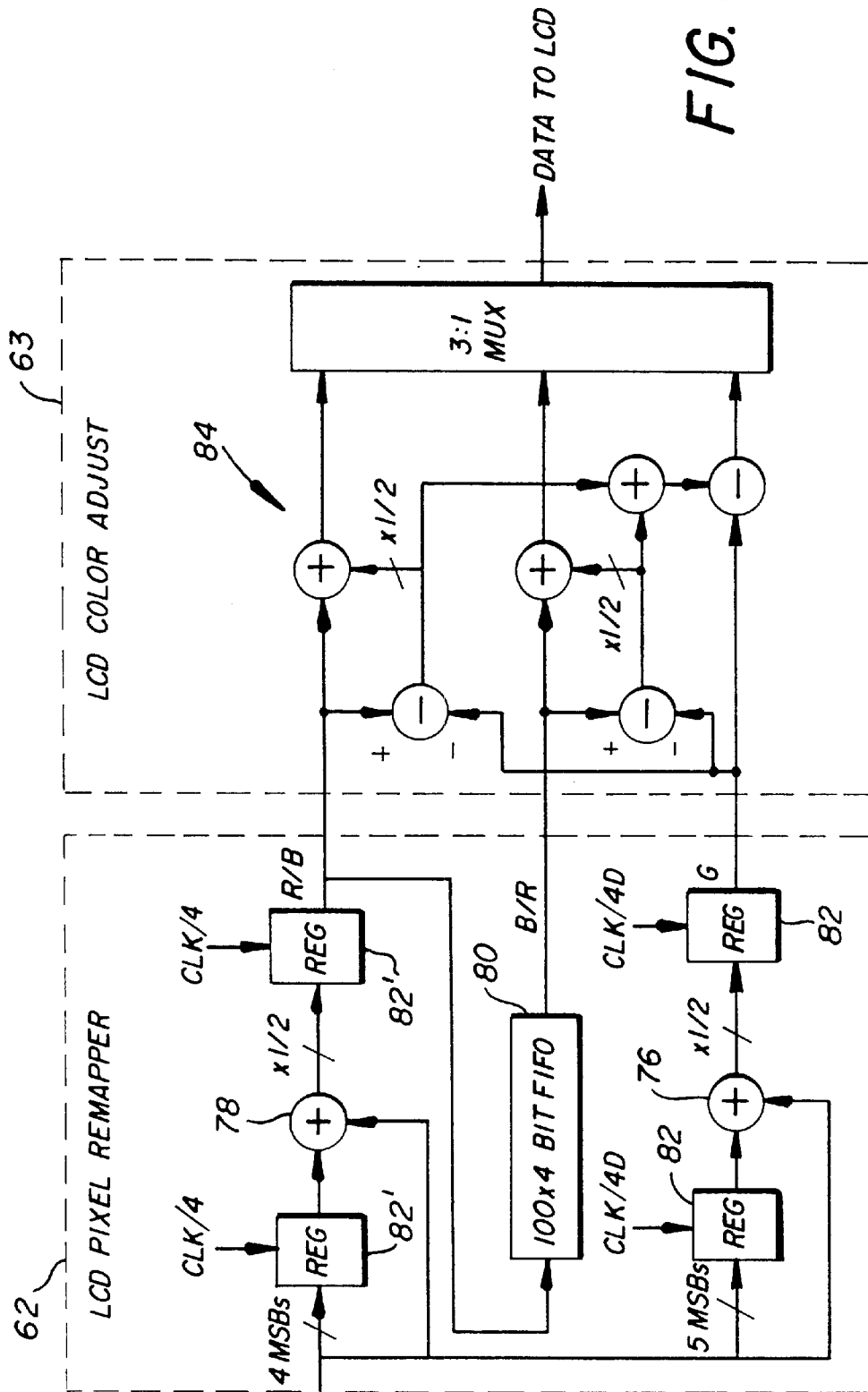


FIG. 8

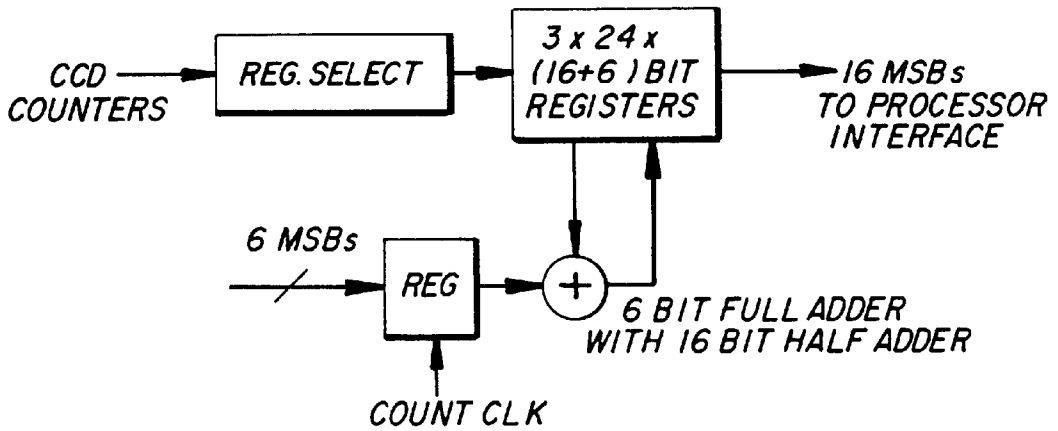


FIG. 9A

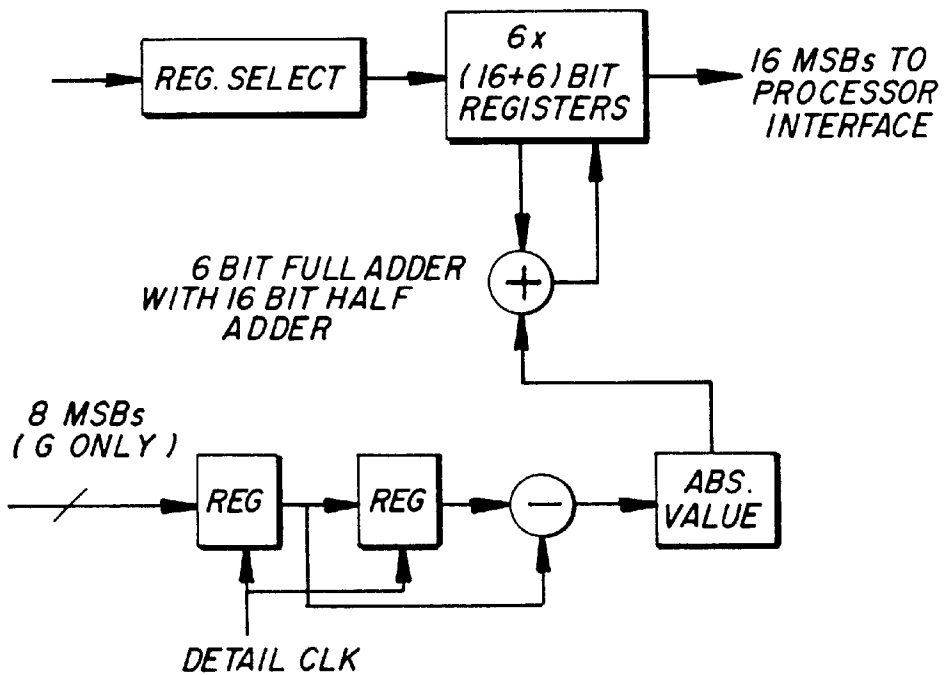


FIG. 9B

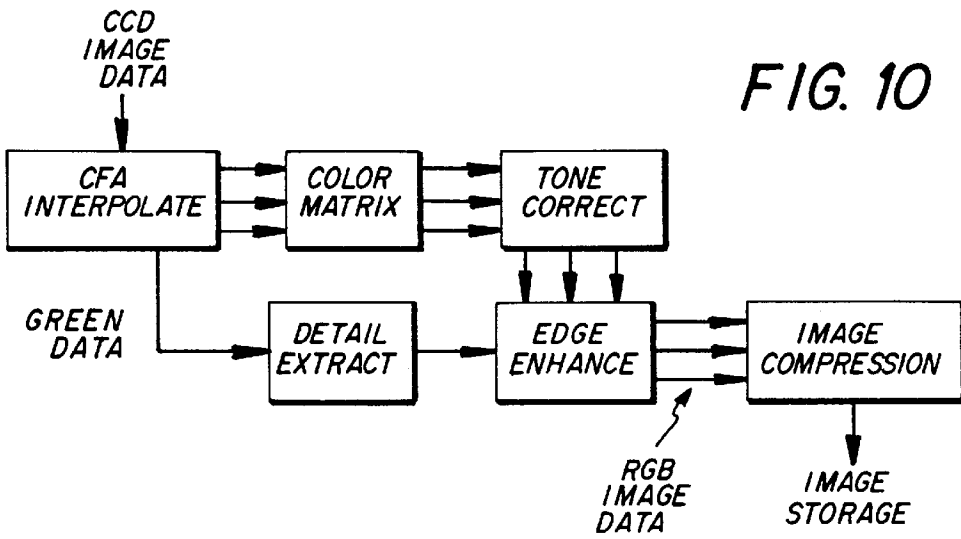


FIG. 10

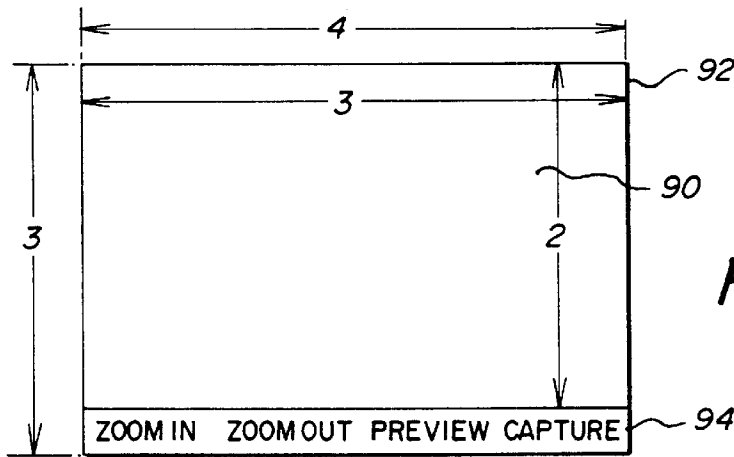


FIG. 11

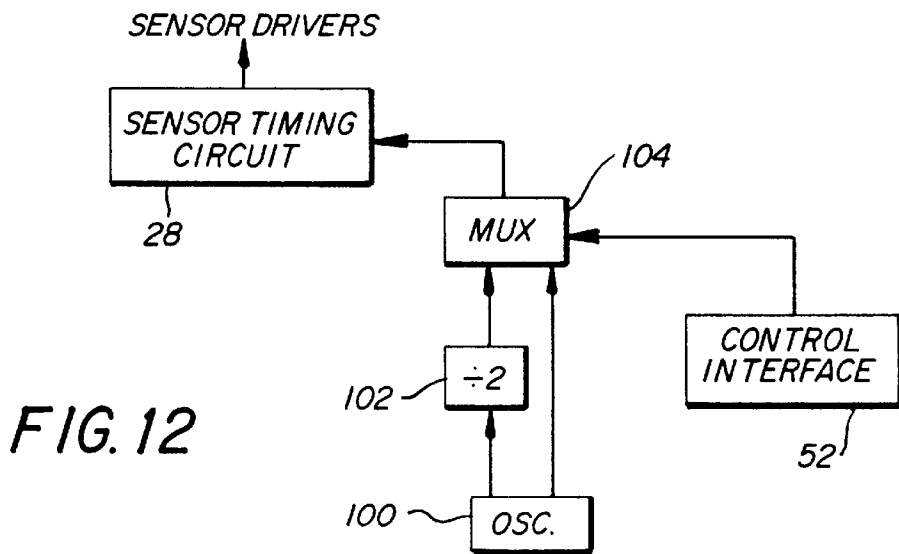


FIG. 12

## 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  $\frac{2}{3}$  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 same-colored 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. 6A and 6B show the line timing for the preview mode of operation;

FIG. 7 shows the special line skipping pattern used in the

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 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. 3A. 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"x6") 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. 6a and 6b. 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  $\frac{1}{30}$  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. 6A and 6B. As shown in FIG. 6A, 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. 6B, lines 5 and 6 are read out normally, and then lines 7, 8, 9, and 10 are eliminated. Next, the FIG. 6A timing is used to read out lines 11 and 12, while eliminating lines 13 and 14, and then the FIG. 6B 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 $\times$ 768 pixels and 3:2 aspect ratio) is to have an LCD display with 512 $\times$ 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. 1B. In this discussion, an LCD pixel array of about 240 lines $\times$ 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. 1B). Thus, there are approximately  $\frac{1}{4}$  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. 3A, as described in connection with the "line skipping" mode. This allows the sensor readout time to be decreased by more than  $\frac{1}{2}$  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 $\times$ 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. 9A and 9B 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 4x6 rectangular image regions, for each of R, G, and B; a block diagram of the calculation in one color is shown in FIG. 9A. 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. 9B. 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. 3B 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. 3A 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 1/2 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. 3A.

In particular, if the dual register CCD in FIG. 3B had 512x768 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

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(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 inte-

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grated 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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(12) **EX PARTE REEXAMINATION CERTIFICATE** (8510th)  
**United States Patent**  
**Parulski et al.**

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

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- (51) **Int. Cl.**  
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*H04N 3/15* (2006.01)  
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(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.

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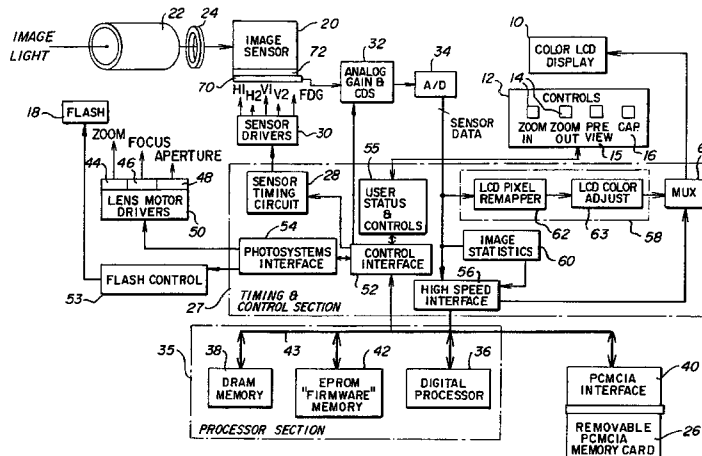
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Primary Examiner—Linh M. Nguyen

(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.



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**1**  
**EX PARTE**  
**REEXAMINATION CERTIFICATE**  
**ISSUED UNDER 35 U.S.C. 307**

NO AMENDMENTS HAVE BEEN MADE TO  
THE PATENT

**2**  
AS A RESULT OF REEXAMINATION, IT HAS BEEN  
DETERMINED THAT:  
  
The patentability of claims **15** and **23-27** is confirmed.  
**5** Claims **1-14**, **16-22**, and **28** were not reexamined.

\* \* \* \* \*

# **EXHIBIT C**





US006573927B2

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

(10) **Patent No.:** **US 6,573,927 B2**  
(45) **Date of Patent:** **Jun. 3, 2003**

(54) **ELECTRONIC STILL CAMERA FOR CAPTURING DIGITAL IMAGE AND CREATING A PRINT ORDER**

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(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)

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

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(21) Appl. No.: **08/977,382**

(22) Filed: **Nov. 24, 1997**

(65) **Prior Publication Data**

US 2003/0025808 A1 Feb. 6, 2003

**Related U.S. Application Data**

(60) Provisional application No. 60/037,963, filed on Feb. 20, 1997.

(51) **Int. Cl.<sup>7</sup>** ..... **H04N 5/76**

(52) **U.S. Cl.** ..... **348/32; 348/231.7**

(58) **Field of Search** ..... 348/231, 232, 348/233, 213; 358/1.9, 1.15, 1.16, 906; 347/2, 231.99, 231.2, 231.3, 231.7, 231.9

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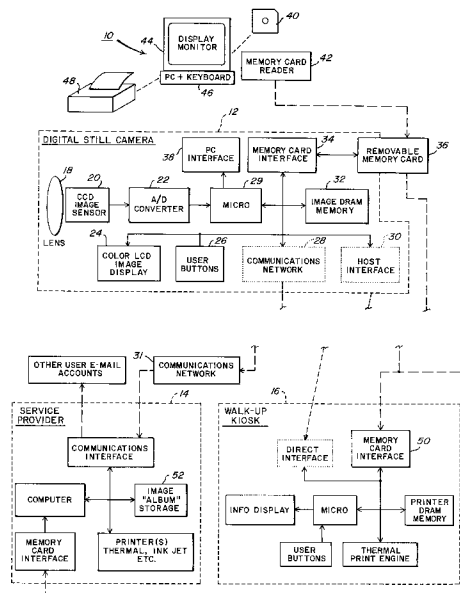
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*Assistant Examiner*—Jacqueline Wilson  
(74) *Attorney, Agent, or Firm*—David M. Woods

(57) **ABSTRACT**

A digital camera includes a liquid crystal display (LCD) for viewing images captured from an image sensor and stored on a removable memory card. The LCD also presents a user interface (UI) that allows the user to create a print order "utilization file". As individual images are viewed, the user can decide how many (if any) prints to make of the image, the print size, and the, print quality (low cost ink jet versus high quality thermal prints, for example). The memory card can then be inserted in a home printer, walk-up kiosk, or dropped off/mailed to a photofinisher, or the camera itself can be connected to the printer or kiosk via a wired or wireless (e.g., IrDA) link. The print order can then be automatically produced without any additional user intervention.

**24 Claims, 5 Drawing Sheets**



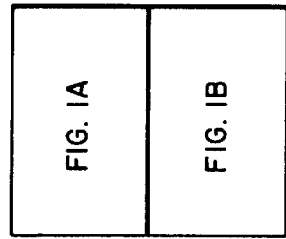
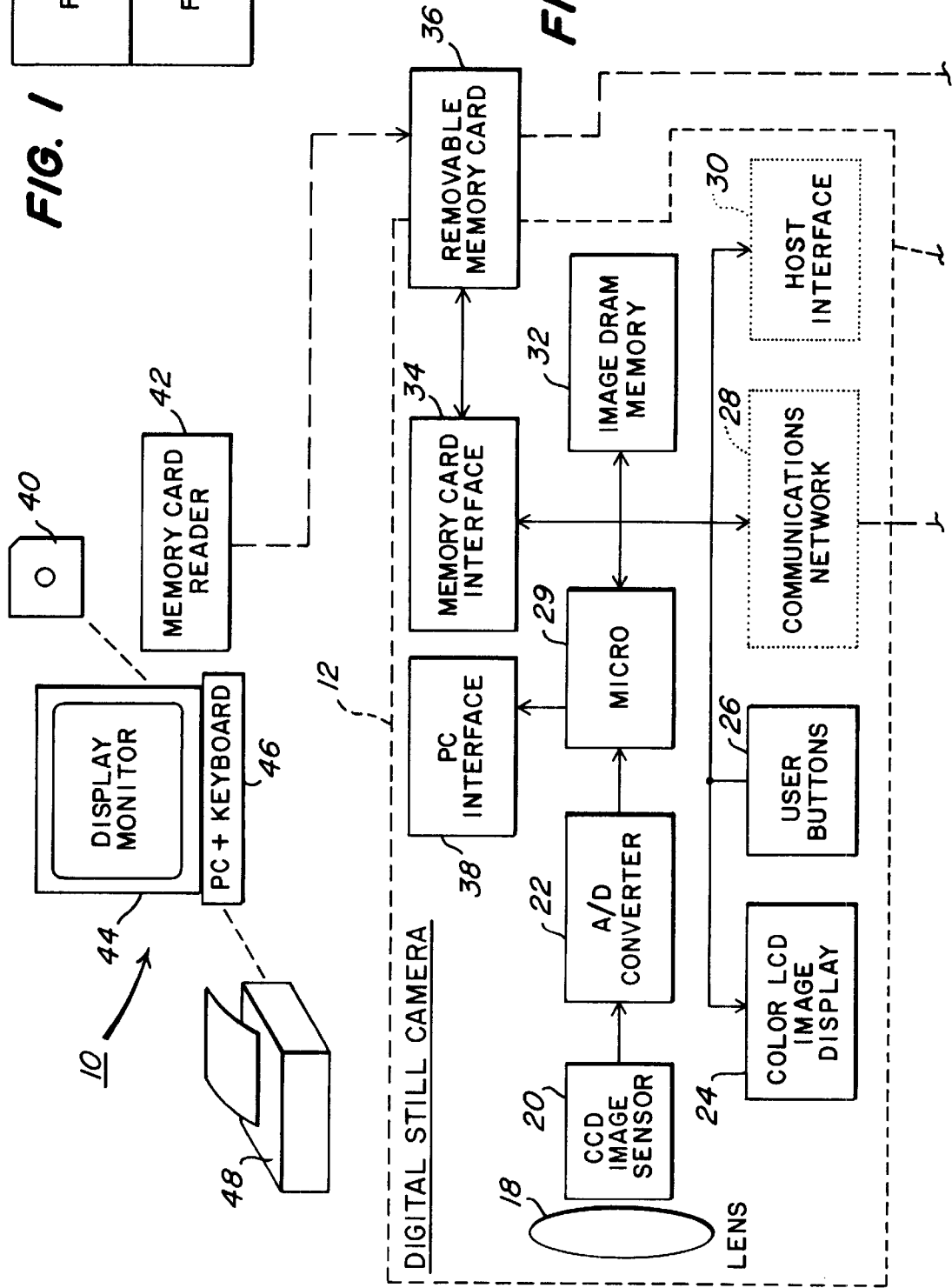


FIG. 1



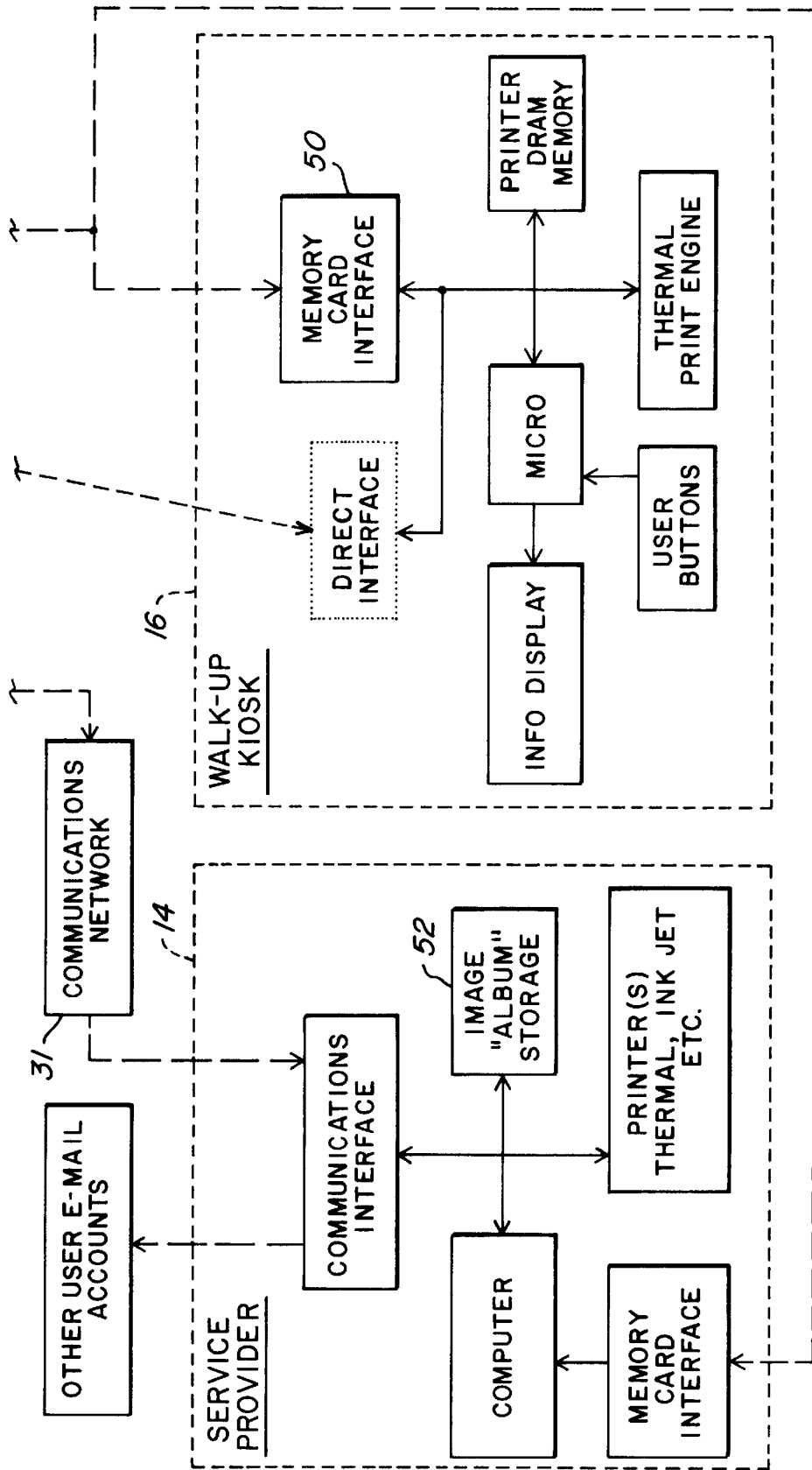


FIG. 1B

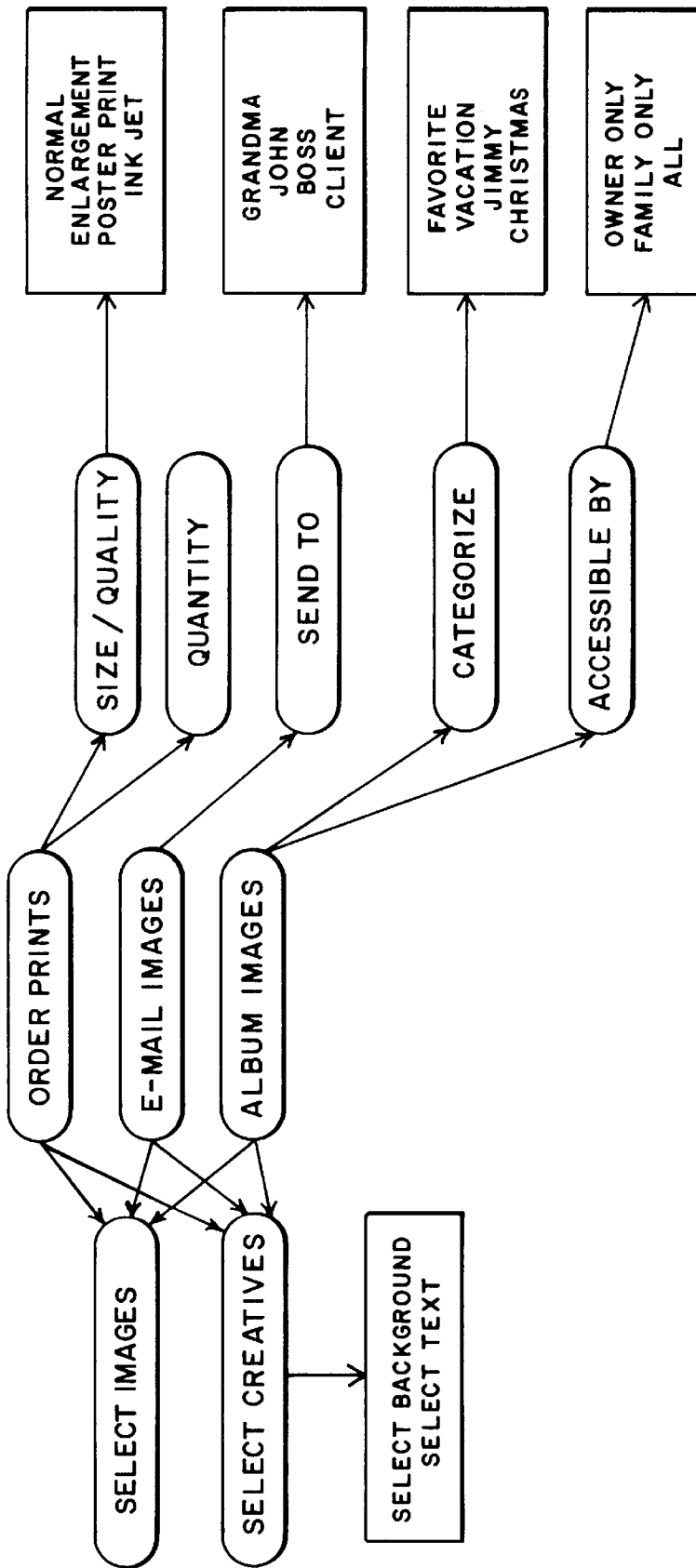
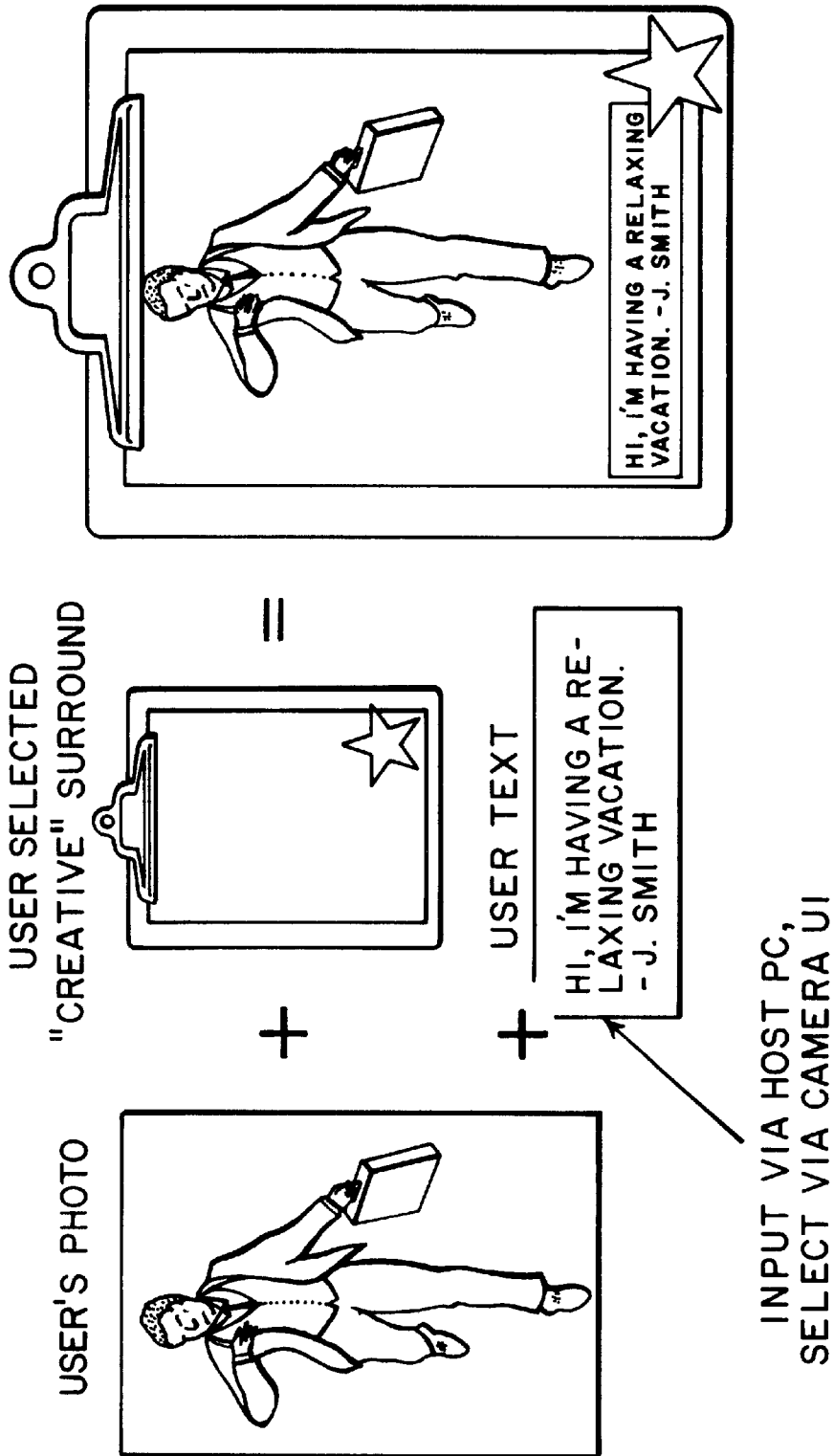


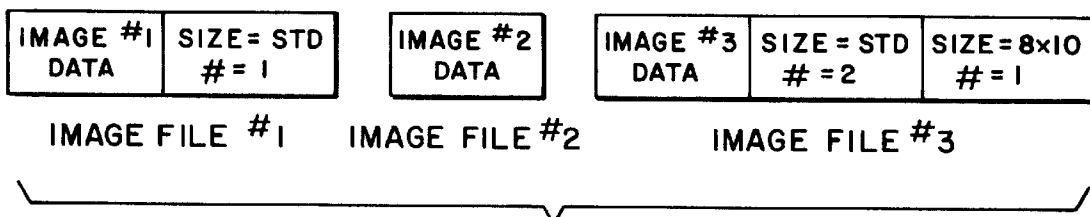
FIG. 2



**FIG. 3**

<p>— GLOBAL INFORMATION —                  (CUSTOMER NAME, ADDRESS, BILLING INFO, ORDER DATE)</p>
<p>— PRINT ORDER INFO —                  (SIZE, NUMBER OF COPIES, IMAGE REFERENCES)</p>
<p>— E-MAIL ORDER INFO —                  (E-MAIL ADDRESS, IMAGE REFERENCES)</p>
<p>— ALBUM ORDER INFO —                  (ALBUM HEADING, ACCESS, IMAGE REFERENCES)</p>
<p>— CREATIVE DETAIL —                  (TEMPLATE, USER TEXT, IMAGE REFERENCE, IMAGE CROPPING)</p>
<p>— IMAGE REFERENCES —                  (IMAGE FORMAT, IMAGE LOCATION)</p>

**FIG. 4**



**FIG. 5**

## ELECTRONIC STILL CAMERA FOR CAPTURING DIGITAL IMAGE AND CREATING A PRINT ORDER

### CROSS REFERENCE TO RELATED APPLICATION

Reference is made to and priority claimed from U.S. Provisional Application Ser. No. 60/037,963, filed Feb. 20, 1997, entitled ELECTRONIC CAMERA WITH "UTILIZATION" SELECTION CAPABILITY.

### CROSS-REFERENCE TO RELATED APPLICATION(S)

Reference is made to commonly assigned copending applications Ser. No. 60/037,962, entitled "Network Configuration File for Automatically Transmitting Images from an Electronic Still Camera" and filed on the same date herewith in the names of Joseph Ward, Kenneth A. Parulski, and James D. Allen, and which is assigned to the assignee of this application.

### 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 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, mailing address, etc.

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

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 camera and system of our invention meets this need by allowing the user to select "downstream" services at the time of capture, using the camera's LCD screen and user interface. The digital camera includes a liquid crystal display (LCD) for viewing images captured from a CCD sensor and stored on a removable memory card. The LCD also presents a user interface (UI) that allows the user to create a print order "utilization file". As individual images are viewed, the user can decide how many (if any) prints to make of the image, the print size, and the print quality (low cost ink jet versus high quality thermal prints, for example). The memory card can then be inserted in a home printer, walk-up kiosk, or dropped off/mailed to a photofinisher, or the camera itself can be connected to the printer or kiosk via a wired or wireless (e.g., IrDA) link. The print order can then be automatically produced without any additional user intervention.

Alternately, a modem in the camera or card reader can transmit the utilization file and the image data to a print service provider, which can produce the prints and return them via mail to the user, or to a party designated by the user. The utilization file can alternately include e-mail addresses to allow images to be automatically sent to others, postal address information for sending print images, or albuming information to allow images to be placed in an on-line image database.

### 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.

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 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 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 (charge card number, mailing addresses, etc.). 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. 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 (or disconnecting the camera 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 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"x6" size) image of 2 different images, and 2 standard size images plus one "enlargement" (8"x10" 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. Alternately, 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**.

Alternately, the camera 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 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 includes a transmitter, e.g., a cellular connection in the communications interface **28**, the camera 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 (FTP, mailto, etc.). Alternately, the camera 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 is inserted into the dock. Alternately, the memory card **36** could be removed from the camera 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 alternately 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" (family, friends, etc.) 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, and which is incorporated herein 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 alternately be connected to an internet service provider (ISP) (not shown) such as AOL (America On Line), Earthlink, Eznet, etc. 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"x6") 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"x36") 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 that is then inserted into the camera, 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. Alternately, a low resolution version of the templates desired by the user can be stored in the camera, 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 (via the card). The full utilization file (Print order, e-mail order, etc.) 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 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 electronic albuming, and a third containing e-mail order information. Alternately, 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 alternately 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"x10" 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

```
00000000 UTILIZATION ORDER SPECIFICATION (Non-zero initial number identifies encryption
key)
%Section: GlobalInfo
  %Section: ConsumerInfo (Provides info on camera owner and default mailing address)
    %Name: ~Smith~John~W~
    %Consumer ID: Njj1007
    %Address: ~1 Picture Avenue~
              ~Apartment 8b~
              ~PO Box 123~
              ~Anytown~
              ~State~
    %PostalCode:~14650~
    %CountryCode:USA
    %Email:~jdoe@kodak.com~
```

## APPENDIX I-continued

## DIGITAL CAMERA UTILIZATION FILE

```

%PhoneDay: ~(716) 555-1111~
%PhoneNight: ~(716) 555-2222~
%CreditCardExpDate: 1996 03 24
%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
%EndSection: 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: ImageDetail3
%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)
  %Section: ImageDetail 1
    %FileType: FlashPix Version 2.0
    %ImageLocation: LocalCard~Vacation/Image4.FPX~
  %Section: ImageDetail 2

```

APPENDIX I-continued

DIGITAL CAMERA UTILIZATION FILE

```
%FileType: Flashpix Version 2.0
%ImageLocation: LocalCardVacation/Image7.FPX~
%Section: ImageDetail 3
%FileType: Flashpix Version 2.0
%ImageLocation: LocalCard~Vacation/Image10.FPX~
%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 still camera for capturing images that can be printed by a separate printing device, 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;
  - (e) a processor for controlling the transfer of the digital images from the removable memory card to the internal memory and for producing a print utilization file;
  - (f) a display coupled to the internal memory for displaying at least one digital image; and
  - (g) a user interface for scrolling through the plurality of digital images stored on the removable memory card in order to display particular digital images and for selecting particular digital images to be printed, wherein the print utilization file includes the names of at least two digital image files to be printed by the printing device, the at least two digital image files corresponding to selected ones of the digital images produced from the images captured by the image sensor, and the processor stores the print utilization file on the removable memory card separate from the digital image files.
2. The electronic still camera as claimed in claim 1 wherein the user interface enables selection of the quantity of prints to be printed for each digital image file and the print utilization file further includes the quantity of prints to be printed for each digital image file.
3. The electronic still camera as claimed in claim 1 wherein the user interface enables selection of the size of the prints to be printed for each digital image file and the print utilization file further includes the size of the prints to be printed for each digital image file.
4. The electronic still camera as claimed in claim 1 wherein the print utilization file further includes the file type of each digital image file.
5. The electronic still camera as claimed in claim 4

6. The electronic still camera as claimed in claim 1 wherein the print utilization file further includes a camera owner name and a mailing address of such camera owner.
7. The electronic still camera as claimed in claim 6 wherein the print utilization file further includes a credit card number of the camera owner.
8. The electronic still camera as claimed in claim 1 wherein the removable memory card further stores at least one creative background, and the user interface enables selection of the at least one creative background to be combined with a particular digital image.
9. An electronic imaging system including an electronic still camera for capturing images and a separate printing device for printing selected captured images, the electronic imaging system including:
  - (a) an electronic still camera comprising:
    - (i) an image sensor for capturing a plurality of images of scenes and for producing image signals representative of the corresponding scenes;
    - (ii) an analog-to-digital converter for digitizing the image signals to produce digital images;
    - (iii) a removable memory card for storing a plurality of digital image files corresponding to the digital images;
    - (iv) an internal memory for storing at least one digital image to be displayed;
    - (v) a processor for controlling the transfer of the digital images from the removable memory card to the internal memory and for producing a print utilization file;
    - (vi) a display coupled to the internal memory for displaying at least one digital image; and
    - (vii) a user interface for scrolling through the plurality of digital images stored on the removable memory card in order to display particular digital images and for selecting particular digital images to be printed, wherein the print utilization file includes the names of at least two digital image files to be printed by the printing device, the at least two digital image files corresponding to selected ones of the digital images produced from the images captured by the image sensor, and the processor stores the print utilization file on the removable memory card separate from the digital image files; and
  - (b) the printing device comprising:
    - (i) an interface for receiving the removable memory card;
    - (ii) a microprocessor for reading the print utilization file from the removable memory card to determine the selected digital image files to be printed; and
    - (iii) a print engine responsive to the microprocessor for producing the prints of the selected digital image files.
10. The electronic imaging system as claimed in claim 9 wherein the user interface enables selection of the quantity of prints to be printed for each digital image file, the print

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utilization file further includes the quantity of prints to be printed for each digital image file, and the printing device producing the specified quantity of prints for each digital image file.

11. The electronic imaging system as claimed in claim 9 wherein the user interface enables selection of the size of the prints to be printed for each digital image file, the print utilization file further includes the size of the prints to be printed for each digital image file, and the printing device produces the specified size of the prints for each digital image file.

12. The electronic imaging system as claimed in claim 9 wherein the print utilization file further includes the file type of each digital image file.

13. The electronic imaging system as claimed in claim 12 wherein the file type of at least one digital image file is a JPEG file type.

14. The electronic imaging system as claimed in claim 9 wherein the print utilization file further includes a camera owner name and a mailing address of such camera owner.

15. The electronic imaging system as claimed in claim 14 wherein the print utilization file further includes a credit card number of the camera owner.

16. The electronic imaging system as claimed in claim 9 wherein the removable memory card further stores at least one creative background, the user interface enables selection of the at least one creative background to be combined with a particular digital image, and the printing device produces a print of the combined creative background and particular digital image.

17. A method for capturing and selecting digital images to be printed by a separate printing device, comprising the steps of:

- (a) capturing a plurality of images of scenes and producing image signals representative of the corresponding scenes;
- (b) digitizing the image signals to produce digital images;
- (c) storing a plurality of digital image files corresponding to the digital images on a removable memory card;
- (e) providing a user interface for scrolling through the plurality of digital images stored on the removable memory card in order to display particular digital images;

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(f) in response to a user selecting particular digital images to be printed, producing a print utilization file and storing such print utilization file on the removable memory card separate from the digital image files, wherein the print utilization file identifies at least two digital image files to be printed by the printing device, the at least two digital image files corresponding to selected ones of the digital images produced from the images captured in step (a).

18. The method as claimed in claim 17 wherein the user interface enables selection of the quantity of prints to be printed for each digital image file and the print utilization file further includes the quantity of prints to be printed for each digital image file.

19. The method as claimed in claim 17 wherein the user interface enables selection of the size of the prints to be printed for each digital image file and the print utilization file further includes the size of the prints to be printed for each digital image file.

20. The method as claimed in claim 17 wherein the print utilization file further includes the file type of each digital image file.

21. The method as claimed in claim 20 wherein the file type of at least one digital image file is a JPEG file type.

22. The method as claimed in claim 17 wherein the print utilization file further includes a camera owner name and a mailing address of such camera owner.

23. The method as claimed in claim 22 wherein the print utilization file further includes a credit card number of the camera owner.

24. The method as claimed in claim 17 further including the steps of:

- (g) transferring the removable memory card from the electronic still camera to the separate printing device;
- (h) reading the print utilization file to determine the digital image files selected by the user to be printed; and
- (i) printing the selected digital image files identified in the print utilization file.

\* \* \* \* \*