EXHIBIT

42

US007024214B2

(12) **United States Patent**
Loveland

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(45) **Date of Patent: Apr. 4, 2006**

(54) **SYNCHRONIZING OVER A NUMBER OF SYNCHRONIZATION MECHANISMS USING FLEXIBLE RULES**

(75) Inventor: **Shawn Domenic Loveland**, Sammamish, WA (US)

(73) Assignee: **Microsoft Corporation**, Redmond, WA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 446 days.

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H04B 15/00 (2006.01)

(52) **U.S. Cl.** **455/502**; 455/501; 455/503; 455/500; 370/350; 370/503; 370/506; 375/354; 375/355; 375/358

(58) **Field of Classification Search** 455/500–502, 455/507, 556, 456, 403, 419, 445, 446, 561, 455/550.1, 39, 503; 375/355, 358, 354; 370/350, 370/503, 506
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,390,216	A *	2/1995	Bilitza et al.	375/354
5,450,573	A *	9/1995	Gronemeyer	713/375
6,134,283	A *	10/2000	Sands et al.	375/354
6,256,304	B1 *	7/2001	Vayrynen	370/350
6,285,680	B1 *	9/2001	Steinka et al.	370/431
6,308,223	B1 *	10/2001	Opgenoorth	709/248
6,577,878	B1 *	6/2003	Park et al.	455/561
6,711,151	B1 *	3/2004	Ziegler	370/350
2001/0048728	A1	12/2001	Peng	375/354
2001/0054115	A1	12/2001	Ferguson et al.	709/248
2002/0068552	A1 *	6/2002	Siemens	455/415
2002/0197984	A1 *	12/2002	Monin et al.	455/419
2003/0036398	A1 *	2/2003	Asakawa	455/503
2003/0119524	A1 *	6/2003	Carlsson	455/456
2003/0125057	A1 *	7/2003	Pesola	455/502
2003/0126327	A1 *	7/2003	Pesola et al.	710/74

OTHER PUBLICATIONS

Efficient Data Sharing With Conditional Remote Memory Transfers, Hummel, S.F., Computer Architecture News, vol. 24, No. 5, 1996, pp. 9-17.

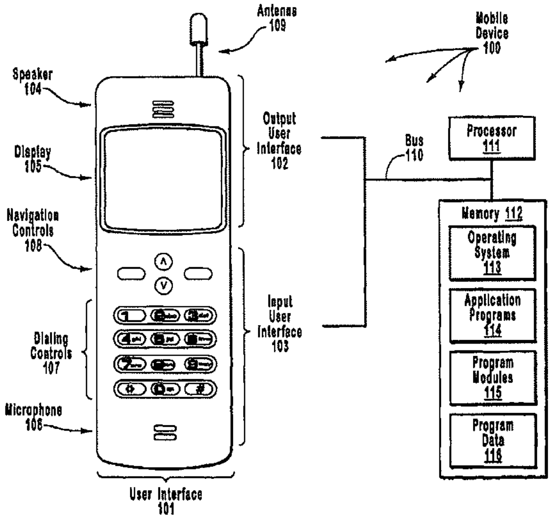
(Continued)

Primary Examiner—Sonny Trinh
Assistant Examiner—Khai Nguyen
(74) *Attorney, Agent, or Firm*—Workman Nydegger

(57) **ABSTRACT**

Two computer systems in a network each have a local store that contains a copy of a data item that is to be synchronized. One of the computer systems may be, for example, a mobile device while the other may be a synchronization server. In order to determine whether to synchronize a data item, and what synchronization mechanism to use, one of the computer systems references a flexible set of rules that may be influenced by instructions from a network administrator or a mobile device user. The flexible set of rules takes into consideration the value of the data, the cost associated with synchronization, the security of the synchronization mechanisms, the security of the mobile device, as well as the location of the mobile user in dictating whether and how to synchronize.

58 Claims, 3 Drawing Sheets



SYNCHRONIZING OVER A NUMBER OF SYNCHRONIZATION MECHANISMS USING FLEXIBLE RULES

BACKGROUND OF THE INVENTION

1. The Field of the Invention

The present invention relates to computer network operations. In particular, the present invention relates to methods, systems, and computer program products for synchronizing by flexibly using multiple synchronization mechanisms while considering the then-existing economic and/or security considerations involved with synchronization over a particular mechanism to a particular device.

2. Background and Relevant Art

Computer networks allow more individuals more ready access to more information than ever before. The Internet is a conglomerate of interconnected computer networks that spreads far and wide throughout the world. An individual need only have an Internet-enabled computer (or device) and an Internet connection to be able to access information from across the globe.

Mobile devices such as mobile telephones, Personal Digital Assistants (PDAs) and laptop computers also may have the ability to access various objects (e.g., documents) for particular remote network locations. However, accessing documents over a network may be quite time consuming and costly and thus remote access may be unacceptable in many applications. Accordingly, with the memory capabilities of mobile devices increasing, many mobile devices have caching mechanisms that allow them to locally store synchronized copies of more relevant objects that are also stored in another network location.

Synchronization ensures that the copy of a document on the mobile device is an identical replica of a remote copy of the document. After synchronization, however, changes may be made to both of the remote copy or the local copy. Accordingly, the local and remote copies may become quite different after some time. However, the copies are once again made identical during the next synchronization.

Conventional synchronization mechanisms give the user very little control over synchronization. Basically, the user just selects items to synchronize and selects a single synchronization mechanism to use. This rigid approach ignores some factors that are relevant to whether, when, and how to synchronize.

For example, some data is more valuable than others. Yet, the conventional technique does not consider the value of the data once the items for synchronization are selected. For example, a user may select to synchronize an in-box. However, the in-box contains high-value e-mails (such as an e-mail offering a highly coveted job) as well as low value e-mails (such as unwanted spam). Yet, all of the e-mails are synchronized in the exact same manner.

Also current synchronization mechanisms do not consider the costs associated with synchronization. For example, synchronization mechanisms may involve networks with a wide variety of costs and latencies. For example, synchronization over an analog dialup that uses a Global System for Mobile communication (GSM) network has a relatively low bandwidth of approximately 9.6 to 14.4 kilobits per second. A connection over a General Packet Radio Server (GPRS) network allows somewhat faster throughput speeds of up to 115 kilobits per second. However, current GPRS networks are relatively expensive. A connection over an 802.11b (also called "WiFi") wireless network can attain speeds of up to 11 megabits per second, orders of magnitude greater than

GSM or GPRS. In addition, use of 802.11b networks is typically free to those who have access to the network. However, 802.11b networks are typically less available as they currently span much less of the globe than do GSM or GPRS networks.

Current synchronization techniques also typically do not consider security concerns associated with synchronization. For example, the channel used for synchronization may have various levels of inherent security that guard against eavesdropping. For example, physical network connections are very secure, 802.11b networks are somewhat secure, with GSM dialup networks being somewhat less secure, and with GPRS networks being less secure. Also, the devices to which data may be synchronized may have varying levels of security. For example, some devices give access to any locally stored document to anyone who happens to possess the device, even if that person just stole the device from the legitimate user. Other devices are more secure by requiring a password when first logging in. Others are even more secure by having the screen saver turn on after a short period of lack of use, and require a password to restore the device once the screen saver is on. Others are yet even more secure by having an encrypted file system.

Accordingly, what is desired as mechanisms that use a synchronization mechanism that is appropriate given the economic and security concerns that exist at the time of the synchronization.

BRIEF SUMMARY OF THE INVENTION

The principles of the present invention provide for systems, methods and computer program products for performing synchronization in a flexible manner. Instead of just allowing the user a choice as to what to synchronize and then having the user manually synchronize, one or more of the pair of computer systems involved with the synchronization automatically considers the then-existing circumstances to determine whether, when and how to synchronize. In one described example, the synchronization occurs between a mobile device and a synchronization server. The methods of the present invention may be performed by either synchronizing computer system (e.g., by either the mobile device or the synchronization server).

It is first determined that a data item is to be synchronized. This may be accomplished in response to a user-issued instruction, or in response to a message from the other device indicating that the data item ought to be synchronized. The determination may also have been made by consulting a flexible set of rules that are dictated by a network administrator of the synchronization server as well as by the mobile device user.

Once it has been determined that a data item is to be synchronized, the computer system identifies the available synchronization mechanisms, and then once again consults with the flexible rules to determine which of the available synchronization mechanisms to use. The computer system then synchronizes using the selected synchronization mechanism.

The flexible selection rules may be set and changed by a network administrator and by a user of the mobile device. The flexible selection rules take into consideration the value of the data, the economic cost of synchronization, the security of the synchronization mechanism, and the security of the mobile device. Accordingly, it is much less likely that the flexible rules will allow for highly sensitive data to be shared with an insecure device or over an insecure synchronization channel. Likewise, it is much less likely that a less valuable item of data will be synchronized over an expensive network.

The synchronization rules also take into consideration the location of the mobile device and user. If none of the available synchronization mechanisms are selectable based on the flexible rules, then the synchronization may be delayed, and then the synchronization mechanism may be repeatedly reevaluated until there is a selectable synchronization mechanism.

Should synchronization occur, and later a security condition for synchronization changes, then the effects of the synchronization may be reversed. For example, suppose that the flexible rules indicate that synchronization to a mobile device is proper since the mobile device has configuration settings in which a screen saver is activated after five minutes of non-use, and that a user password is required to restore the device each time the screen saver is activated. Later, suppose the user deactivates the screen saver. The synchronization server may query the mobile device to determine that the screen saver has been deactivated. Since the original conditions for synchronization are no longer met, the synchronization server may issue an instruction to erase the data item from the mobile device, or (if change tracking is enabled) then may instruct the mobile device to roll back the data item to its pre-synchronization state.

Accordingly, the principles of the present invention perform synchronization in a much more appropriate manner considering the surrounding circumstances. In addition, the effects of synchronization may be reversed if security changes so require. Furthermore, the network administrator (and the mobile user) has much more control over when synchronization occurs. This results in a more secure, cost effective, and efficient synchronization design.

Additional features and advantages of the invention will be set forth in the description that follows, and in part will be obvious from the description, or may be learned by the practice of the invention. The features and advantages of the invention may be realized and obtained by means of the instruments and combinations particularly pointed out in the appended claims. These and other features of the present invention will become more fully apparent from the following description and appended claims, or may be learned by the practice of the invention as set forth hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to describe the manner in which the above-recited and other advantages and features of the invention can be obtained, a more particular description of the invention briefly described above will be rendered by reference to specific embodiments thereof which are illustrated in the appended drawings. Understanding that these drawings depict only typical embodiments of the invention and are not therefore to be considered to be limiting of its scope, the invention will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

FIG. 1 illustrates an example of a telephonic device that may implement the principles of the present invention.

FIG. 2 illustrates an example network environment that provides a suitable operating environment for the present invention.

FIG. 3 illustrates a flowchart of a method for flexibly synchronizing in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention extends to systems, methods and computer program products for performing synchronization in a flexible manner. Two computer systems in a network each have a local store that contains a copy of a data item that is to be synchronized between the two computer systems. One of the computer systems may be, for example, a mobile device while the other may be a synchronization server. In order to determine whether to synchronize a data item, and what synchronization mechanism to use, one of the computer systems references a flexible set of rules that may be influenced by instructions from a network administrator or a mobile device user.

The flexible set of rules takes into consideration the value of the data, the cost associated with synchronization, the security of the synchronization mechanisms, the security of the mobile device, and/or the location of the mobile device and user in dictating whether and how to synchronize. If synchronization occurs, and the security conditions for synchronization are later not satisfied (e.g., the mobile device's configuration settings have been changed to make the device much less secure), the effects of the synchronization may be reversed. In essence, the principles of the present invention synchronize the appropriate data onto the appropriate device in a manner appropriate to maximize the mobile user's value, benefit, and user experience while at the same time minimize the cost and time of the transaction, and preserving synchronization security.

The embodiments of the present invention may comprise a general-purpose or special-purpose computer system including various computer hardware components, which are discussed in greater detail below. Embodiments within the scope of the present invention also include computer-readable media for carrying or having computer-executable instructions or data structures stored thereon. Such computer-readable media may be any available media, which is accessible by a general-purpose or special-purpose computer system. By way of example, and not limitation, such computer-readable media can comprise physical storage media such as RAM, ROM, EPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other media which can be used to carry or store desired program code means in the form of computer-executable instructions or data structures and which may be accessed by a general-purpose or special-purpose computer system.

When information is transferred or provided over a network or another communications connection (either hardwired, wireless, or a combination of hardwired or wireless) to a computer system or computer device, the connection is properly viewed as a computer-readable medium. Thus, any such connection is properly termed a computer-readable medium. Combinations of the above should also be included within the scope of computer-readable media. Computer-executable instructions comprise, for example, instructions and data which cause a general-purpose computer system or special-purpose computer system to perform a certain function or group of functions.

In this description and in the following claims, a "computer system" is defined as one or more software modules, one or more hardware modules, or combinations thereof, that work together to perform operations on electronic data. For example, the definition of computer system includes the hardware components of a personal computer, as well as software modules, such as the operating system of the

In one embodiment, the client **210** is a mobile device while the server **220** is a synchronization server that provides synchronization services to the mobile device. Although the principles of the present invention is not limited to this embodiment, the following will frequently refer to the embodiment in which the client **210** is a mobile device and the server **220** is a synchronization server. The synchronization server may be a service offered within a corporate network or other common sphere of trust protected by a firewall other security mechanisms from the general public. The mobile device may sometimes be within the corporate network, and may other times be far outside of the corporate network. However, there is no requirement that the synchronization server be within a corporate network. The synchronization server may be, for example, implemented as an Internet service.

FIG. **3** illustrates a flowchart of a method **300** for performing synchronization in a flexible manner considering the then-existing circumstances. The method determines whether, how, and when to synchronize a particular data item by consulting a flexible set of rules that may be set by a user of one of the computer systems, and possible overwritten as dictated by a network administrator. It should be noted that the method **300** may be performed by either the client **210** (e.g., a mobile device) or the server **220** (e.g., a synchronization server).

The flexible set of rules balance the economic value of the data with the economic cost associated with synchronization. The rules also consider the security of the synchronization mechanism as well as the security of the computer system with which synchronization is desired. The rules balance the security risk associated with synchronization with the value in having access to synchronized data. The security rules may also consider the location of the mobile user and/or device in determining whether to synchronize.

The value of the data may be determined by user preferences and/or by a network administrator. For example, to a user, spam e-mails will typically be less important to synchronize. However, e-mails from particular senders (e.g., clients, bosses, business partners, spouses, or the like) may be of greater value to a user. E-mails that contain the words "coin" or "penny" may be of higher value to a penny collector than e-mails that do not contain such words. To a network administrator, contacts stored in a business folder may be more important than contacts stored in a personal folder. While these are just examples, the examples demonstrate that there is a wide variety of criteria from which a value of a data item may be derived based on user preferences and network administrator dictates.

Referring back to FIG. **3**, the method **300** begins by consulting the set of flexible selection rules (act **301**). Based on this consultation, it is determined whether or not to synchronize the data item (decision block **302**). For example, the network administrator or mobile device user may have determined that data items must have at least a predetermined value in order to be synchronized. Spam, for example, might fall below that threshold. If the data item is not to be synchronized (NO in decision block **302**), then the method **300** simply ends without synchronization.

If the data item is to be synchronized based on the consultation with the flexible set of rules (YES in decision block **302**), then the method proceeds to a step for flexibly using an appropriate synchronization mechanism considering the then-existing circumstances (step **303**). This may include any corresponding acts for accomplishing this functional result-oriented step. However, in the illustrated embodiment, the step **303** includes corresponding acts **304**, **305**, **306** and **307**.

Note that in the illustrated embodiment, whether to synchronize is determined by consultation with a set of rules. This determination may also be made by receiving an instruction from the synchronization server, or by receiving a user-issued instruction from the mobile device user. There is no requirement that the flexible set of rules be consulted as to whether the data item is to be synchronized.

Once it has been determined that a data item is to be synchronized, the method identifies which synchronization mechanisms of a number of synchronization mechanisms are currently available (act **304**). For example, a mobile device may be capable of synchronizing with a synchronization server using a number of synchronization mechanisms such as GSM, GPRS, Bluetooth, 802.11a, 802.11b (WiFi), or the like. However, it may be that the mobile device in not within an 802.11a or 802.11b hot spot, or within a Bluetooth network range. Accordingly, the only available synchronization mechanisms would be GSM and GPRS in this example. Note that although the determination of available synchronization mechanisms (act **304**) is illustrated as occurring after the determination as to whether to synchronize the data item, the identification of the available synchronization mechanisms may occur before determining that any particular data item is to be synchronized. For example, the mobile device or the synchronization server may constantly or periodically reevaluate the available synchronization mechanisms. Whether synchronization mechanisms are available may even be a consistently updated configuration setting.

The method also consults the set of flexible selection rules (act **305**) to select one of the synchronization mechanisms (act **306**). For example, the flexible selection rules may not only be used to identify the value of the data, but may also be used to determine the economic costs associated synchronizing the data item over each synchronization mechanism. For example, analog dialup over a Public Switched Telephone Network (PSTN) network or GSM is a relatively slow way of synchronizing, but is currently typically less expensive than synchronization over a GPRS network. If the data item was relatively small, synchronization may be more appropriate over a GSM network since it might not take long even over a lower bandwidth connection to synchronize the data item.

Synchronization costs may also depend on the time of day, or the day of the week. Accordingly, the flexible rules may also consider the time of day, and day of the week in selecting an appropriate network. If the costs associated with a particular synchronization mechanism are to change shortly, then the synchronization may be delayed a short while so as to fall into a less expensive cost structure.

The flexible selection rules also may consider the security of the network associated with the synchronization mechanisms Some networks are inherently more secure than others. For example, the mobile device may be within the same trusted corporate network as the synchronization server. If remotely connected, the security of the connection (e.g., Virtual Private Network "VPN", Short Message Service "SMS", Secure Sockets Layer "SSL", or direct Remote Access Services "RAS") may be evaluated to determine how difficult it would be for eavesdropping or redirection of the connection.

The flexible selection rules may also consider the security of the mobile device with which synchronization may occur. The mobile device may have some rigid security attributes

EXHIBIT 43

US006791536B2

(12) United States Patent

Keely et al.

(10) Patent No.: US 6,791,536 B2

(45) Date of Patent: Sep. 14, 2004

(54) SIMULATING GESTURES OF A POINTING DEVICE USING A STYLUS AND PROVIDING FEEDBACK THERETO

(75) Inventors: **Leroy B. Keely**, Portola Valley, CA (US); **David F. Jones**, Redmond, WA (US); **David Switzer**, Redmond, WA (US); **Michael Hin-cheung Tsang**, Bellevue, WA (US); **William Hong Vong**, Seattle, WA (US)

(73) Assignee: **Microsoft Corporation**, Redmond, WA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 69 days.

(21) Appl. No.: **09/815,272**

(22) Filed: **Mar. 23, 2001**

(65) **Prior Publication Data**

US 2002/0057263 A1 May 16, 2002

Related U.S. Application Data

(60) Provisional application No. 60/247,844, filed on Nov. 10, 2000.

(51) **Int. Cl.**^{7} **G09G 5/00**

(52) **U.S. Cl.** **345/173**; 345/161; 345/163; 345/168; 345/173; 345/179; 345/863

(58) **Field of Search** 345/173, 156, 345/161, 163, 167, 168, 179, 863; 178/19.01, 19.04, 20.01; 703/17, 19, 21–24

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,899,138	A	*	2/1990	Araki et al.	345/175
5,404,458	A	*	4/1995	Zetts	710/73
5,592,566	A	*	1/1997	Pagallo et al.	382/187
5,602,570	A	*	2/1997	Capps et al.	345/173
5,666,113	A	*	9/1997	Logan	341/34
5,864,635	A	*	1/1999	Zetts et al.	382/187
5,880,411	A	*	3/1999	Gillespie et al.	178/18.01
6,049,329	A	*	4/2000	Zetts et al.	345/179
6,262,719	B1	*	7/2001	Bi et al.	345/179
6,266,050	B1	*	7/2001	Oh et al.	345/173

* cited by examiner

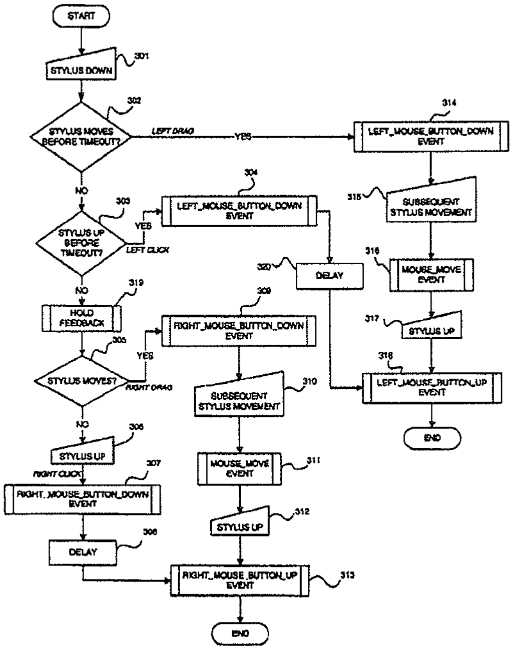
Primary Examiner—Henry N. Tran

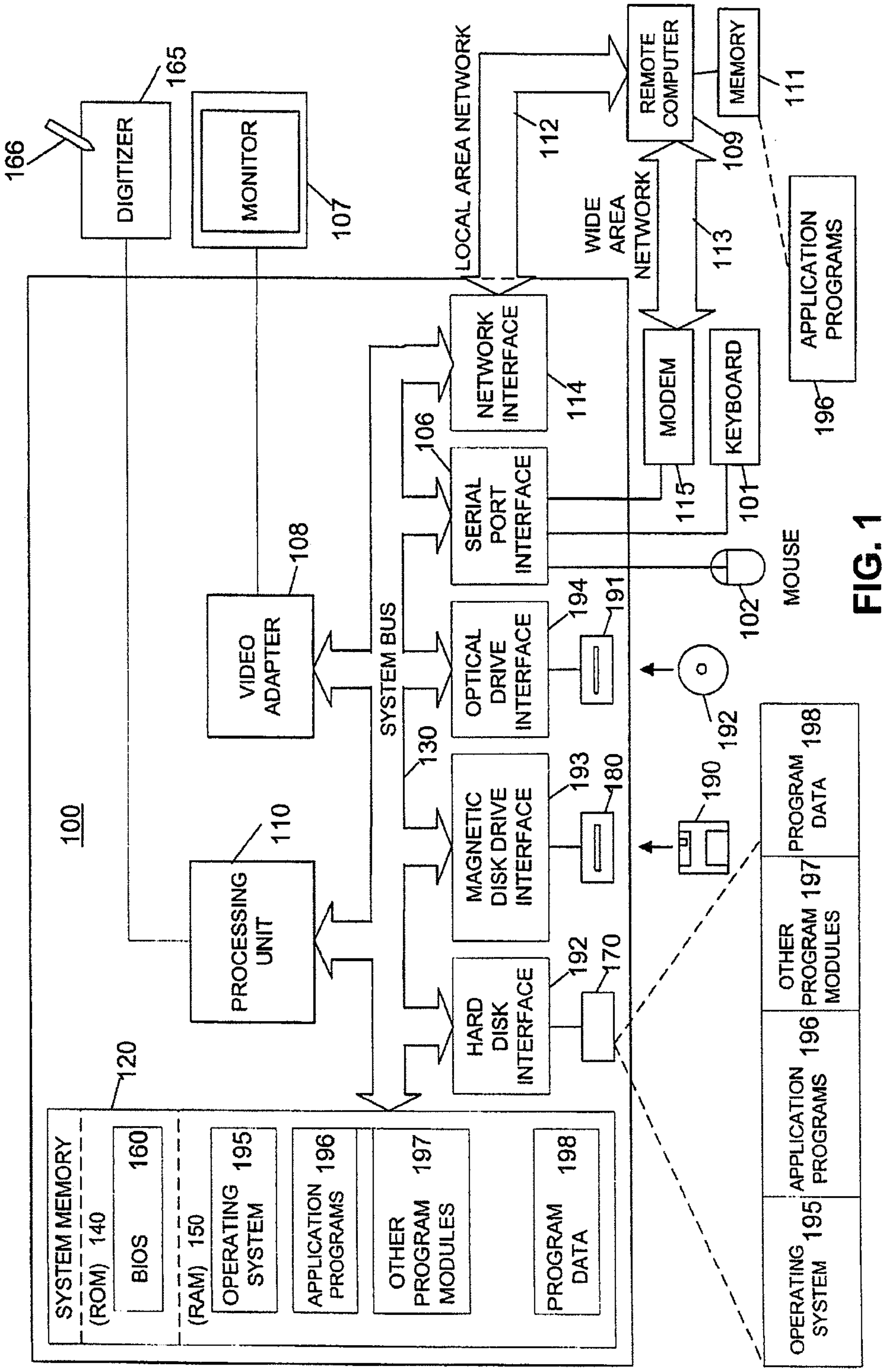
(74) *Attorney, Agent, or Firm*—Banner & Witcoff, Ltd.

(57) **ABSTRACT**

A method and apparatus for simulating at least one gesture of a pointing device such as a mouse. A left click, right click, left drag, right drag, and/or mouse movement may be simulated using a stylus in conjunction with a touch-sensitive display surface. For example, a computer having the display surface may detect whether a stylus is being held down on a touch-sensitive display surface for at least a threshold amount of time. The computer may further detect whether the stylus is then removed from the touch-sensitive display surface after at least the threshold amount of time. Responsive to the stylus being removed, the computer may generate at least one event representing a right mouse button being pressed.

47 Claims, 4 Drawing Sheets


START
STYLUS DOWN
301
STYLUS MOVES BEFORE TIMEOUT?
302
LEFT DRAG
YES
LEFT_MOUSE_BUTTON_DOWN EVENT
314
SUBSEQUENT STYLUS MOVEMENT
315
MOUSE_MOVE EVENT
316
STYLUS UP
317
LEFT_MOUSE_BUTTON_UP EVENT
318
END
NO
STYLUS UP BEFORE TIMEOUT?
303
YES
LEFT CLICK
LEFT_MOUSE_BUTTON_DOWN EVENT
304
DELAY
320
NO
HOLD FEEDBACK
319
STYLUS MOVES?
305
YES
RIGHT DRAG
RIGHT_MOUSE_BUTTON_DOWN EVENT
309
SUBSEQUENT STYLUS MOVEMENT
310
MOUSE_MOVE EVENT
311
STYLUS UP
312
NO
STYLUS UP
306
RIGHT CLICK
RIGHT_MOUSE_BUTTON_DOWN EVENT
307
DELAY
308
RIGHT_MOUSE_BUTTON_UP EVENT
313
END


166
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DIGITIZER
MONITOR
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LOCAL AREA NETWORK
112
REMOTE COMPUTER
MEMORY
111
109
WIDE AREA NETWORK
113
APPLICATION PROGRAMS
196
100
PROCESSING UNIT
110
VIDEO ADAPTER
108
SYSTEM BUS
130
NETWORK INTERFACE
114
106
SERIAL PORT INTERFACE
MODEM
115
KEYBOARD
101
MOUSE
102
OPTICAL DRIVE INTERFACE
194
191
192
MAGNETIC DISK DRIVE INTERFACE
193
180
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HARD DISK INTERFACE
192
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SYSTEM MEMORY
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(ROM) 140
BIOS
160
(RAM) 150
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OTHER PROGRAM MODULES 197
PROGRAM DATA 198

FIG. 1

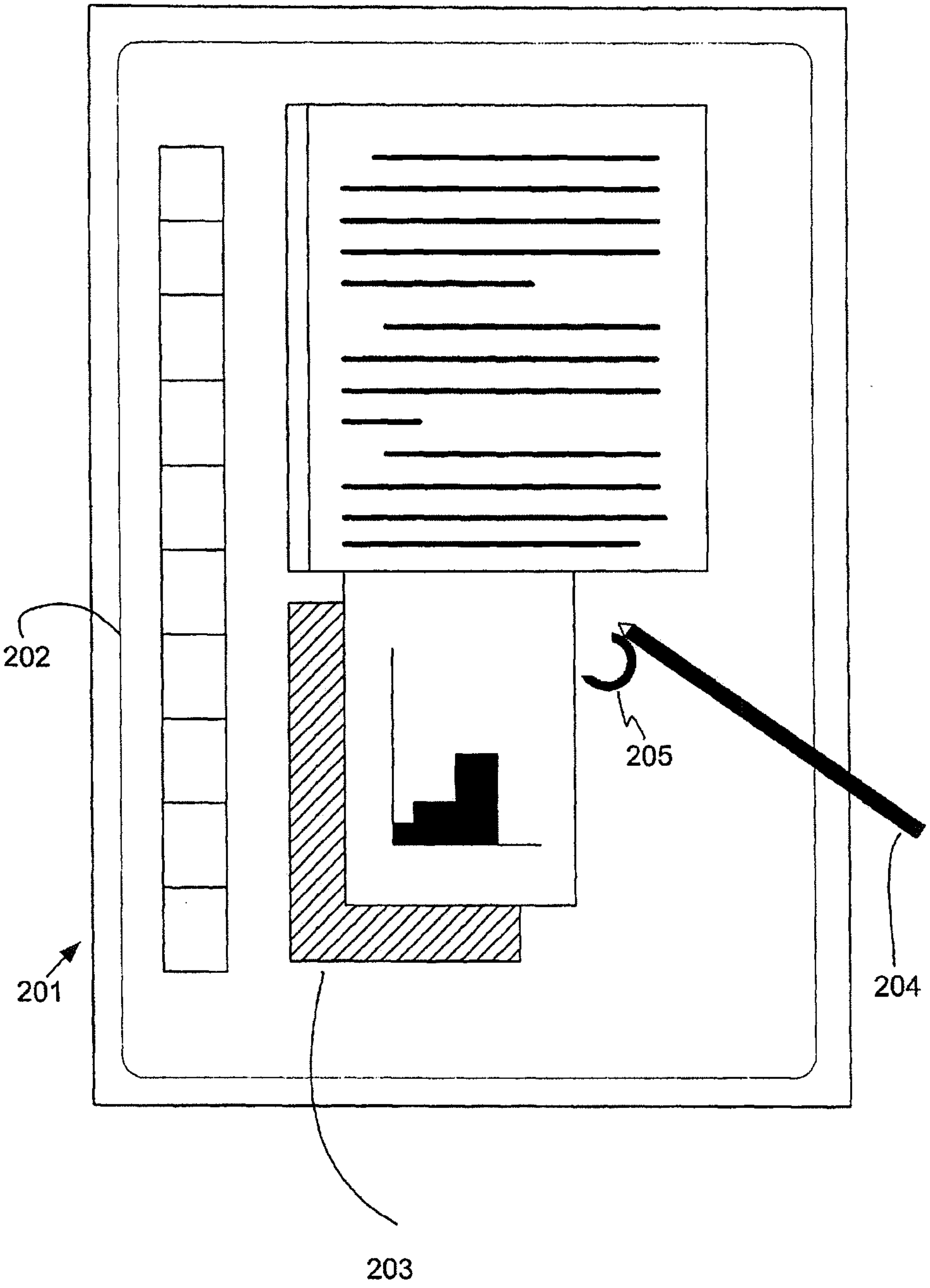

FIG. 2

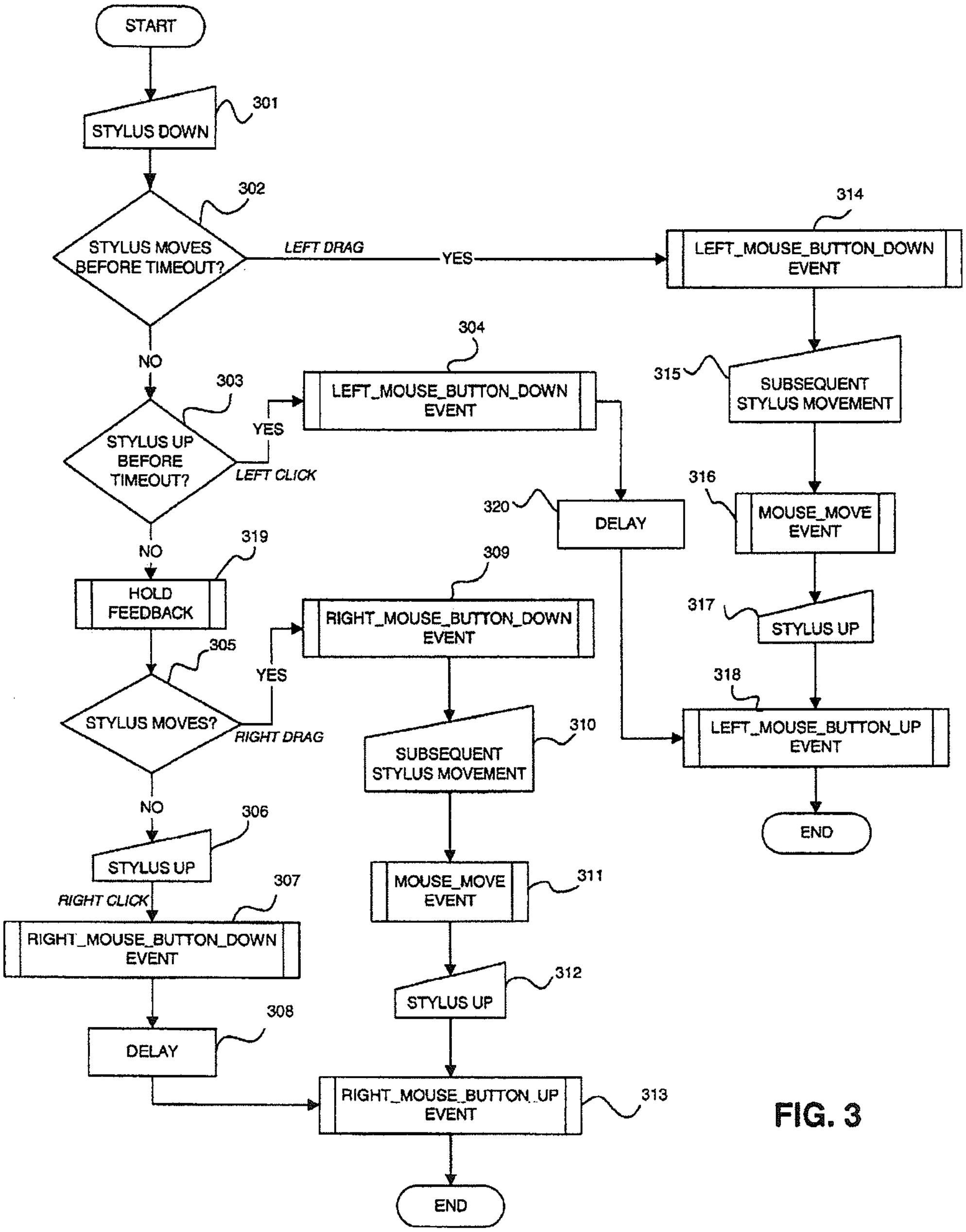
START
STYLUS DOWN
301
302
STYLUS MOVES BEFORE TIMEOUT?
LEFT DRAG
YES
314
LEFT_MOUSE_BUTTON_DOWN EVENT
NO
303
STYLUS UP BEFORE TIMEOUT?
YES
LEFT CLICK
304
LEFT_MOUSE_BUTTON_DOWN EVENT
315
SUBSEQUENT STYLUS MOVEMENT
320
DELAY
316
MOUSE_MOVE EVENT
NO
319
HOLD FEEDBACK
309
RIGHT_MOUSE_BUTTON_DOWN EVENT
317
STYLUS UP
305
YES
STYLUS MOVES?
RIGHT DRAG
318
LEFT_MOUSE_BUTTON_UP EVENT
310
SUBSEQUENT STYLUS MOVEMENT
NO
306
STYLUS UP
END
RIGHT CLICK
307
RIGHT_MOUSE_BUTTON_DOWN EVENT
311
MOUSE_MOVE EVENT
312
STYLUS UP
308
DELAY
RIGHT_MOUSE_BUTTON_UP EVENT
313
END

FIG. 3

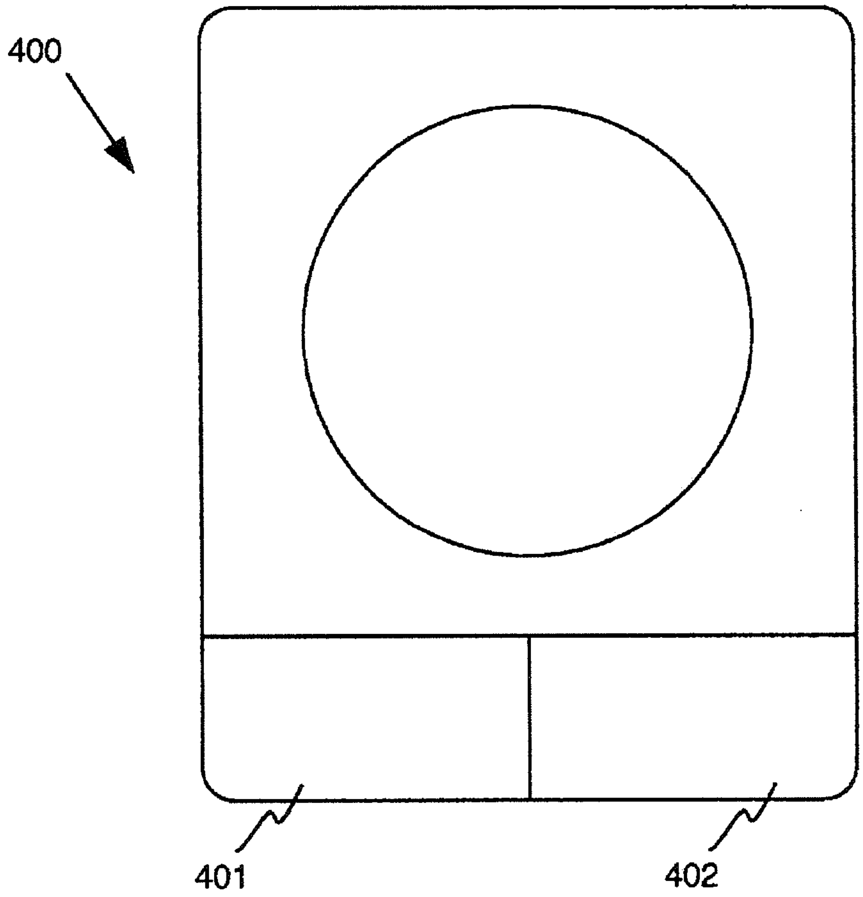

FIG. 4

SIMULATING GESTURES OF A POINTING DEVICE USING A STYLUS AND PROVIDING FEEDBACK THERETO

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority to U.S. provisional patent application Serial No. 60/247,844, entitled Simulating Gestures of a Mouse Using a Stylus and Providing Feedback Thereto, filed Nov. 10, 2000, which is hereby incorporated by reference as to its entirety. The present application is also related to application Ser. No. 09/760,631, entitled Method and Apparatus For Improving the Appearance of Digitally Represented Handwriting, filed Nov. 10, 2000; to application Ser. No. 60/247,841, entitled Highlevel Active Pen Matrix, filed Nov. 10, 2000; to application Ser. No. 60/247/973, entitled Selection Handles in Editing Electronic Documents, filed Nov. 10, 200; to application Ser. No. 60,247,842, entitled Insertion Point Bungee Space Tool, filed Nov. 10, 2000; to application Ser. No. 60/247,400, entitled System and Method for Accepting Disparate Types of User Input, filed Nov. 10, 2000; to application Ser. No. 60/247,972, entitled In Air Gestures, filed Nov. 10, 2000; to application Ser. No. 60/247,831, entitled Mouse Input Panel Windows Class List, filed Nov. 10, 2000; to application Ser. No. 60/247,843, entitled Mouse Input Panel and User Interface, filed Nov. 10, 2000; to application Ser. No. 60/247,479, entitled System and Method for Inserting Implicit Page Breaks, filed Nov. 10, 2000; to application Ser. No. 09/750,288, entitled Classifying, Anchoring, and Transforming Ink, filed Dec. 29, 2000; to application Ser. No. 09/736,170, entitled Highlevel Active Pen Matrix, filed Dec. 15, 2000; and to application Ser. No. 09/741,107, entitled Mode Hinting/Switching, filed Dec. 21, 2000; each of which is incorporated by reference herein as to their entireties.

FIELD OF THE INVENTION

The present invention is directed generally to apparatus and methods for simulating various gestures of a pointing device with multiple switches, such as a two button mouse in a computer system, and for providing feedback thereto, and more specifically to simulating gestures such as the left click of a mouse, the right click of a mouse, and mouse dragging by manipulation of a stylus in conjunction with a touch-sensitive computer display, as well as generating appropriate visual or other feedback in response to certain gestures.

BACKGROUND OF THE INVENTION

Typical computer systems, especially computer systems using graphical user interface (GUI) systems such as Microsoft WINDOWS, are optimized for accepting user input from two discrete input devices: a keyboard for entering text, and a pointing device such as a mouse with two or more buttons or other selectors for driving the user interface. Virtually all software applications designed to run on Microsoft WINDOWS are optimized to accept user input in the same manner. For instance, many applications make extensive use of a primary switch of the pointing device such as the left button of a mouse (a gesture commonly referred to as a "left click" of a mouse) to select an object, and a secondary switch such as the right button of the mouse (a gesture commonly referred to as a "right click" of a mouse) to display context-sensitive command menus. It is noted that other operating systems incorporate left and right click operability as well. The user may generate other gestures using the mouse such as by clicking the left or right button of the mouse and moving the mouse while the button is depressed (a gesture commonly referred to as either a "left drag" or a "right drag," respectively).

While such mouse gestures are of course easily done with an actual mouse, it is not always convenient for a user to use a mouse with a computer even though the computer may have a GUI system. For instance, when using a portable system there may not always be a surface available upon which to place a mouse. Some systems utilize a touch-sensitive display screen with a stylus as an input device. The user places the stylus tip upon the touch-sensitive display screen at various locations to control objects displayed on the display screen. A problem with this type of system is that the stylus is limited in the types of actions that may be easily performed as compared with a mouse. For instance, the typical stylus can perform only three types of movements: placing the stylus tip onto the screen, moving the stylus tip across the screen, and removing the stylus tip from the screen. While a user may operate a remote toolbar to select a different tool, the excessive movement renders the control of the system laborious, inconvenient, and slow. Using the tip of the stylus-type device, there is presently no convenient way to simulate or distinguish between, for example, a right click as opposed to a left click as interpreted by the operating system.

In order to make the full range of interface features accessible to users of such a stylus-based computer, there is a need for an intuitive way of simulating mouse gestures with the stylus. Although not necessary, it is preferable and more useful that any new way of simulating mouse gestures be compatible with existing software applications that conventionally are used with a mouse.

There is also a need for providing helpful feedback to the user of the stylus to indicate whether gestures made with the stylus are those that are intended by the user. This is useful with a stylus-type input device since there is conventionally little to no natural tactile or auditory feedback when using a stylus than there is when using a mouse (e.g., the buttons of a mouse often have a definitive mechanical "click" feel and sound when pressed). As will be seen, such feedback is even more useful when provided in conjunction with various gesture simulation techniques of the present invention.

SUMMARY OF THE INVENTION

As discussed in the various copending patent applications incorporated herein by reference, aspects of the present invention are directed to a tablet-like computer that may be used for directly writing on a touch-sensitive display surface using a stylus. The computer may allow the user to write and to edit, manipulate, and create objects through the use of the stylus. Many of the features discussed in these copending applications are even more useful in combination with various aspects of the present invention discussed herein.

An aspect of the present invention is directed to methods and apparatus for simulating gestures of a pointing device, such as a mouse, trackball, or joystick, by use of a stylus on a touch-sensitive display surface. For example, a left click of a mouse may be simulated, e.g., where the user holds the stylus down on the touch-sensitive display surface without substantial movement and then removes the stylus from the display surface before the expiration of a threshold amount of time. A right click of a mouse may be simulated, e.g., where the user waits until at least the threshold amount of time before removing the stylus. Where the stylus is moved along the display surface during certain stylus gestures, left or right dragging may thereby be simulated.

Another aspect of the present invention is directed to methods and apparatus for providing feedback to a user in a stylus-based touch-sensitive display surface computer system. The user may accordingly be given some indication that the user has performed a particular stylus gesture, e.g., by displaying a visual object on the display surface to indicate a particular status. Such feedback may be responsive to certain stylus gestures such as pressing and holding the stylus against the display surface for at least a certain minimum amount of time. More generally, the feedback may be in the form of a "state change indicator," which may be visual on the display surface such as an icon, bitmap, or other visual object or indicator, and/or auditory such as a sound emitted from the computer's speakers. The state change indicator may be animated and or otherwise vary with stylus hold time. Significant advantages of this aspect of the invention are realized in conjunction with the various features discussed in the copending patent applications incorporated herein by reference.

These and other features of the invention will be apparent upon consideration of the following detailed description of preferred embodiments. Although the invention has been defined using the appended claims, these claims are exemplary in that the invention is intended to include the elements and steps described herein in any combination or subcombination. Accordingly, there are any number of alternative combinations for defining the invention, which incorporate one or more elements from the specification, including the description, claims, and drawings, in various combinations or subcombinations. It will be apparent to those skilled in the relevant technology, in light of the present specification, that alternate combinations of aspects of the invention, either alone or in combination with one or more elements or steps defined herein, may be utilized as modifications or alterations of the invention or as part of the invention. It is intended that the written description of the invention contained herein covers all such modifications and alterations.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing summary of the invention, as well as the following detailed description of preferred embodiments, is better understood when read in conjunction with the accompanying drawings, which are included by way of example, and not by way of limitation with regard to the claimed invention. In the accompanying drawings, elements are labeled with three-digit reference numbers, wherein the first digit of a reference number indicates the drawing number in which the element is first illustrated. The same reference number in different drawings refers to the same element.

FIG. 1 is a schematic diagram of a general-purpose digital computing environment that can be used to implement various aspects of the invention.

FIG. 2 is a plan view of a tablet computer and stylus that can be used in accordance with various aspects of the present invention.

FIG. 3 is a flow chart showing an exemplary set of steps that may be performed in order to simulate a right click of a mouse according to aspects of the present invention.

FIG. 4 is a plan view of an illustrative embodiment of a trackball having left and right buttons.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

FIG. 1 shows an exemplary embodiment of a general-purpose digital computing environment that can be used to implement various aspects of the invention. In this embodiment, computer **100** includes a processing unit **110**, a system memory **120**, and a system bus **130** that couples various system components including the system memory to the processing unit **110**. The system bus **130** may be any of several types of bus structures including a memory bus or memory controller, a peripheral bus, and a local bus using any of a variety of bus architectures. The system memory includes read only memory (ROM) **140** and random access memory (RAM) **150**.

A basic input/output system **160** (BIOS), containing the basic routines that help to transfer information between elements within the computer **100**, such as during start-up, is stored in ROM **140**. Computer **100** also includes a hard disk drive **170** for reading from and writing to a hard disk (not shown), a magnetic disk drive **180** for reading from or writing to a removable magnetic disk **190**, and an optical disk drive **191** for reading from or writing to a removable optical disk **192** such as a CD ROM or other optical media. The hard disk drive **170**, magnetic disk drive **180**, and optical disk drive **191** are connected to the system bus **130** by a hard disk drive interface **192**, a magnetic disk drive interface **193**, and an optical disk drive interface **194**, respectively. The drives and their associated computer-readable media provide nonvolatile storage of computer readable instructions, data structures, program modules and other data for the personal computer **100**. It will be appreciated by those skilled in the art that other types of computer readable media which can store data that is accessible by a computer, such as magnetic cassettes, flash memory cards, digital video disks, Bernoulli cartridges, random access memories (RAMs), read only memories (ROMs), and the like, may also be used in the example operating environment.

A number of program modules can be stored on the hard disk, magnetic disk **190**, optical disk **192**, ROM **140** or RAM **150**, including an operating system **195**, one or more application programs **196**, other program modules **197**, and program data **198**. A user can enter commands and information into the computer **100** through input devices such as a keyboard **101** and pointing device **102**. Other input devices (not shown) may include a microphone, joystick, game pad, satellite dish, scanner, or the like. These and other input devices are often connected to the processing unit **110** through a serial port interface **106** that is coupled to the system bus, but may be connected by other interfaces, such as a parallel port, game port or a universal serial bus (USB). A monitor **107** or other type of display device is also connected to the system bus **130** via an interface, such as a video adapter **108**. In addition to the monitor, personal computers typically include other peripheral output devices (not shown), such as speakers and printers.

The computer **100** can operate in a networked environment using logical connections to one or more remote computers, such as a remote computer **109**. Remote computer **109** can be a server, a router, a network PC, a peer device or other common network node, and typically includes many or all of the elements described above relative to computer **100**, although only a memory storage device **111** has been illustrated in FIG. **1**. The logical connections depicted in FIG. **1** include a local area network (LAN) **112** and a wide area network (WAN) **113**. Such networking environments are commonplace in offices, enterprise-wide computer networks, intranets and the Internet.

When used in a LAN networking environment, the computer **100** is connected to the local network **112** through a network interface or adapter **114**. When used in a WAN networking environment, the personal computer **100** typically includes a modem **115** or other means for establishing a communications over the wide area network **113**, such as the Internet. The modem **115**, which may be internal or external, is connected to the system bus **130** via the serial port interface **106**. In a networked environment, program modules depicted relative to the personal computer **100**, or portions thereof, may be stored in the remote memory storage device.

It will be appreciated that the network connections shown are example and other means of establishing a communications link between the computers can be used. The existence of any of various well-known protocols such as TCP/IP, Ethernet, FTP, HTTP and the like is presumed, and the system can be operated in a client-server configuration to permit a user to retrieve web pages from a web-based server. Any of various conventional web browsers can be used to display and manipulate data on web pages.

FIG. **2** illustrates a tablet PC **201** that can be used in accordance with various aspects of the present invention. Any or all of the features, subsystems, and functions in the system of FIG. **1** can be included in the computer of FIG. **2**. Tablet PC **201** includes a large touch-sensitive display surface **202**, e.g., a digitizing flat panel display, for example, a liquid crystal display (LCD) screen, on which a plurality of windows **203** is displayed. Using a stylus **204**, a user can select, highlight, and write on the digitizing display area. Examples of suitable digitizing display panels include electromagnetic pen digitizers, such as the Mutoh or Wacom pen digitizers. Other types of pen digitizers, e.g., optical digitizers, may also be used. Tablet PC **201** interprets marks made using stylus **204** in order to manipulate data, enter text, and execute conventional computer application tasks such as spreadsheets, word processing programs, and the like. The touch-sensitive display surface **202** may also be proximity-sensitive such that the tip of the stylus **204** may be sensed by the display surface **202** when proximate thereto without actually contacting the display surface **202**.

The stylus **204** may be equipped with or without buttons or other features to augment its selection capabilities. In one embodiment, the stylus **204** may be implemented as a "pencil" or "pen", in which one end constitutes a writing, or tip, portion and the other end constitutes an "eraser" end that, when moved across the display indicates portions of the display that are to be erased. The term "stylus" as used herein is intended to have a broad definition that includes, e.g., a user's own finger, a pen, a pencil, a stick, a rod, and/or any other similar device suitable for pointing at a particular location on the display surface **202**. Other types of pointing devices, such as a mouse, trackball, or the like may be used with the tablet PC **201** in addition to or conjunction with the stylus **204**.

Referring now to FIG. **3**, an example of how a left drag of a mouse is simulated is now discussed. Any or all of steps set forth herein and in FIG. **3** may be performed by special software, hardware, and/or firmware that runs in conjunction with, or is part of, the operating system of the computer **201**. To simulate a left drag, the user may touch the stylus **204** or other similar user pointing device to the display surface **202**, an action referred to hereafter as "placing the stylus down" (step **301**). Responsive to the computer **201** detecting the stylus being placed down, the computer **201** may begin counting time, e.g., by using a timer, up to at least a threshold amount of time. A timeout condition is defined responsive to the threshold amount of time having passed. In one embodiment, the threshold amount of time is about 600 milliseconds. However, the threshold amount of time may be any amount of time, such as between 300 and 600 milliseconds, or between 600 milliseconds and 1 second, or greater than 1 second. If the computer **201** detects that the stylus moves prior to the timeout condition occurring (step **302**), then in response the computer **201** may generate a standard Microsoft WINDOWS LeftMouseButtonDown event (or other event that represents the primary switch of the pointing device being activated) in the original position where the stylus **204** was first brought down (step **314**), which may be sent to the software application presently in use. At this point, any subsequent movement of the stylus **204** across the display surface **202** may be detected by the computer **201** (step **315**), and in response the computer **201** may generate one or more Microsoft WINDOWS MouseMove events (step **316**) (or other events representing movement of the pointing device). When the stylus **204** is eventually removed from the display surface **202** (hereafter referred to as "bringing the stylus up") (step **317**), the computer **201** may detect this and in response may generate a Microsoft WINDOWS LeftMouseButtonUp event (step **318**) (or other event that represents the primary switch being deactivated). Thus, via steps **301**, **302**, and **314**–**318**, a left drag of a mouse is simulated.

To simulate a left click of a mouse without dragging, if the computer **201** detects that the stylus **204** is not moved prior to the timeout condition (step **302**), and if instead the stylus **204** is brought up prior to the timeout condition (step **303**), then in response the computer **201** may generate first a LeftMouseButtonDown event (or other event that represents the primary switch being activated), then optionally delay for a period of time (step **320**) such as about 20 milliseconds or some other amount of time, and then generate a LeftMouseButtonUp event (steps **304** and **318**) (or other event that represents the primary switch being deactivated). Thus, via steps **301**–**304**, **318**, and **320**, a slightly delayed left click of a mouse is simulated.

To simulate a right click of a mouse without dragging, if the computer **201** detects that the stylus **204** is not moved either prior to the timeout condition or after the timeout condition (steps **302** and **305**), and if the computer **201** further detects that the stylus **204** is not brought up until after the timeout condition (steps **303** and **306**), and thus that the stylus **204** has been held down for at least the threshold amount of time, then in response the computer **201** may generate first a Microsoft WINDOWS RightMouseButtonDown event (step **307**) (or other event that represents the secondary switch of the pointing device being activated). The computer **201** may, further in response, optionally delay for a period of time (step **308**), in one embodiment, about 20 milliseconds, and then generate a Microsoft WINDOWS RightMouseButtonUp event (step **313**) (or other event that represents the secondary switch being deactivated). The computer **201** may also generate and display a state change indicator (step **319**) that indicates to the user that the stylus **204** has been placed down for a certain minimum amount of time, as will be discussed below in more detail.

It is noted that steps **319** may be in a variety of places within the flowchart of FIG. **3** other than the one shown, such as between steps **305** and **306**. Steps **301**–**303**, **305**–**308**, and **313**, thus simulate a delayed right click of a mouse.

To simulate a right drag of a mouse, if the computer **201** detects that the stylus **204** is not moved until after the timeout condition (step **305**), then in response the computer **201** may generate a RightMouseButtonDown event (step **309**) (or other event that represents the secondary switch being activated). Upon the computer **201** detecting any subsequent movement of the stylus **204** along the display surface **202** (step **310**), the computer **201** may in response generate one or more MouseMove events (step **311**) (or other events representing movement of the pointing device). When thé computer detects that the stylus **204** is brought up (**312**), in response the computer **201** may generate a RightMouseButtonUp event (step **313**) (or other event that represents the secondary switch being deactivated). This simulates, via steps **301–303**, **305**, and **309–313**, a right drag of a mouse.

As a further feature of the right click simulation, a special hold event may be defined wherein the stylus **204** is held against the display screen **202** without substantial movement for at least another threshold amount of time, say about 700 milliseconds, or between 0.5 and 1 second, or between about 1 and 3 seconds or more, the computer **201** may detect such a hold event and in response act by immediately interpreting any subsequent holding of the stylus **204** as holding the left mouse button down (or, more generally, as activating the primary switch of the pointing device). Thus, the computer **201** may, after 600 milliseconds of stylus holding, go on to steps **305** and **319**, and where the stylus **204** is released prior to, say, 5 seconds or some other time limit, then steps **306–308** and **313** may be implemented. However, if instead the stylus **204** is further held at least 5 seconds, then the special subroutine may, in response, immediately generate a LeftMouseButtonDown event (or other event that represents the primary switch of the pointing device being activated). Then, when the stylus is eventually released, a LeftMouseButtonUp event (or other event that represents the primary switch being deactivated) would be generated by the special subroutine. If the stylus **204** is moved along the display surface **202**, then the computer **201** may immediately in response generate one or more MouseMove events (or other events representing movement of the pointing device). When the stylus **204** is eventually removed from the display surface **202**, all pending RightMouse events (or other events that represent action by the secondary switch of the pointing device) that would normally have been generated in accordance with the method shown in FIG. **3** would be canceled.

In the above and remaining discussion, it is assumed that a Microsoft WINDOWS operating system is being used with the computer **201**. However, any operating system, especially a GUI operating system, may be used in accordance with the present invention. Further, although the above embodiments are sample methods for simulating mouse gestures using a stylus, there are many variations that are encompassed by the present invention. For instance, the stylus gestures required for simulation a left click and a right click might be reversed, or a user may not need to always keep the stylus **204** down on the display surface **202** during the entire time that a drag is executed, such that a first touch/touch-and-hold of the stylus **204** at a first location on the display surface **202**, and a second touch/touch-and-hold at a second location, may thereby simulate a drag from the first location to the second location.

As discussed in the co-pending patent applications incorporated by reference herein, the computer **201** according to embodiments of the present invention may have the ability to select ink when in pen mode. A user can press and hold, then drag over ink, text, or other objects, within a document to select those objects. A press and hold operation may switch into selection mode. Because the user is using the stylus **204** or other similar user pointing device, there are different considerations as compared with when a mouse is used. For instance, while the user of a mouse may hear and feel the click of a mouse button to ensure that a click has been performed, the user of the stylus **204** may not receive clear enough feedback that the intended gesture has been made properly. Also, it is desirable to indicate to the user that a particular requested mode has really been switched to, such as selection mode. Further, where the user must hold down the stylus **204** for at least a certain threshold amount of time to simulate, for example, a right click, feedback to the user indicating that the threshold time has passed would be useful.

Such feedback may be in the form of a state change indicator, which may be visual (e.g., a graphical icon, a symbol, a bitmapped or other image, etc., displayed on the display surface **202** such as state change indicator **205** in FIG. **2**), auditory (e.g., a click, a beep, tone, etc. emanating from the computer **201** and/or stylus **204**), and/or tactile (e.g., vibration of the computer **201** and/or stylus **204**). For example, where the user selects the pen icon in the application toolbar (as described in at least one of the co-pending patent applications incorporated herein by reference), the user may drag the stylus **204** over a document displayed on the display surface **202** such that digital ink is generated on the display surface **202**. At this point, the user may switch to selection mode by pressing and holding the stylus **204** for at least a threshold amount of time that may be the same as the threshold amount of time or that may be different. For instance, the threshold minimum amount of time that the user must hold the stylus **204** against the display surface **202** may be, in one embodiment, about 400 milliseconds, or between about 400 milliseconds and about 1 second, or more than about 1 second. Responsive to the user holding without substantial movement the stylus **204** against the display surface **202** for the minimum threshold amount of time, the computer **201** may generate a state change indicator on the display surface **202** which may be located at a location depending upon the location of the tip of the stylus **204**. For example, the state change indicator may be located at or near the location of the tip of the stylus **204**.

In some embodiments, the state change indicator may be animated and/or may otherwise change over time. For instance, the state change indicator **205** is shown as a partially completed clock-like loop that may become more complete over time in, e.g., a clockwise direction. In such embodiments with animation, the state change indicator may actually begin prior to the threshold amount of time passing, as an indication to the user that the threshold amount of time will soon pass. For instance, where a first threshold amount of time is 1 second, holding the stylus **204** against the display surface **202** for 500 milliseconds may cause an icon (a state change indicator) in the shape of a wand tip to appear on the display surface **202** at or near the location of the stylus **204**. As the stylus **204** is continued to be held, the icon may animate and begin to glow to indicate that a gesture is beginning to form. At the first threshold amount of time, the animation may have reached the point where the wand tip is fully glowing. Moreover, at the passing of the first threshold of time, the user may thereby be placed in selection mode, which is indicated by the look of the state change indicator.

As a further possibility in connection with the above example, at a second threshold amount of time of, e.g., 2 seconds, the wand tip may further animate and/or change to indicate that a right click will now be simulated when the stylus **204** is removed from the display surface **202**.

Where the user removes the stylus **204** from the display surface **202** prior to the threshold of time passing, then any subsequent stylus movement may be interpreted by the computer **201** as normal stylus input. Also, in this situation any state change indicator and/or animation thereof may be immediately canceled and removed from the display surface **202**.

While exemplary systems and methods embodying the present invention are shown by way of example, it will be understood, of course, that the invention is not limited to these embodiments. Modifications may be made by those skilled in the art, particularly in light of the foregoing teachings. For example, each of the elements of the aforementioned embodiments may be utilized alone or in combination with elements of the other embodiments. Also, although the above exemplary embodiments were described with regard to simulating a mouse, the simulation of other pointing devices (e.g., a trackball **400**, such as shown in FIG. **4**, having a left button **401** and a right button **402**) falls within the scope and spirit of the invention described herein.

We claim:

1. In a computer, a method for simulating at least one gesture of a pointing device having at least a primary switch and a secondary switch, the method comprising the steps of:

first detecting whether a stylus is being held down on a touch-sensitive display surface for at least a threshold amount of time;

second detecting whether the stylus is then removed from the touch-sensitive display surface after at least the threshold amount of time; and

responsive to the stylus being removed as detected in the step of second detecting, generating at least one event representing the secondary switch of the pointing device being activated.

2. The method of claim **1**, wherein the step of generating further includes generating at least one event representing the secondary switch being deactivated after the event representing the secondary switch of the pointing device being activated.

3. The method of claim **1**, further including generating a state change indicator responsive to the step of first detecting.

4. The method of claim **1**, further including the steps of:

third detecting whether the stylus is moved along the touch-sensitive display surface prior to being removed from the touch-sensitive display surface but after the threshold amount of time has passed; and

responsive to the stylus being moved as detected in the step of third detecting, generating at least one event representing the secondary switch of the pointing device being activated.

5. The method of claim **4**, further including the steps of:

fourth detecting whether the stylus is moved along the touch-sensitive display surface after the step of third detecting; and

responsive to the stylus being moved as detected in the step of fourth detecting, generating at least one event representing movement of the pointing device.

6. The method of claim **5**, further including the steps of:

fifth detecting whether the stylus is removed from the touch-sensitive display surface after the step of fourth detecting; and

responsive to the stylus being removed as detected in the step of fifth detecting, generating at least one event representing the secondary switch of the pointing device being deactivated.

7. The method of claim **1**, further including generating at least one event representing the primary switch of the pointing device being activated responsive to the stylus being removed from the touch-sensitive display surface before the threshold amount of time as detected in the step of first detecting.

8. The method of claim **7**, further including generating at least one event representing the primary switch of the pointing device being deactivated after the event representing the primary switch of the pointing device being activated.

9. The method of claim **1**, further including the steps of:

sixth detecting whether the stylus moves along the touch-sensitive display surface prior to the threshold amount of time having passed; and

generating at least one event representing the primary switch of the pointing pointing device being activated responsive to the stylus being moved along the touch-sensitive display surface as detected in the step of sixth detecting.

10. The method of claim **9**, further including the steps of:

seventh detecting whether the stylus is moved along the touch-sensitive display surface after the step of sixth detecting; and

responsive to the stylus being moved as detected in the step of seventh detecting, generating at least one event representing movement of the pointing device.

11. The method of claim **10**, further including the steps of:

eighth detecting whether the stylus is removed from the touch-sensitive display surface after the step of seventh detecting; and

responsive to the stylus being removed as detected in the step of eighth detecting, generating at least one event representing the primary switch of the pointing device being activated.

12. The method of claim **1**, wherein the pointing device comprises a mouse, the primary switch comprises a left button of the mouse, and the secondary switch comprises a right button of the mouse.

13. The method of claim **1**, wherein the pointing device comprises a trackball, the primary switch comprises a left button of the trackball, and the secondary switch comprises a right button of the trackball.

14. A computer configured to simulate at least one gesture of a pointing device having a primary switch and a secondary switch responsive to stylus input, the computer comprising:

a touch-sensitive display surface; and

a processor coupled to the touch-sensitive display surface and configured to detect whether the stylus is held against the touch-sensitive display surface for at least a threshold amount of time, and in response to the stylus being held against the touch-sensitive display surface for at least the threshold amount of time generating at least one event representing an activation of the secondary switch of the pointing device, and in response to the stylus being removed from the touch-sensitive display surface before the threshold amount of time generating at least one event representing an activation of the primary switch of the pointing device.

15. The computer of claim **14**, wherein the processor is further configured to generate at least one event representing the secondary switch of the pointing device being deactivated after the event representing the secondary switch of the pointing device being activated.

16. The method of claim **14**, wherein the pointing device comprises a mouse, the primary switch comprises a left button of the mouse, and the secondary switch comprises a right button of the mouse.

17. The method of claim 14, wherein the pointing device comprises a trackball, the primary switch comprises a left button of the trackball, and the secondary switch comprises a right button of the trackball.

18. A computer-readable medium having computer-executable instructions for performing steps for simulating at least one gesture of a pointing device having a primary switch and a secondary switch, the steps comprising:

first detecting whether a stylus is being held on a touch-sensitive display surface for at least a threshold amount of time;

second detecting whether the stylus is then removed from the touch-sensitive display surface after at least the threshold amount of time; and

responsive to the stylus being removed as detected in the step of second detecting, generating event representing the secondary switch of the pointing device being activated.

19. The computer-readable medium of claim 18, further having computer-executable instructions for performing the step of generating at least one event representing the secondary switch of the pointing device being deactivated after the event representing the secondary switch of the pointing device being activated.

20. The method of claim 18, wherein the pointing device comprises a mouse, the primary switch comprises a left button of the mouse, and the secondary switch comprises a right button of the mouse.

21. The method of claim 18, wherein the pointing device comprises a trackball, the primary switch comprises a left button of the trackball, and the secondary switch comprises a right button of the trackball.

22. In a computer, a method for simulating at least one gesture of a pointing device having a primary switch and a secondary switch, the method comprising the steps of:

first detecting whether a stylus is being held down on a touch-sensitive display surface for at least a first threshold amount of time;

second detecting whether the stylus is then removed from the touch-sensitive display surface before or after the first threshold amount of time;

responsive to the stylus being removed at a time before the first threshold amount of time has passed, generating at least one event representing one of the primary switch of the pointing device being activated or the secondary switch of the pointing device being activated; and

responsive to the stylus being removed at a time after the first threshold amount of time has passed, generating at least one event representing the other of the primary switch of the pointing device being activated and the secondary switch of the pointing device being activated.

23. The method of claim 22, further including the steps of:

third detecting whether the stylus is moved along the touch-sensitive display surface prior to the threshold amount of time having passed; and

responsive to the stylus being moved as detected in the step of third detecting, generating at least one event representing a primary switch drag of the pointing device.

24. The method of claim 23, further including the steps of:

fourth detecting whether the stylus is moved along the touch-sensitive display surface after to the first threshold amount of time having passed but not before; and

responsive to the stylus being moved as detected in the step of fourth detecting, generating at least one event representing a secondary switch drag of the pointing device.

25. The method of claim 22, wherein the first threshold amount of time is about 600 milliseconds.

26. The method of claim 22, wherein the first threshold amount of time is between 300 and 600 milliseconds.

27. The method of claim 22, wherein the first threshold amount of time is between 600 milliseconds and 1 second.

28. The method of claim 22, further including the steps of:

fifth detecting whether the stylus remains held down on the touch-sensitive display surface for at least a second threshold amount of time later in time than the first threshold amount of time; and

responsive to the stylus remaining held down as detected in the step of fifth detecting, generating at least one event representing the secondary switch of the pointing device being activated.

29. The method of claim 28, wherein the second threshold of time is about 700 milliseconds.

30. The method of claim 22, further including generating a state change indicator responsive to the stylus being held down for at least a third threshold amount of time.

31. The method of claim 30, wherein the third threshold amount of time is equal to the first threshold amount of time.

32. The method of claim 30, wherein the step of generating the state change indicator includes generating a visual state change indicator on the touch-sensitive display surface that changes over time.

33. The method of claim 32, wherein the third threshold amount of time is less than the first threshold amount of time.

34. The method of claim 30, wherein the step of generating the state change indicator includes generating a visual state change indicator on the touch-sensitive display surface at a location depending upon a location of the stylus.

35. The method of claim 22, wherein the pointing device comprises a mouse, the primary switch comprises a left button of the mouse, and the secondary switch comprises a right button of the mouse.

36. The method of claim 22, wherein the pointing device comprises a trackball, the primary switch comprises a left button of the trackball, and the secondary switch comprises a right button of the trackball.

37. In a computer, a method for providing feedback responsive to use of a stylus on a touch-sensitive display surface, the method comprising the steps of:

detecting whether a stylus is being held down on a touch-sensitive display surface for at least a threshold amount of time; and

generating a state change indicator responsive to the stylus being held down for at least the threshold amount of time.

38. The method of claim 37, wherein the step of generating includes generating a visual state change indicator on the touch-sensitive display surface.

39. The method of claim 37, wherein the step of generating includes generating a visual state change indicator at a location on the touch-sensitive display surface depending upon a location of the stylus.

40. The method of claim 37, wherein the step of generating includes generating an animated visual state change indicator on the touch-sensitive display surface.

41. The method of claim 37, wherein the pointing device comprises a mouse, the primary switch comprises a left button of the mouse, and the secondary switch comprises a right button of the mouse.

42. The method of claim **37**, wherein the pointing device comprises a trackball, the primary switch comprises a left button of the trackball, and the secondary switch comprises a right button of the trackball.

43. An apparatus comprising:

a touch-sensitive display surface; and

a processor coupled to the touch-sensitive display surface and configured to:

responsive to detecting that a stylus is brought down on the touch-sensitive display surface, count at least a threshold amount of time and determine whether the stylus is held down on the touch-sensitive display surface for at least the threshold amount of time, and

responsive to detecting that the stylus is later removed from the touch-sensitive display surface, generate at least one event representing one or the other of a left click of a pointing device and a right click of a pointing device depending upon whether the stylus is removed before or after the threshold amount of time has passed.

44. The apparatus of claim **43**, wherein the processor is running a program, the program being configured to be responsive to the event generated by the processor.

45. The apparatus of claim **43**, wherein the event comprises one of a LeftMouseButtonDown event and a RightMouseButtonDown event.

46. The method of claim **43**, wherein the pointing device comprises a mouse having a primary switch corresponding to the left click and a secondary switch corresponding to the right click, the primary switch comprising a left button of the mouse, and the secondary switch comprising a right button of the mouse.

47. The method of claim **43**, wherein the pointing device comprises a trackball, having a primary switch corresponding to the left click and a secondary switch corresponding to the right click, the primary switch comprising a left button of the trackball, and the secondary switch comprising a right button of the trackball.

* * * * *

EXHIBIT

44

US006791536B2

(12) United States Patent
Keely et al.

(10) Patent No.: **US 6,791,536 B2**
(45) Date of Patent: **Sep. 14, 2004**

(54) **SIMULATING GESTURES OF A POINTING DEVICE USING A STYLUS AND PROVIDING FEEDBACK THERETO**

(75) Inventors: **Leroy B. Keely**, Portola Valley, CA (US); **David F. Jones**, Redmond, WA (US); **David Switzer**, Redmond, WA (US); **Michael Hin-cheung Tsang**, Bellevue, WA (US); **William Hong Vong**, Seattle, WA (US)

(73) Assignee: **Microsoft Corporation**, Redmond, WA (US)

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(21) Appl. No.: **09/815,272**

(22) Filed: **Mar. 23, 2001**

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Related U.S. Application Data

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(51) **Int. Cl.**^{7} **G09G 5/00**

(52) **U.S. Cl.** **345/173**; 345/161; 345/163; 345/168; 345/173; 345/179; 345/863

(58) **Field of Search** 345/173, 156, 345/161, 163, 167, 168, 179, 863; 178/19.01, 19.04, 20.01; 703/17, 19, 21–24

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,899,138	A	*	2/1990	Araki et al.	345/175
5,404,458	A	*	4/1995	Zetts	710/73
5,592,566	A	*	1/1997	Pagallo et al.	382/187
5,602,570	A	*	2/1997	Capps et al.	345/173
5,666,113	A	*	9/1997	Logan	341/34
5,864,635	A	*	1/1999	Zetts et al.	382/187
5,880,411	A	*	3/1999	Gillespie et al.	178/18.01
6,049,329	A	*	4/2000	Zetts et al.	345/179
6,262,719	B1	*	7/2001	Bi et al.	345/179
6,266,050	B1	*	7/2001	Oh et al.	345/173

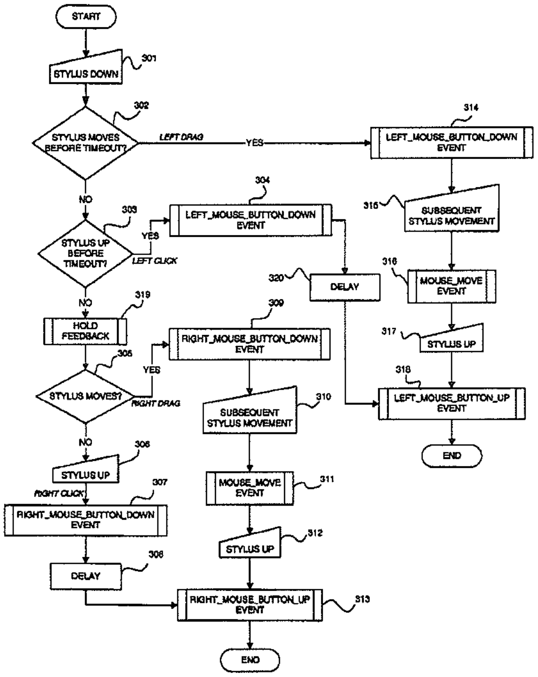
* cited by examiner

Primary Examiner—Henry N. Tran
(74) *Attorney, Agent, or Firm*—Banner & Witcoff, Ltd.

(57) **ABSTRACT**

A method and apparatus for simulating at least one gesture of a pointing device such as a mouse. A left click, right click, left drag, right drag, and/or mouse movement may be simulated using a stylus in conjunction with a touch-sensitive display surface. For example, a computer having the display surface may detect whether a stylus is being held down on a touch-sensitive display surface for at least a threshold amount of time. The computer may further detect whether the stylus is then removed from the touch-sensitive display surface after at least the threshold amount of time. Responsive to the stylus being removed, the computer may generate at least one event representing a right mouse button being pressed.

47 Claims, 4 Drawing Sheets


START
STYLUS DOWN
301
302
STYLUS MOVES BEFORE TIMEOUT?
LEFT DRAG
YES
314
LEFT_MOUSE_BUTTON_DOWN EVENT
NO
304
303
LEFT_MOUSE_BUTTON_DOWN EVENT
315
SUBSEQUENT STYLUS MOVEMENT
YES
STYLUS UP BEFORE TIMEOUT?
LEFT CLICK
316
320
DELAY
MOUSE_MOVE EVENT
NO
319
HOLD FEEDBACK
309
RIGHT_MOUSE_BUTTON_DOWN EVENT
317
STYLUS UP
305
YES
STYLUS MOVES?
RIGHT DRAG
318
LEFT_MOUSE_BUTTON_UP EVENT
SUBSEQUENT STYLUS MOVEMENT
310
END
NO
306
STYLUS UP
RIGHT CLICK
307
RIGHT_MOUSE_BUTTON_DOWN EVENT
MOUSE_MOVE EVENT
311
STYLUS UP
312
DELAY
308
RIGHT_MOUSE_BUTTON_UP EVENT
313
END

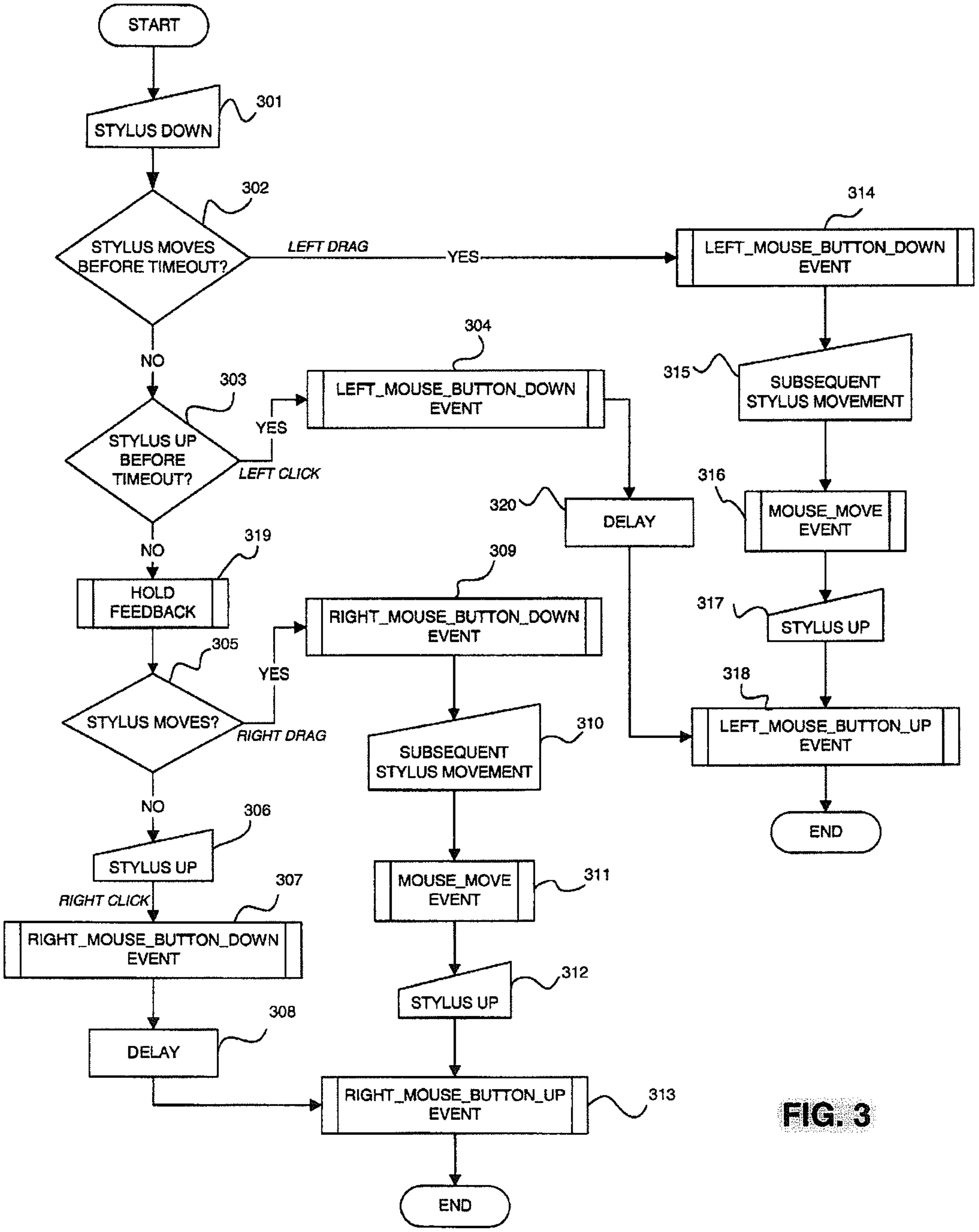

START
301
STYLUS DOWN
302
STYLUS MOVES BEFORE TIMEOUT?
LEFT DRAG
YES
314
LEFT_MOUSE_BUTTON_DOWN EVENT
NO
303
STYLUS UP BEFORE TIMEOUT?
YES
LEFT CLICK
304
LEFT_MOUSE_BUTTON_DOWN EVENT
315
SUBSEQUENT STYLUS MOVEMENT
316
MOUSE_MOVE EVENT
320
DELAY
NO
319
HOLD FEEDBACK
309
RIGHT_MOUSE_BUTTON_DOWN EVENT
317
STYLUS UP
305
STYLUS MOVES?
YES
RIGHT DRAG
318
LEFT_MOUSE_BUTTON_UP EVENT
310
SUBSEQUENT STYLUS MOVEMENT
END
NO
306
STYLUS UP
RIGHT CLICK
307
RIGHT_MOUSE_BUTTON_DOWN EVENT
311
MOUSE_MOVE EVENT
312
STYLUS UP
308
DELAY
313
RIGHT_MOUSE_BUTTON_UP EVENT
END

FIG. 3

SIMULATING GESTURES OF A POINTING DEVICE USING A STYLUS AND PROVIDING FEEDBACK THERETO

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority to U.S. provisional patent application Serial No. 60/247,844, entitled Simulating Gestures of a Mouse Using a Stylus and Providing Feedback Thereto, filed Nov. 10, 2000, which is hereby incorporated by reference as to its entirety. The present application is also related to application Ser. No. 09/760,631, entitled Method and Apparatus For Improving the Appearance of Digitally Represented Handwriting, filed Nov. 10, 2000; to application Ser. No. 60/247,841, entitled Highlevel Active Pen Matrix, filed Nov. 10, 2000; to application Ser. No. 60/247/973, entitled Selection Handles in Editing Electronic Documents, filed Nov. 10, 200; to application Ser. No. 60,247,842, entitled Insertion Point Bungee Space Tool, filed Nov. 10, 2000; to application Ser. No. 60/247,400, entitled System and Method for Accepting Disparate Types of User Input, filed Nov. 10, 2000; to application Ser. No. 60/247,972, entitled In Air Gestures, filed Nov. 10, 2000; to application Ser. No. 60/247,831, entitled Mouse Input Panel Windows Class List, filed Nov. 10, 2000; to application Ser. No. 60/247,843, entitled Mouse Input Panel and User Interface, filed Nov. 10, 2000; to application Ser. No. 60/247,479, entitled System and Method for Inserting Implicit Page Breaks, filed Nov. 10, 2000; to application Ser. No. 09/750,288, entitled Classifying, Anchoring, and Transforming Ink, filed Dec. 29, 2000; to application Ser. No. 09/736,170, entitled Highlevel Active Pen Matrix, filed Dec. 15, 2000; and to application Ser. No. 09/741,107, entitled Mode Hinting/Switching, filed Dec. 21, 2000; each of which is incorporated by reference herein as to their entireties.

FIELD OF THE INVENTION

The present invention is directed generally to apparatus and methods for simulating various gestures of a pointing device with multiple switches, such as a two button mouse in a computer system, and for providing feedback thereto, and more specifically to simulating gestures such as the left click of a mouse, the right click of a mouse, and mouse dragging by manipulation of a stylus in conjunction with a touch-sensitive computer display, as well as generating appropriate visual or other feedback in response to certain gestures.

BACKGROUND OF THE INVENTION

Typical computer systems, especially computer systems using graphical user interface (GUI) systems such as Microsoft WINDOWS, are optimized for accepting user input from two discrete input devices: a keyboard for entering text, and a pointing device such as a mouse with two or more buttons or other selectors for driving the user interface. Virtually all software applications designed to run on Microsoft WINDOWS are optimized to accept user input in the same manner. For instance, many applications make extensive use of a primary switch of the pointing device such as the left button of a mouse (a gesture commonly referred to as a "left click" of a mouse) to select an object, and a secondary switch such as the right button of the mouse (a gesture commonly referred to as a "right click" of a mouse) to display context-sensitive command menus. It is noted that other operating systems incorporate left and right click operability as well. The user may generate other gestures using the mouse such as by clicking the left or right button of the mouse and moving the mouse while the button is depressed (a gesture commonly referred to as either a "left drag" or a "right drag," respectively).

While such mouse gestures are of course easily done with an actual mouse, it is not always convenient for a user to use a mouse with a computer even though the computer may have a GUI system. For instance, when using a portable system there may not always be a surface available upon which to place a mouse. Some systems utilize a touch-sensitive display screen with a stylus as an input device. The user places the stylus tip upon the touch-sensitive display screen at various locations to control objects displayed on the display screen. A problem with this type of system is that the stylus is limited in the types of actions that may be easily performed as compared with a mouse. For instance, the typical stylus can perform only three types of movements: placing the stylus tip onto the screen, moving the stylus tip across the screen, and removing the stylus tip from the screen. While a user may operate a remote toolbar to select a different tool, the excessive movement renders the control of the system laborious, inconvenient, and slow. Using the tip of the stylus-type device, there is presently no convenient way to simulate or distinguish between, for example, a right click as opposed to a left click as interpreted by the operating system.

In order to make the full range of interface features accessible to users of such a stylus-based computer, there is a need for an intuitive way of simulating mouse gestures with the stylus. Although not necessary, it is preferable and more useful that any new way of simulating mouse gestures be compatible with existing software applications that conventionally are used with a mouse.

There is also a need for providing helpful feedback to the user of the stylus to indicate whether gestures made with the stylus are those that are intended by the user. This is useful with a stylus-type input device since there is conventionally little to no natural tactile or auditory feedback when using a stylus than there is when using a mouse (e.g., the buttons of a mouse often have a definitive mechanical "click" feel and sound when pressed). As will be seen, such feedback is even more useful when provided in conjunction with various gesture simulation techniques of the present invention.

SUMMARY OF THE INVENTION

As discussed in the various copending patent applications incorporated herein by reference, aspects of the present invention are directed to a tablet-like computer that may be used for directly writing on a touch-sensitive display surface using a stylus. The computer may allow the user to write and to edit, manipulate, and create objects through the use of the stylus. Many of the features discussed in these copending applications are even more useful in combination with various aspects of the present invention discussed herein.

An aspect of the present invention is directed to methods and apparatus for simulating gestures of a pointing device, such as a mouse, trackball, or joystick, by use of a stylus on a touch-sensitive display surface. For example, a left click of a mouse may be simulated, e.g., where the user holds the stylus down on the touch-sensitive display surface without substantial movement and then removes the stylus from the display surface before the expiration of a threshold amount of time. A right click of a mouse may be simulated, e.g., where the user waits until at least the threshold amount of time before removing the stylus. Where the stylus is moved along the display surface during certain stylus gestures, left or right dragging may thereby be simulated.

Another aspect of the present invention is directed to methods and apparatus for providing feedback to a user in a stylus-based touch-sensitive display surface computer system. The user may accordingly be given some indication that the user has performed a particular stylus gesture, e.g., by displaying a visual object on the display surface to indicate a particular status. Such feedback may be responsive to certain stylus gestures such as pressing and holding the stylus against the display surface for at least a certain minimum amount of time. More generally, the feedback may be in the form of a "state change indicator," which may be visual on the display surface such as an icon, bitmap, or other visual object or indicator, and/or auditory such as a sound emitted from the computer's speakers. The state change indicator may be animated and or otherwise vary with stylus hold time. Significant advantages of this aspect of the invention are realized in conjunction with the various features discussed in the copending patent applications incorporated herein by reference.

These and other features of the invention will be apparent upon consideration of the following detailed description of preferred embodiments. Although the invention has been defined using the appended claims, these claims are exemplary in that the invention is intended to include the elements and steps described herein in any combination or subcombination. Accordingly, there are any number of alternative combinations for defining the invention, which incorporate one or more elements from the specification, including the description, claims, and drawings, in various combinations or subcombinations. It will be apparent to those skilled in the relevant technology, in light of the present specification, that alternate combinations of aspects of the invention, either alone or in combination with one or more elements or steps defined herein, may be utilized as modifications or alterations of the invention or as part of the invention. It is intended that the written description of the invention contained herein covers all such modifications and alterations.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing summary of the invention, as well as the following detailed description of preferred embodiments, is better understood when read in conjunction with the accompanying drawings, which are included by way of example, and not by way of limitation with regard to the claimed invention. In the accompanying drawings, elements are labeled with three-digit reference numbers, wherein the first digit of a reference number indicates the drawing number in which the element is first illustrated. The same reference number in different drawings refers to the same element.

FIG. 1 is a schematic diagram of a general-purpose digital computing environment that can be used to implement various aspects of the invention.

FIG. 2 is a plan view of a tablet computer and stylus that can be used in accordance with various aspects of the present invention.

FIG. 3 is a flow chart showing an exemplary set of steps that may be performed in order to simulate a right click of a mouse according to aspects of the present invention.

FIG. 4 is a plan view of an illustrative embodiment of a trackball having left and right buttons.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

FIG. 1 shows an exemplary embodiment of a general-purpose digital computing environment that can be used to implement various aspects of the invention. In this embodiment, computer **100** includes a processing unit **110**, a system memory **120**, and a system bus **130** that couples various system components including the system memory to the processing unit **110**. The system bus **130** may be any of several types of bus structures including a memory bus or memory controller, a peripheral bus, and a local bus using any of a variety of bus architectures. The system memory includes read only memory (ROM) **140** and random access memory (RAM) **150**.

A basic input/output system **160** (BIOS), containing the basic routines that help to transfer information between elements within the computer **100**, such as during start-up, is stored in ROM **140**. Computer **100** also includes a hard disk drive **170** for reading from and writing to a hard disk (not shown), a magnetic disk drive **180** for reading from or writing to a removable magnetic disk **190**, and an optical disk drive **191** for reading from or writing to a removable optical disk **192** such as a CD ROM or other optical media. The hard disk drive **170**, magnetic disk drive **180**, and optical disk drive **191** are connected to the system bus **130** by a hard disk drive interface **192**, a magnetic disk drive interface **193**, and an optical disk drive interface **194**, respectively. The drives and their associated computer-readable media provide nonvolatile storage of computer readable instructions, data structures, program modules and other data for the personal computer **100**. It will be appreciated by those skilled in the art that other types of computer readable media which can store data that is accessible by a computer, such as magnetic cassettes, flash memory cards, digital video disks, Bernoulli cartridges, random access memories (RAMs), read only memories (ROMs), and the like, may also be used in the example operating environment.

A number of program modules can be stored on the hard disk, magnetic disk **190**, optical disk **192**, ROM **140** or RAM **150**, including an operating system **195**, one or more application programs **196**, other program modules **197**, and program data **198**. A user can enter commands and information into the computer **100** through input devices such as a keyboard **101** and pointing device **102**. Other input devices (not shown) may include a microphone, joystick, game pad, satellite dish, scanner, or the like. These and other input devices are often connected to the processing unit **110** through a serial port interface **106** that is coupled to the system bus, but may be connected by other interfaces, such as a parallel port, game port or a universal serial bus (USB). A monitor **107** or other type of display device is also connected to the system bus **130** via an interface, such as a video adapter **108**. In addition to the monitor, personal computers typically include other peripheral output devices (not shown), such as speakers and printers.

The computer **100** can operate in a networked environment using logical connections to one or more remote computers, such as a remote computer **109**. Remote computer **109** can be a server, a router, a network PC, a peer device or other common network node, and typically includes many or all of the elements described above relative to computer **100**, although only a memory storage device **111** has been illustrated in FIG. 1. The logical connections depicted in FIG. 1 include a local area network (LAN) **112** and a wide area network (WAN) **113**. Such networking environments are commonplace in offices, enterprise-wide computer networks, intranets and the Internet.

When used in a LAN networking environment, the computer **100** is connected to the local network **112** through a network interface or adapter **114**. When used in a WAN networking environment, the personal computer **100** typically includes a modem **115** or other means for establishing a communications over the wide area network **113**, such as the Internet. The modem **115**, which may be internal or external, is connected to the system bus **130** via the serial port interface **106**. In a networked environment, program modules depicted relative to the personal computer **100**, or portions thereof, may be stored in the remote memory storage device.

It will be appreciated that the network connections shown are example and other means of establishing a communications link between the computers can be used. The existence of any of various well-known protocols such as TCP/IP, Ethernet, FTP, HTTP and the like is presumed, and the system can be operated in a client-server configuration to permit a user to retrieve web pages from a web-based server. Any of various conventional web browsers can be used to display and manipulate data on web pages.

FIG. **2** illustrates a tablet PC **201** that can be used in accordance with various aspects of the present invention. Any or all of the features, subsystems, and functions in the system of FIG. **1** can be included in the computer of FIG. **2**. Tablet PC **201** includes a large touch-sensitive display surface **202**, e.g., a digitizing flat panel display, for example, a liquid crystal display (LCD) screen, on which a plurality of windows **203** is displayed. Using a stylus **204**, a user can select, highlight, and write on the digitizing display area. Examples of suitable digitizing display panels include electromagnetic pen digitizers, such as the Mutoh or Wacom pen digitizers. Other types of pen digitizers, e.g., optical digitizers, may also be used. Tablet PC **201** interprets marks made using stylus **204** in order to manipulate data, enter text, and execute conventional computer application tasks such as spreadsheets, word processing programs, and the like. The touch-sensitive display surface **202** may also be proximity-sensitive such that the tip of the stylus **204** may be sensed by the display surface **202** when proximate thereto without actually contacting the display surface **202**.

The stylus **204** may be equipped with or without buttons or other features to augment its selection capabilities. In one embodiment, the stylus **204** may be implemented as a "pencil" or "pen", in which one end constitutes a writing, or tip, portion and the other end constitutes an "eraser" end that, when moved across the display indicates portions of the display that are to be erased. The term "stylus" as used herein is intended to have a broad definition that includes, e.g., a user's own finger, a pen, a pencil, a stick, a rod, and/or any other similar device suitable for pointing at a particular location on the display surface **202**. Other types of pointing devices, such as a mouse, trackball, or the like may be used with the tablet PC **201** in addition to or conjunction with the stylus **204**.

Referring now to FIG. **3**, an example of how a left drag of a mouse is simulated is now discussed. Any or all of steps set forth herein and in FIG. **3** may be performed by special software, hardware, and/or firmware that runs in conjunction with, or is part of, the operating system of the computer **201**. To simulate a left drag, the user may touch the stylus **204** or other similar user pointing device to the display surface **202**, an action referred to hereafter as "placing the stylus down" (step **301**). Responsive to the computer **201** detecting the stylus being placed down, the computer **201** may begin counting time, e.g., by using a timer, up to at least a threshold amount of time. A timeout condition is defined responsive to the threshold amount of time having passed. In one embodiment, the threshold amount of time is about 600 milliseconds. However, the threshold amount of time may be any amount of time, such as between 300 and 600 milliseconds, or between 600 milliseconds and 1 second, or greater than 1 second. If the computer **201** detects that the stylus moves prior to the timeout condition occurring (step **302**), then in response the computer **201** may generate a standard Microsoft WINDOWS LeftMouseButtonDown event (or other event that represents the primary switch of the pointing device being activated) in the original position where the stylus **204** was first brought down (step **314**), which may be sent to the software application presently in use. At this point, any subsequent movement of the stylus **204** across the display surface **202** may be detected by the computer **201** (step **315**), and in response the computer **201** may generate one or more Microsoft WINDOWS MouseMove events (step **316**) (or other events representing movement of the pointing device). When the stylus **204** is eventually removed from the display surface **202** (hereafter referred to as "bringing the stylus up") (step **317**), the computer **201** may detect this and in response may generate a Microsoft WINDOWS LeftMouseButtonUp event (step **318**) (or other event that represents the primary switch being deactivated). Thus, via steps **301**, **302**, and **314**–**318**, a left drag of a mouse is simulated.

To simulate a left click of a mouse without dragging, if the computer **201** detects that the stylus **204** is not moved prior to the timeout condition (step **302**), and if instead the stylus **204** is brought up prior to the timeout condition (step **303**), then in response the computer **201** may generate first a LeftMouseButtonDown event (or other event that represents the primary switch being activated), then optionally delay for a period of time (step **320**) such as about 20 milliseconds or some other amount of time, and then generate a LeftMouseButtonUp event (steps **304** and **318**) (or other event that represents the primary switch being deactivated). Thus, via steps **301**–**304**, **318**, and **320**, a slightly delayed left click of a mouse is simulated.

To simulate a right click of a mouse without dragging, if the computer **201** detects that the stylus **204** is not moved either prior to the timeout condition or after the timeout condition (steps **302** and **305**), and if the computer **201** further detects that the stylus **204** is not brought up until after the timeout condition (steps **303** and **306**), and thus that the stylus **204** has been held down for at least the threshold amount of time, then in response the computer **201** may generate first a Microsoft WINDOWS RightMouseButtonDown event (step **307**) (or other event that represents the secondary switch of the pointing device being activated). The computer **201** may, further in response, optionally delay for a period of time (step **308**), in one embodiment, about 20 milliseconds, and then generate a Microsoft WINDOWS RightMouseButtonUp event (step **313**) (or other event that represents the secondary switch being deactivated). The computer **201** may also generate and display a state change indicator (step **319**) that indicates to the user that the stylus **204** has been placed down for a certain minimum amount of time, as will be discussed below in more detail.

It is noted that steps **319** may be in a variety of places within the flowchart of FIG. **3** other than the one shown, such as between steps **305** and **306**. Steps **301**–**303**, **305**–**308**, and **313**, thus simulate a delayed right click of a mouse.

To simulate a right drag of a mouse, if the computer **201** detects that the stylus **204** is not moved until after the timeout condition (step **305**), then in response the computer **201** may generate a RightMouseButtonDown event (step **309**) (or other event that represents the secondary switch being activated). Upon the computer **201** detecting any subsequent movement of the stylus **204** along the display surface **202** (step **310**), the computer **201** may in response generate one or more MouseMove events (step **311**) (or other events representing movement of the pointing device). When the computer detects that the stylus **204** is brought up (**312**), in response the computer **201** may generate a RightMouseButtonUp event (step **313**) (or other event that represents the secondary switch being deactivated). This simulates, via steps **301–303**, **305**, and **309–313**, a right drag of a mouse.

As a further feature of the right click simulation, a special hold event may be defined wherein the stylus **204** is held against the display screen **202** without substantial movement for at least another threshold amount of time, say about 700 milliseconds, or between 0.5 and 1 second, or between about 1 and 3 seconds or more, the computer **201** may detect such a hold event and in response act by immediately interpreting any subsequent holding of the stylus **204** as holding the left mouse button down (or, more generally, as activating the primary switch of the pointing device). Thus, the computer **201** may, after 600 milliseconds of stylus holding, go on to steps **305** and **319**, and where the stylus **204** is released prior to, say, 5 seconds or some other time limit, then steps **306–308** and **313** may be implemented. However, if instead the stylus **204** is further held at least 5 seconds, then the special subroutine may, in response, immediately generate a LeftMouseButtonDown event (or other event that represents the primary switch of the pointing device being activated). Then, when the stylus is eventually released, a LeftMouseButtonUp event (or other event that represents the primary switch being deactivated) would be generated by the special subroutine. If the stylus **204** is moved along the display surface **202**, then the computer **201** may immediately in response generate one or more MouseMove events (or other events representing movement of the pointing device). When the stylus **204** is eventually removed from the display surface **202**, all pending RightMouse events (or other events that represent action by the secondary switch of the pointing device) that would normally have been generated in accordance with the method shown in FIG. **3** would be canceled.

In the above and remaining discussion, it is assumed that a Microsoft WINDOWS operating system is being used with the computer **201**. However, any operating system, especially a GUI operating system, may be used in accordance with the present invention. Further, although the above embodiments are sample methods for simulating mouse gestures using a stylus, there are many variations that are encompassed by the present invention. For instance, the stylus gestures required for simulation a left click and a right click might be reversed, or a user may not need to always keep the stylus **204** down on the display surface **202** during the entire time that a drag is executed, such that a first touch/touch-and-hold of the stylus **204** at a first location on the display surface **202**, and a second touch/touch-and-hold at a second location, may thereby simulate a drag from the first location to the second location.

As discussed in the co-pending patent applications incorporated by reference herein, the computer **201** according to embodiments of the present invention may have the ability to select ink when in pen mode. A user can press and hold, then drag over ink, text, or other objects, within a document to select those objects. A press and hold operation may switch into selection mode. Because the user is using the stylus **204** or other similar user pointing device, there are different considerations as compared with when a mouse is used. For instance, while the user of a mouse may hear and

feel the click of a mouse button to ensure that a click has been performed, the user of the stylus **204** may not receive clear enough feedback that the intended gesture has been made properly. Also, it is desirable to indicate to the user that a particular requested mode has really been switched to, such as selection mode. Further, where the user must hold down the stylus **204** for at least a certain threshold amount of time to simulate, for example, a right click, feedback to the user indicating that the threshold time has passed would be useful.

Such feedback may be in the form of a state change indicator, which may be visual (e.g., a graphical icon, a symbol, a bitmapped or other image, etc., displayed on the display surface **202** such as state change indicator **205** in FIG. 2), auditory (e.g., a click, a beep, tone, etc. emanating from the computer **201** and/or stylus **204**), and/or tactile (e.g., vibration of the computer **201** and/or stylus **204**). For example, where the user selects the pen icon in the application toolbar (as described in at least one of the co-pending patent applications incorporated herein by reference), the user may drag the stylus **204** over a document displayed on the display surface **202** such that digital ink is generated on the display surface **202**. At this point, the user may switch to selection mode by pressing and holding the stylus **204** for at least a threshold amount of time that may be the same as the threshold amount of time or that may be different. For instance, the threshold minimum amount of time that the user must hold the stylus **204** against the display surface **202** may be, in one embodiment, about 400 milliseconds, or between about 400 milliseconds and about 1 second, or more than about 1 second. Responsive to the user holding without substantial movement the stylus **204** against the display surface **202** for the minimum threshold amount of time, the computer **201** may generate a state change indicator on the display surface **202** which may be located at a location depending upon the location of the tip of the stylus **204**. For example, the state change indicator may be located at or near the location of the tip of the stylus **204**.

In some embodiments, the state change indicator may be animated and/or may otherwise change over time. For instance, the state change indicator **205** is shown as a partially completed clock-like loop that may become more complete over time in, e.g., a clockwise direction. In such embodiments with animation, the state change indicator may actually begin prior to the threshold amount of time passing, as an indication to the user that the threshold amount of time will soon pass. For instance, where a first threshold amount of time is 1 second, holding the stylus **204** against the display surface **202** for 500 milliseconds may cause an icon (a state change indicator) in the shape of a wand tip to appear on the display surface **202** at or near the location of the stylus **204**. As the stylus **204** is continued to be held, the icon may animate and begin to glow to indicate that a gesture is beginning to form. At the first threshold amount of time, the animation may have reached the point where the wand tip is fully glowing. Moreover, at the passing of the first threshold of time, the user may thereby be placed in selection mode, which is indicated by the look of the state change indicator.

As a further possibility in connection with the above example, at a second threshold amount of time of, e.g., 2 seconds, the wand tip may further animate and/or change to indicate that a right click will now be simulated when the stylus **204** is removed from the display surface **202**.

Where the user removes the stylus **204** from the display surface **202** prior to the threshold of time passing, then any subsequent stylus movement may be interpreted by the computer **201** as normal stylus input. Also, in this situation any state change indicator and/or animation thereof may be immediately canceled and removed from the display surface **202**.

While exemplary systems and methods embodying the present invention are shown by way of example, it will be understood, of course, that the invention is not limited to these embodiments. Modifications may be made by those skilled in the art, particularly in light of the foregoing teachings. For example, each of the elements of the aforementioned embodiments may be utilized alone or in combination with elements of the other embodiments. Also, although the above exemplary embodiments were described with regard to simulating a mouse, the simulation of other pointing devices (e.g., a trackball **400**, such as shown in FIG. **4**, having a left button **401** and a right button **402**) falls within the scope and spirit of the invention described herein.

We claim:

1. In a computer, a method for simulating at least one gesture of a pointing device having at least a primary switch and a secondary switch, the method comprising the steps of:

first detecting whether a stylus is being held down on a touch-sensitive display surface for at least a threshold amount of time;

second detecting whether the stylus is then removed from the touch-sensitive display surface after at least the threshold amount of time; and

responsive to the stylus being removed as detected in the step of second detecting, generating at least one event representing the secondary switch of the pointing device being activated.

2. The method of claim **1**, wherein the step of generating further includes generating at least one event representing the secondary switch being deactivated after the event representing the secondary switch of the pointing device being activated.

3. The method of claim **1**, further including generating a state change indicator responsive to the step of first detecting.

4. The method of claim **1**, further including the steps of:

third detecting whether the stylus is moved along the touch-sensitive display surface prior to being removed from the touch-sensitive display surface but after the threshold amount of time has passed; and

responsive to the stylus being moved as detected in the step of third detecting, generating at least one event representing the secondary switch of the pointing device being activated.

5. The method of claim **4**, further including the steps of:

fourth detecting whether the stylus is moved along the touch-sensitive display surface after the step of third detecting; and

responsive to the stylus being moved as detected in the step of fourth detecting, generating at least one event representing movement of the pointing device.

6. The method of claim **5**, further including the steps of:

fifth detecting whether the stylus is removed from the touch-sensitive display surface after the step of fourth detecting; and

responsive to the stylus being removed as detected in the step of fifth detecting, generating at least one event representing the secondary switch of the pointing device being deactivated.

7. The method of claim **1**, further including generating at least one event representing the primary switch of the pointing device being activated responsive to the stylus being removed from the touch-sensitive display surface before the threshold amount of time as detected in the step of first detecting.

8. The method of claim **7**, further including generating at least one event representing the primary switch of the pointing device being deactivated after the event representing the primary switch of the pointing device being activated.

9. The method of claim **1**, further including the steps of:

sixth detecting whether the stylus moves along the touch-sensitive display surface prior to the threshold amount of time having passed; and

generating at least one event representing the primary switch of the pointing pointing device being activated responsive to the stylus being moved along the touch-sensitive display surface as detected in the step of sixth detecting.

10. The method of claim **9**, further including the steps of:

seventh detecting whether the stylus is moved along the touch-sensitive display surface after the step of sixth detecting; and

responsive to the stylus being moved as detected in the step of seventh detecting, generating at least one event representing movement of the pointing device.

11. The method of claim **10**, further including the steps of:

eighth detecting whether the stylus is removed from the touch-sensitive display surface after the step of seventh detecting; and

responsive to the stylus being removed as detected in the step of eighth detecting, generating at least one event representing the primary switch of the pointing device being activated.

12. The method of claim **1**, wherein the pointing device comprises a mouse, the primary switch comprises a left button of the mouse, and the secondary switch comprises a right button of the mouse.

13. The method of claim **1**, wherein the pointing device comprises a trackball, the primary switch comprises a left button of the trackball, and the secondary switch comprises a right button of the trackball.

14. A computer configured to simulate at least one gesture of a pointing device having a primary switch and a secondary switch responsive to stylus input, the computer comprising:

a touch-sensitive display surface; and

a processor coupled to the touch-sensitive display surface and configured to detect whether the stylus is held against the touch-sensitive display surface for at least a threshold amount of time, and in response to the stylus being held against the touch-sensitive display surface for at least the threshold amount of time generating at least one event representing an activation of the secondary switch of the pointing device, and in response to the stylus being removed from the touch-sensitive display surface before the threshold amount of time generating at least one event representing an activation of the primary switch of the pointing device.

15. The computer of claim **14**, wherein the processor is further configured to generate at least one event representing the secondary switch of the pointing device being deactivated after the event representing the secondary switch of the pointing device being activated.

16. The method of claim **14**, wherein the pointing device comprises a mouse, the primary switch comprises a left button of the mouse, and the secondary switch comprises a right button of the mouse.

17. The method of claim **14**, wherein the pointing device comprises a trackball, the primary switch comprises a left button of the trackball, and the secondary switch comprises a right button of the trackball.

18. A computer-readable medium having computer-executable instructions for performing steps for simulating at least one gesture of a pointing device having a primary switch and a secondary switch, the steps comprising:

first detecting whether a stylus is being held on a touch-sensitive display surface for at least a threshold amount of time;

second detecting whether the stylus is then removed from the touch-sensitive display surface after at least the threshold amount of time; and

responsive to the stylus being removed as detected in the step of second detecting, generating event representing the secondary switch of the pointing device being activated.

19. The computer-readable medium of claim **18**, further having computer-executable instructions for performing the step of generating at least one event representing the secondary switch of the pointing device being deactivated after the event representing the secondary switch of the pointing device being activated.

20. The method of claim **18**, wherein the pointing device comprises a mouse, the primary switch comprises a left button of the mouse, and the secondary switch comprises a right button of the mouse.

21. The method of claim **18**, wherein the pointing device comprises a trackball, the primary switch comprises a left button of the trackball, and the secondary switch comprises a right button of the trackball.

22. In a computer, a method for simulating at least one gesture of a pointing device having a primary switch and a secondary switch, the method comprising the steps of:

first detecting whether a stylus is being held down on a touch-sensitive display surface for at least a first threshold amount of time;

second detecting whether the stylus is then removed from the touch-sensitive display surface before or after the first threshold amount of time;

responsive to the stylus being removed at a time before the first threshold amount of time has passed, generating at least one event representing one of the primary switch of the pointing device being activated or the secondary switch of the pointing device being activated; and

responsive to the stylus being removed at a time after the first threshold amount of time has passed, generating at least one event representing the other of the primary switch of the pointing device being activated and the secondary switch of the pointing device being activated.

23. The method of claim **22**, further including the steps of:

third detecting whether the stylus is moved along the touch-sensitive display surface prior to the threshold amount of time having passed; and

responsive to the stylus being moved as detected in the step of third detecting, generating at least one event representing a primary switch drag of the pointing device.

24. The method of claim **23**, further including the steps of:

fourth detecting whether the stylus is moved along the touch-sensitive display surface after to the first threshold amount of time having passed but not before; and

responsive to the stylus being moved as detected in the step of fourth detecting, generating at least one event representing a secondary switch drag of the pointing device.

25. The method of claim **22**, wherein the first threshold amount of time is about 600 milliseconds.

26. The method of claim **22**, wherein the first threshold amount of time is between 300 and 600 milliseconds.

27. The method of claim **22**, wherein the first threshold amount of time is between 600 milliseconds and 1 second.

28. The method of claim **22**, further including the steps of:

fifth detecting whether the stylus remains held down on the touch-sensitive display surface for at least a second threshold amount of time later in time than the first threshold amount of time; and

responsive to the stylus remaining held down as detected in the step of fifth detecting, generating at least one event representing the secondary switch of the pointing device being activated.

29. The method of claim **28**, wherein the second threshold of time is about 700 milliseconds.

30. The method of claim **22**, further including generating a state change indicator responsive to the stylus being held down for at least a third threshold amount of time.

31. The method of claim **30**, wherein the third threshold amount of time is equal to the first threshold amount of time.

32. The method of claim **30**, wherein the step of generating the state change indicator includes generating a visual state change indicator on the touch-sensitive display surface that changes over time.

33. The method of claim **32**, wherein the third threshold amount of time is less than the first threshold amount of time.

34. The method of claim **30**, wherein the step of generating the state change indicator includes generating a visual state change indicator on the touch-sensitive display surface at a location depending upon a location of the stylus.

35. The method of claim **22**, wherein the pointing device comprises a mouse, the primary switch comprises a left button of the mouse, and the secondary switch comprises a right button of the mouse.

36. The method of claim **22**, wherein the pointing device comprises a trackball, the primary switch comprises a left button of the trackball, and the secondary switch comprises a right button of the trackball.

37. In a computer, a method for providing feedback responsive to use of a stylus on a touch-sensitive display surface, the method comprising the steps of:

detecting whether a stylus is being held down on a touch-sensitive display surface for at least a threshold amount of time; and

generating a state change indicator responsive to the stylus being held down for at least the threshold amount of time.

38. The method of claim **37**, wherein the step of generating includes generating a visual state change indicator on the touch-sensitive display surface.

39. The method of claim **37**, wherein the step of generating includes generating a visual state change indicator at a location on the touch-sensitive display surface depending upon a location of the stylus.

40. The method of claim **37**, wherein the step of generating includes generating an animated visual state change indicator on the touch-sensitive display surface.

41. The method of claim **37**, wherein the pointing device comprises a mouse, the primary switch comprises a left button of the mouse, and the secondary switch comprises a right button of the mouse.

42. The method of claim **37**, wherein the pointing device comprises a trackball, the primary switch comprises a left button of the trackball, and the secondary switch comprises a right button of the trackball.

43. An apparatus comprising:

a touch-sensitive display surface; and

a processor coupled to the touch-sensitive display surface and configured to:

responsive to detecting that a stylus is brought down on the touch-sensitive display surface, count at least a threshold amount of time and determine whether the stylus is held down on the touch-sensitive display surface for at least the threshold amount of time, and

responsive to detecting that the stylus is later removed from the touch-sensitive display surface, generate at least one event representing one or the other of a left click of a pointing device and a right click of a pointing device depending upon whether the stylus is removed before or after the threshold amount of time has passed.

44. The apparatus of claim **43**, wherein the processor is running a program, the program being configured to be responsive to the event generated by the processor.

45. The apparatus of claim **43**, wherein the event comprises one of a LeftMouseButtonDown event and a RightMouseButtonDown event.

46. The method of claim **43**, wherein the pointing device comprises a mouse having a primary switch corresponding to the left click and a secondary switch corresponding to the right click, the primary switch comprising a left button of the mouse, and the secondary switch comprising a right button of the mouse.

47. The method of claim **43**, wherein the pointing device comprises a trackball, having a primary switch corresponding to the left click and a secondary switch corresponding to the right click, the primary switch comprising a left button of the trackball, and the secondary switch comprising a right button of the trackball.

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