(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification:
G06F 3/033 (2006.01)

(21) International Application Number:
PCT/US2006/031527

(22) International Filing Date: 11 August 2006 (11.08.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
11/228,700   16 September 2005 (16.09.2005)   US

(71) Applicant (for all designated States except US): APPLE COMPUTER, INC. [US/US]; 1 Infinite Loop, Cupertino, CA 95014 (US).

(72) Inventor; and
(75) Inventor/Applicant (for US only):   ORDING, Bas [NL/US]; 1119 Dolores Street, #4, San Francisco, CA 94110 (US).

(74) Agent: ALLEN, Billy, C., III; WONG, CABELLO, LUTSCH, RUTHERFORD & BRUCCULERI LLP, 20333 SH 249, Suite 600, Houston, TX 77070 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
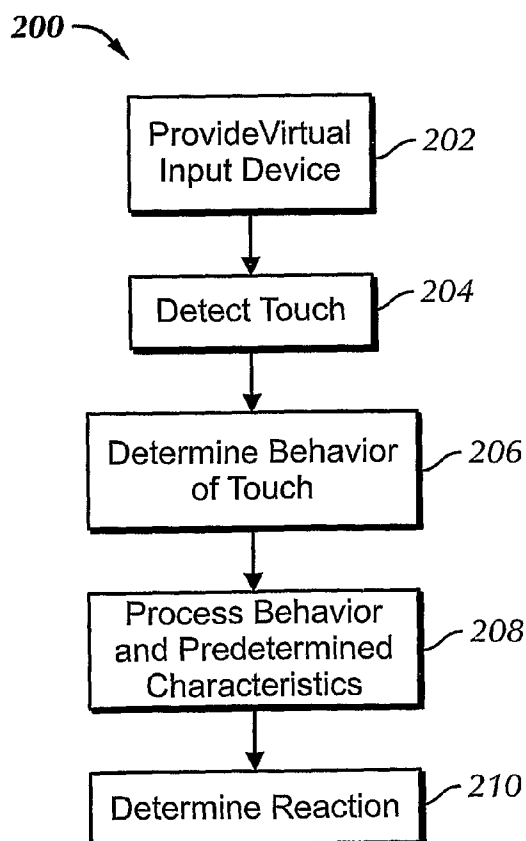
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
—   with international search report

[Continued on next page]

(54) Title: OPERATION OF A COMPUTER WITH TOUCH SCREEN INTERFACE

200 ⟍

ProvideVirtual Input Device ⟋ 202

Detect Touch ⟋ 204

Determine Behavior of Touch ⟋ 206

Process Behavior and Predetermined Characteristics ⟋ 208

Determine Reaction ⟋ 210

(57) Abstract: A touch screen computer executes an application. A method of operating the touch screen computer in response to a user is provided. A virtual input device is provided on the touch screen. The virtual input device comprises a plurality of virtual keys. It is detected that a user has touched the touch screen to nominally activate at least one virtual key, and a behavior of the user with respect to touch is determined. The determined behavior is processed and a predetermined characteristic is associated with the nominally-activated at least one virtual key. A reaction to the nominal activation is determined based at least in part on a result of processing the determined behavior.

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

OPERATION OF A COMPUTER WITH TOUCH SCREEN INTERFACE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This applications claims priority from 11/228,700 filed September 16, 2005 which is a continuation-in-part of prior Application No. 10/903,964, from which priority under 35 U.S.C. § 120 is claimed, which is hereby incorporated by reference in its entirety. This application is also related to the following co-pending applications: U.S. Serial No.: 10/840,862, filed May 6, 2004; U.S. Serial No: 11/048,264, filed July 30, 2004; U.S. Serial No. 11/038,590, filed July 30, 2004; U.S. Serial No.: 11/228,737 filed September 16, 2005; and U.S. Serial No. 11/228,758, filed September 16, 2005; all of which are hereby incorporated herein by reference in their entirety for all purposes.

BACKGROUND

Technical Field

[0002] The present patent application relates to touch screen user interfaces and, in particular, relates to operation of a computer based on interaction by a user with a virtual GUI item, such as a virtual keyboard on a touch screen user interface.

Description of the Related Art

[0003] A touch screen is a type of display screen that has a touch-sensitive transparent panel covering the screen, or can otherwise recognize touch input on the screen. Typically, the touch screen display is housed within the same housing as computer circuitry including processing circuitry operating under program control. When using a touch screen to provide input to an application executing on a computer, a user makes a selection on the display screen by pointing directly to graphical user interface (GUI) objects displayed on the screen (usually with a stylus or a finger).

[0004] A collection of GUI objects displayed on a touch screen may be considered a virtual keyboard. Similar to a conventional external keyboard that is not so closely associated with a display screen, the virtual keyboard includes a plurality of keys ("virtual keys"). Activation of a particular virtual key (or combination of virtual

keys) generates a signal (or signals) that is provided as input to an application executing on the computer.

[0005]   Touch screen keyboards, by nature of the hardware on which they operate, typically glean much more information about a user's actions than can be gleaned with a typical external keyboards. For example, whereas a typical external keyboard includes a single "sensor" (such as a mechanical switch or electrical connection) or a small number of sensors per key, touch screen keyboards typically have many more sensors per virtual key.

[0006]   It is desirable to use the information about a user's actions to make the user experience with the computer, via the touch screen virtual keyboard, more powerful than is usual (or, perhaps, even possible) with computers using external keyboards.

[0007]   On the other hand, even touch screens, with their numerous sensors, typically lack the ability to directly glean some types of information about a user's actions. It is desirable to use the information available to infer other types of information, for example, information which cannot be directly gleaned about the user's actions.

SUMMARY

[0008]   A touch screen computer executes an application. A method of operating the touch screen computer in response to a user is provided. A virtual input device is provided on the touch screen. The virtual input device comprises a plurality of virtual GUI items (which may be, in some specific examples, virtual keys of a virtual keyboard). It is detected that a user has touched the touch screen to nominally activate at least one virtual GUI item (e.g., virtual key), and a behavior of the user with respect to touch is determined. The determined behavior is processed and a predetermined characteristic is associated with the nominally-activated at least one virtual GUI item. A reaction to the nominal activation is determined based at least in part on a result of processing the determined behavior.

BRIEF DESCRIPTION OF FIGURES

Fig. 1 is a block diagram of an exemplary touch-screen based computer system, in accordance with one embodiment of the present invention

Fig. 2 is a flow chart broadly illustrating a method by which behavior of a user's touch, with respect to a virtual input device displayed on a touch screen of a multipoint sensing device, is processed to affect a reaction to the user's touch.

Fig. 3 illustrates using processing signals created by the multipoint sensing device in response to the user's touch in order to infer the pressure with which the user's touched the touch screen to activate a nominally-activated virtual key.

Fig. 4 illustrates a table data structure useable to determine reactions based on matching predetermined behavioral characteristics to actual behavioral characteristics with respect to nominally-activating particular virtual keys.

Fig. 5 is a flowchart illustrating an example of processing to determine a reaction with respect to particular user behavior.

Fig. 6A illustrates a timeline corresponding to "durations" of user behavior in the temporal domain.

Fig. 6B illustrates a table data structure similar to the table illustrated in Fig. 4, to determine reactions based on user behaviors with respect to "durations" such as are illustrated in Fig. 6A.

Fig. 7 illustrates a table structure for determining reactions based on user behavior with respect to nominally activating combinations of virtual keys.

Fig. 8 is a flow chart illustrating an example of processing to determine a reaction with respect to particular user behavior with respect to nominally activating combinations of virtual keys.

Fig. 9 illustrates a possible reaction to a nominal virtual key activation is display of a menu.

Fig. 10 illustrates an example of a display having GUI items that are not virtual keys.

DETAILED DESCRIPTION

[0009]   Examples and aspects are discussed below with reference to the figures. However, it should be understood that the detailed description given herein with respect to these figures is for explanatory purposes only, and not by way of limitation.

[0010]   Fig.1 is a block diagram of an exemplary computer system 50, in accordance with one embodiment of the present invention. The computer system 50 may correspond to a personal computer system, such as a desktop computer system, a laptop computer system, a tablet computer system or a handheld computer system. The computer system may also correspond to a computing device, such as a cell phone, PDA, dedicated media player, consumer electronic device, and the like.

[0011]   The exemplary computer system 50 shown in Fig. 1 includes a processor 56 configured to execute instructions and to carry out operations associated with the computer system 50. For example, using instructions retrieved for example from memory, the processor 56 may control the reception and manipulation of input and output data between components of the computing system 50. The processor 56 can be implemented on a single-chip, multiple chips or multiple electrical components. For example, various architectures can be used for the processor 56, including dedicated or embedded processor, single purpose processor, controller, ASIC, and so forth.

[0012]   In most cases, the processor 56 together with an operating system operates to execute computer code and produce and use data. Operating systems are generally well known and will not be described in greater detail. By way of example, the operating system may correspond to OS/2, DOS, Unix, Linux, Palm OS, and the like. The operating system can also be a special purpose operating system, such as may be used for limited purpose appliance-type computing devices. The operating system, other computer code and data may reside within a memory block 58 that is operatively coupled to the processor 56. Memory block 58 generally provides a place to store computer code and data that are used by the computer system 50. By way of example, the memory block 58 may include Read-Only Memory (ROM), Random-Access Memory (RAM), hard disk drive and/or the like. The information could also reside on a removable storage medium and loaded or installed onto the computer system 50 when needed. Removable storage mediums include, for example, CD-ROM, PC-CARD, memory card, floppy disk, magnetic tape, and a network component.

[0013]   The computer system 50 also includes a display device 68 that is operatively coupled to the processor 56. The display device 68 may be a liquid

crystal display (LCD) (e.g., active matrix, passive matrix and the like). Alternatively, the display device 68 may be a monitor such as a monochrome display, color graphics adapter (CGA) display, enhanced graphics adapter (EGA) display, variable-graphics-array (VGA) display, super VGA display, cathode ray tube (CRT), and the like. The display device may also correspond to a plasma display or a display implemented with electronic inks.

[0014]   The display device 68 is generally configured to display a graphical user interface (GUI) 69 that provides an easy to use interface between a user of the computer system and the operating system or application running thereon. Generally speaking, the GUI 69 represents, programs, files and operational options with graphical images. The graphical images may include windows, fields, dialog boxes, menus, icons, buttons, cursors, scroll bars, etc. Such images may be arranged in predefined layouts, or may be created dynamically to serve the specific actions being taken by a user. During operation, the user can select and activate various graphical images in order to initiate functions and tasks associated therewith. By way of example, a user may select a button that opens, closes, minimizes, or maximizes a window, or an icon that launches a particular program. The GUI 69 can additionally or alternatively display information, such as non interactive text and graphics, for the user on the display device 68.

[0015]   The computer system 50 also includes an input device 70 that is operatively coupled to the processor 56. The input device 70 is configured to transfer data from the outside world into the computer system 50. The input device 70 may for example be used to perform tracking and to make selections with respect to the GUI 69 on the display 68. The input device 70 may also be used to issue commands in the computer system 50. The input device 70 may include a touch sensing device configured to receive input from a user's touch and to send this information to the processor 56. By way of example, the touch-sensing device may correspond to a touchpad or a touch screen. In many cases, the touch-sensing device recognizes touches, as well as the position and magnitude of touches on a touch sensitive surface. The touch sensing means reports the touches to the processor 56 and the processor 56 interprets the touches in accordance with its programming. For example, the processor 56 may initiate a task in accordance with a particular touch. A dedicated

processor can be used to process touches locally and reduce demand for the main processor of the computer system. The touch sensing device may be based on sensing technologies including but not limited to capacitive sensing, resistive sensing, surface acoustic wave sensing, pressure sensing, optical sensing, and/or the like. Furthermore, the touch sensing means may be based on single point sensing or multipoint sensing. Single point sensing is capable of only distinguishing a single touch, while multipoint sensing is capable of distinguishing multiple touches that occur at the same time.

[0016]   The input device 70 may be a touch screen that is positioned over or in front of the display 68. The touch screen 70 may be integrated with the display device 68 or it may be a separate component. The touch screen 70 has several advantages over other input technologies such as touchpads, mice, etc. For one, the touch screen 70 is positioned in front of the display 68 and therefore the user can manipulate the GUI 69 directly. For example, the user can simply place their finger over an object to be controlled. In touch pads, there is no one–to-one relationship such as this. With touchpads, the touchpad is placed away from the display typically in a different plane. For example, the display is typically located in a vertical plane and the touchpad is typically located in a horizontal plane. This makes its use less intuitive, and therefore more difficult when compared to touch screens. In addition to being a touch screen, the input device 70 can be a multipoint input device. Multipoint input devices have advantages over conventional singlepoint devices in that they can distinguish more than one object (finger). Singlepoint devices are simply incapable of distinguishing multiple objects. By way of example, a multipoint touch screen, which can be used herein, is shown and described in greater detail in copending and commonly assigned U.S. Patent Application No.: 10/840,862, which is hereby incorporated herein by reference.

[0017]   The computer system 50 also includes capabilities for coupling to one or more I/O devices 80. By way of example, the I/O devices 80 may correspond to keyboards, printers, scanners, cameras, speakers, and/or the like. The I/O devices 80 may be integrated with the computer system 50 or they may be separate components (e.g., peripheral devices). In some cases, the I/O devices 80 may be connected to the computer system 50 through wired connections (e.g., cables/ports). In other cases, the

I/O devices 80 may be connected to the computer system 80 through wireless connections. By way of example, the data link may correspond to PS/2, USB, IR, RF, Bluetooth or the like.

[0018]   Particular processing within a touch-screen based computer is now described, where the processing accomplishes execution of an application as well as providing a display on the touch screen of the computer. The display processing includes providing a composite display that has characteristics based on the application display as well as characteristics relative to a virtual input device. The virtual input device display includes at least an input portion, to receive appropriate touch input to the touch screen relative to the displayed input device, for a user to interact with the virtual input device. The user interaction with the virtual input device includes activating portions of the virtual input device to provide user input to affect the application processing. The virtual input device (i.e., processing on the computer to accomplish the virtual input device) processes the user interaction and, based on the processing, provides the corresponding user input to the application.

[0019]   The virtual input device display is typically highly correlated to the virtual input device processing of user interaction with the virtual input device. For example, if the virtual input device is a virtual keyboard, the virtual input device display may include a graphic representation of the keys of a typical QWERTY keyboard, whereas virtual input device processing of user interaction with the virtual keyboard includes determining which virtual keys have been activated by the user and providing corresponding input (e.g., letters and/or numbers) to the application.

[0020]   We now turn to Fig. 2, which is a flow chart illustrating a broad aspect of the invention. In particular, the Fig. 2 flow chart broadly illustrates a method by which behavior of a user's touch, with respect to a virtual input device displayed on a touch screen of a multipoint sensing device, is processed to affect a reaction to the user's touch. At step 202, the virtual input device is provided on the touch screen. The virtual input device may be, for example, a virtual QWERTY-style keyboard or other input device having virtual keys.

[0021]   At step 204, a user's touch on the multipoint sensing device, to nominally activate a virtual key, is detected. Detecting a user's touch may be conventional. At step 206, the "behavior" of the user's touch is determined. The behavior is typically

determined by processing signals created by the multipoint sensing device in response to the user's touch. Behaviors may be, for example, in the spatial domain (i.e., where on the multipoint sensing device the user touched to nominally activate the virtual key) or in the time domain (i.e., with what timing the user touched the multipoint sensing device to nominally activate the virtual key) and a combination of both spatial and time domain.

[0022] At step 208, the determined behavior and predetermined characteristics associated with the nominally-activated virtual key are processed. At step 210, based on the processing in step 208, a reaction is determined to activation of the nominally-activated virtual key. Examples of predetermined characteristics are illustrated later in this description. Broadly speaking, however, the predetermined characteristics for a virtual key are characteristics associated with particular behaviors or ranges of behaviors of a user's touch to nominally activate that virtual key.

[0023] Fig. 3 illustrates using processing signals created by the multipoint sensing device in response to the user's touch in order to infer the pressure with which the user's touched the touch screen to activate a nominally-activated virtual key. Such processing is useful in the case where a pressure signal is not directly available from the touch screen, or to supplement a pressure signal that is directly available from the touch screen. The area 302 represents points on the touch screen that correspond to a particular virtual key. While the area 302 is a square, virtual keys need not be limited to being a particular shape.

[0024] Area 306 indicates (in a spatial domain) points on a touch screen that a user touched to nominally activate the virtual key of area 302. Similarly, area 304 indicates points on the touch screen that a user touched to nominally activate the virtual key of area 302. Which points are touched may be determined, for example, from the processing signals created by the multipoint sensing device in response to the user's touch.

[0025] Since area 304 encompasses more points than area 306, the touch corresponding to area 304 was with greater pressure than the touch corresponding to area 306. Furthermore, an indication of the actual pressure with which a virtual key is nominally activated may be inferred from the area corresponding to the user's touch.

[0026]   While Fig. 3 illustrates all of the points within areas 304 and 306 fall within the area 302, this need not necessarily be the case. Furthermore, while Fig. 3 illustrates using the user's behavior in the spatial domain to infer pressure with which a virtual key is nominally activated, in some examples, the user's behavior in the time domain may be used to infer pressure with which a virtual key is nominally activated. In other examples, a combination of the user's behavior in the spatial domain and the time domain may be used to infer pressure with which a virtual key is nominally activated.

[0027]   Having described one particular example of behavior of a user's touch of a touch screen to nominally activate a virtual key, we now describe one example of processing to process the determined behavior with which the user nominally activates a virtual key and predetermined characteristics for the nominally-activated virtual key.

[0028]   Referring to Fig. 4, this figure illustrates a table in which each row is for a different one of a plurality of virtual keys. For example, row 408 is for one virtual key; row 410 is for another virtual key; and row 412 is for yet another virtual key. Column 402 includes indications of the virtual keys. Column 404 includes indications of predetermined behavioral characteristics for the virtual keys.

[0029]   The predetermined behavioral characteristics are discussed in detail later. Broadly speaking, the predetermined behavioral characteristics are predetermined values of user's behavior (for example, specific values or ranges of values) in the spatial domain, the time domain or both. Using the Fig. 3 example, predetermined behavioral characteristics indicated in column 404 may include, for example, specific values of inferred pressure of a user's touch of a touch screen to nominally activate a virtual key indicated in column 402. As another example, the predetermined characteristics indicated in column 404 may include ranges of values of inferred pressure of a user's touch of the touch screen to nominally activate a virtual key indicated in column 402.

[0030]   The column 406 includes indications of reactions corresponding to the predetermined characteristics indicated in column 404. That is, each reaction indicated in column 406 is an action to be taken (or, in some cases, not taken) when a

determined behavior is matched to a particular predetermined behavioral characteristic in column 404.

[0031]   An example of processing to determine a reaction with respect to particular user behavior is now described with reference to the flowchart in Fig. 5. For ease of illustration, the operation of the Fig. 5 example is discussed with respect to the Fig. 4 table, and with respect to a particular nominally-activated key, although the method illustrated in the Fig. 5 flowchart is not limited to being used with respect to a data structure of the form shown in Fig. 4.

[0032]   Turning now to Fig. 5, at step 502, the possible predetermined behavioral characteristics in column 404 for the particular nominally-activated virtual key (in column 402) are accessed. For example, the particular nominally-activated key may be indicated in the entry where row 410 intersects with column 402. The accessed possible predetermined behavioral characteristics would then be within the rectangle 414.

[0033]   At step 504, the determined behavior (i.e., the behavior of the user's touch in the spatial and/or time domain) is matched to the possible predetermined behavioral characteristics indicated in column 404. Then, in step 506, based on the matching, a reaction from column 406 is determined.   Using the example of row 410, the determined reaction would be one of the reactions indicated within the rectangle 416.

[0034]   We now discuss in greater detail, with reference to Figs. 6A and 6B, what may be the predetermined behavioral characteristics indicated, for example, in column 404 of the Fig. 4 table and corresponding determined reactions.   In the example of Figs. 6A and 6B, the predetermined behavioral characteristics are in the time domain only and, specifically, are durations (here, ranges of durations) of the user's touch of the touch screen to nominally activate a virtual key.

[0035]   Fig. 6A illustrates a timeline 650, with increasing duration from left to right.   Various durations are indicated on the timeline, including "z", "x" and "y," from left to right.   Reference numeral 651 indicates a duration less than "z." Reference numeral 652 indicates a duration greater than or equal to "z" and less than "x." Reference numeral 654 indicates a duration greater than or equal to "x" and less

than "y." Finally, reference numeral 656 indicates a duration greater than or equal to "y."

[0036]   Fig. 6B illustrates a portion of a table similar to the table illustrated in Fig. 4. The column 602 includes the entry for one particular nominally-activated virtual key.   The column 604 includes entries for the predetermined behavioral characteristics.   In the Fig. 6B example, the column 604 includes entries for the durations 651, 652, 654 and 656 denoted on the Fig. 6A timeline 650.

[0037]   As discussed with reference to Fig. 5, the predetermined behavioral characteristics are matched to the determined behavior of the user's touch that nominally activates the virtual key.   Based on the match, a reaction is determined. Column 606 of the Fig. 6B table portion includes indications of such reactions.

[0038]   The reaction indications in column 606 are indicated by reference numerals 681, 682, 684 and 686; corresponding to the predetermined behavioral characteristics indicated by reference numerals 651, 652, 654 and 656.   Referring to the specific reaction indications in column 606, the reaction indication 681 indicates that the nominally-activated virtual key is to not, in fact, be activated. That is, the duration of the touching is too short to indicate an actual activation of the virtual key. Similarly, the reaction indication 686 indicates that the nominally-activated virtual key is to not be actually activated.   In this case, the duration of the touching is too long, presumably corresponding to a resting finger or hand part and not to an intentional activation.

[0039]   The remaining reaction indications are the reaction indication 682 and the reaction indication 684.   The reaction indication 682 indicates that the nominally-activated key is to be actually activated a single time.   The reaction indication 684 indicates that the nominally-activated key is to be actually activated repeated times, with the number of times to repeat the actual activation a function of the duration of the touching.

[0040]   Fig. 6A and Fig. 6B illustrate a simple example of determining reactions based on a determined behavior of the user in the time domain.   As discussed above, reactions may be determined based on determined behaviors in the spatial domain, and based on a combination of determined behaviors in the spatial domain and in the

time domain. The number and range of determined behaviors that may be used to determine reactions is limited, to some extent, only by what behavioral characteristics can be discerned or inferred.

[0041]   A determined behavior in the spatial domain – inferred pressure -- was discussed above with reference to Fig. 3. Other possible behaviors in the spatial domain include, for example, the area of the touch of a nominally-activated virtual key relative to the area of the touch of an adjacent such virtual key (i.e., there is not a "direct hit" of the user's finger in touching a virtual key). Possible behaviors that are in a combination of the spatial domain and the time domain are referred to, in some instances, as "gestures." See, for example, co-pending United States patent application no. 10/903,964, entitled GESTURES FOR TOUCH SENSITIVE INPUT DEVICES and filed July 30, 2004.

[0042]   Furthermore, the possible reactions, too, are somewhat limitless. Particularly where possible reactions are common possible reactions (such as, for example, a single activation or repeated activations), the reaction indication entry may be a link to a repository of such common possible reactions.

[0043]   In some examples, the possible reactions and/or the predetermined behavioral characteristics may be user configurable, for example, using a menu or other utility. In some examples the possible reactions and/or the predetermined behavioral characteristics are automatically and dynamically configurable, based on the ongoing determined behavior of the user.

[0044]   Fig. 9 illustrates a possible reaction is display of a menu 902. For example, the user may activate the "e" virtual key 906 with a particular behavior, and the reaction includes display of the menu 902. The menu 902, in the Fig. 9 illustration, includes additional virtual keys (e.g., 904a and 904b) corresponding to different forms of "e." In some examples, actual display of the menu 902 is bypassed based on particular behaviors, although the virtual keys of the menu 902 are still present and able to be activated. For example, the user may nominally activate the "e" virtual key 906 with a "brush" gesture toward the additional virtual key 904 that is desired to be activated. The user would know the location of the additional virtual keys 904 based, for example, on previous use operation of the virtual keyboard. Not

displaying the menu 902, a shortcut is provided for activating the additional virtual keys 904.

[0045] We now discuss, with reference to Fig. 7 and Fig. 8, an example where a combination of virtual keys is nominally activated. This example is similar in many ways to the example discussed above with reference to Fig. 5 and Figs. 6A and 6B. Referring first to Fig. 7, the column 702 includes entries for combinations of nominally-activated virtual keys. For example, one such entry in column 702 may be for a virtual key corresponding to an "a" in combination with a virtual key corresponding to a "SHIFT."

[0046] Each single possible combination of nominally-activated keys need not have a separate entry in the column 702. Where the combinations of predetermined behavioral characteristics in column 704 and the possible reactions in column 706 have common characteristics for plural combinations of nominally-activated virtual keys, the entries in column 704 and/or column 706 may be common to the plural combinations of predetermined behavioral characteristics, and parameterized if necessary to accommodate unique attributes associated with particular ones of the combinations of nominally-activated virtual keys.

[0047] Typically, many combinations of virtual keys do not have corresponding entries, such combinations typically resulting from inadvertent touching of the combinations of virtual keys. For a combination that does not have a corresponding entry, there would be no reaction to the combination. As another example, the such combinations may have corresponding entries, and the reaction would be "no reaction" or a reaction to generate an alert (e.g., a "beep" or other alert) to the user.

[0048] Referring to Fig. 8, the flowchart 800 illustrates an example of processing to determine a reaction with respect to particular user behavior relative to a combination of nominally-activated virtual keys. While not so limited, the operation of the Fig. 8 processing is described with reference to the data structure illustrated in Fig. 7.

[0049] At step 802, the possible predetermined behavioral characteristics in column 704 for the particular combination of nominally-activated virtual keys (in column 702) are accessed. At step 804, the determined behavior (i.e., the behavior of

the user's touch in the spatial and/or time domain) is matched to the possible predetermined behavioral characteristics indicated in column 704. Then, in step 806, based on the matching, a reaction from column 706 is determined.

[0050]   Fig. 10 illustrates an example of a display having virtual GUI items that are not virtual keys of a virtual keyboard. The general concepts discussed above with the specific example of virtual keys of a virtual keyboard are generally applicable to virtual GUI items. For example, less pressure and/or shorter duration of touching (e.g., by a finger 1002) may be required to activate the "keep" virtual GUI item 1004 than to activate the "delete" virtual GUI item 1006. In addition, the processing may be such that activation of some GUI items (such as the "delete" GUI item, for example) require additional behavior, such as a "wiggle" or other gesture, which would serve as additional confirmation that it is intended for the GUI item to be activated.

[0051]   In some examples, the combination is "registered" only upon a particular condition, such as one virtual key of the combination being released.

[0052]   In some examples, a "preview" function is provided. Thus, for example, before a virtual GUI item's activation is committed, an indication of the activation is displayed. This may be particularly useful, for example, where the virtual GUI items are particularly small. Fig. 11 illustrates a finger 1102 whose touch may be activating either the "w" virtual key or the "e" virtual key. The temporary overlay 1108 displays an indication that the "e" virtual key is to be activated, before the "e" virtual key activation is committed as typed text 1110. For example, the finger 1102 being lifted while a particular virtual key is indicated as being to be activated may cause the particular virtual key to actually be activated. In the Fig. 11 example, if the "e" virtual key is not to be activated, then the finger 1102 may be moved (e.g., without lifting it) on the touch screen to activate a different virtual key.

[0053]   The various aspects, features, embodiments or implementations of the invention described above can be used alone or in various combinations. The invention is preferably implemented by software, but can also be implemented in hardware or a combination of hardware and software. The invention can also be embodied as computer readable code on a computer readable medium. The computer readable medium is any data storage device that can store data that can thereafter be

read by a computer system. Examples of the computer readable medium include read-only memory, random-access memory, CD-ROMs, DVDs, magnetic tape, optical data storage devices, and carrier waves. The computer readable medium can also be distributed over network-coupled computer systems so that the computer readable code is stored and executed in a distributed fashion.

[0054]   The advantages of the invention are numerous. Different embodiments or implementations may, but need not, yield one or more of the disclosed advantages. As set forth above, one advantage of the invention is that how a touch screen computer reacts to a user's touch to a virtual keyboard provided on the touch screen can be based on a deep appreciation for the behavior with which the user touches the touch screen. Another advantage of the invention is that how the touch screen computer reacts to the user's touch can be highly configurable.

[0055]   The many features and advantages of the present invention are apparent from the written description and, thus, it is intended by the appended claims to cover all such features and advantages of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, the invention should not be limited to the exact construction and operation as illustrated and described. Hence, all suitable modifications and equivalents may be resorted to as falling within the scope of the invention.

What is Claimed

1. A method of operating a touch screen computer in response to a user, the touch screen computer executing an application, comprising:

     providing a virtual input device, comprising a plurality of virtual graphical user interface (GUI) items, on the touch screen;

     detecting that a user has touched the touch screen to nominally activate at least one virtual GUI item and determining a behavior of the user with respect to said touch;

     processing said determined behavior and a predetermined characteristic associated with said nominally-activated at least one virtual GUI item; and

     determining a reaction to said nominal activation based at least in part on a result of said processing step.

2. The method of claim 1, wherein:

the behavior of the user includes a pressure with which the user touches the touch screen to nominally activate the at least one virtual GUI item,

3. The method of claim 2, wherein:

determining the pressure includes processing a determined total area of the touch screen touched by the user.

4. The method of claim 3, further including:

determining the total area of the touch screen touched by the user based on processing data corresponding to a number of points of the touch screen touched by the user.

5. The method of claim 2, wherein:

determining the pressure includes processing pressure data indicated by the touch screen.

6. The method of claim 2, wherein:

determining the pressure includes processing a combination of pressure data indicated by the touch screen and data corresponding to a number of points of the touch screen touched by the user.

7. The method of claim 1, wherein:

the behavior of the user includes a duration which the user touches the touch screen to nominally activate the at least one virtual GUI item.

8. The method of claim 1, wherein:

the behavior of the user includes a particular gesture with respect to the virtual GUI item.

9. The method of claim 7, wherein:

the predetermined characteristic includes a characterization of how to react to duration.

10. The method of claim 7, wherein:

the predetermined characteristic includes displaying a preview indication associated with the nominally activated virtual GUI item.

11. The method of claim 10, further comprising:

determining whether the user has made a particular gesture with respect to said touch screen in conjunction with displaying the preview indication, to determine whether to actually activate the nominally-activated virtual GUI item.

12. The method of claim 9, wherein how to react to duration includes whether to treat the duration which the user touches the touch screen to nominally activate the at least one virtual GUI item as a plurality of individual repeated activations of said virtual GUI item.

13. The method of claim 12, wherein:

treating the duration which the user touches the touch screen to nominally activate the at least one virtual GUI item as a plurality of individual activations of said at least

one virtual GUI item includes determining a particular number of individual activations with which to treat the duration based on a function of the duration.

14. The method of claim 1, wherein:

the reaction includes treating the user touching the touch screen as not actually activating the at least one virtual GUI item.

15. The method of claim 14, wherein:

the determined behavior is duration, and duration is not within predetermined characteristic of a duration appropriate to actually activate the nominally activated at least one virtual GUI item.

16. The method of claim 1, wherein:

determining reaction includes causing treating the nominally-activated at least one virtual GUI item as an originally-activated virtual GUI item and causing a plurality of new virtual GUI items to be formed on the touch screen.

17. The method of claim 16, further comprising:

causing the virtual GUI itemboard display to be modified to display indications corresponding to the new virtual GUI items formed on the touch screen.

18. The method of claim 16 wherein:

the plurality of new virtual GUI items are a sub-menu of the activated virtual GUI item.

19. The method of claim 17, wherein:

the virtual GUI item is a first virtual GUI item; and

the method further comprises detecting that the user has touched the touch screen to nominally activate one of the new virtual GUI items formed on the touch screen.

20. The method of claim 19, wherein:

the virtual GUI items are virtual keys of a virtual keyboard;

the behavior of the user is a duration between the user touching the touch screen
to nominally activate the first virtual key and the user touching the touch screen to
nominally activate the one of the new virtual keys; and

if the duration is less than a predetermined time, omitting the step of causing the
virtual keyboard display to be modified to display indications corresponding to the
new virtual keys.

21. A computer-readable medium having a computer program tangibly embodied
thereon, the computer program including steps for operating a touch screen computer
in response to a user while the touch screen computer executing an application, the
steps of the computer program comprising:

   providing a virtual input device, comprising a plurality of virtual graphical
user interface (GUI) items, on the touch screen;

   detecting that a user has touched the touch screen to nominally activate at least
one virtual GUI item and determining a behavior of the user with respect to said
touch;

   processing said determined behavior and a predetermined characteristic
associated with said nominally-activated at least one virtual GUI item; and

   determining a reaction to said nominal activation based at least in part on a
result of said processing step.

22. The computer-readable medium of claim 19, wherein:

the behavior of the user includes a pressure with which the user touches the touch
screen to nominally activate the at least one virtual GUI item,

23. The computer-readable medium of claim 22, wherein:

determining the pressure includes processing a determined total area of the touch
screen touched by the user.

24. The computer-readable medium of claim 23, the computer program further
including the step of:

determining the total area of the touch screen touched by the user based on processing data corresponding to a number of points of the touch screen touched by the user.

25. The computer-readable medium of claim 21, wherein:

the behavior of the user includes a duration which the user touches the touch screen to nominally activate the at least one virtual GUI item.

26. The computer-readable medium of claim 25, wherein:

the predetermined characteristic includes a characterization of how to react to duration.

27. The computer-readable medium of claim 26, wherein how to react to duration includes whether to treat the duration which the user touches the touch screen to nominally activate the at least one virtual GUI item as a plurality of individual repeated activations of said virtual GUI item.

28. The computer-readable medium of claim 27, wherein:

treating the duration which the user touches the touch screen to nominally activate the at least one virtual GUI item as a plurality of individual activations of said at least one virtual GUI item includes determining a particular number of individual activations with which to treat the duration based on a function of the duration.

29. The computer-readable medium of claim 21, wherein:

the reaction includes treating the user touching the touch screen as not actually activating the at least one virtual GUI item.

30. The computer-readable medium of claim 27, wherein:

the determined behavior is duration, and duration is not within predetermined characteristic of a duration appropriate to actually activate the nominally activated at least one virtual GUI item.

31. The computer-readable medium of claim 21, wherein:

determining reaction includes causing treating the nominally-activated at least one virtual GUI item as an originally-activated virtual GUI item and causing a plurality of new virtual GUI items to be formed on the touch screen.

32. The computer-readable medium of claim 29, wherein:

the virtual GUI items are virtual keys of a virtual keyboard; and

the computer program further includes a step of causing the virtual keyboard display to be modified to display indications corresponding to the new virtual keys formed on the touch screen.

33. The computer-readable medium of claim 31, wherein:

the plurality of new virtual keys are a sub-menu of the activated virtual key.

34. The computer-readable medium of claim 32, wherein:

the virtual key is a first virtual key; and

the computer program further comprises detecting that the user has touched the touch screen to nominally activate one of the new virtual keys formed on the touch screen.

35. The computer-readable medium of claim 34, wherein:

the behavior of the user is a duration between the user touching the touch screen to nominally activate the first virtual key and the user touching the touch screen to nominally activate the one of the new virtual keys; and

if the duration is less than a predetermined time, omitting the step of causing the virtual keyboard display to be modified to display indications corresponding to the new virtual keys.

36. A touch screen computer operating at least partially in response to a user, the touch screen computer executing an application including steps of:

providing a virtual input device, comprising a plurality of virtual graphical user interface (GUI) items, on the touch screen;

detecting that a user has touched the touch screen to nominally activate at least one virtual GUI item and determining a behavior of the user with respect to said touch;

processing said determined behavior and a predetermined characteristic associated with said nominally-activated at least one virtual GUI item; and

determining a reaction to said nominal activation based at least in part on a result of said processing step.

37. The touch screen computer of claim 36, wherein:

the behavior of the user includes a pressure with which the user touches the touch screen to nominally activate the at least one virtual GUI item,

38. The computer of claim 37, wherein:

the predetermined characteristic includes a characterization of how to react to the pressure.

39. The method of claim 36, wherein:

the behavior of the user includes a duration which the user touches the touch screen to nominally activate the at least one virtual GUI item.

40. The method of claim 39, wherein:

the predetermined characteristic includes a characterization of how to react to duration.

41. A method of operating a touch screen computer in response to a user, the touch screen computer executing an application, comprising:

providing a virtual keyboard, comprising a plurality of virtual keys, on the touch screen;

detecting that a user has touched the touch screen to nominally activate at least one virtual key and determining a behavior of the user with respect to said touch;

processing said determined behavior and a predetermined characteristic associated with said nominally-activated at least one virtual key; and

determining a reaction to said nominal activation based at least in part on a result of said processing step.

42. The method of claim 41, wherein:

the behavior of the user includes a pressure with which the user touches the touch screen to nominally activate the at least one virtual GUI item,

43. The method of claim 42, wherein:

the predetermined characteristic includes a characterization of how to react to the pressure.

44. The method of claim 40, wherein:

the behavior of the user includes a duration which the user touches the touch screen to nominally activate the at least one virtual GUI item.

45. The method of claim 44, wherein:

the predetermined characteristic includes a characterization of how to react to duration.

46. A computer-readable medium having a computer program tangibly embodied thereon, the computer program including steps for operating a touch screen computer in response to a user while the touch screen computer executing an application, the steps of the computer program comprising:

providing a virtual keyboard, comprising a plurality of virtual keys, on the touch screen;

detecting that a user has touched the touch screen to nominally activate at least one virtual key and determining a behavior of the user with respect to said touch;

processing said determined behavior and a predetermined characteristic associated with said nominally-activated at least one virtual key; and

determining a reaction to said nominal activation based at least in part on a result of said processing step.

47. The method of claim 46, wherein:

the behavior of the user includes a pressure with which the user touches the touch screen to nominally activate the at least one virtual GUI item,

48. The method of claim 47, wherein:

the predetermined characteristic includes a characterization of how to react to the pressure.

49. The method of claim 46, wherein:

the behavior of the user includes a duration which the user touches the touch screen to nominally activate the at least one virtual GUI item.

50. The method of claim 49, wherein:

the predetermined characteristic includes a characterization of how to react to duration.

51. A method of operating a touch screen computer, the touch screen computer executing an application, comprising:

  displaying a virtual input device on the touch screen;

  detecting that a user has touched the touch screen to nominally activate at least one virtual GUI item of the virtual input device; and

  based at least in part on a behavior of the user and a predetermined characteristic associated with said nominally-activated at least one virtual GUI item, determining a reaction to said nominal activation.

52. The method of claim 51, wherein:

  the behavior of the user is a characteristic of the user's touch of the touch screen.

53. A computer-readable medium including a program to operate a touch screen computer, the touch screen computer executing an application, the program to operate a touch screen computer comprising:

  displaying a virtual input device on the touch screen;

detecting that a user has touched the touch screen to nominally activate at least one virtual GUI item of the virtual input device; and

based at least in part on a behavior of the user and a predetermined characteristic associated with said nominally-activated at least one virtual GUI item, determining a reaction to said nominal activation.

54.   The method of claim 53, wherein:

the behavior of the user is a characteristic of the user's touch of the touch screen.
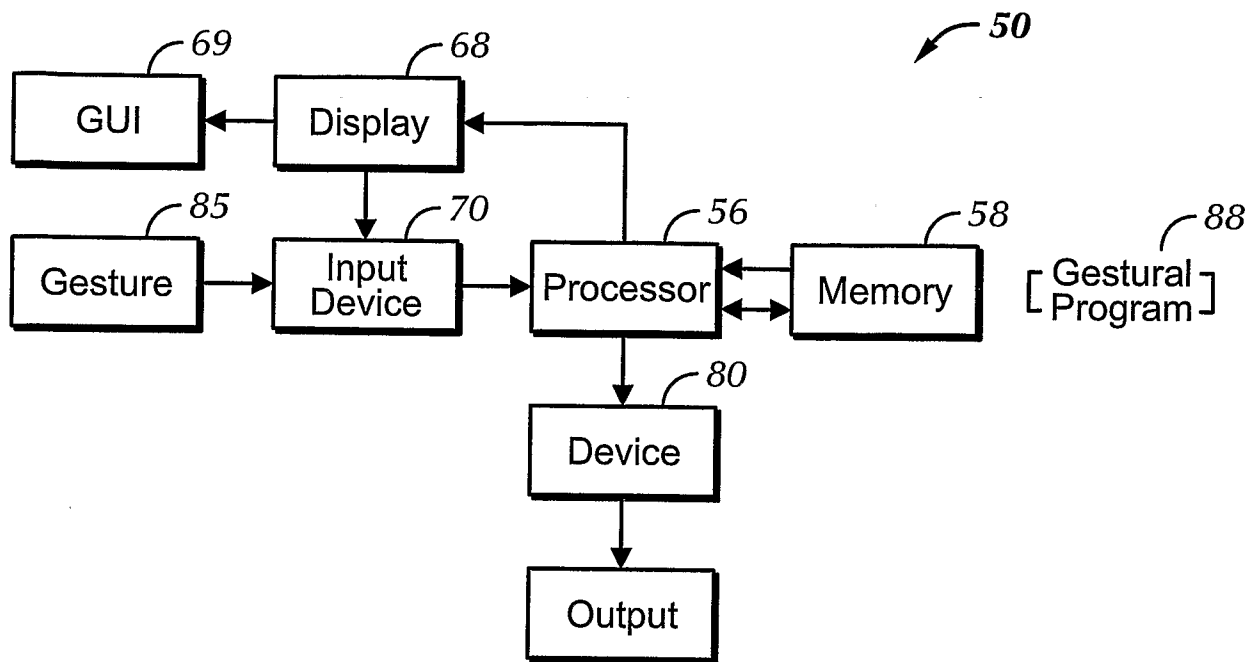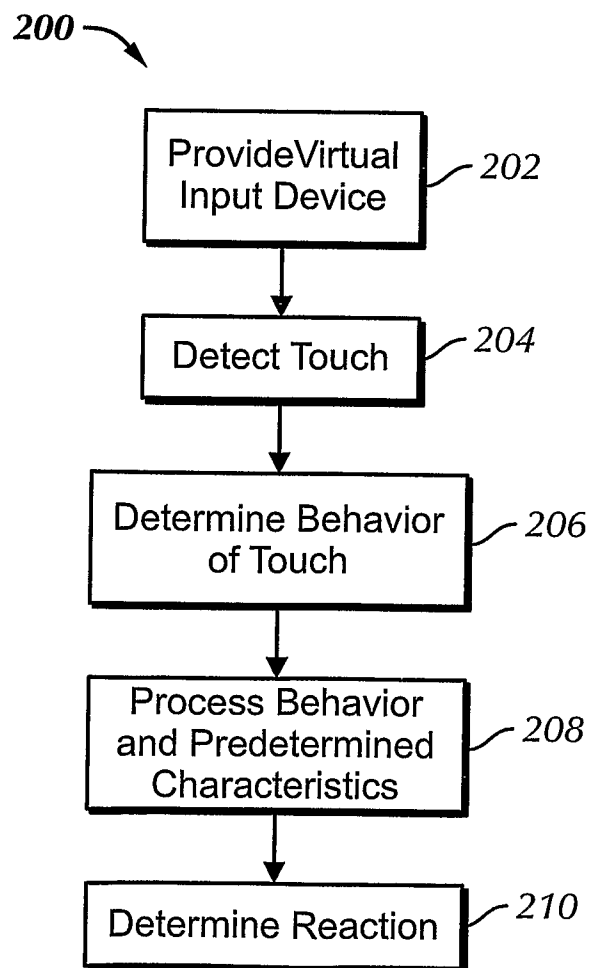
FIG. 1
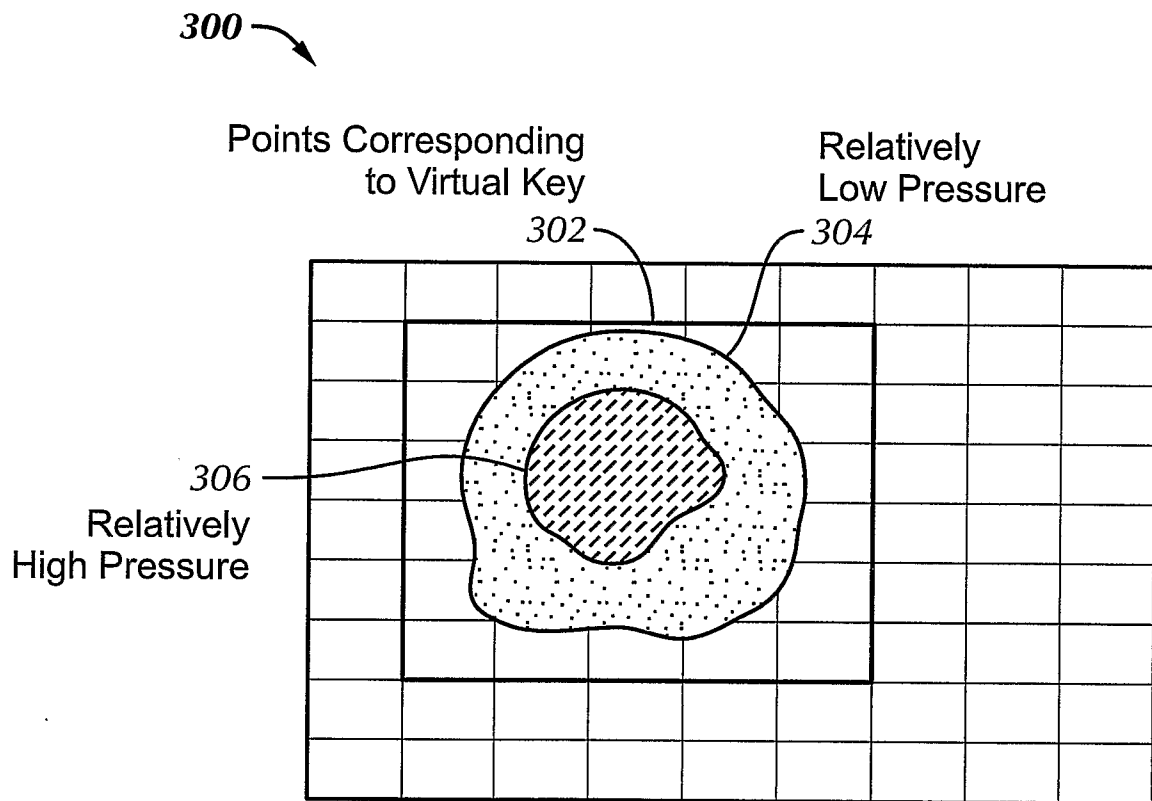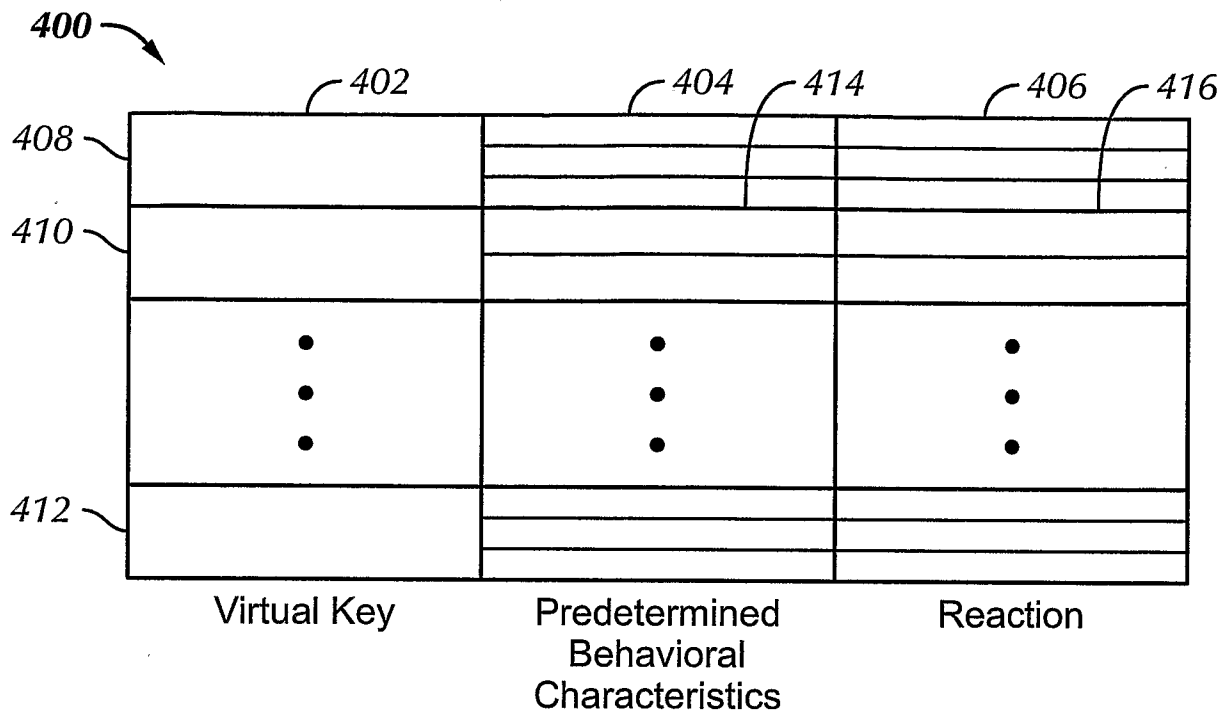

FIG. 2

Portion of Multi-Point Capable Touch Screen

FIG. 3

Virtual Key	Predetermined Behavioral Characteristics	Reaction
⋮	⋮	⋮

FIG. 4

```
Access Possible Predetermined
Behavioral Characteristics for the      502
Nominally-Activated Virtual Key

            ↓

Match Determined Behavior to
One of Accessed Possible
Predetermined Behavioral                504
Characteristics for the
Nominally-Activated Virtual Key

            ↓

Determine Reaction
Corresponding to the
Determined or Predetermined             506
Behavioral Characteristic
```

FIG. 5

650

| 652 | 654 | 656 |

0 — 651

Duration Z   Duration X   Duration Y

FIG. 6A

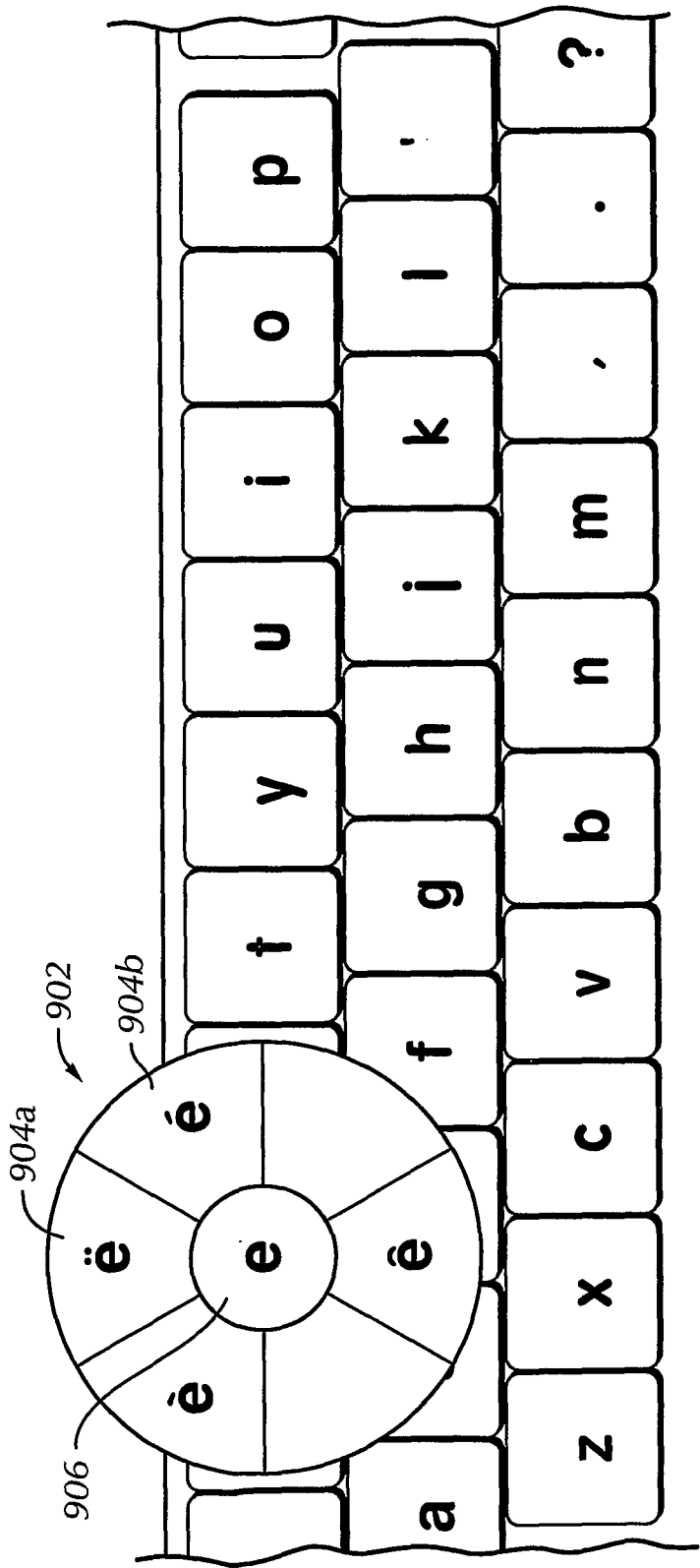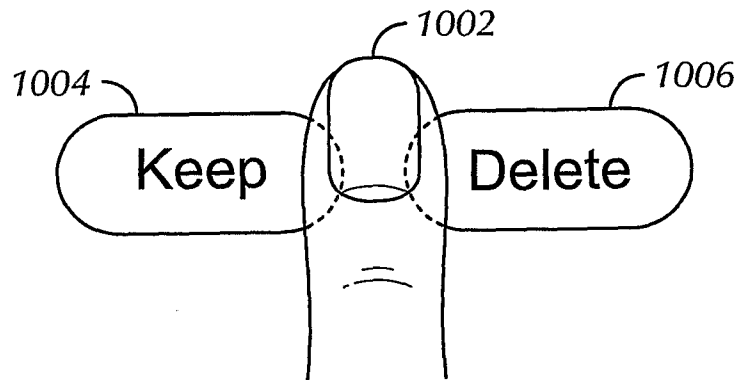| 602	604	606
	651 Duration < Z	681 No Activation
	652 Duration < X and > Z	682 Single Activation
	654 Duration ≥ X and Duration < Y	684 Repeated Activation as Function of Duration
	656 Duration ≥ Y	686 No Activation

FIG. 6B
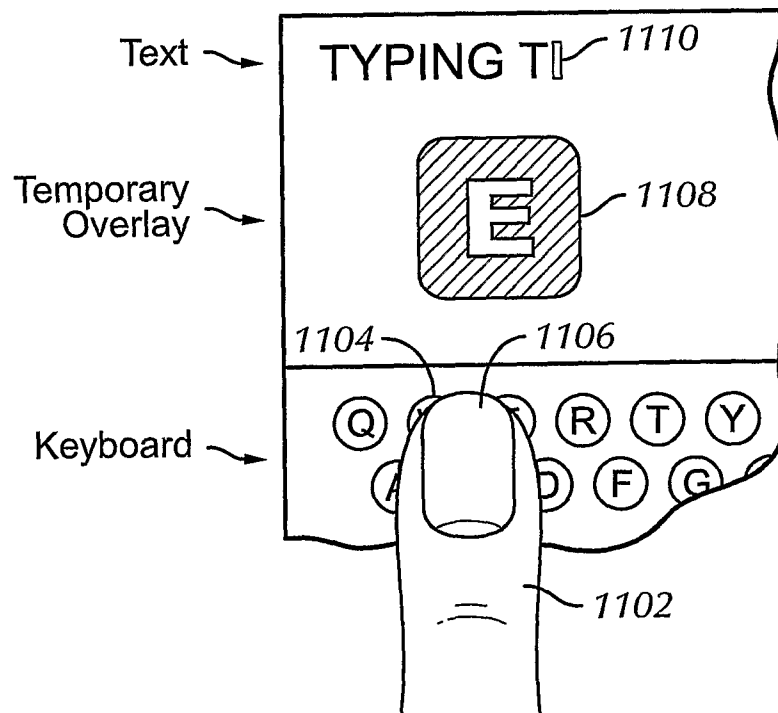
Combination of Virtual Keys	Combination of Predetermined Behavioral Characteristics	Reaction
702	704	706
⋮	⋮	⋮

FIG. 7

800

Access Possible Combination of Predetermined Behavioral Characteristics for the Combination of Nominally-Activated Virtual Keys — *802*

↓

Match Determined Combination to Any Accessed Possible Combinations — *804*

↓

Determine Reaction Corresponding to the Determined Possible Combinations — *806*

FIG. 8

FIG. 9

FIG. 10

FIG. 11

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F3/033

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	-/--	

X	Further documents are listed in the continuation of Box C.		X	See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 February 2007	27/02/2007

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Pfaffelhuber, Thomas

C(Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT	
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 100 42 300 A1 (BURGBACHER AXEL C [DE]; METTANG UWE [DE]) 28 March 2002 (2002-03-28)	1,2,7,8, 21,22, 25,36, 37,39, 41,42, 44,46, 47,49, 51,53
A	abstract	3-6, 9-20,23, 24, 26-35, 38,40, 43,45, 48,50, 52,54
	paragraphs [0006], [0014], [0015], [0033] - [0038], [0042], [0048] figures 1-3 claims 11-13	
X	WO 99/28813 A (NORTHERN TELECOM LTD [CA]) 10 June 1999 (1999-06-10)	1,2,7, 21,22, 25,36, 37,39, 51,53
A	abstract	3-6, 8-20,23, 24, 26-35, 38, 40-50, 52,54
	figures 4,12,13,14a,14b page 3 pages 9-13	
X	DE 100 59 906 A1 (BS BIOMETRIC SYSTEMS GMBH [DE]) 6 June 2002 (2002-06-06)	1,2,21, 22,36, 37,51,53
A	the whole document	3-20, 23-35, 38-50, 52,54
A	US 5 874 948 A (SHIEH JOHNNY MENG-HAN [US]) 23 February 1999 (1999-02-23) figures 2,3,9 column 2, line 17 - line 34 column 2, line 65 - column 3, line 63 column 4, line 28 - line 42	1-54

-/--

INTERNATIONAL SEARCH REPORT

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 2006/020305 A (APPLE COMPUTER [US]; HOTELLING STEVE [US]; STRICKON JOSHUA A [US]; HUP) 23 February 2006 (2006-02-23) cited in the application the whole document	1,21,36, 41,46, 51,53
P,X	WO 2005/114369 A2 (APPLE COMPUTER [US]; HOTELLING STEVE [US]; STRICKON JOSHUA A [US]; HUP) 1 December 2005 (2005-12-01) cited in the application the whole document	1,21,36, 41,46, 51,53
P,X	WO 2006/026012 A2 (HEWLETT PACKARD DEVELOPMENT CO [US]; HUDDLESTON WYATT [US]; ROBIDEAUX) 9 March 2006 (2006-03-09) the whole document	1,21,36, 41,46, 51,53

INTERNATIONAL SEARCH REPORT

Information on patent family members

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
DE 10042300	A1	28-03-2002	NONE		
WO 9928813	A	10-06-1999	US	6037937 A	14-03-2000
DE 10059906	A1	06-06-2002	NONE		
US 5874948	A	23-02-1999	NONE		
WO 2006020305	A	23-02-2006	NONE		
WO 2005114369	A2	01-12-2005	AU	2005246219 A1	01-12-2005
			CA	2557940 A1	01-12-2005
			EP	1745356 A2	24-01-2007
			US	2006097991 A1	11-05-2006
WO 2006026012	A2	09-03-2006	US	2006044280 A1	02-03-2006