**Title:** TOUCH INTERFACE FOR MOBILE DEVICE

**Abstract:** A device may include a display to show a representation of a three-dimensional image; a first touch panel to provide a first user input based on the display; a second touch panel to provide a second user input based on the display; and processing logic to associate the first user input and the second user input so that the first user input and the second user input emulate physical manipulation of the three-dimensional image and to alter the representation of the three-dimensional image based on the emulated physical manipulation of the three-dimensional image. The processing logic may also associate approximately simultaneously application of the first user input and the second user input so that the first user input and the second user input emulate altering the view of the two-dimensional image, and alter the two-dimensional representation based on received, approximately simultaneously application of the first user input and the second user input.
TOUCH INTERFACE FOR MOBILE DEVICE

BACKGROUND

The proliferation of devices, such as handheld and portable devices, has grown tremendously within the past decade. Many of these devices include some kind of display to provide a user with visual information. Visual information may include, for example three-dimensional renderings of various objects, application menus, and/or two-dimensional renderings that cannot be legibly contained within the size of the display. These devices may also include an input device, such as a keypad, touch screen, and/or one or more buttons to allow a user to enter some form of input. However, in some instances, the input device may prove inadequate for manipulating three-dimensional objects. In other instances, the capabilities of the input device may be limited, preventing convenient use of application menus and/or viewing of information that may not legibly fit within a single display screen.

SUMMARY

According to one aspect, a device may include a display to show a representation of a three-dimensional image; a first touch panel to provide a first user input based on the display; a second touch panel to provide a second user input based on the display; and processing logic to associate the first user input and the second user input so that the first user input and the second user input emulate physical manipulation of the three-dimensional image and to alter the representation of the three-dimensional image based on the emulated physical manipulation of the three-dimensional image.

Additionally, the first touch panel may be integral with the display.

Additionally, the first touch panel and the second touch panel may be in separate planes.

Additionally, the second touch panel may be substantially parallel to the first touch panel.

Additionally, the second touch panel may be substantially perpendicular to the first touch panel.

Additionally, the first user input may correspond to information visible on the display and the second user input may correspond to information implied from visible information on the display.
Additionally, the device may further include a device to provide tactile simulation through at least one of the first touch panel or the second touch panel.

Additionally, the device may further include a housing, where at least one of the first touch panel or the second touch panel may be located inside the housing.

Additionally, the device may further include a memory, where the memory may store a recorded touch sequence on the first touch panel and the second touch panel and may associate the recorded touch sequence with a particular input.

According to another aspect, a method performed by a mobile device may include displaying a representation of a three-dimensional image; detecting a touch on a first panel located on the mobile device; detecting a touch on a second panel located on the mobile device; detecting relative movement between the touch on the first panel and the touch on the second panel; and altering the display of the representation of the three-dimensional image based on the relative movement.

Additionally, the first panel located on the mobile device may be overlaid on a first surface containing a display screen and the second panel located on the mobile device may be overlaid on a second surface separate from the display screen.

Additionally, the touch on the first panel may correspond to information displayed on the representation of the three-dimensional image and the touch on the second panel may correspond to information implied from the information displayed on the representation of the three-dimensional image.

Additionally, the method may include providing tactile feedback through at least one of the first panel or the second panel.

Additionally, altering the display may include rotating the three-dimensional image.

According to still another aspect, a computer-readable memory having computer-executable instructions may include one or more instructions for displaying a two-dimensional representation of an object; one or more instructions for storing information regarding three-dimensional aspects of the object; one or more instructions for determining coordinates of a touch on a first panel located on a mobile device; one or more instructions for determining coordinates of a touch on a second panel located on the mobile device; one or more instructions for associating the coordinates of the touch on the first panel with the two-dimensional representation of the object; one or more instructions for associating the coordinates of the touch on the second panel with the information regarding three-dimensional aspects of the object; one or more
instructions for identifying relative changes between the coordinates of the touch on the first panel and the coordinates of the touch on the second panel; and one or more instructions for altering the two-dimensional representation of the object based on the relative changes between the coordinates of the touch on the first panel and the coordinates of the touch on the second panel.

Additionally, the computer-readable memory may further include one or more instructions for providing tactile feedback in response to the touch on the first panel or the touch on the second panel.

According to still another aspect, a device may include means for displaying a three-dimensional representation on a two-dimensional display; means for detecting a touch on a first panel located on the device; means for associating the touch on the first panel with a first surface of the three-dimensional representation; means for detecting a touch on a second panel located on the device; means for associating the touch on the second panel with a second surface of the three-dimensional representation; means for determining relative movement between the touch on the first panel and the touch on the second panel; and means for altering the display of the representation of the three-dimensional image based on the relative movement.

Additionally, the device may further include means for providing tactile feedback based on the relative movement.

In another aspect, a mobile communications device may include a housing that includes a primary surface on one plane and a secondary surface on another plane; a display, mounted on the primary surface, to render a three-dimensional representation appearing to have multiple surfaces; a touch panel to receive touch input, the touch panel being mounted with a first portion of the touch panel on the primary surface and a section portion of the touch panel on the secondary surface; processing logic to associate input to the touch panel with the display, where the first portion of the touch panel is associated with one surface of the three-dimensional representation and where the second portion is associated with another surface of the three-dimensional representation, where the rendering of the three-dimensional representation may be altered based on input from a touch pattern contacting the first portion of the touch panel and the second portion of the touch panel.

Additionally, the input may correspond to both information visible on the display and information implied from visible information on the display.
Additionally, at least a portion of the touch panel may be overlaid on the display.

In another aspect, a device may include a display for rendering a two-dimensional representation; a first touch panel to provide a first user input representing a first dimension; a second touch panel to provide a second user input representing a second dimension; and processing logic. The processing logic may associate approximately simultaneous application of the first user input and the second user input so that the first user input and the second user input emulate altering the view of the two-dimensional representation, and may alter the two-dimensional representation based on the first user input and the second user input.

Additionally, the processing logic may alter the magnification of the two-dimensional representation based on received, approximately simultaneous application of the first user input and the second user input.

Additionally, the processing logic may alter the orientation of the two-dimensional representation based on received, approximately simultaneous application of the first user input and the second user input.

Additionally, the processing logic may selectively alter one of the magnification or orientation of the two-dimensional representation based on received, approximately simultaneous application of the first user input and the second user input.

Additionally, the processing logic may further associate non-simultaneous application of the first user input with horizontal movement of the two-dimensional representation and non-simultaneous application of the second user input with vertical movement of the two-dimensional representation.

Additionally, the first touch panel and the second touch panel may be in substantially orthogonal planes.

In still another aspect, a method may be performed by a mobile device. The method may include displaying a two-dimensional representation; detecting approximately simultaneous touches on a first panel located on the mobile device and on a second panel located on the mobile device; detecting relative movement between the touches; and altering the display of the representation of the two-dimensional representation based on the relative movement.

Additionally, altering the display may include selectively altering one of the magnification or orientation of the two-dimensional representation based on the relative movement.
Additionally, the method may further include detecting a touch on the first panel or on the second panel; and selectively scrolling the two-dimensional representation based on the touch on the first panel or on the second panel.

Additionally, the first touch panel and the second touch panel may be in substantially orthogonal planes.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate one or more embodiments described herein and, together with the description, explain these embodiments. In the drawings:

- Fig. 1A is a diagram of the front side of an exemplary mobile device in which methods and systems described herein may be implemented;
- Fig. 1B is a diagram of the back side of an exemplary mobile device in which methods and systems described herein may be implemented;
- Fig. 2 is a block diagram illustrating components of the mobile device of Figs. 1A and 1B according to an exemplary implementation;
- Fig. 3 is a functional block diagram of the mobile device of Fig. 2;
- Fig. 4 is an illustration of an exemplary operation on a mobile device according to an exemplary implementation;
- Fig. 5 illustrates a table that may include different types of parameters that may be obtained for particular user input using the mobile device of Figs. 1A and 1B;
- Fig. 6 is an illustration of an exemplary operation on a mobile device according to another exemplary implementation;
- Fig. 7 is a flow diagram illustrating exemplary operations associated with the exemplary mobile device of Figs. 1A and 1B;
- Figs. 8A-C provide illustrations of exemplary operations on a mobile device according to another exemplary implementation; and
- Fig. 9 is a flow diagram illustrating exemplary operations associated with the exemplary mobile device of Fig. 8.

**DETAILED DESCRIPTION**

The following detailed description refers to the accompanying drawings. The same reference numbers in different drawings may identify the same or similar elements. Also, the following detailed description does not limit the invention.
OVERVIEW

The term "touch," as used herein, may refer to a touch of a body part (e.g., a finger) or a pointing device (e.g., a stylus, pen, etc.). A touch may be deemed to have occurred by virtue of the proximity of the body part or pointing device to a sensor, even if physical contact has not occurred. The term "touch panel," as used herein, may refer to a touch-sensitive panel or any panel that may signal a touch when the body part or the pointing device is close to the panel (e.g., a capacitive panel, a near field panel, etc.) and that can detect the location of touches within the surface area of a touch panel. As used herein, a touch panel may be overlaid on a display screen of a device or may be located separately from the display screen. The term "touch pattern," as used herein, may refer to a pattern that is made on a surface by tracking one or more touches within a time period.

Touch screens may be used in many electronic devices such as cellular radiotelephones, personal digital assistants (PDAs), smartphones, portable gaming devices, media player devices, camera devices, laptop computers, etc. Touch screen technology has generally been limited to two-dimensional ("2-D") graphic interfaces. Manipulating renderings of three-dimensional ("3-D") objects or interfaces has not been particularly intuitive. Furthermore, touch panels have generally failed to provide an intuitive user interface for performing multiple types of commands for a 2-D representation. Implementations described herein provide two or more touch panels integrated with a mobile device so that displayed 3-D objects and/or 3-D menus can be manipulated in a natural and intuitive manner. Other implementations described herein provide two or more touch panels integrated with a mobile device so that 2-D representations can be manipulated in an intuitive manner. Additionally, tactile feedback may provide an additional dynamic for mobile devices with touch panels.

EXEMPLARY DEVICE

Fig. 1A is a diagram of the front of exemplary mobile device 100, and Fig. 1B is a diagram of the back of exemplary mobile device 100 in which methods and systems described herein may be implemented. Implementations are described herein in the context of a mobile device having multiple touch panels. As used herein, the term "mobile device" may include a cellular radiotelephone; a Personal Communications System (PCS) terminal that may combine a cellular radiotelephone with data processing, facsimile and data communications capabilities; a personal digital assistant (PDA) that can include a radiotelephone, pager, Internet/Intranet access, Web browser,
organizer, calendar and/or a global positioning system (GPS) receiver; a gaming device; a media player device; a digital camera; a laptop and/or palmtop receiver; or another appliance that includes 2-D and/or 3-D graphics display capabilities. Mobile devices may also be referred to as "pervasive computing" devices.

Referring collectively to Figs. IA and IB, mobile device 100 may include housing 110, speaker 120, display 130, control buttons 140, keypad 150, microphone 160, camera 170, front touch panel 180, and back touch panel 190. Housing 110 may protect the components of mobile device 100 from outside elements and provide a mounting surface for certain components. Speaker 120 may provide audible information to a user of mobile device 100. Speaker 120 may include any component capable of transducing an electrical signal to a corresponding sound wave. For example, a user may listen to voices or music through speaker 120.

Display 130 may provide visual information to the user and serve—in conjunction with front touch panel 180 and back touch panel 190—as a user interface to detect user input. For example, display 130 may display information and controls regarding various applications executed by mobile device 100, such as computer-generated imagery (CGI), 3-D computer-aided design (CAD) models, 3-D menu presentations, video games, other 3-D images and 2-D representations. As used herein, "3-D images" may be any graphic or model that use a three-dimensional representation of geometric data that is stored in mobile device 100 for the purposes of rendering images on a 2-D display. Display 130 may also provide information and 2-D representations for other applications, such as a phone book/contact list program, a calendar, an organizer application, navigation/mapping applications, as well as other applications. As used herein, "2-D representation" may be any 2-D image, such as a menu, scrolling screen, document replica, or web page. For example, display 130 may present information and images associated with global positioning system (GPS) navigation services so that maps with selected routes are adjusted based on user input. Display 130 may further provide information and menu controls regarding incoming or outgoing telephone calls and/or incoming or outgoing electronic mail (e-mail), instant messages, short message service (SMS) messages, etc. Display 130 may also display images associated with a camera, including pictures or videos taken through camera lens 170 and/or received by mobile device 100. Display 130 may also display downloaded content (e.g., news, images, or other information).
Display 130 may include a device that can display signals generated by mobile
device 100 as text or images on a screen (e.g., a liquid crystal display (LCD), cathode
ray tube (CRT) display, organic light-emitting diode (OLED) display, surface-
conduction electro-emitter display (SED), plasma display, field emission display (FED),
bistable display, etc.). In certain implementations, display 130 may provide a high-
resolution, active-matrix presentation suitable for the wide variety of applications and
features associated with typical mobile devices.

Control buttons 140 may be included to permit the user to interact with mobile
device 100 to cause mobile device 100 to perform one or more operations, such as place
a telephone call, play various media, accessing an application, etc. For example,
control buttons 140 may include a dial button, hang up button, play button, etc. One of
control buttons 140 may be a menu button that permits the user to view on display 130
various settings. In one implementation, control keys 140 may be pushbuttons.

Keypad 150 may also be optionally included to provide input to mobile device
100. Keypad 150 may include a standard telephone keypad. In one implementation,
each key of keypad 150 may be, for example, a pushbutton. A user may utilize keypad
150 for entering information, such as a phone number, or activating a special function.
Alternatively, keypad 150 may take the form of a keyboard that may facilitate the entry
of alphanumeric text.

Microphone 160 may receive audible information from the user. Microphone
160 may include any component capable of transducing air pressure waves to a
corresponding electrical signal. Camera 170 may include a lens for capturing a still
image or video and may include other camera elements that enable mobile device 100
to take still pictures and/or videos and show them on display 130.

As shown in Fig. IA, front touch panel 180 may be integrated with and/or
overlaid on display 130 to form a touch screen or a panel-enabled display that may
function as a user input interface. For example, front touch panel 180 may include a
pressure-sensitive (e.g., resistive), near field-sensitive (e.g., capacitive), acoustically-
sensitive (e.g., surface acoustic wave), photo-sensitive (e.g., infra-red), and/or any other
type of touch panel that allows display 130 to be used as an input device. Front touch
panel 180 may include the ability to identify movement of a body part or pointing
device as it moves on or near the surface of front touch panel 180.

In one embodiment, front touch panel 180 may include a resistive touch overlay
having a top layer and a bottom layer separated by spaced insulators. The inside
surface of each of the two layers may be coated with a material—such as a transparent metal oxide coating—that facilitates a gradient across the top and bottom layer when voltage is applied. Touching (e.g., pressing down) on the top layer may create electrical contact between the top and bottom layers, producing a closed circuit between the top and bottom layers and allowing identification of, for example, X and Y touch coordinates. The touch coordinates may be associated with a portion of display 130 having corresponding coordinates.

In other implementations, front touch panel 180 may be smaller or larger than display 130. In still other implementations, front touch panel 180 may not overlap the area of display 130, but instead may be located elsewhere on the front surface of housing 110, including, for example under keypad 150 and/or control buttons 140. In other embodiments, front touch panel 180 may be divided into multiple touch panels, such as touch panels in strips around the edge of display 130. In still other implementations, front touch panel may cover display 130 and wrap around to at least a portion of one other surface of housing 110.

Back touch panel 190, as shown in Fig. 1B, may be located on or in the rear surface of housing 110. In contrast with front touch panel 180, back touch panel 190 may not be overlaid on and/or integral with display 130 or another display. Back touch panel 190 may be of the same type of touch panel technology as front touch panel 180; or back touch panel 190 may use different technology. Also, in certain implementations, back touch panel 190 may be located behind the housing 110, so as to not be visible. As described in more detail herein, back touch panel 190 may be operatively connected with front touch panel 180 and display 130 to support a user interface for mobile device 100 that accepts inputs from both front touch panel 180 and back touch panel 190.

The components described above with respect to mobile device 100 are not limited to those described herein. Other components, such as connectivity ports, memory slots, and/or additional speakers, may be located on mobile device 100, including, for example, on a rear or side panel of housing 110.

Fig. 2 is a block diagram illustrating components of mobile device 100 according to an exemplary implementation. Mobile device 100 may include bus 210, processing logic 220, memory 230, front touch panel 180, back touch panel 190, touch panel controller 240, input device 250, output device 260, and power supply 270. Mobile device 100 may be configured in a number of other ways and may include other
or different elements. For example, mobile device 100 may include one or more modulators, demodulators, encoders, and decoders for processing data.

Bus 210 may permit communication among the components of mobile device 100. Processing logic 220 may include a processor, a microprocessor, an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), or the like. Processing logic 220 may execute software instructions/programs or data structures to control operation of mobile device 100.

Memory 230 may include a random access memory (RAM) or another type of dynamic storage device that may store information and instructions for execution by processing logic 220; a read only memory (ROM) or another type of static storage device that may store static information and instructions for use by processing logic 220; a flash memory (e.g., an electrically erasable programmable read only memory (EEPROM)) device for storing information and instructions; and/or some other type of magnetic or optical recording medium and its corresponding drive. Memory 230 may also be used to store temporary variables or other intermediate information during execution of instructions by processing logic 220. Instructions used by processing logic 220 may also, or alternatively, be stored in another type of computer-readable medium accessible by processing logic 220. A computer-readable medium may include one or more physical or logical memory devices.

Front touch panel 180 and back touch panel 190 may accept touches from a user that can be converted to signals used by mobile device 100. Touch coordinates on front touch panel 180 and back touch panel 190 are communicated to touch panel controller 240. Data from touch panel controller 240 may eventually be passed on to processing logic 220 for processing to, for example, associate the touch coordinates with information displayed on display 130.

Input device 250 may include one or more mechanisms in addition to front touch panel 180 and back touch panel 190 that permit a user to input information to mobile device 100, such as microphone 160, keypad 150, control buttons 140, a keyboard, a gesture-based device, an optical character recognition (OCR) based device, a joystick, a virtual keyboard, a speech-to-text engine, a mouse, a pen, voice recognition and/or biometric mechanisms, etc. In one implementation, input device 250 may also be used to activate and/or deactivate front touch panel 180 and/or back touch panel 190.

Output device 260 may include a mechanism that outputs information to the user, including a display, such as display 130, a printer, one or more speakers, such as
speaker 120, etc. Power supply 270 may include one or more batteries or another power source used to supply power to components of mobile device 100. Power supply 270 may also include control logic to control application of power from power supply 270 to one or more components of mobile device 100.

Mobile device 100 may provide a 3-D graphical user interface as well as provide a platform for a user to make and receive telephone calls, send and receive electronic mail, text messages, play various media, such as music files, video files, multi-media files, games, and execute various other applications. Mobile device 100 may perform these operations in response to processing logic 220 executing sequences of instructions contained in a computer-readable medium, such as memory 230. Such instructions may be read into memory 230 from another computer-readable medium. In alternative embodiments, hard-wired circuitry may be used in place of or in combination with software instructions to implement operations described herein. Thus, implementations described herein are not limited to any specific combination of hardware circuitry and software.

Fig. 3 is a functional block diagram of exemplary components that may be included in mobile device 100. As shown, mobile device 100 may include touch panel controller 240, database 310, touch engine 320, tactile simulator 330, processing logic 220, and display 130. In other implementations, mobile device 100 may include fewer, additional, or different types of functional components than those illustrated in Fig. 3 (e.g., a web browser).

Touch panel controller 240 may identify touch coordinates from front touch panel 180 and back touch panel 190. Coordinates from touch panel controller 240 may be passed on to touch engine 320 to associate the touch coordinates with, for example, patterns of movement. Changes in the touch coordinates on front touch panel 180 and/or back touch panel 190 may be interpreted as a corresponding motion.

Database 310 may be included in memory 230 (Fig. 2) and act as an information repository for touch engine 320. For example, touch engine 320 may associate changes in the touch coordinates on front touch panel 180 and/or back touch panel 190 with particular movement scenarios stored in database 310. In another implementation, touch engine 320 may allow the user to create personalized movements, so that touch engine 320 may retrieve and/or store personalized touch patterns in database 310.

Touch engine 320 may include hardware and/or software for processing signals that are received at touch panel controller 240. More specifically, touch engine 320
may use the signal received from touch panel controller 240 to detect touches on front
touch panel 180 and/or back touch panel 190 and a movement pattern associated with
the touches so as to differentiate between types of touches. The touch detection, the
movement pattern, and the touch location may be used to provide a variety of user input
to mobile device 100.

Processing logic 220 may implement changes in display 130 based on signals
from touch engine 320. For example, in response to signals that are received at touch
panel controller 240, touch engine 320 may cause processing logic 220 to "rotate" or
alter the perspective of an object (e.g., a video, a picture, an object, a document, etc.)
shown on display 130. In another example, touch engine 320 may cause processing
logic 220 to display a menu that is associated with an item previously displayed on the
touch screen at one of the touch coordinates.

In another example, processing logic 220 may coordinate touch signals from
touch engine 320 with tactile feedback using tactile simulator 330. For example, in
certain implementations, mobile device 100 may be a video game player capable of
generating audio, video, and control outputs upon reading a software program having
encoded simulation control information. Tactile simulator 330 may provide one or
more indicators (e.g., movement, heat, vibration, etc.) in response to control signals
from processing logic 220. For example, tactile simulator may provide feedback by
vibration of one or more touch panels based on the user input on front touch panel 180
and/or back touch panel 190.

Fig. 4 is an illustration of an exemplary operation of mobile device 100
according to an exemplary implementation. Mobile device 100 may include display
130, front touch panel 180 and back touch panel 190 (not visible in Fig. 4, but shown in
Fig. 1B). As shown in Fig. 4, a user may position a thumb on the surface of front touch
panel 180 and a finger on the surface of back touch panel 190. The thumb may move in
direction 410 along the surface of front touch panel 180, while the finger may move in
opposite direction 420 along the surface of back touch panel 190. The movement of the
thumb and finger may be interpreted by mobile device 100 as rotational movement
around the X-axis in Fig. 4.

A 3-D image, object 430, may be shown on display 130. Object 430 is shown
separated from display 130 in Fig. 4 for illustrative purposes. In the example of Fig. 4,
as the movement of the thumb and finger proceeds in directions 410 and 420,
respectively, object 430 may rotate in direction 440 corresponding to directions 410 on
a top surface of object 430 and corresponding to direction 420 on a bottom surface (not visible) of object 430. Thus, display 130 may show the orientation of object 430 rotate from displaying surface 432 as the top surface to displaying surface 434 as the top surface based on the movement of the user’s thumb and finger.

In the implementation of Fig. 4, front touch panel 180 and back touch panel 190 are in separate planes. Thus the direction of movement 410 on front touch panel 180 and the opposite direction of movement 420 on back touch panel 190 may emulate physical manipulation of the 3-D image, object 430. While the user input from the thumb on front touch panel 180 may correspond to the directly visible information on display 130, the input from the user’s finger on back touch panel 190 may correspond to information implied from visible information on display 130. More specifically, back touch panel 190 may correspond to the bottom surface of a graphic model that would not be visible in the 3-D rendering shown on display 130. Thus, referring to the example in Fig. 4, the user’s thumb may be initially applied to front touch panel 180 on the apparent surface 432 of object 430, while the user’s finger may be applied to back touch panel 190 on what would intuitively be the non-visible opposite surface of object 430.

The directions 410 and 420 represented in Fig. 4 are exemplary. Other movements or combinations of movements may be used to intuitively manipulate a 3-D image displayed on display 130. For example, a user may keep one finger stationary on one touch panel, such as touch panel 190, to "anchor" the displayed image while using another finger, on touch panel 180 for example, to reorient the 3-D image displayed on display 130. In certain implementations, two or more fingers may be used on each touch panel to provide user input. Also, while Fig. 4 depicts a one-handed operation of mobile device 100, fingers from two hands may be used in a similar manner. In other implementations, mobile device 100 may allow the user to record personalized touch patterns so that motions most-intuitive to a particular user may be stored and recalled for subsequent user input sequences. Fig. 5 illustrates a table that may include different types of parameters that may be obtained for particular touch patterns using mobile device 100.

Fig. 5 provides an exemplary table 500 of touch parameters that may be stored in mobile device 100 and specifically in, for example, database 310 (Fig. 3). In certain implementations, a particular combination of touch movements may be stored in memory and recognized by mobile device 100, so that mobile device 100 may
effectively "learn" touch patterns of a particular user. As shown in table 500, elements of a stored touch pattern may include the finger size registered on a touch pad, the finger shape registered on a touch pad, the length of time of the touch, the movement speed, and/or the movement direction.

Fig. 6 provides an illustration of an exemplary operation on a mobile device according to another exemplary implementation. Mobile device 600 may include display 130, front touch panel 180, left side touch panel 610 and top touch panel 620. Additional panels (not visible in Fig. 6) may optionally be included on the right side, bottom or rear surface of mobile device 600. As shown in Fig. 6, a user may position a finger on the surface of front touch panel 180 and a finger on the surface of left side touch panel 610. The finger on left side touch panel 610 may move in direction 630 along the surface of the left side touch panel 610, while the finger on front touch panel 180 may remain stationary. The movement of the finger along left side touch panel 610 (in direction 630) and the stationary position of the finger on the surface of front touch panel 180 may be interpreted by mobile device 600 as rotational movement around the Z-axis in Fig. 6.

A 3-D image, object 640, may be shown on display 130. Object 640 is shown separated from display 130 in Fig. 6 for illustrative purposes. In the example of Fig. 6, as the movement of the finger proceeds along left side touch panel 610 in direction 630, object 640 may rotate in direction 650 corresponding to the movement of the finger along the left side panel. Thus, display 130 may show the orientation of object 640 rotate along the Z-axis while surface 642 remains visible to the user.

Using the touch panels 180, 610 and/or 620, other touch movements or combinations of movements may be used to intuitively manipulate a 3-D image displayed on display 130. Also, while front touch panel 180, left side touch panel 610, and top touch panel 620 are shown as separate panels, two or more of these panels may be combined in some implementations as a single touch panel. Thus, a user touch may rotate the visible surface of an object on display 130 to a non-visible orientation by dragging his finger from, for example, the portion of the touch panel on the front surface of mobile device 600 to portion of the touch panel on a side surface of mobile device 600.

In other implementations, touch panels—such as front touch panel 180, left side touch panel 610, and/or top touch panel 620—may be integrated with one or more tactile simulators (such as tactile simulator 330 of Fig. 3). In one implementation, the
tactile simulator may include, for example, a tactile bar on which the touch panels may be mounted. Signals may be transmitted to the tactile bar by the processing logic (such a processing logic 220 of Fig. 2) to control the motion of weights located within the tactile bar, vibration of motors within the tactile bar, and/or temperature changes of the tactile bar. For example motors having eccentric weights may be used to cause the tactile bar to selectively vibrate. Additionally, movement of weights within the tactile bar may impart a sense of motion.

Fig. 7 is a flow diagram 700 illustrating an exemplary operation associated with implementations of a mobile device, such as mobile device 100. A 3-D image may be displayed (block 710). For example, mobile device 100 may present the 3-D image on display 130. A user may desire to view other perspectives of the image and engage touch panels on mobile device 100 to rotate the image. The user may place his thumb on a touch panel on the front surface of mobile device 100. The touch on the front surface may be detected and a direction of movement on the front surface may be identified, if any (block 720). For example, mobile device 100 may detect a touch and movement of the user's thumb as it moves on the front touch panel. A touch on the back surface may be detected and a direction of movement on the back surface may be identified, if any (block 730). For example, the user may place his finger on a touch panel on the back surface of mobile device 100. Mobile device 100 may detect the touch on the back panel and identify a direction of movement of the finger.

The relation of the front surface movement and the back surface movement may be correlated (block 740). For example, based on the motion of the thumb and finger on the front and back touch panels, mobile device 100 may correlate a relation of movement along the front panel and movement along the back panel. The movement may be correlated with the displayed image so as to indicate rotation about a particular axis. In block 750, the display of the 3-D image may be adjusted based on the correlation of the front surface movement and the back surface movement. Thus, for example, mobile device 100 may adjust the display of the 3-D image based on the correlation of the movement of the user's finger and thumb.

Figs. 8A-C illustrate exemplary operations on mobile device 800 according to another exemplary implementation. Mobile device 800 may include display 130, left side touch panel 810, top left touch panel 820, and top right touch panel 830. Additional panels (not visible in Figs. 8A-C) may optionally be included, for example, on the right side of mobile device 800. As shown in Fig. 8A, a user may position a
finger on the surface of left side touch panel 810 and another finger on the surface of top left touch panel 820. The finger on left side touch panel 810 may slide back-and forth in direction 815 along the surface of the left side touch panel 810, while the finger on top left touch panel 820 may slide in direction 825 along the surface of the top left touch panel 820. In another implementation, a user may provide input by sliding another finger or thumb in direction 835 along a right side touch panel (not shown) that can be positioned on mobile device 800 similarly to that of left side touch panel 810.

The position of touch panels 810, 820 and 830 shown in Fig. 8A-C are exemplary. Generally, touch panels may be mounted on surfaces of mobile device 800 so as to be orthogonal to each other on at least two surfaces of mobile device 800. Although mobile device 800 may include four touch panels (e.g., touch panels 810, 820 and 830 and a right side touch panel not visible in Figs. 8A-C), not all panels may be activated at one time. A user may selectively activate particular touch panels to correspond to a user's preference or manual dexterity (e.g., right- or left-handed), and to minimize the opportunity for inadvertent user input. For example, in Fig. 8A-C, a predominantly left-handed user may select from a user-interface in mobile device 800 to activate only left side touch panel 810 and top left touch panel 820. In another implementation, a left-handed user, as shown in Fig. 8A, may prefer to activate a right side touch panel (not visible) and top left touch panel 820 and/or top right touch panel 830 so as to provide input with, for example a thumb in direction 835 and index finger in direction 825. In another implementation, touch panels 820 and 830 may be combined as a single touch panel.

User input via the touch panels may be interpreted by mobile device 800 to either emulate physical manipulation of a 2-D representation on display 130 (e.g., scrolling left/right or up/down) or emulate altering the magnification of the 2-D representation (e.g., zoom in/out). For example, referring specifically to Fig. 8A, the movement of a finger along left side touch panel 810 (in direction 815) or the movement of a finger along top left touch panel 820 (in direction 825), when occurring separately, may be interpreted by mobile device 800 to trigger display 130 to scroll an image (in the direction indicated). However, when the fingers are approximately simultaneously moved toward or away from each other along left side touch panel 810 and top left touch panel 820, mobile device 800 may interpret the simultaneous motion as a command to zoom in or out on the image on display 130. In another implementation, simultaneous movement along left side touch panel 810 and top left
touch panel 820 in the same direction (e.g., substantially clockwise or counter-clockwise), may be interpreted by mobile device 800 to trigger display 130 to rotate the displayed image (in the direction indicated). Thus, mobile device 800 may distinguish between simultaneous and consecutive touches and selectively alter display 130 based on the timing and direction of each touch.

Referring to Fig. 8B, mobile device 800 is shown as receiving input from a user via movement of a finger along top left touch panel 820 in the direction of arrow 845. Because there is no contact with another touch panel (e.g., left side touch panel 810), user device 800 may interpret the movement along touch panel 820 as a command to move the image on display 130 in the direction 830. Similarly, isolated movement along left side touch panel 810 may be interpreted as a command to move the image on display 130 up or down. In another implementation, isolated movements along one of touch panels 810 or 820 may be interpreted as a vertical or horizontal scrolling command to view, for example, a menu or other text. Generally, the software in user device 800 may be optimized so that the cursor position may move to the top and/or left of the displayed image as the display is scrolled to reduce the number of key operations by the user to reach the desired cursor position on the display.

Referring to Fig. 8C, mobile device 800 is shown as receiving input from a user via approximately simultaneous movement of fingers along top left touch panel 820 in the direction of arrow 855 and along left side touch panel 810 in the direction of arrow 865. Because there is simultaneous movement on both touch panels 810 and 820, user device 800 may interpret the movements along the touch panels as a command to zoom the image on display 130. Particularly, the direction of movements 855 and 865 away from each other may be interpreted as a command to "zoom in" (e.g., enlarge) on the displayed image. Conversely, movements toward each other may be interpreted as a command to "zoom out" (e.g., reduce) from the displayed image.

Using touch panels 810, 820 and/or 830, other touch movements or combinations of movements may be used to intuitively manipulate a 2-D image displayed on display 130. Generally, by assigning functions as described herein to touch pads mounted substantially orthogonally on a mobile device, single hand operation of the mobile device can be realized for scrolling and zooming of the display.

Fig. 9 is a flow diagram 900 illustrating an exemplary operation associated with implementations of a mobile device, such as mobile device 800. A 2-D image may be displayed (block 910). For example, mobile device 800 may present the 2-D image on
display 130. The 2-D image may be an object, a menu, text, or other information. A user may desire to view other information or other views of the displayed information. Thus, the user may engage touch panels on mobile device 800 to alter the display. The user may place his finger on a first touch panel on a surface of mobile device 800. The touch on the first touch panel may be detected and a direction of movement on the first touch panel may be identified, if any (block 920). For example, mobile device 800 may detect a touch and movement of the user's finger as it moves on a top surface touch panel. The motion may be from the user's left to right.

In order to determine what user input is intended by the first touch, mobile device 800 may also determine if another touch on a second touch panel is occurring approximately simultaneously (block 930). If no other touch is identified, the display may be scrolled in the direction corresponding to the touch on the first panel (block 940). For example, the touch on first touch panel along the top surface of mobile device 800 may be interpreted as a horizontal scroll input from left to right. Mobile device 800 may, thus, scroll the displayed image or menu from left to right.

If an approximately simultaneous touch on a second panel is identified, the direction of movement on the second panel may be identified (block 950). For example, a touch on a second panel may be identified on a right side panel of mobile device 800 with a downward motion. The relative directions of movement may be correlated (block 960). For example, mobile device 800 may determine whether the relative movements are toward each other (e.g., zoom out), away from each other (e.g., zoom in), or in the same rotational direction (e.g., rotate clockwise or counter-clockwise). The display of the 2-D image may be adjusted based on the simultaneous touches on the touch panels (block 970). For example, left-to-right movement along the top surface touch panel and downward movement along the right side touch panel may be interpreted, for example, as input to zoom in or enlarge a displayed image.

CONCLUSION

Implementations described herein may include a mobile device with a display and multiple touch panels. The touch panels may be positioned on various locations on the mobile device, including, for example, on the display screen and on the back surface of the mobile device and/or on one or more side surfaces. In some implementations, the user of the mobile device may simultaneously (or approximately simultaneously) touch two or more touch panels to manipulate displayed 3-D objects in a natural and intuitive manner. In other implementations, the user of the mobile device may alternatively
scroll with a single touch panel or simultaneously (or approximately simultaneously) touch two touch panels to zoom or rotate a displayed 2-D object.

The foregoing description of the embodiments described herein provides illustration and description, but is not intended to be exhaustive or to limit the invention to the precise form disclosed. Modifications and variations are possible in light of the above teachings or may be acquired from practice of the invention.

For example, implementations have been mainly described in the context of a mobile device. These implementations, however, may be used with any type of device that includes a display with more than one accessible surface.

As another example, implementations have been described with respect to certain touch panel technology. Other technology may be used to accomplish certain implementations, such as different types of touch panel technologies, including but not limited to, resistive touch panels, surface acoustic wave technology, capacitive touch panels, infrared touch panels, strain gage mounted panels, optical imaging touch screen technology, dispersive signal technology, acoustic pulse recognition, and/or total internal reflection technologies. Furthermore, in some implementations, multiple types of touch panel technology may be used within a single device.

Further, while a series of blocks has been described with respect to Figs. 7 and 9, the order of the blocks may be varied in other implementations. Moreover, non-dependent blocks may be performed in parallel.

Aspects described herein may be implemented in methods and/or computer program products. Accordingly, aspects may be embodied in hardware and/or in software (including firmware, resident software, micro-code, etc.). Furthermore, aspects described herein may take the form of a computer program product on a computer-readable or computer-readable storage medium having computer-readable or computer-readable program code embodied in the medium for use by or in connection with an instruction execution system. The actual software code or specialized control hardware used to implement these aspects is not limiting. Thus, the operation and behavior of the aspects were described without reference to the specific software code—it being understood that software and control hardware could be designed to implement the aspects based on the description herein.

Further, certain aspects described herein may be implemented as "logic" that performs one or more functions. This logic may include hardware, such as a processor,
microprocessor, an application specific integrated circuit or a field programmable gate array, or a combination of hardware and software.

It should be emphasized that the term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers, steps, or components, but does not preclude the presence or addition of one or more other features, integers, steps, components, or groups thereof.

Even though particular combinations of features are recited in the claims and/or disclosed in the specification, these combinations are not intended to limit the invention. In fact, many of these features may be combined in ways not specifically recited in the claims and/or disclosed in the specification.

No element, act, or instruction used in the description of the present application should be construed as critical or essential to the invention unless explicitly described as such. Also, as used herein, the article "a" is intended to include one or more items. Where only one item is intended, the term "one" or similar language is used. Further, the phrase "based on," as used herein is intended to mean "based, at least in part, on" unless explicitly stated otherwise.

The scope of the invention is defined by the claims and their equivalents.
WHAT IS CLAIMED IS:

1. A device comprising:
   a display to show a representation of a three-dimensional image;
   a first touch panel to provide a first user input based on the display;
   a second touch panel to provide a second user input based on the display; and
   processing logic to:
   associate the first user input and the second user input so that the first
   user input and the second user input emulate physical manipulation of the three-
   dimensional image, and
   alter the representation of the three-dimensional image based on the
   emulated physical manipulation of the three-dimensional image.

2. The device of claim 1, where the first touch panel is integral with the display.

3. The device of claim 1, where the first touch panel and the second touch panel
   are in separate planes.

4. The device of claim 1, where the second touch panel is substantially parallel
to the first touch panel.

5. The device of claim 3, where the second touch panel is substantially
   perpendicular to the first touch panel.

6. The device of claim 1, where the first user input corresponds to information
   visible on the display and where the second user input corresponds to information
   implied from visible information on the display.

7. The device of claim 1, further comprising a device to provide tactile
   simulation through at least one of the first touch panel or the second touch panel.

8. The device of claim 1, further comprising a housing, where at least one of the
   first touch panel or the second touch panel is located inside the housing.

9. The device of claim 1, further comprising a memory, where the memory
stores a recorded touch sequence on the first touch panel and the second touch panel and associates the recorded touch sequence with a particular input.

10. A method performed by a mobile device, the method comprising:
displaying a representation of a three-dimensional image;
detecting a touch on a first panel located on the mobile device;
detecting a touch on a second panel located on the mobile device;
detecting relative movement between the touch on the first panel and the touch on the second panel; and
altering the display of the representation of the three-dimensional image based on the relative movement.

11. The method of claim 10, where the first panel located on the mobile device is overlaid on a first surface containing a display screen and the second panel located on the mobile device is overlaid on a second surface separate from the display screen.

12. The method of claim 10, where the touch on the first panel corresponds to information displayed on the representation of the three-dimensional image and where the touch on the second panel corresponds to information implied from the information displayed on the representation of the three-dimensional image.

13. The method of claim 10, further comprising providing tactile feedback through at least one of the first panel or the second panel.

14. The method of claim 10, where altering the display comprises rotating the three-dimensional image.

15. A computer-readable memory comprising computer-executable instructions, the computer-readable memory comprising:
one or more instructions for displaying a two-dimensional representation of an object;
one or more instructions for storing information regarding three-dimensional aspects of the object;
one or more instructions for determining coordinates of a touch on a first panel;
located on a mobile device;

one or more instructions for determining coordinates of a touch on a second panel located on the mobile device;

one or more instructions for associating the coordinates of the touch on the first panel with the two-dimensional representation of the object;

one or more instructions for associating the coordinates of the touch on the second panel with the information regarding three-dimensional aspects of the object;

one or more instructions for identifying relative changes between the coordinates of the touch on the first panel and the coordinates of the touch on the second panel; and

one or more instructions for altering the two-dimensional representation of the object based on the relative changes between the coordinates of the touch on the first panel and the coordinates of the touch on the second panel.

16. The computer-readable memory of claim 15, further comprising:

one or more instructions for providing tactile feedback in response to the touch on the first panel or the touch on the second panel.

17. A device comprising:

means for displaying a three-dimensional representation on a two-dimensional display;

means for detecting a touch on a first panel located on the device;

means for associating the touch on the first panel with a first surface of the three-dimensional representation;

means for detecting a touch on a second panel located on the device;

means for associating the touch on the second panel with a second surface of the three-dimensional representation;

means for determining relative movement between the touch on the first panel and the touch on the second panel; and

means for altering the display of the representation of the three-dimensional image based on the relative movement.

18. The device of claim 17, further comprising:

means for providing tactile feedback based on the relative movement.
19. A mobile communications device comprising:
   a housing that includes a primary surface on one plane and a secondary surface
   on another plane;
   a display, mounted on the primary surface, to render a three-dimensional
   representation appearing to have multiple surfaces;
   a touch panel to receive touch input, the touch panel being mounted with a first
   portion of the touch panel on the primary surface and a section portion of the touch
   panel on the secondary surface; and
   processing logic to associate input to the touch panel with the display, where the
   first portion of the touch panel is associated with one surface of the three-dimensional
   representation and where the second portion is associated with another surface of the
   three-dimensional representation, where the rendering of the three-dimensional
   representation is altered based on input from a touch pattern contacting the first portion
   of the touch panel and the second portion of the touch panel.

20. The device of claim 19, where the input corresponds to both information visible on the display and information implied from visible information on the display.

21. The device of claim 19, where at least a portion of the touch panel is overlaid on the display.

22. A device comprising:
   a display for rendering a two-dimensional representation;
   a first touch panel to provide a first user input representing a first dimension;
   a second touch panel to provide a second user input representing a second
   dimension; and
   processing logic to:
   associate approximately simultaneous application of the first user input
   and the second user input so that the first user input and the second user input
   emulate altering a view of the two-dimensional representation,
   receive approximately simultaneous application of the first user input
   and second user input; and
   alter the two-dimensional representation based on the received,
approximately simultaneous application of the first user input and the second user input.

23. The device of claim 22, where the processing logic alters the magnification of the two-dimensional representation based on received, approximately simultaneous application of the first user input and the second user input.

24. The device of claim 22, where the processing logic alters the orientation of the two-dimensional representation based on received, approximately simultaneous application of the first user input and the second user input.

25. The device of claim 22, where the processing logic selectively alters one of the magnification or orientation of the two-dimensional representation based on received, approximately simultaneous application of the first user input and the second user input.

26. The device of claim 22, where the processing logic further associates non-simultaneous application of the first user input with horizontal movement and non-simultaneous application of the second user input with vertical movement.

27. The device of claim 22, where the first touch panel and the second touch panel are in substantially orthogonal planes.

28. A method performed by a mobile device, the method comprising:
   displaying a two-dimensional representation;
   detecting approximately simultaneous touches on a first panel located on the mobile device and on a second panel located on the mobile device;
   detecting relative movement between the touches; and
   altering the display of the two-dimensional representation based on the relative movement.

29. The method of claim 28, where altering the display comprises selectively altering one of the magnification or orientation of the two-dimensional representation based on the relative movement.
30. The method of claim 28, further comprising:
detecting a touch on the first panel or on the second panel; and
selectively scrolling the two-dimensional representation based on the touch on
the first panel or on the second panel.

31. The method of claim 28, where the first touch panel and the second touch
panel are in substantially orthogonal planes.
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**FIG. 5**
FIG. 7

710. DISPLAY 3-D IMAGE

720. DETECT TOUCH ON FRONT SURFACE AND IDENTIFY DIRECTION OF MOVEMENT

730. DETECT TOUCH ON BACK SURFACE AND IDENTIFY DIRECTION OF MOVEMENT

740. CORRELATE RELATION OF FRONT SURFACE MOVEMENT AND BACK SURFACE MOVEMENT

750. ADJUST DISPLAY OF 3-D IMAGE BASED ON CORRELATION
DISPLAY 2-D IMAGE

DETECT TOUCH ON FIRST PANEL AND IDENTIFY DIRECTION OF MOVEMENT

TOUCH ON SECOND PANEL?

NO  SCROLL DISPLAY IN DIRECTION CORRESPONDING TO TOUCH ON FIRST PANEL

YES  IDENTIFY DIRECTION OF MOVEMENT ON SECOND PANEL

CORRELATE RELATIVE DIRECTIONS OF MOVEMENT

ADJUST DISPLAY OF 2-D IMAGE BASED ON TOUCHES ON PANELS

FIG. 9