December 07, 2017

INPUT COMBINATION TO ACTIVATE DIFFERENT INPUT MODES UTILIZING A PRESENCE-SENSITIVE SCREEN

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ABSTRACT

A computing device is described that changes input modes associated with a presence-sensitive screen, based on tactile user inputs detected by touch and/or pressure sensors that are distinct from the presence-sensitive screen. Input modes define the actions taken by a computing device in response to receiving indications of user input at the presence-sensitive screen, such as navigating through a user interface of the computing device, adjusting a setting of the computing device, or altering a state of the computing device. The computing device interprets inputs detected at the sensors to change which functions are performed when a user provides subsequent inputs at the presence-sensitive screen. This way, a computing device can use its presence-sensitive screen to detect more types of inputs that, traditionally, might require additional input components (e.g., a mechanical button, a mechanical switch, etc.) beyond just the presence-sensitive screen.

DESCRIPTION

A computing device may receive tactile user inputs as a user interacts with applications that are executing on the computing device (e.g., a mobile phone, tablet computer, smartphone, desktop computer, or similar device). Some computing devices include a presence-sensitive screen, as well as additional mechanical switches and buttons in the housing of the computing device, to detect tactile user inputs for adjusting volume levels, etc. To save power, size, weight, or to otherwise improve design, some computing devices rely almost solely on a presence-sensitive screen to detect tactile user input and forgo the use of mechanical switches and mechanical buttons.

By trading the convenience that mechanical switches and buttons provide for improvements in power, size, and weight, such computing devices may make it less efficient for users to provide certain types of input. Computing devices operating according to techniques described throughout this publication can perform the process shown in Figure 1 to switch between multiple inputs modes associated with a presence-sensitive screen—thereby enabling the computing device to perform additional functions using the presence-sensitive screen (e.g., funtions that are traditionally associated with mechanical switches and buttons).

In a simple case, the computing device is a mobile phone. The mobile phone operates in an initial input mode associated with the presence-sensitive screen, where a user input detected by the presence-sensitive screen will cause the mobile phone to perform a user-interface action or initiate the execution of an application stored on the mobile phone. The mobile phone also operates in other input modes associated with the presence-sensitive screen, beyond just the initial input mode. For instance, an alternate mode associated with the presence-sensitive screen may enable the mobile phone to detect user inputs at the presence-sensitive screen (e.g., a radial swipe input across the presence-sensitive input screen) for adjusting a volume of the mobile phone.

To cause the mobile phone to switch to an alternate input mode, the user may squeeze the mobile phone to apply pressure to each side of the mobile phone. Pressure sensors within the computing device may measure the applied force, or touch/impedance sensors of the computing device may determine whether human skin is in contact with the mobile phone while the pressure is being applied. If the measured force satisfies a threshold force, or if the touch/impedance sensors provide an indication that human skin is in contact with the mobile phone while the pressure is being applied, the mobile phone switches from the initial input mode to the alternate input mode. When operating in the alternate input mode, the mobile phone may receive a clockwise radial swipe input at the presence-sensitive screen and in response, increase a volume level, while a counter-clockwise radial swipe input may cause the mobile phone to decrease the volume level.

By utilizing a combination of inputs (e.g., a squeeze input followed by a gesture), the computing system facilitates quick and easy access to various settings of the computing device that might traditionally be adjusted via inputs to mechanical buttons or mechanical switches. In this way, the computing system provides a variable and dynamic interface for common interactions without relying on additional input components, beyond just the presence-sensitive screen.

Removing buttons from a computing device adds an aesthetic sleekness to the device. Further, removing buttons from a computing device may make the computing device more waterproof and more robust to wear and tear (as there are fewer moving parts). However, removing buttons also may increase the amount of time and the number of user inputs required to adjust settings of the computing device previously assigned to one of such buttons. Rather than forcing the user to navigate through multiple menus in order to adjust the desired settings or settling for the detriments of button-laden computing devices, the techniques described herein may use a combination of general device inputs to accomplish the same tasks. Using the techniques described herein, the user may be able to adjust the various settings without illuminating the screen to navigate through menus, reducing the overall power consumption of the device. Further, by checking characteristics of the first user input to activate the alternate input mode, the computing device that implements the techniques described herein may reduce false positive triggering of the alternate input mode and the related state adjustments. The techniques described herein have many applications and use cases, some of which are described below.

Consider the example process shown in Figure 1, which is executable by a computing device (e.g., a mobile phone, a tablet computer, a wearable computing device, a countertop computing device, a home automation computing device, a laptop computer, a desktop computer, a computing system connected to a projection style input device, a television, a stereo, an automobile, and all other types of mobile and non-mobile computing device that may be configured to receive input from one or more of a touch sensor, a pressure sensor, or a presence-sensitive input device) to receive user inputs in accordance with the techniques described herein.

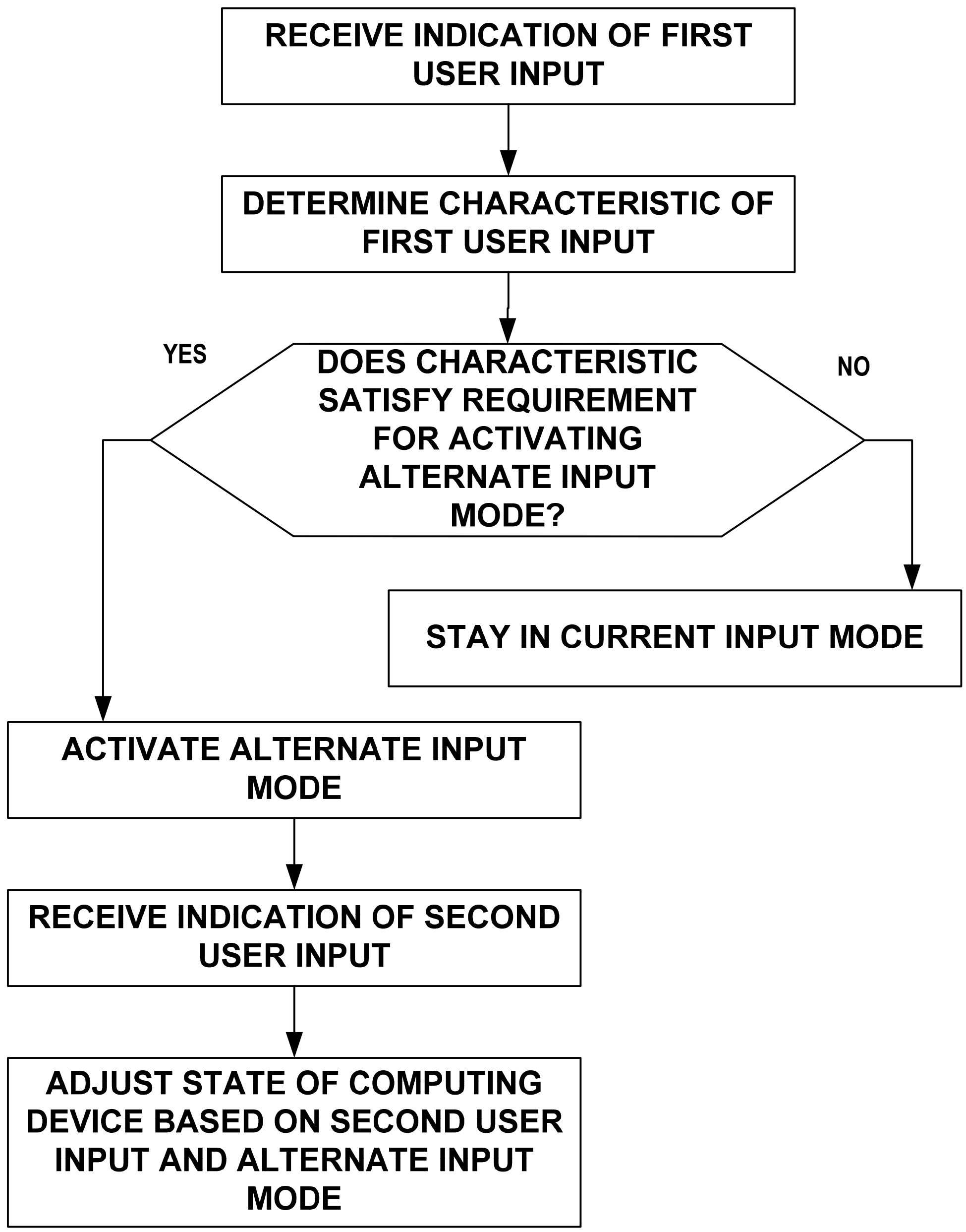

Figure 1

In the context of Figure 1, a computing device is initially operating in an initial input mode associated with the presence-sensitive screen, where various inputs cause the computing device to navigate through various levels of a user interface or cause the computing device to execute portions of applications stored on the computing device. While operating in the initial input mode, the computing device receives an indication of a first user input, such as a squeeze of the computing device, a hard press of a portion of the computing device (e.g., a presence-sensitive input screen), or multiple concurrent touches of different portions of the computing device. The computing device determines a characteristic of the first user input, such as a level of force applied by the input, a source of the input, or a duration of the input (e.g., the first user input may be held throughout the duration of the process, or the first user input may need to be held for a certain amount of time before the input mode switches). If the characteristic does not match a requirement for activating an alternate input mode, the computing device remains in the initial input mode. If the characteristic does match the requirement, the computing device activates the alternate input mode associated with the presence-sensitive screen. In the alternate input mode, the computing device shifts into a higher power state where the computing device actively "listens" for additional inputs (e.g., at the presence-sensitive screen). When the computing device receives an indication of a second user input, the computing device adjusts a state or alters a setting of the computing device based on the second user input.

The requirement for activating the alternate input mode may be adjusted over time based on usage over time. For instance, while the requirement may be initially set to a default level of force for an average adult, the computing device might increase the requirement if the user regularly interacts with the computing device with above average force. Conversely, the computing device might decrease the requirement if the user regularly interacts with the computing device with below average force. Other settings on the phone may further affect the requirement. For instance, if a childproof setting is activated, in an effort to ensure that a child does not inadvertently adjust settings of the computing device, the force requirement for activating the alternate input mode may be increased to an amount that may be difficult for a child to apply to the computing device. Alternately, if a mode is activated to assist those with physical limitations or disabilities, the computing device may decrease the force requirement such that those users with physical limitations or disabilities may adjust the desired settings easily.

In some instances, the first user input may be a complex user input. For instance, the requirement may include a particular force for a hard press on a presence-sensitive screen of the computing device (or for a squeezing force of the housing of the computing device), as well as a detection of human flesh touching the computing device by a set of one or more impedance sensors. Requiring a complex user input may further contribute to reducing false positive triggering of the alternate input mode that may inadvertently adjust settings of the computing device against the user's wishes.

In some examples, the computing device may provide feedback to the user that indicates that the alternate input mode has been activated. Expanding the simple case described above (i.e., where a user squeezes a mobile phone to activate the alternate input mode), in one instance, the mobile phone may alter the graphical user interface to indicate that the alternate input mode is active. In other instances, the mobile phone may provide a form of haptic feedback, such as a vibration, when the mobile phone activates the alternate input mode.

Once the alternate input mode is activated, different gestures or types of the second user input may adjust different settings on the computing device. For instance, in the example of the mobile phone, a radial swipe gesture (i.e., moving an input device in a circular motion while touching the presence-sensitive screen) may adjust a volume of the mobile phone. A vertical swipe gesture, however, may alter a different setting. For instance, a vertical swipe gesture upwards on the presence-sensitive screen may increase a brightness of the display, while a vertical swipe gesture downwards on the presence-sensitive screen may decrease the brightness of the display. Further, a horizontal swipe gesture may adjust yet another state, such as enabling hands-free engagement of the mobile phone (e.g., voice controls), connecting with a second computing device that is in close proximity to the mobile phone, turning on or off an alarm, answering a phone call, or ending a phone call, among other things.

To revert back to the initial input mode, the computing device may analyze any number of factors. For instance, in examples where the computing device is only in the alternate input mode while the computing device is still detecting the first user input, the computing device may revert back to the initial input mode once the first user input is concluded (e.g., when the computing device no longer detects a continuous touch gesture on the screen, when the computing device no longer detects force of the first user input, when the computing device no longer detects touch impedance, some combination of the three, etc.). In other examples where the computing device is in the alternate input mode until the state adjustment is complete, the computing device may revert back to the initial input mode once the second user input is concluded. The computing device may operate on a slight delay, analyzing, for instance, the average force applied over a trailing period of a certain number of milliseconds, so that the computing device does not unintentionally adjust the state or setting as the user releases pressure for the final time.

While this publication has used examples of how the techniques may apply to a mobile phone, other devices with various structures may implement similar techniques. For instance, the computing device may be a virtual reality headset. In such instances, the housing of the virtual reality headset may include pressure sensors, touch sensors, and/or impedance sensors to detect various touches on the housing of the virtual reality headset. The first user input may be either a single-handed grip of the virtual reality headset or a two-handed grip of the virtual reality headset. The requirement to activate the alternate input mode may further some amount of squeezing force applied to the housing of the virtual reality headset in addition to the grip. In the alternate input mode, the user may utilize motion controls, voice controls, or additional touch controls to adjust a setting of the virtual reality headset, such as the volume, the brightness, or to scroll a setting displayed by the virtual reality headset. The requirement may be set to be distinct from the general force of gripping the virtual reality headset to put on and remove the virtual reality headset.

In other examples, the computing device may be an automobile. Many modern automobiles may include buttons on the steering wheel to enable the driver to perform various actions without diverting the driver's attention. However, for an automobile that implements the techniques described herein, the driver may perform the same actions while keeping the cleaner, buttonless aesthetic of more classic vehicles. For instance, the steering wheel may include touch sensors, pressure sensors, and/or impedance sensors to detect and measure user input. With one hand, a user may squeeze the steering wheel, or the steering wheel may include a presence-sensitive portion on either a front face or a back face of the steering wheel that may detect press inputs from the user. This squeeze or press gesture may activate the alternate input method. With the other hand, the user may perform a second gesture, such as a squeeze, a swipe, a press, a vocal command, or some other type of input. Based on this gesture, the automobile may adjust a setting or state of the automobile, such as changing a song that is currently playing, changing the volume of the audio system, changing a radio station, enabling or disabling cruise control, adjusting a speed of the cruise control, or controlling a navigation system, among other things.

Some larger computing devices, such as a large touch screen on a table or a projection device that projects the display onto a larger surface, may not be suitable for squeezing inputs. As such, the table or surface may be equipped with touch sensors that measure the force of press inputs. A hard press on the table or surface may be the required action to activate the alternate input method. The user may than use either the hand pressing on the table or surface or the alternate hand to perform the second user input to adjust any of the states or settings suitable for adjustment on such a device (e.g., the volume of a connected audio output device, a brightness of the display, enabling hands-free engagement of the mobile phone (e.g., voice controls), connecting with a second computing device that is in close proximity to the mobile phone, turning on or off an alarm, answering a phone call, or ending a phone call, among other things).

Medium-sized computing devices, such as tablet computers, may implement a different set of user input requirements for activating an alternate input method. For instance, a hard press on a presence-sensitive screen may be a suitable first input, though the tablet computer may further include an impedance sensor on the back of the tablet computer to verify that a user's skin is touching the tablet computer as opposed to some other object or force. In other examples, the tablet computer may measure squeezing forces applied to the tablet computer to determine whether to initiate the alternate input mode. Tablet computers are unique in that tablet computers are almost equally used while being held by two hands and while resting on another surface without being held. As such, the impedance sensors may determine whether the tablet computer is being held. Based on whether the tablet computer is being held or not, the tablet computer may use the hard press (if the tablet computer is not being held) or the squeezing gesture (if the tablet computer is being held) as the first user input that is measured to determine whether the tablet computer should activate the alternate input mode.

In this way, the computing system provides a variable and dynamic interface for common interactions without relying on additional input components, beyond just the presence-sensitive screen. Removing buttons from a computing device adds an aesthetic sleekness to the device. Further, removing buttons from a computing device may make the computing device more waterproof and more robust to wear and tear (as there are fewer moving parts). However, removing buttons also may increase the amount of time and the number of user inputs required to adjust settings of the computing device previously assigned to one of such buttons. Rather than forcing the user to navigate through multiple menus in order to adjust the desired settings or settling for the detriments of button-laden computing devices, the techniques described herein may use a combination of general device inputs to accomplish the same tasks. Using the techniques described herein, the user may be able to adjust the various settings without illuminating the screen to navigate through menus, reducing the overall power consumption of the device. Further, by checking characteristics of the first user input to activate the alternate input mode, the computing device that implements the techniques described herein may reduce false positive triggering of the alternate input mode and the related state adjustments. The techniques described herein have many applications and use cases, some of which are described below.