US 20150119108A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2015/0119108 A1**

(43) **Pub. Date: Apr. 30, 2015**

PHILBIN et al.

(54) **MOBILE DEVICE MODE OF OPERATION FOR VISUALLY IMPAIRED USERS**

(71) Applicant: **CELLCO PARTNERSHIP D/B/A VERIZON WIRELESS**, Basking Ridge, NJ (US)

(72) Inventors: **David A. PHILBIN**, Arlington, MA (US); **John P. CHIN**, Upper Montclair, NJ (US); **Yuk Lun LI**, Morganville, NJ (US)

(73) Assignee: **CELLCO PARTNERSHIP D/B/A VERIZON WIRELESS**, Basking Ridge, NJ (US)

(21) Appl. No.: **14/062,445**

(22) Filed: **Oct. 24, 2013**

Publication Classification

(51) **Int. Cl.**

H04M 1/725 (2006.01)

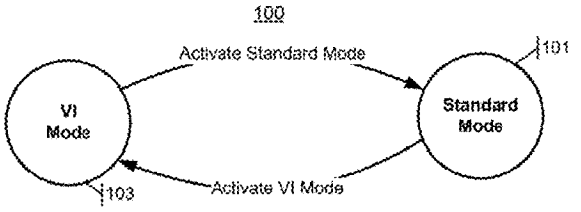
H04W 52/02 (2006.01)

(52) **U.S. Cl.**

CPC ***H04M 1/72594*** (2013.01); ***H04W 52/0274*** (2013.01)

(57) **ABSTRACT**

A mobile device operates in a standard mode of operation, or operates in a visually impaired (VI) mode of operation designed for visually impaired users and in which a display screen of the mobile device is turned off by default. The display screen may thus remain turned off in the VI mode even when conditions under which the display screen is turned on in the standard mode are satisfied. The display screen may further remain turned off in the VI mode even when conditions under which a touch-screen input interface of the mobile device is turned on in either of the standard and VI modes. The mobile device may be configured to automatically transition from the VI mode to the standard mode in response to detecting a gaze directed towards the display screen.



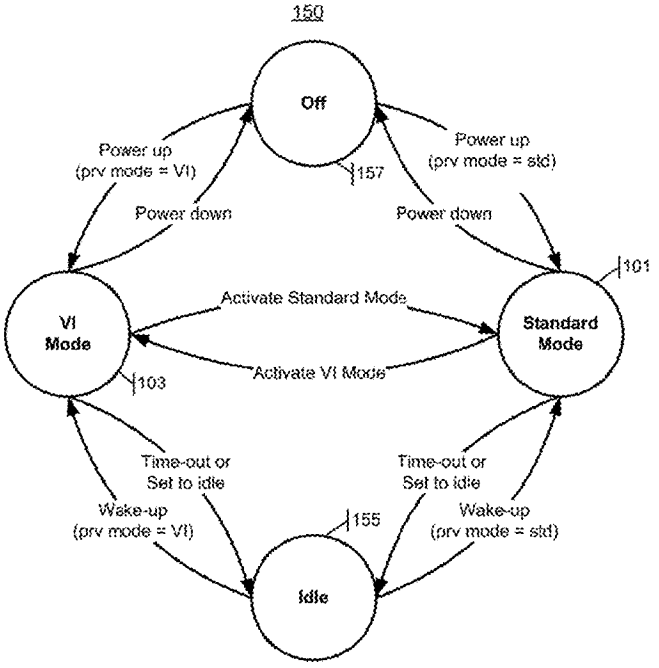


FIG. 1A

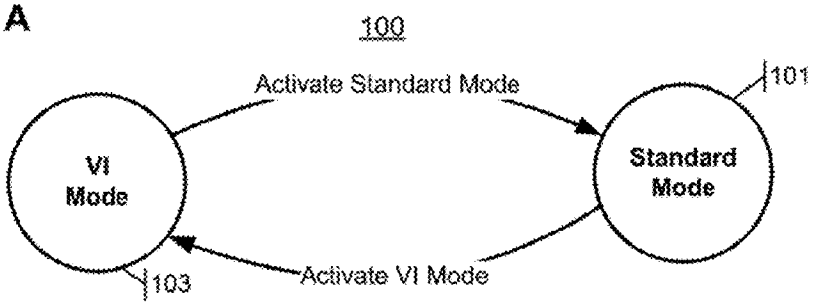

100
Activate Standard Mode
101
VI Mode
Standard Mode
103
Activate VI Mode

FIG. 1B

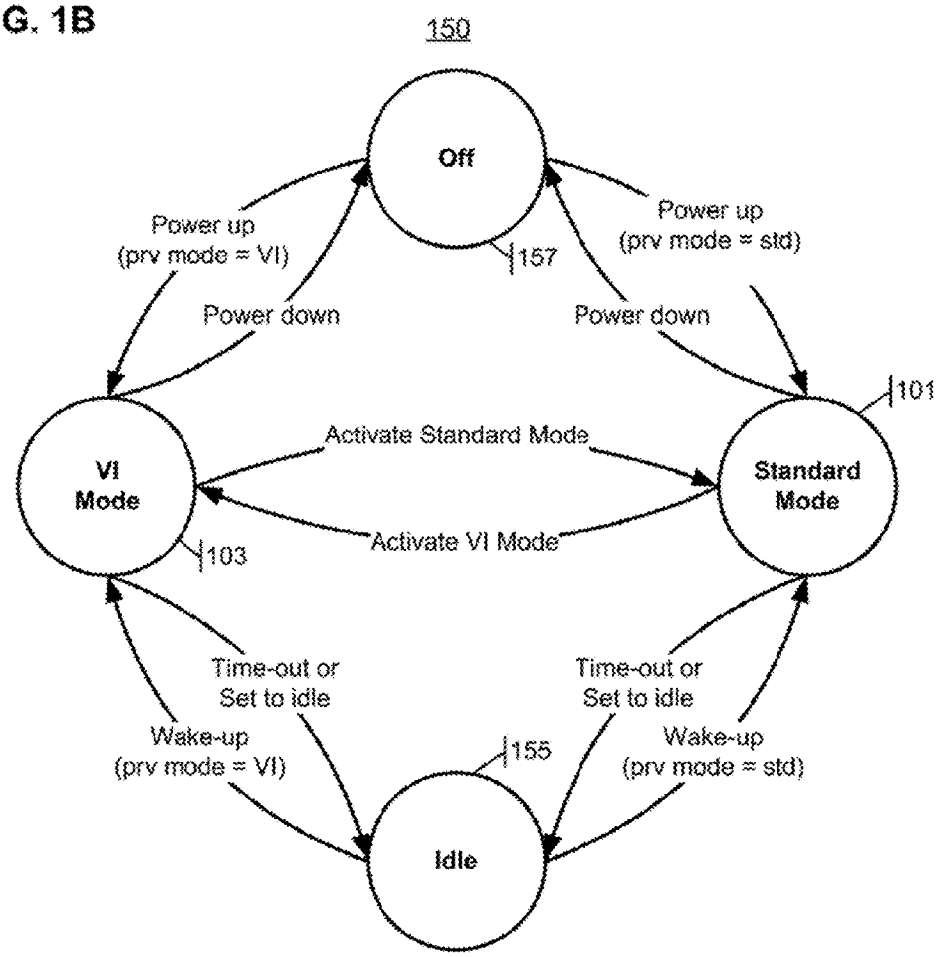

150
Off
Power up (prv mode = VI)
157
Power up (prv mode = std)
Power down
Power down
101
VI Mode
Activate Standard Mode
Standard Mode
Activate VI Mode
103
Time-out or Set to idle
Time-out or Set to idle
Wake-up (prv mode = VI)
155
Wake-up (prv mode = std)
Idle

FIG. 2A

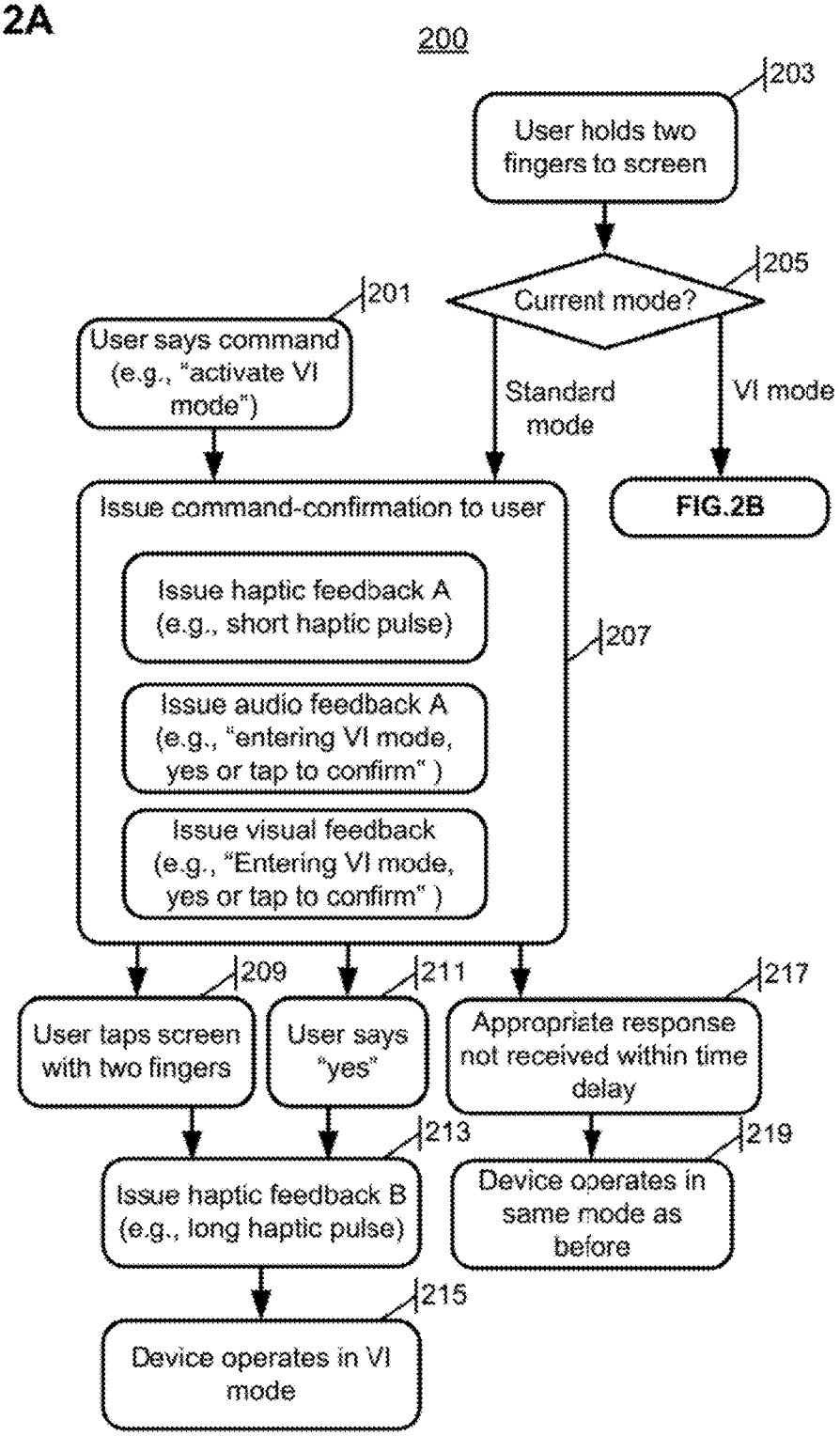

200
203
User holds two fingers to screen
205
Current mode?
201
User says command (e.g., "activate VI mode")
Standard mode
VI mode
FIG.2B
Issue command-confirmation to user
Issue haptic feedback A (e.g., short haptic pulse)
Issue audio feedback A (e.g., "entering VI mode, yes or tap to confirm")
Issue visual feedback (e.g., "Entering VI mode, yes or tap to confirm")
207
209
211
217
User taps screen with two fingers
User says "yes"
Appropriate response not received within time delay
213
219
Issue haptic feedback B (e.g., long haptic pulse)
Device operates in same mode as before
215
Device operates in VI mode

FIG. 2B

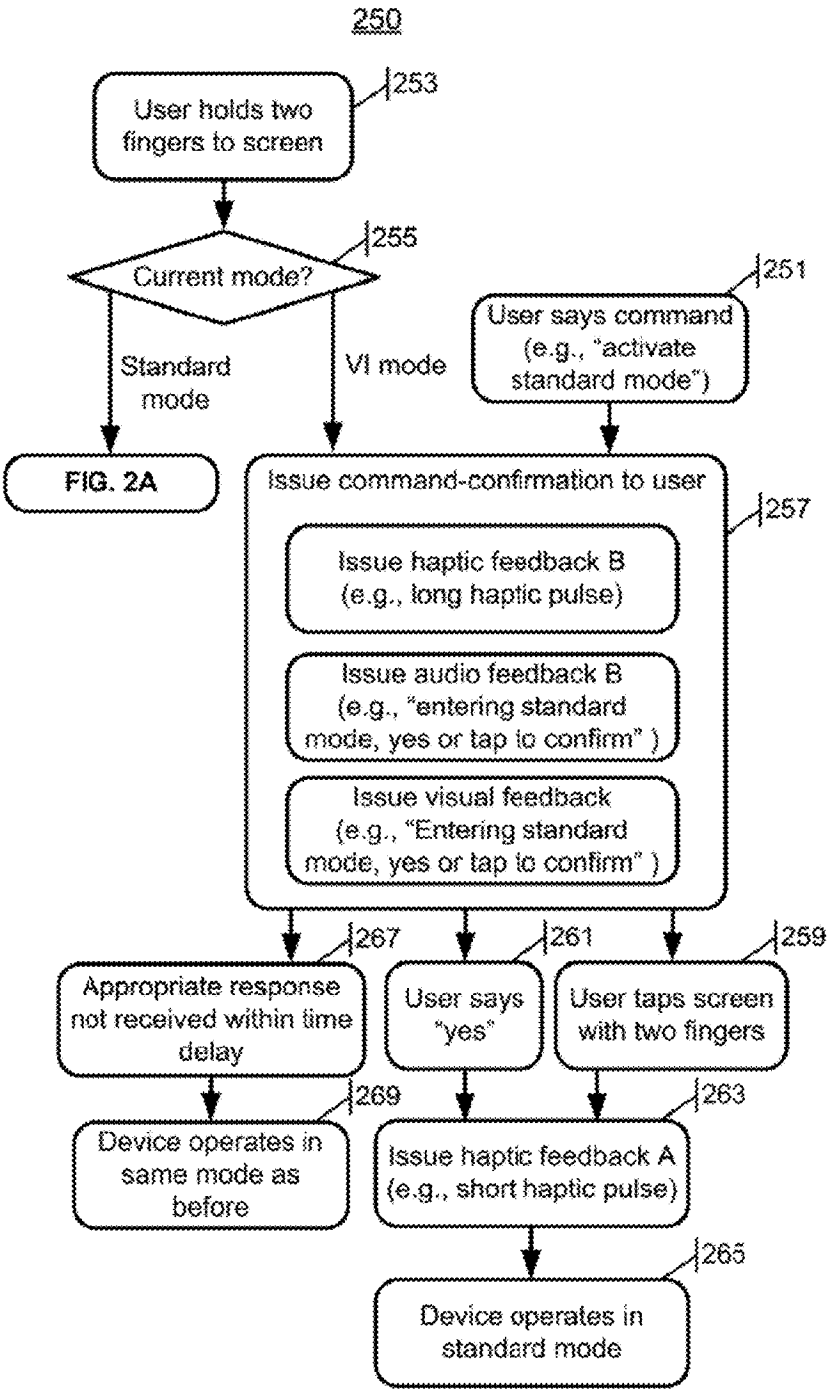

250
User holds two fingers to screen
253
Current mode?
255
Standard mode
VI mode
User says command (e.g., "activate standard mode")
251
FIG. 2A
Issue command-confirmation to user
257
Issue haptic feedback B (e.g., long haptic pulse)
Issue audio feedback B (e.g., "entering standard mode, yes or tap to confirm")
Issue visual feedback (e.g., "Entering standard mode, yes or tap to confirm")
267
261
259
Appropriate response not received within time delay
User says "yes"
User taps screen with two fingers
269
263
Device operates in same mode as before
Issue haptic feedback A (e.g., short haptic pulse)
265
Device operates in standard mode

FIG. 3A

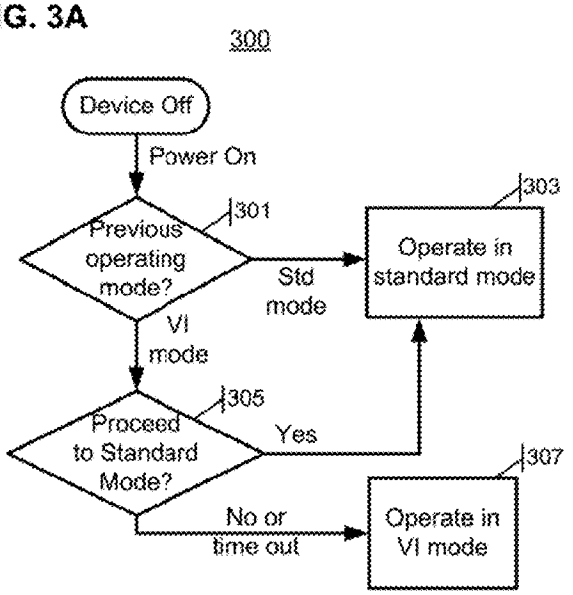

300
Device Off
Power On
301
Previous operating mode?
Std mode
303
Operate in standard mode
VI mode
305
Proceed to Standard Mode?
Yes
307
No or time out
Operate in VI mode

FIG. 3B

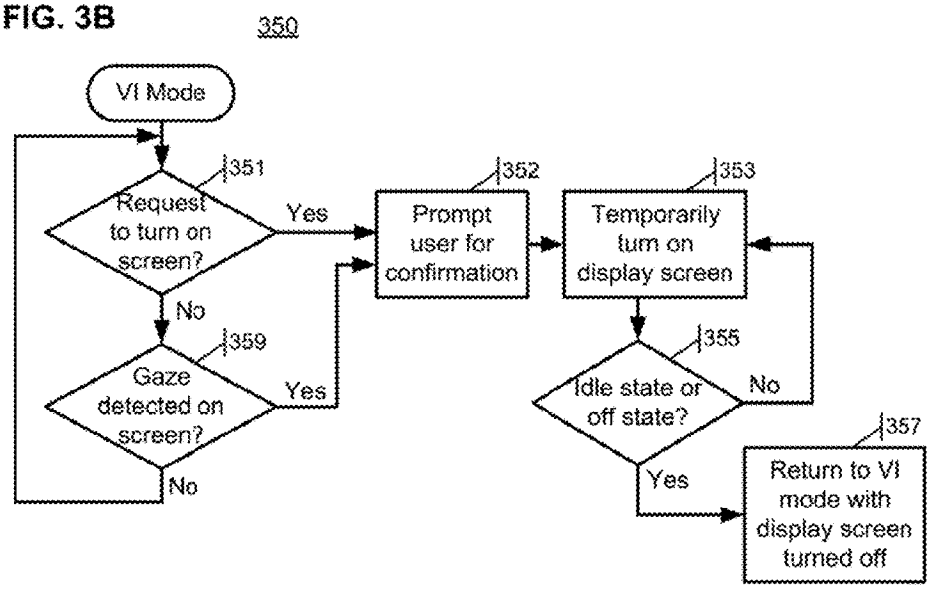

350
VI Mode
351
Request to turn on screen?
Yes
352
Prompt user for confirmation
353
Temporarily turn on display screen
No
359
Gaze detected on screen?
Yes
No
355
Idle state or off state?
No
Yes
357
Return to VI mode with display screen turned off

FIG. 4A

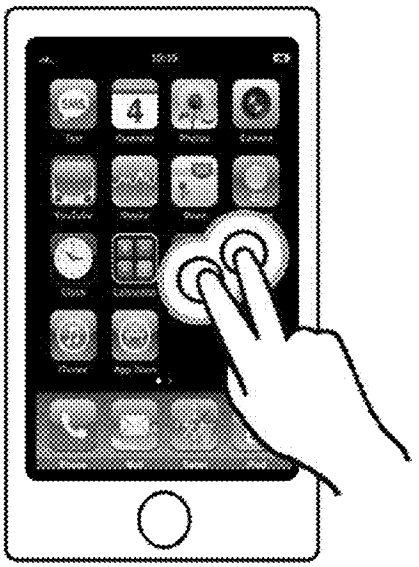


FIG. 4B

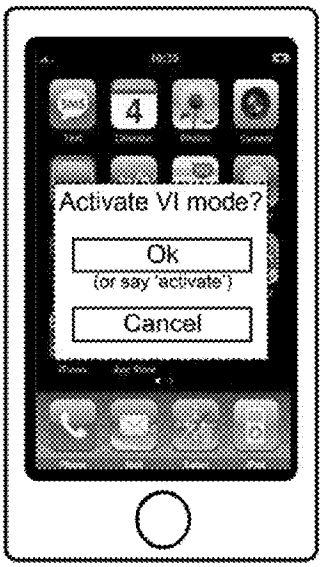


FIG. 4C

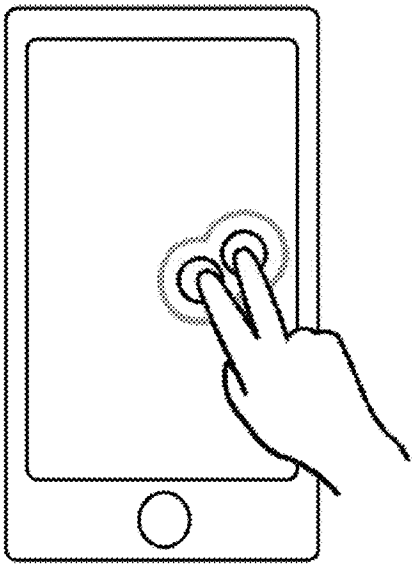


FIG. 4D

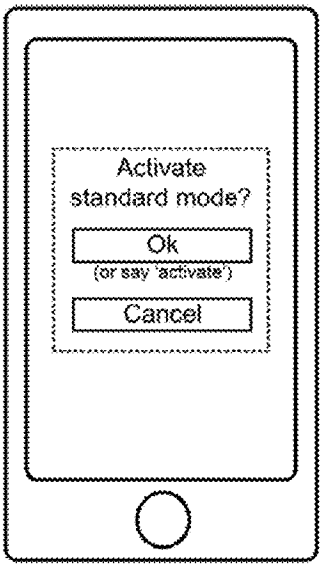


FIG. 4E

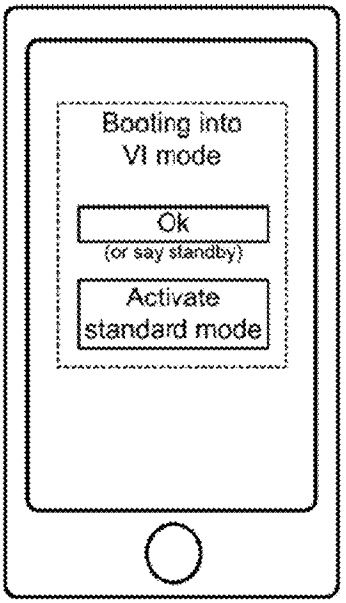


FIG. 4F

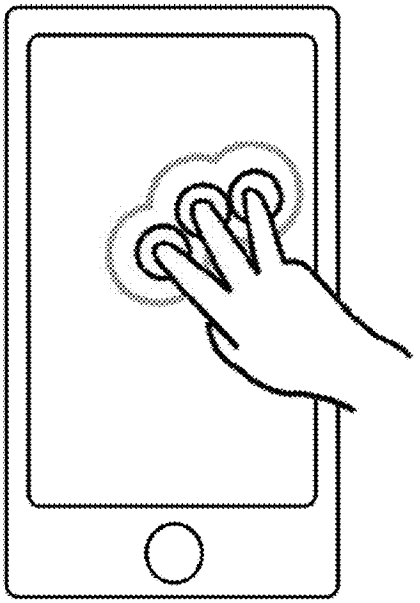
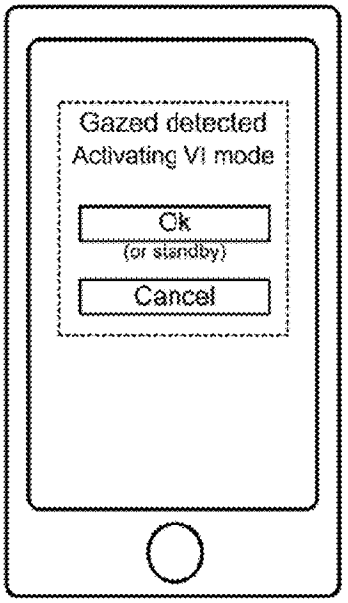


FIG. 4G



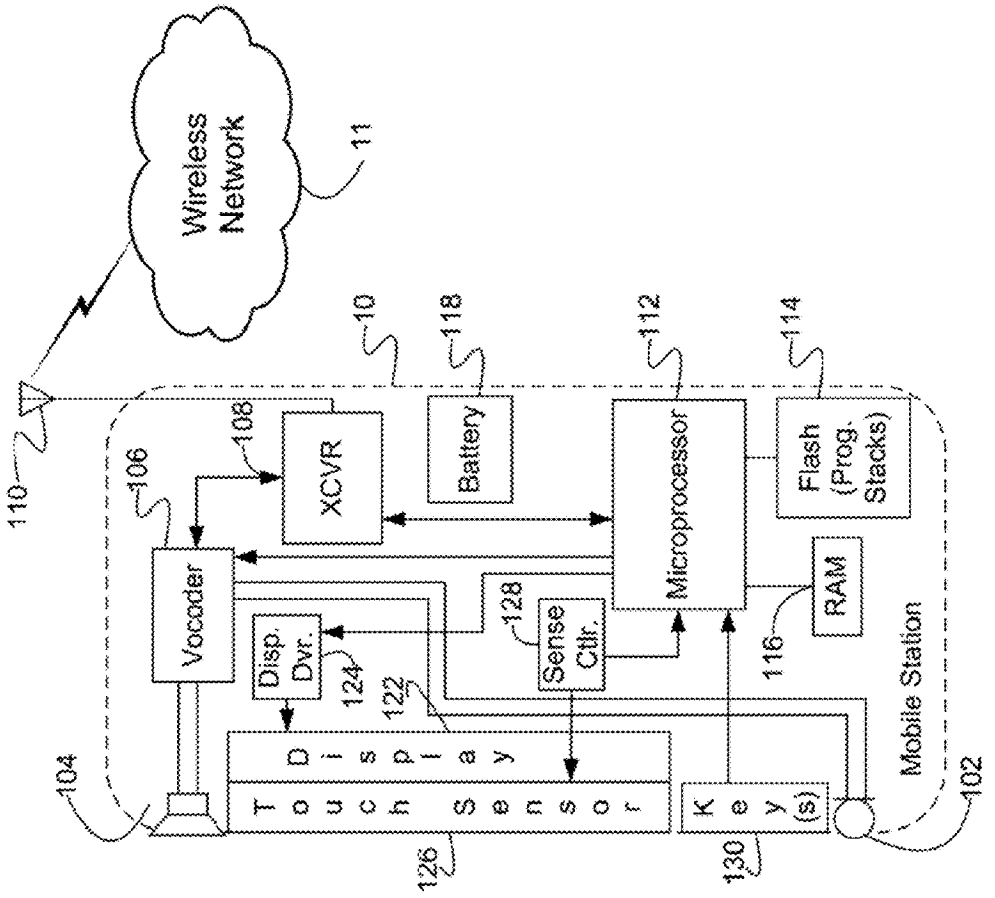

Wireless Network
11
10
118
112
114
110
106
108
XCVR
Battery
Microprocessor
Flash (Prog. Stacks)
Vocoder
128
Sense Ctlr.
RAM
116
Disp. Dvr.
124
122
Display
Touch Sensor
Key (s)
Mobile Station
104
102
126
130

FIG. 5

MOBILE DEVICE MODE OF OPERATION FOR VISUALLY IMPAIRED USERS

BACKGROUND

[0001] Mobile devices such as smart-phones have increasingly large display screens. The display screen consumes a large amount of power, and operation of the display screen causes the battery of the mobile device to quickly become depleted. For example, a standard display panel for a mobile device can consume around 1 Watt of power when active with normal brightness. In order to reduce battery usage, the display screen is generally automatically dimmed and/or turned off after a short period of inactivity.

[0002] The user interfaces of mobile devices are heavily dependent on the display of information to users. Indeed, the user interfaces generally rely on touch-screen technology for receiving user input. In order to use touch-screen input, the display screen must be powered on to display content and virtual buttons for selection by the user, and to detect the user's touch on the screen. The display must thus generally be powered on at any time that information is displayed to the user, and any time that user input is expected from the user.

[0003] Visually impaired users of mobile devices, such as blind users, use the touch-screen interface of their mobile devices to interact with the mobile devices. Visually impaired users, however, may not generally require the display screen of their mobile devices to be powered on as they interact with the touch-sensitive input interface. A need therefore exists for enabling visually impaired users of mobile devices to power off the display screens of their mobile devices to as to reduce power consumption. The turning off of the display screen can additionally avoid other persons from viewing information normally displayed on the screen.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] The drawing figures depict one or more implementations in accord with the present teachings, by way of example only, not by way of limitation. In the figures, like reference numerals refer to the same or similar elements.

[0005] FIGS. **1**A and **1**B are state diagrams illustratively showing transitions between the various modes of operation of a mobile device.

[0006] FIGS. **2**A and **2**B are flow diagrams illustratively showing processes for transitioning between modes of operation in a mobile device.

[0007] FIG. **3**A is a flow diagrams illustratively showing operations that may be performed when a mobile device powers up from a powered-off state into the standard mode or the VI mode of operation.

[0008] FIG. **3**B is a flow diagram illustratively showing operations that may be performed when a mobile device operating in the VI mode receives a user command to turn on the display screen.

[0009] FIGS. **4**A-**4**G are illustrations of mobile devices operating in different modes of operation, and receiving user commands for changing the mode of operation of the mobile device.

[0010] FIG. **5** is a high-level functional block diagram of an exemplary mobile device as may operate in the standard and VI modes of operation.

DETAILED DESCRIPTION

[0011] In the following detailed description, numerous specific details are set forth by way of examples in order to provide a thorough understanding of the relevant teachings. However, the present teachings may be practiced without such details. In other instances, well known methods, procedures, components, and/or circuitry have been described at a relatively high-level, without detail, in order to avoid unnecessarily obscuring aspects of the present teachings.

[0012] The various methods and system disclosed herein relate to providing an operating mode for visually impaired users of mobile devices, such as an operating mode that keeps the display screen powered off by default in order to reduce the power consumption of the mobile devices.

[0013] Visually impaired persons use mobile devices, such as smart-phones, for a similarly wide range of uses as non visually impaired users. Visually impaired users commonly use mobile devices for placing and receiving phone calls, accessing applications and/or the Internet, and listening to music, podcasts, movies, or other audio or audio-visual content. Users, whether visually impaired or not, interact with and control the mobile devices through user input interfaces that commonly take the form of touch-screen input interfaces. In a touch-screen interface, information is displayed for the user on the display screen, and can include one or more buttons for receiving input from the user. In response to the user touching a touch-sensitive sensor overlaid on the display screen (or forming part of the screen), the touch-sensitive sensor detects the location of the user's touch, determines whether the detected location is associated with any button or other function, and performs the function associated with the activated button or determined function.

[0014] While non visually impaired users rely heavily on visual information displayed on a display screen of the mobile device in interacting with and obtaining information from the mobile device, blind users as well as certain other visually impaired users do not generally use the display screen in their interactions with the mobile device. For such users, the display screen is not needed when they interact with the mobile device, and the display screen thus unnecessarily consumes the limited power stored in the mobile device battery. In fact, the display screen may inadvertently enable other persons to view information displayed on the screen, and the display of content on the screen may thus present privacy concerns for visually impaired users.

[0015] A mobile device may thus advantageously enable the display screen of the mobile device to be turned off by default. The display screen may be turned off by default when the mobile device operates in a visually impaired (VI) mode of operation designed for visually impaired users, while the display screen operates normally when the mobile device operates in a standard mode of operation.

[0016] The mobile device is configured such that it can separately turn on the display screen and the touch-sensitive input interface. The mobile device can thus simultaneously turn both the display screen and the touch-sensitive input interface on or off, or the mobile device can turn one on while the other remains turned off. During operation in the standard mode, both the display screen and the touch-sensitive input interface are generally turned on or turned off concurrently. However, during operation in the VI mode, the display screen generally remains turned off—even when the touch-sensitive input interface is turned on.

[0017] A user of the mobile device can select whether the mobile device operates in the standard mode or in the VI mode, and can alternate between the modes of operation by selectively activating one mode or the other.

[0018] FIG. **1**A is a state diagram **100** illustratively showing transitions between the various modes of operation of a mobile device. In particular, the state diagram **100** shows two modes of operation of the mobile device: the standard mode **101** and the VI mode **103**. The standard mode **101** is the default mode of operation of the mobile device, such as the mode in which the device operates when first turned on (e.g., following production and/or installation of the operating system).

[0019] When operating in the standard mode **101**, the display screen of the mobile device is powered and turned on under a variety of conditions. In general, in the standard mode **101**, the display screen is turned on to display information to the user when a button or key of the mobile device is activated. For example, the display screen is turned on in the standard mode **101** in response to a user pressing a power button to boot-up the device (from being powered off). The display screen is further turned on in the standard mode **101** in response to a user pressing any button or key to wake-up the device (from being in an idle state). The display screen may also be turned on in the standard mode **101** in response to the device booting-up or waking-up automatically, such as in response to a scheduled reminder, timer, or other alarm. In each of these instances, the device is powered up from a low power state (e.g., an "off" state or an "idle" state, such as a locked, standby, or sleep state). In the low power state, the display screen is turned off. In response to being powered up from the low power state in the standard mode **101**, the display screen is turned on. However, the display screen may turn off after a pre-determined period of inactivity (e.g., a period of 15 s during which no user input is received by the mobile device, or another user-selectable length of time) or in response to a user lock command, a user idle command (e.g., a sleep or lock command), or a power down command.

[0020] In general, in the standard mode **101**, the touch-sensitive input interface is turned on and off at substantially the same times (and/or for substantially the same periods of time) as the display screen. Thus, the touch-sensitive input interface is generally turned on, and is active and ready to sense a user's touch command, whenever the display screen is turned on. Conversely, the touch-sensitive input interface is generally turned off, and cannot sense users' touch, whenever the display screen is turned off.

[0021] When the mobile device operates in the VI mode **103**, the display screen of the mobile device remains turned off by default, such that it remains off (and powered down) at substantially all times. Thus, even when one of the conditions that trigger the display screen to be turned on in the standard mode **101** is satisfied, the display screen remains turned off in the VI mode **103**. For example, the display screen is not turned on in the VI mode **103** in response to a user pressing a power button to boot-up the device (from being powered off). The display screen is further not turned on in the VI mode **103** in response to a user pressing any button or key to wake-up the device (from being in an idle state).

[0022] In the VI mode **103**, however, the touch-sensitive input interface may nonetheless be turned on or activated under substantially the same conditions that trigger the display screen (and the touch-sensitive input interface) to be turned on in the standard mode **101**. As such, in the VI mode **103**, the touch-sensitive input interface is turned on and monitors for user touch input in response to a user pressing a power button to boot-up the device (from being powered off). The touch-sensitive input interface is further turned on in the VI mode **103** in response to a user pressing any button or key to wake-up the device (from being in an idle state). The touch-sensitive input interface may be turned back off after a pre-determined period of inactivity (e.g., a period of 15 s during which no user input is received by the mobile device) or in response to a user lock command, a user idle command (e.g., a sleep or lock command), or a power down command.

[0023] The display screen generally remains turned off in the VI mode **103**, and displays no information to the user. In particular, in the VI mode **103**, the display screen remains turned off even when a user is actively engaging with the touch-sensitive input interface.

[0024] Similarly to the standard mode **101**, the mobile device can enter a low power state, such as a powered-off state or an idle state (e.g., a locked, standby, or sleep state), when operating in the VI mode **103**. In the low power state, the display screen remains turned off while the touch-screen user interface is also turned off. The mobile device may enter the low power state when operating in the VI mode **103** in much the same ways as the device enters the low power state when operating in the standard mode **101**. In particular, the device can enter a low power state after a pre-determined period of inactivity (e.g., a period of 15 s during which no user input is received by the mobile device) or in response to a user lock command, a user idle command (e.g., a sleep or lock command), or a power down command.

[0025] The standard mode **101** and VI mode **103** may further provide users with different user interfaces. In the case of the VI mode **103**, for example, the user interface may be adjusted to provide enhanced non-visual forms of feedback to users. Thus, in the VI mode **103**, screen reader software may be automatically turned on (or turned on by default) to cause text that would usually be displayed on the display screen to be read to users. The screen reader software may additionally provide audio descriptions of certain elements displayed on a screen, such as description of the positions of frames that would be displayed on the display screen if the display screen were turned on, or of virtual buttons that the user may activate on the touch-sensitive input interface (e.g., "OK button in lower left corner of screen; Cancel button in lower right corner of screen"). In contrast, screen reader software may be turned off by default when operating in the standard mode **101**, and/or may not provide audio descriptions of non-text elements displayed on the screen.

[0026] In addition to audio feedback, operation in the VI mode **103** may provide enhanced haptic feedback. In one example, haptic feedback can be used to provide confirmation to a user that the user's selection of a virtual button through the touch-sensitive input interface was received, for instance by issuing a haptic pulse in response to and shortly after receiving the user's selection. In another example, haptic feedback can be used to provide confirmation that a user's finger contacting the touch-sensitive input interface is located above a frame, button, or icon, for instance by issuing a haptic vibration when the finger is located above the frame. In contrast, haptic feedback may generally be turned off by default when operating in the standard mode **101**.

[0027] In the VI mode **103**, the user interface of the mobile device may further automatically activate a spoken command input interface to enable the mobile device to receive input

commands spoken by the user and received through a microphone. The spoken command input interface may be used to receive dictation from a user, and/or to receive commands for performing tasks on the mobile device (e.g., to select an icon, open a menu, or the like). The spoken command input interface may be deactivated by default in the standard mode **101**.

[0028] As shown in state diagram **100**, the mobile device can transition between the standard mode **101** and the VI mode **103** of operation in response to an activation of either mode by a user. Thus, when operating in the standard mode **101**, the user may activate the VI mode to cause a transition into the VI mode **103**. Conversely, when operating in the VI mode **103**, the user may activate the standard mode to cause a transition into the standard mode **101**.

[0029] When the mobile device operates in the VI mode **103**, the display screen remains powered down at substantially all times. The display screen may nonetheless be activated at selected times and for limited purposes. For example, immediately following a boot-up or wake-up operation, the display screen may be temporarily activated for a limited period of time for the express purpose of providing a sighted user with a visual notification indicating that the mobile device is in the VI mode **103** (e.g., by displaying an on-screen pop-up notification indicating that the mobile device is in the VI mode). The notification can provide the user with an opportunity to activate a standard mode **101** (e.g., by displaying an on-screen prompt for activating the standard mode **101**) and may indicate the amount of time remaining before the mobile device automatically enters VI mode **103** if the standard mode **101** is not activated by the user. During display of the visual indication and/or on-screen prompt, no other information is displayed on the display screen. The display screen may be turned off after a pre-determined limited period of time has elapsed.

[0030] FIG. **1**B is a second state diagram **150** illustratively showing transitions between the various modes of operation of a mobile device in more detail. In addition to the standard mode **101** and VI mode **103** shown in diagram **100**, diagram **150** shows transitions into and out of the idle state **155** (e.g., a sleep, standby, or locked state) and the powered-off state **157**.

[0031] As shown, the mobile device enters the idle state **155** from either the standard mode **101** or the VI mode **103** in response to a time-out or a command to set the mobile device to idle. In the idle state **155**, both the display screen and the touch-sensitive input interface are turned off. The mobile device remains in the idle state **155** until an activating event is detected. An activating event may include a user pressing a key of the mobile device to cause the mobile device to be woken-up, an alarm being activated or a timer expiring, or the like. When the activating event is detected, the mobile device wakes-up and automatically determines the previous mode of operation in which the mobile device operated immediately prior to entering the idle state **155**. In response to determining that the previous mode was the standard mode **101**, the mobile device is woken-up and made to operate in the standard mode **101**. In response to determining that the previous mode was the VI mode **103**, the mobile device is woken-up and made to operate in the VI mode **103**.

[0032] The mobile device can alternatively enter the powered-off state **157** from either the standard mode **101** or the VI mode **103** in response to a user's power-down command, a power-down trigger (e.g., a restart trigger), or a battery reaching a critically low level. In the powered-off state **157**, the display screen, the touch-screen user interface, as well as all other parts of the mobile device are turned off. The mobile device remains in the powered-off state **157** until a power button is activated or a charging cable is connected. When the power button is activated or the charging cable is connected, the mobile device powers-up and automatically determines the previous mode of operation in which the mobile device operated immediately prior to powering down into the powered-off state **157**. In response to determining that the previous mode was the standard mode **101**, the mobile device is powered-up and made to operate in the standard mode **101**. In response to determining that the previous mode was the VI mode **103**, the mobile device is powered-up and made to operate in the VI mode **103**.

[0033] In some examples, the mobile device operating in the VI mode may provide non-visual user interface features to users that are not generally available in the standard mode. For example, when operating in the VI mode, the mobile device may provide enhanced haptic feedback in response to touch input from users, provide alternate control methods based on hand gestures using the touch-sensitive input interface, on free-space gestures measured using an accelerometer and/or gyroscope mounted in the mobile device, and on voice recognition or the like. Operation in the VI mode may further cause audio triggering technology, such as a highly energy efficient audio-monitoring circuit that enables the mobile device to continuously monitor a microphone for voice commands uttered by a user, to be powered such that users can control the mobile device using oral commands.

[0034] FIGS. **2**A and **2**B are flow diagrams illustratively showing processes for transitioning between modes of operation in a mobile device. The processes are illustrative and may correspond to processes that are pre-established in the mobile device. However, other processes (including user-defined processes) may alternatively be used to transition between modes of operation. FIG. **2**A shows a method **200** for transitioning into the VI mode **103**, while FIG. **2**B shows a method **250** for transitioning into the standard mode **101**.

[0035] In accordance with method **200**, a user may begin a process for activating the VI mode **103** using a number of commands. The user may issue an oral command for activating the VI mode **103** as shown in operation **201**, for example by saying a pre-determined phrase (e.g., "activate VI mode") while the mobile device is listening for the pre-determined phrase. The user may alternatively issue a pre-determined gesture command through the touch-screen user interface of the mobile device as shown in operation **203**, such as a two-finger hold gesture (e.g., by holding two adjacent fingers stationary on the screen for 3 s) or other multi-finger gesture. The user may alternatively access a setup menu of the mobile device in order to select a menu option for changing the operating mode of the mobile device, or use a motion-based command (e.g., by performing a pre-determined hand motion while holding the mobile device, such as by gently shaking the mobile device in a horizontal plane for 2 s) in order to change the operating mode. In some situations, in response to receiving the user command for changing the operating mode, the mobile device may determine a current mode of operation of the mobile device (operation **205**). Based on the determination, the mobile device may either proceed with operation **207** of method **200** if the current mode is the standard mode **101**, or with operation **257** of method **250** (shown in FIG. **2**B) if the current mode is the VI mode **103**.

[0036] In operation **207**, the mobile device seeks confirmation from the user regarding the request for changing the mode of operation. As part of seeking user confirmation, the mobile device provides feedback to the user indicating that the request has been received, and prompting the user for confirmation. The feedback can take various forms. As shown, one or more of haptic, audio, and visual feedback can be used. For example, a short haptic pulse can be issued, an auditory notification can be issued (e.g., "entering VI mode, say yes or tap screen to confirm"), and/or a pop-up notification can be issued (e.g., a prompt for "Entering VI mode, select yes or tap to confirm"). Note that the haptic and audio feedback enable visually impaired users to be apprised of impending changes in operating mode.

[0037] If the user issues a confirmation command, for example by tapping the touch-screen user interface with two fingers (operation **209**) or saying a pre-determined command (operation **211**) before a pre-determined time period has lapsed, the mobile device proceeds to issue a final confirmatory haptic feedback in operation **213** (e.g., a long haptic pulse) before changing the operation mode of the mobile device to the VI mode (operation **215**). Alternatively or additionally, a motion-based command can be used to issue the confirmation command (e.g., in operation **209** or **211**), and audio feedback can be used instead of or in addition to haptic feedback in operation **213** (e.g., in the form of a tone descending in frequency). If no confirmation command is received within the pre-determined time period (operation **217**), or if a command to cancel the change in modes is received from the user, the mobile device does not change mode of operation and instead continues to operate in the standard mode (operation **219**).

[0038] In accordance with method **250** of FIG. **2**B, a user of the mobile device can activate a transition back into the standard mode of operation using a similar process. The user may issue an oral command for activating the standard mode **101** as shown in operation **251**, issue a pre-determined gesture command (e.g., a two finger hold) as shown in operation **253**, access an appropriate setup menu of the mobile device, or issue a pre-determined motion command (e.g., shaking the mobile device in a horizontal plane for 2 s). In some situations, in response to receiving the user command for changing the operating mode, the mobile device determines a current mode of operation of the mobile device (operation **255**) so as to determine whether to proceed with operation **257** of method **250** (e.g., if the current mode is the VI mode **103**) or operation **207** of method **200** (e.g., if the current mode is the standard mode **101**).

[0039] In operation **257**, the mobile device seeks confirmation from the user regarding the request for changing the mode of operation. As part of seeking user confirmation, the mobile device provides haptic, audio, or visual feedback to the user so as to prompt the user for confirmation. Operation **257** may include turning on the display screen to provide the visual feedback. If the user issues a confirmation command, for example by tapping the touch-screen user interface with two fingers (operation **259**) or saying a pre-determined command (operation **261**) before a pre-determined time period has lapsed, the mobile device proceeds to issue a final confirmatory haptic feedback in operation **263** before changing the mode of operation of the mobile device to the standard mode (operation **265**). Alternatively or additionally, a motion-based command can be used to issue the confirmation command (e.g., in operation **259** or **261**), and audio feedback can be used instead of or in addition to haptic feedback in operation **263** (e.g., in the form of a tone ascending in frequency). If no confirmation command is received within the pre-determined time period (operation **267**), or if a command to cancel the change in modes is received from the user, the mobile device does not change operation mode and instead continues to operate in the VI mode (operation **269**).

[0040] FIG. **3**A is a flow diagram **300** illustratively showing operations that may be performed when a mobile device powers up from a powered-off state into the standard mode **101** or the VI mode **103**. In diagram **300**, the mobile device powers up and determines the previous mode of operation in which the mobile device operated immediately prior to powering down (operation **301**). In response to determining that the previous mode was the standard mode, the mobile device is powered-up and made to operate in the standard mode (operation **303**). In response to determining that the previous mode was the VI mode, the mobile device is powered-up and the display screen is turned on. The mobile device displays a temporary prompt in operation **305** notifying a user that the device is being powered-up and made to operate in the VI mode. The notification can provide the user with an option for causing the device to power-up and be made to operate in the standard mode instead. If no user input is received in response to the prompt, the VI mode is activated in operation **307** and the display screen is turned off. However, if the user selects the option for powering the device up in the standard mode in operation **305**, the mobile device proceeds to operation **303** and operates in the standard mode.

[0041] In some embodiments, the mobile device may be configured to enable a user to temporarily turn on the display screen when operating in the VI mode. In one example, the temporary turning on of the display screen may enable a visually impaired user to show pictures or other visual content to a non-visually impaired user (e.g., a friend or family member), and/or to seek assistance in operating the mobile device from a non-visually impaired user (e.g., a friend, or technical support person). In general, following the display screen being temporarily turned on in the VI mode, the display screen remains turned on until a user command to turn off the display screen is received, or until the mobile device enters a low power state (e.g., idle or off state), whichever occurs first. In one example, the display screen may remain turned on for a pre-determined or user-selected period (e.g., 3 minutes) following receipt of a command to temporarily turn on the display screen, and may automatically be turned off at the end of the pre-determined or user-selected period unless a follow-on user request to maintain the display screen temporarily turned on is received.

[0042] FIG. **3**B is a flow diagram **350** illustratively showing operations that may be performed when a mobile device operating in the VI mode receives a user command to turn on the display screen. In diagram **350**, the mobile device operating in the VI mode is operative to turn on the display screen under various conditions. In one situation, the mobile device can turn on the display screen in response to receiving a request or command from a user to turn on the display screen (operation **351**). The request can come in the form of an oral command (e.g., "turn display on"), a pre-determined gesture command (e.g., a three-finger hold gesture in which three adjacent fingers are held stationary on the screen for 3 s), or by accessing a corresponding menu option of the mobile device. In response to the request, the mobile device may prompt the user for confirmation that the user wants to turn on the display

screen (operation **352**), for example by issuing one or more of an audio, visual, or haptic notification and waiting for confirmation from the user (e.g., using operations similar to operations **207-213** of FIG. **2**A). If the user confirms the request, the display screen in temporarily turned on (operation **353**) while the device continues to operate in the VI mode. Note that the display screen is only temporarily turned on. As such, as soon as the mobile device enters an idle state or a powered-off state (operation **355**), or as soon as the display screen is otherwise caused to be turned off, the display screen returns to its default operating mode of being turned off while the mobile device operates in the VI mode (operation **357**). The user can once again temporarily turn on the display screen by repeating operation **351**. Additionally, when the display screen is temporarily turned on, the user can turn off the display screen by speaking an oral command (e.g., "turn display off"), a pre-determined gesture command (e.g., the three-finger hold gesture), or by accessing a corresponding menu option of the mobile device.

[0043] In another situation, the mobile device can turn on the display screen in response to automatically determining a need for the display screen (operation **359**), such as by detecting that a gaze is directed towards the display screen of the mobile device. In this situation, the mobile device may continuously monitor whether a gaze of a user of the mobile device is directed towards the display screen of the mobile device when the mobile device operates in the VI mode, for example by using a forward facing camera of the mobile device that tracks eyes (and/or irises, pupils, or glints in eyes) of users looking at the display screen. When a gaze is detected as being directed towards the display screen and is detected to be sustained (e.g., a gaze that is steadily directed at the display screen for at least a 2 s period or another predetermined length of time), the mobile device may prompt the user for confirmation that the user wants to turn on the display screen (operation **352**). The prompt may be an audio prompt to which the user can respond through a spoken command or selection of a response option on the touch-sensitive input interface. The prompt can alternatively be a visual prompt displayed on the display screen after temporarily turning on the display screen, and including response option buttons displayed on the screen for selection using the touch-sensitive user interface. If confirmation is received, the mobile device proceeds with operations **353-357** as described above.

[0044] In some examples, the mobile device monitors whether a gaze of a user is directed towards the display screen (or monitors for triggers used in automatically turning on the display screen) under specified circumstances. For instance, the mobile device may only monitor for users' gazes when particular applications are currently active on the mobile device. An application is currently active on the mobile device if the application is running on the device and is controlling the user interface of the device (e.g., the application is actively running on the mobile device rather than running in the background, and the mobile device is not operating in a low power state). A currently active application can, for example, be an application that a user of the mobile device has activated by selecting an icon for the application on the mobile device's home screen. In one example, the particular applications may be applications that are inherently associated with visual content, such that the mobile device monitors for user gazes only when applications that are inherently associated with visual content, such as photo viewing/sharing applications, video players, or the like, are actively being used on the mobile device. Conversely, in the example, the mobile device may not monitor for user gazes when non-visual applications, such as an audio-book reader, a music or radio player, or the like, are in active use. The particular applications may be applications included in a pre-determined list of applications compatible with the automatic turning on of the display screen when a sustained gaze is detected (e.g., such as applications that are inherently associated with visual content in the example above), and/or a list of user-selected applications among the applications that are installed on the mobile device.

[0045] In another example, the mobile device can turn on the display screen in response to automatically determining a need for the display screen when operating in the VI mode (operation **359**) such as determining that an application that is inherently associated with visual content is active on the mobile device, whether or not a gaze is detected. In the other example, the prompt (operation **352**) may be provided to the user only after the application has been active for a pre-determined period of time (e.g., 5 seconds), such that the prompt is not provided when an application is erroneously activated and is promptly de-activated by the user.

[0046] Conversely, the mobile device can automatically transition from the standard mode to the VI mode so as to turn off the display screen in response to automatically determining that the display screen may pose a distraction to a user when the mobile device operates in the standard mode. For example, the mobile device may determine that a user is driving or otherwise engaging in an activity in which visual distractions should be minimized. The determination can, in one example, be based on determining that an application that is associated with driving (e.g., an application providing turn-by-turn driving directions to a user of the mobile device) is active on the mobile device. The determination can further be based on sensor input (e.g., a sensor determining that the mobile device is docked in a vehicle-dock). The automatic transition from the standard mode to the VI mode may activate a screen reader or other audio-based interface in addition to turning off the display screen.

[0047] In an alternate embodiment, in response to detecting that a gaze is directed towards the display screen of the mobile device (e.g., as in operation **359**), the mobile device can initiate a change in operating mode of the mobile device. In this situation, the mobile device initiates a change of mode from the VI mode to the standard mode, for example by prompting the user for confirmation that the user wants to change the mode of operation (e.g., similarly to operations **257-265** of FIG. **2**B) prior to proceeding with operation in the standard mode upon receiving confirmation, or reverting to the VI mode if no confirmation is received.

[0048] FIGS. **4**A-**4**G are illustrations of mobile devices operating in different modes of operation, and receiving user commands for changing the mode of operation of the mobile device.

[0049] FIG. **4**A shows a mobile device operating in the standard mode of operation in which the display screen is powered on and displaying a home screen. While operating in the standard mode, a user touches the touch-screen user interface with a two-finger hold gesture in order to initiate the activation of the VI mode (e.g., as in operation **203** of FIG. **2**A). In response to the two-finger hold gesture, the mobile device displays a confirmation screen shown in FIG. **4**B prompting the user for confirmation of the command to activate the VI mode (e.g., as in operation **207**). In response to the

user selecting an "Ok" option or saying the command "Activate", the mobile device transitions to the VI mode (e.g., as in operation **215**). Alternatively, the user can select a "Cancel" option or wait a predetermined time-out period to remain in the standard mode (e.g., as in operation **219**).

[0050] FIG. **4**C shows a mobile device operating in the VI mode of operation in which the display screen is powered off but the touch-screen user interface is nonetheless powered up and active. While operating in the VI mode, the user touches the touch-screen user interface with a two-finger hold gesture in order to initiate the activation of the standard mode (e.g., as in operation **253** of FIG. **2**B). In response to the two-finger hold gesture, the mobile device activates the display screen to display the confirmation screen shown in FIG. **4**D (e.g., as in operation **257**). The display screen of FIG. **4**D prompts the user for confirmation of the command to activate the standard mode. The user can select an "Ok" option or say the command "Activate" in order to transition to the standard mode (e.g., as in operation **265**) and cause the mobile device to display content on the display screen. Alternatively, the user can select a "Cancel" option or wait a predetermined time-out period to remain in the VI mode (e.g., as in operation **269**) and cause the display screen to be powered back off.

[0051] FIG. **4**E shows a mobile device being powered up from a powered-off state. The mobile device has determined that it should power-up in the VI mode, for example in response to determining that the mobile device was operating in the VI mode immediately before being powered off (e.g., as in operation **301** of FIG. **3**A). As part of the powering-up process, the mobile device turns on the display screen so as to display a prompt thereon (e.g., as in operation **305**). As shown in FIG. **4**E, the mobile device displays a temporary prompt notifying a user (e.g., sighted user) that the device is being powered up in the VI mode. The prompt provides an option for powering the device up in the standard mode instead. If no user input is received in response to the prompt, the VI mode is activated (e.g., as in operation **307**) and the display screen in turned off. However, if user input for activating the standard mode is received, the mobile device can activate the standard mode instead of the VI mode (e.g., as in operation **303**).

[0052] FIG. **4**F shows a mobile device operating in the VI mode of operation in which the display screen is powered off but the touch-screen user interface is nonetheless powered up and active. While operating in the VI mode, the user touches the touch-screen user interface with a three-finger hold gesture in order to initiate the temporary turning on of the display screen (e.g., as in operations **351**-**357** of FIG. **3**B). In response to the three-finger hold gesture, the mobile device activates the display screen to display a confirmation screen (not shown) prompting the user to confirm the request to temporarily turn on the display screen (e.g., as in operation **352**).

[0053] FIG. **4**G illustrates a mobile device operating in the VI mode of operation and having detected a gaze directed towards the display screen of the mobile device (e.g., as in operation **359** of FIG. **3**B). In response to monitoring for and detecting the gaze, the mobile device activates the display screen to display the confirmation prompt of FIG. **4**G prompting the user to confirm whether the display screen should be temporarily turned on (e.g., as in operation **352**).

[0054] FIG. **5** provides a block diagram illustration of an exemplary mobile device **10**. Although the mobile device **10** may be a smart-phone, a tablet computer, or may be incorporated into another device such as a personal digital assistant (PDA) or the like, for discussion purposes the illustration shows the mobile device **10** in the form of a handset. The mobile device **10** is powered by a battery **118**, and is operative to communicate wirelessly with a network **11** such as a mobile wireless communication network (e.g., a cellular communication network), a Wifi network, or the like.

[0055] The handset embodiment of the mobile device **10** functions as a normal digital wireless telephone station. For that function, the device **10** includes a microphone **102** for audio signal input and a speaker **104** for audio signal output. The microphone **102** and speaker **104** connect to voice coding and decoding circuitry (vocoder) **106**.

[0056] For digital wireless communications, the device **10** also includes at least one digital transceiver (XCVR) **108** connected to an antenna **110**. Today, the device **10** can be configured for digital wireless communications using one or more of the common network technology types. The transceiver **108** provides two-way wireless communication of information, such as vocoded speech samples and/or digital information, in accordance with the technology of the network **11**. The transceiver **108** also sends and receives a variety of signaling messages in support of the various voice and data services provided via the mobile device **10** and the communication network **11**. In some examples, in addition to a transceiver **108** configured for communication through a mobile wireless communication network (e.g., a GSM, 3G, 4G, or LTE network, or the like), an additional transceiver is connected to a separate antenna to provide communication capabilities through a different type of network such as a Wifi network.

[0057] The mobile device **10** includes a display **122**, which the microprocessor **112** controls via a display driver **124**, to present visible outputs to the device user. The device **10** also includes a touch/position sensor **126** comprising the touch-sensitive input interface. The touch-sensitive sensor **126** is relatively transparent, so that the user may view the information presented on the display **122** through the sensor **126**. A sense controller circuit **128** senses signals from elements of the touch/position sensor **126** and detects occurrence and position of each touch of the screen formed by the display **122** and sensor **126**. The sense circuit **128** provides touch position information to the microprocessor **112**, which can correlate that information to the information currently displayed via the display **122**, to determine the nature of user input via the screen.

[0058] The display **122** and touch sensor **126** (and possibly a limited number of keys **130**, if included) are the physical elements providing the textual and graphical user interface for the mobile device **10**. The microphone **102** and speaker **104** may be used as additional user interface elements, for audio input and output.

[0059] The microprocessor **112** is operative to selectively and separately turn on or off the display **122** and the touch sensor **126**. The microprocessor **112** can thus turn on both the display **122** and the touch sensor **126**, turn off both the display **122** and the touch sensor **126**, turn on the display **122** while turning off the touch sensor **126**, or turn off the display **122** while turning on the touch sensor **126**. The turning on and off of one or more of the display **122** and the touch sensor **126** can include sending a command to the one or more of the display **122** and touch sensor **126** to cause the respective element to turn off. Alternatively, the turning on and off of one or more of the display **122** and the touch sensor **126** can include removing power from the one or more of the display **122** and the

touch sensor **126**, for example by opening or closing a switch providing power to the display **122** or a switch providing power to the touch sensor **126**. In general, when the display driver **124** is turned on and off concurrently with the display **122**, while the sense controller circuit **128** is turned on and off concurrently with the touch sensor **126**.

[0060] The microprocessor **112** serves as a programmable controller for the mobile device **10**, in that it controls all operations of the mobile device **10** in accord with programming that it executes, for all normal operations, and for operations involved in activating and operating in each of the standard and VI modes of operation under consideration here. In the example, the mobile device **10** includes flash type program memory **114**, for storage of various "software" or "firmware" program routines and mobile configuration settings. The mobile device **10** may also include a non-volatile random access memory (RAM) **116** for a working data processing memory. Of course, other storage devices or configurations may be added to or substituted for those in the example. In a present implementation, the flash type program memory **114** stores firmware such as a boot routine, device driver software, an operating system, and any of a wide variety of other applications, such as client browser software and short message service software. The memories **114**, **116** also store various data, such as server addresses, downloaded data such as multimedia content, and various data input by the user. Programming stored in the flash type program memory **114**, sometimes referred to as "firmware," is loaded into and executed by the microprocessor **112**.

[0061] As outlined above, the mobile device **10** includes a processor, and programming stored in the flash memory **114** configures the processor so that the mobile station is capable of performing various desired functions, including in this case the functions involved in activating and operating in each of the standard and VI modes of operation.

[0062] Unless otherwise stated, all measurements, values, ratings, positions, magnitudes, sizes, and other specifications that are set forth in this specification, including in the claims that follow, are approximate, not exact. They are intended to have a reasonable range that is consistent with the functions to which they relate and with what is customary in the art to which they pertain.

[0063] The scope of protection is limited solely by the claims that now follow. That scope is intended and should be interpreted to be as broad as is consistent with the ordinary meaning of the language that is used in the claims when interpreted in light of this specification and the prosecution history that follows and to encompass all structural and functional equivalents. Notwithstanding, none of the claims are intended to embrace subject matter that fails to satisfy the requirement of Sections **101**, **102**, or **103** of the Patent Act, nor should they be interpreted in such a way. Any unintended embracement of such subject matter is hereby disclaimed.

[0064] Except as stated immediately above, nothing that has been stated or illustrated is intended or should be interpreted to cause a dedication of any component, step, feature, object, benefit, advantage, or equivalent to the public, regardless of whether it is or is not recited in the claims.

[0065] It will be understood that the terms and expressions used herein have the ordinary meaning as is accorded to such terms and expressions with respect to their corresponding respective areas of inquiry and study except where specific meanings have otherwise been set forth herein. Relational terms such as first and second and the like may be used solely to distinguish one entity or action from another without necessarily requiring or implying any actual such relationship or order between such entities or actions. The terms "comprises," "comprising," or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. An element proceeded by "a" or "an" does not, without further constraints, preclude the existence of additional identical elements in the process, method, article, or apparatus that comprises the element.

[0066] The Abstract of the Disclosure is provided to allow the reader to quickly ascertain the nature of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. In addition, in the foregoing Detailed Description, it can be seen that various features are grouped together in various embodiments for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed embodiments require more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all features of a single disclosed embodiment. Thus the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separately claimed subject matter.

[0067] While the foregoing has described what are considered to be the best mode and/or other examples, it is understood that various modifications may be made therein and that the subject matter disclosed herein may be implemented in various forms and examples, and that the teachings may be applied in numerous applications, only some of which have been described herein. It is intended by the following claims to claim any and all applications, modifications and variations that fall within the true scope of the present teachings.

What is claimed is:

1. A method comprising:

providing two modes of operation for a mobile device including a standard mode and a visually impaired (VI) mode, wherein the VI mode is a mode of operation for visually impaired users of the mobile device;

upon the mobile device powering up from a low power state, automatically determining a mode of operation for the mobile device among the standard mode and the VI mode; and

operating the mobile device in the automatically determined mode of operation, wherein operating the mobile device in the VI mode includes operating the mobile device with a display screen of the mobile device turned off by default.

2. The method of claim **1**, wherein operating the mobile device in the standard mode includes turning on the display screen of the mobile device in response to a set of conditions, and operating the mobile device in the VI mode includes leaving the display screen of the mobile device turned off in response to the set of conditions.

3. The method of claim **2**, wherein the display screen of the mobile device and a touch-screen input interface of the mobile device are turned on in response to the set of conditions during operation of the mobile device in the standard mode, and the display screen remains turned off while the

touch-screen input interface is turned on in response to the set of conditions during operation of the mobile device in the VI mode.

4. The method of claim **1**, wherein the automatically determining a mode of operation of the mobile device comprises determining a mode in which the mobile device operated immediately prior to entering the low power state.

5. The method of claim **1**, wherein upon determining the mode of operation of the mobile device to be the VI mode, performing steps of:

temporarily turning on the display screen of the mobile device, and displaying a user notification on the display screen for a pre-determined period of time; and

turning off the display screen upon determining that no user command is received to activate the standard mode within the pre-determined period of time.

6. The method of claim **1**, wherein upon determining the mode of operation of the mobile device to be the VI mode, performing steps of:

turning on the display screen of the mobile device, and displaying a user notification on the display screen for a pre-determined period of time; and

operating the device in the standard mode in response to receiving a user command to activate the standard mode within the pre-determined period of time.

7. The method of claim **1**, further comprising:

during operation of the mobile device in the VI mode, receiving a user command to temporarily turn on the display screen;

in response to receiving the user command, turning on the display screen of the mobile device and displaying content to the user on the display screen.

8. The method of claim **7**, wherein the receiving the user command to temporarily turn on the display screen comprises detecting a pre-determined multi-finger gesture on a touch-sensitive input interface of the mobile device.

9. A method comprising:

providing two modes of operation for a mobile device including a standard mode and a visually impaired (VI) mode, wherein a display screen of the mobile device is turned off by default during operation in the VI mode;

operating the mobile device in a user-selected mode of operation, wherein operating the mobile device in the user-selected VI mode includes:

monitoring, using a forward facing camera of the mobile device, whether a gaze of a user of the mobile device is directed towards the display screen of the mobile device; and

upon detecting that the gaze is directed towards the display screen for a predetermined amount of time, initiating a change in mode of operation of the mobile device to the standard mode.

10. The method of claim **9**, wherein the initiating the change in mode of operation of the mobile device comprises:

determining whether an application that is currently active on the mobile device is included in a pre-determined list of applications for which a change in mode of operation can be automatically initiated; and

turning on the display screen of the mobile device in response to detecting that the gaze is directed towards the display screen and that the application that is currently active on the mobile device is included in the pre-determined list.

11. The method of claim **9**, wherein the initiating the change in mode of operation comprises:

temporarily turning on the display screen of the mobile device in response to detecting that the gaze is directed towards the display screen, and displaying a user notification on the display screen for a pre-determined period of time; and

cancelling the change in mode of operation of the mobile device and turning off the display screen upon determining that the user does not wish to activate the standard mode.

12. A mobile device comprising:

a display screen operative to display information to a user of the mobile device;

a memory; and

a processor operative to execute machine-readable instructions stored in the memory to cause the mobile device to perform functions including functions to:

provide two modes of operation for the mobile device including a standard mode and a visually impaired (VI) mode, wherein the VI mode is a mode of operation for visually impaired users of the mobile device;

upon the mobile device powering up from a low power state, automatically determining a mode of operation for the mobile device among the standard mode and the VI mode; and

operating the mobile device in the automatically determined mode of operation, wherein operating the mobile device in the VI mode includes operating the mobile device with the display screen of the mobile device turned off by default.

13. The mobile device of claim **12**, wherein operating the mobile device in the standard mode includes turning on the display screen of the mobile device in response to a set of conditions, and operating the mobile device in the VI mode includes leaving the display screen of the mobile device turned off in response to the set of conditions.

14. The mobile device of claim **13**, further comprising:

a touch-screen user interface operative to receive touch input from the user of the mobile device,

wherein the display screen of the mobile device and the touch-screen input interface of the mobile device are turned on in response to the set of conditions during operation of the mobile device in the standard mode, and the display screen remains turned off while the touch-screen input interface is turned on in response to the set of conditions during operation of the mobile device in the VI mode.

15. The mobile device of claim **12**, wherein the automatically determining a mode of operation of the mobile device comprises determining a mode in which the mobile device operated immediately prior to entering the low power state.

16. The mobile device of claim **12**, wherein upon determining the mode of operation of the mobile device to be the VI mode, the processor causes the mobile device to perform functions to:

temporarily turn on the display screen of the mobile device, and display a user notification on the display screen for a pre-determined period of time; and

turn off the display screen upon determining that no user command is received to activate the standard mode within the pre-determined period of time.

17. The mobile device of claim **12**, wherein upon determining the mode of operation of the mobile device to be the VI mode, the processor causes the mobile device to perform functions to:

turn on the display screen of the mobile device, and display a user notification on the display screen for a pre-determined period of time; and

operate the device in the standard mode in response to receiving a user command to activate the standard mode within the pre-determined period of time.

18. The mobile device of claim **12**, wherein the processor causes the mobile device to perform further functions to:

during operation of the mobile device in the VI mode, receive a user command to temporarily turn on the display screen;

in response to receiving the user command, turn on the display screen of the mobile device and display content to the user on the display screen.

19. The mobile device of claim **18**, further comprising:

a touch-screen user interface operative to receive touch input from the user of the mobile device,

wherein the receiving the user command to temporarily turn on the display screen comprises detecting a pre-determined multi-finger gesture on a touch-sensitive input interface of the mobile device.

* * * * *