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(54) **SPEAKERPHONE CONTROL FOR MOBILE DEVICE**

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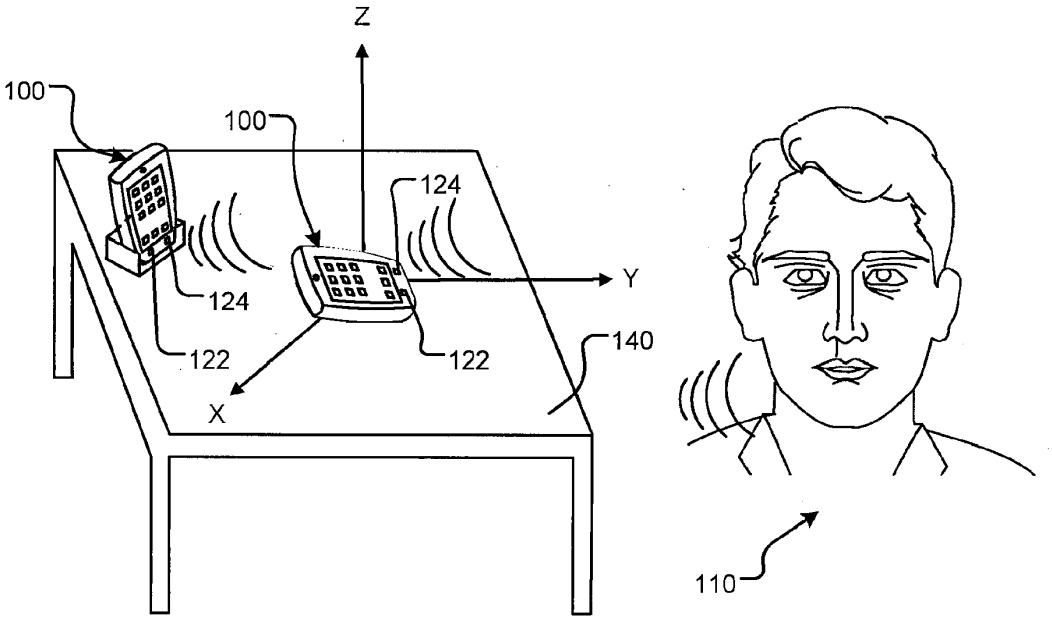
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(57) **ABSTRACT**

A speakerphone system integrated in a mobile device is automatically controlled based on the current state of the mobile device. In one implementation, the mobile device is controlled based on an orientation or position of the mobile device. In another implementation, the control of the speakerphone includes automatically controlling one or more graphical user interfaces associated with the speakerphone system.



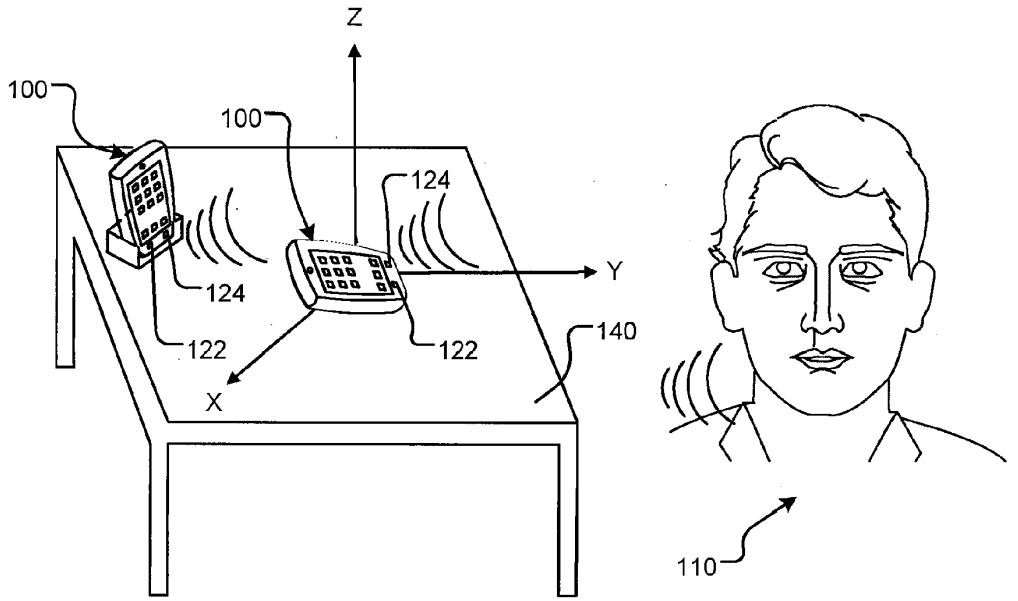


FIG. 1A

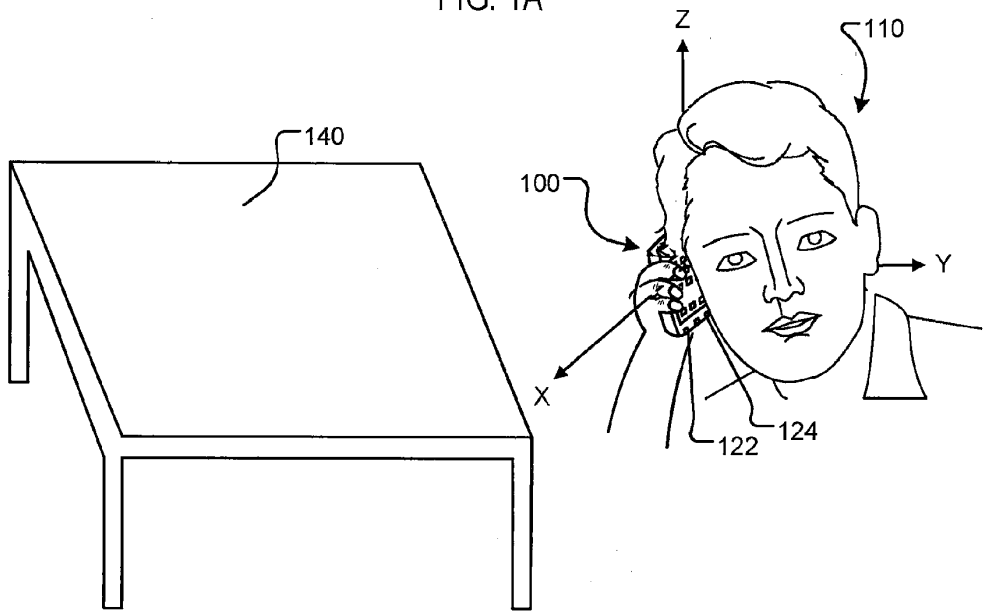


FIG. 1B

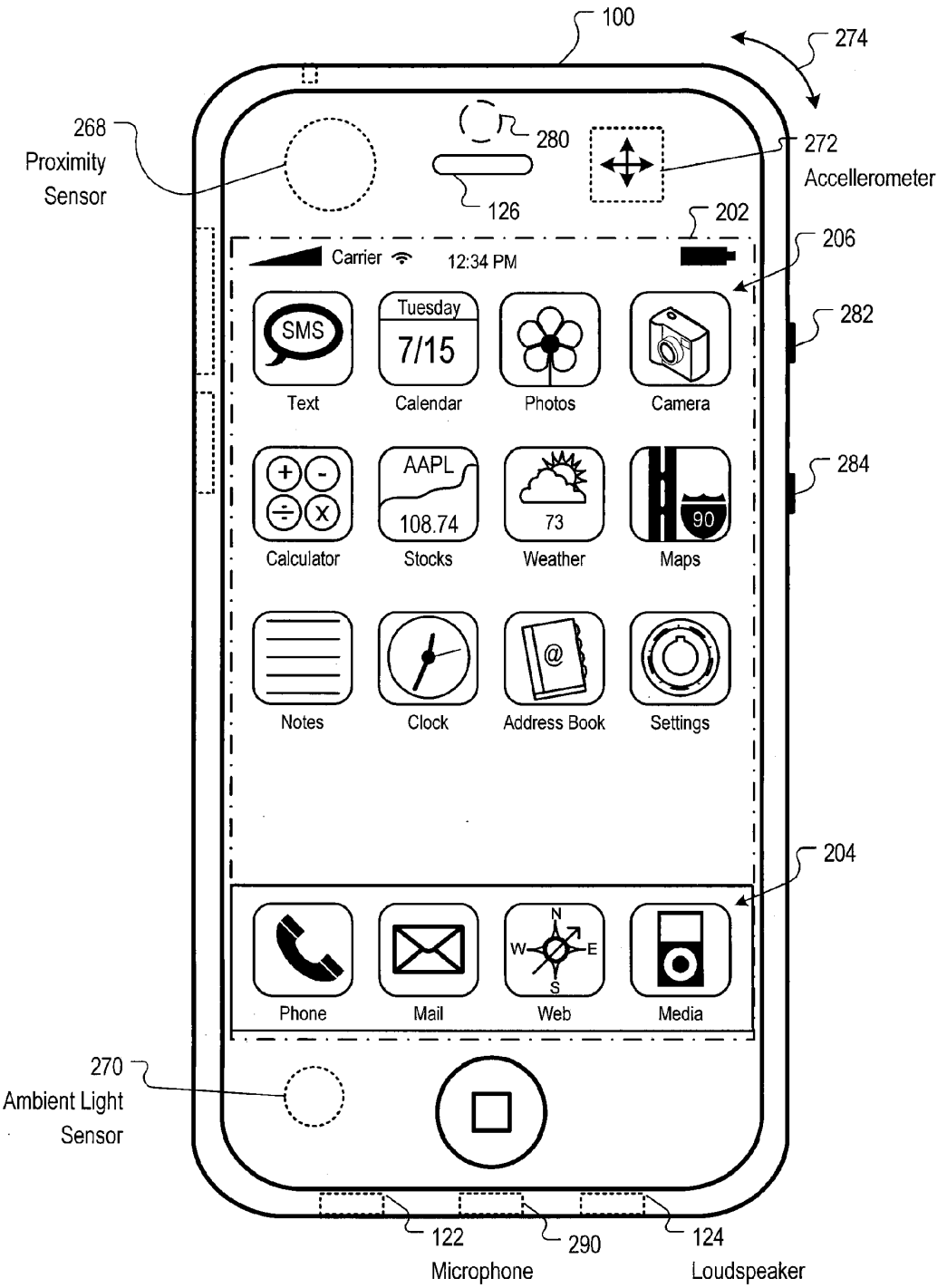

100
274
268
Proximity
Sensor
280
126
272
Accellerometer
202
206
Carrier
12:34 PM
SMS
Text
Tuesday
7/15
Calendar
Photos
Camera
282
AAPL
108.74
Stocks
73
Weather
90
Maps
284
Calculator
Notes
Clock
Address Book
Settings
204
Phone
Mail
N
W
E
S
Web
Media
270
Ambient Light
Sensor
122
Microphone
290
124
Loudspeaker

FIG. 2

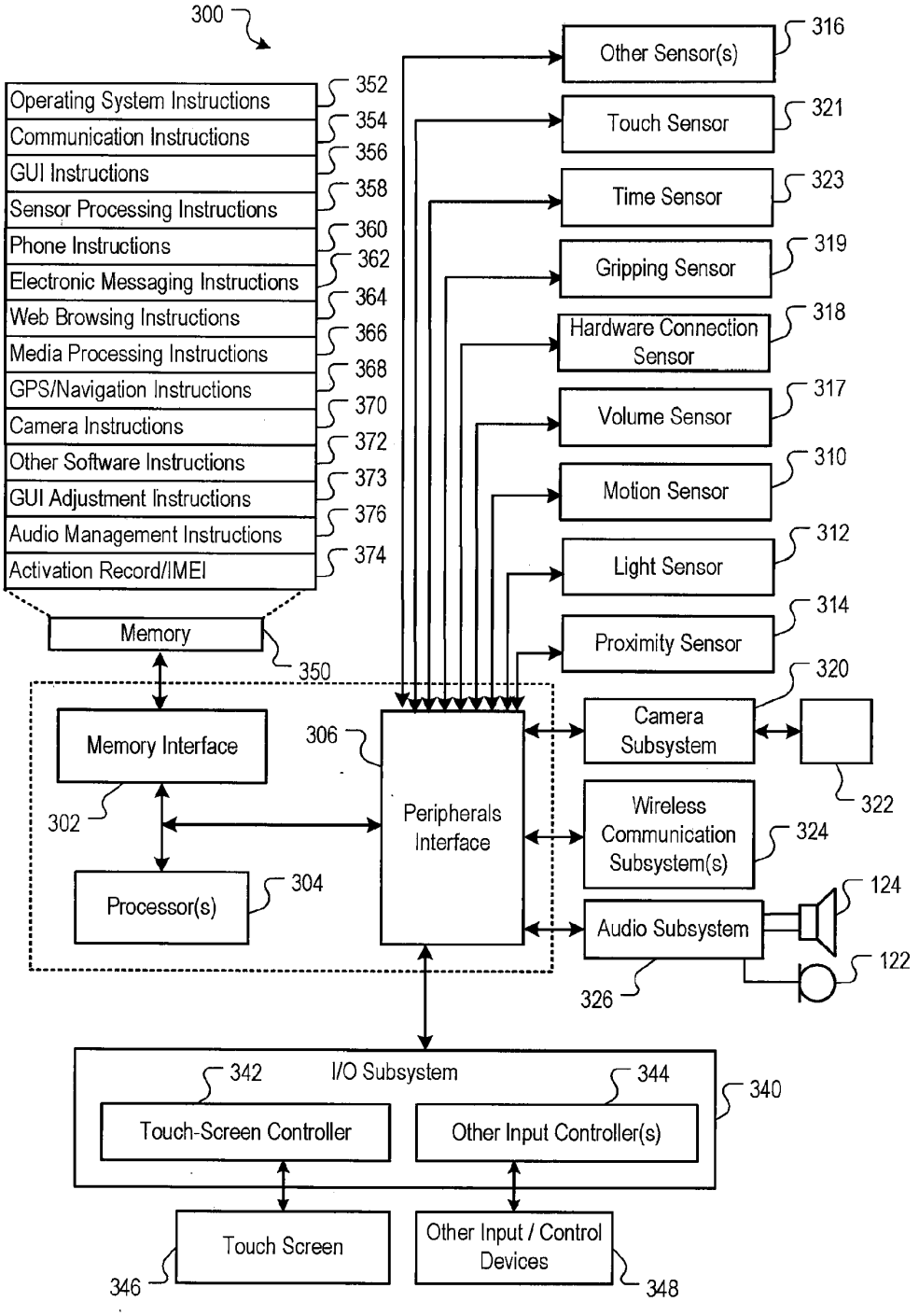

300
Operating System Instructions
352
Communication Instructions
354
GUI Instructions
356
Sensor Processing Instructions
358
Phone Instructions
360
Electronic Messaging Instructions
362
Web Browsing Instructions
364
Media Processing Instructions
366
GPS/Navigation Instructions
368
Camera Instructions
370
Other Software Instructions
372
GUI Adjustment Instructions
373
Audio Management Instructions
376
Activation Record/IMEI
374
Memory
350
Memory Interface
302
Processor(s)
304
306
Peripherals Interface
Other Sensor(s)
316
Touch Sensor
321
Time Sensor
323
Gripping Sensor
319
Hardware Connection Sensor
318
Volume Sensor
317
Motion Sensor
310
Light Sensor
312
Proximity Sensor
314
Camera Subsystem
320
322
Wireless Communication Subsystem(s)
324
Audio Subsystem
124
122
326
I/O Subsystem
342
344
340
Touch-Screen Controller
Other Input Controller(s)
Touch Screen
346
Other Input / Control Devices
348

FIG. 3

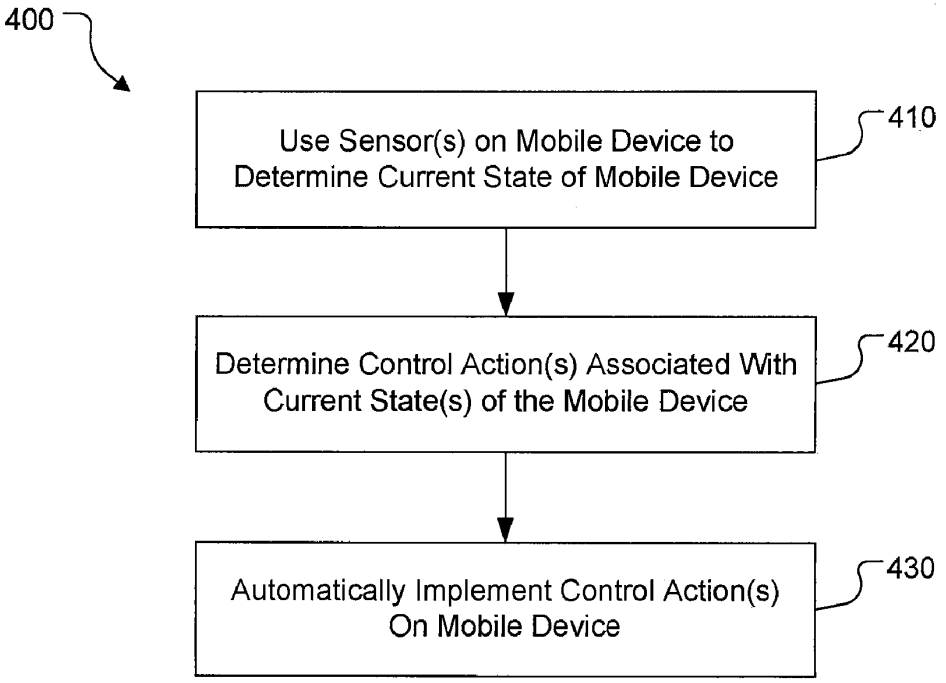

400
Use Sensor(s) on Mobile Device to Determine Current State of Mobile Device
410
Determine Control Action(s) Associated With Current State(s) of the Mobile Device
420
Automatically Implement Control Action(s) On Mobile Device
430

FIG. 4

Mapping States to Control Actions

State of the Mobile Device	Control Action to the Speakerphone
The Mobile Device Orienting Towards/Away from a Voice Source	Deactivating / Activating Speakerphone
The Mobile Device in Proximity / within a Distance to a Voice Source	Deactivating / Activating Speakerphone
The Mobile Device being Gripped/Released by a User	Deactivating / Activating Speakerphone
The Mobile Device being Disconnected/Connected to Hardware Device(s)	Deactivating / Activating Speakerphone
The Mobile Device at an Angle more Horizontal/ Perpendicular with the Ground	Deactivating / Activating Speakerphone
The Mobile Device Receiving Higher/Lower Volume from a Voice Source	Deactivating / Activating Speakerphone
The Mobile Device Receiving Input / Not Receiving From User Interface	Deactivating / Activating Speakerphone

FIG. 5

SPEAKERPHONE CONTROL FOR MOBILE DEVICE

RELATED APPLICATION

[0001] This subject matter is related to U.S. patent application Ser. No. 11/937,463, for "Variable Device Graphical User Interface," filed Nov. 8, 2007, the subject matter of which is incorporated by reference herein its entirety.

TECHNICAL FIELD

[0002] This subject matter is generally related to mobile devices.

BACKGROUND

[0003] Modern mobile devices (e.g., mobile phones, media players) often include a speakerphone system. The speakerphone system, which typically includes a loudspeaker and a microphone integrated into the mobile device, can free the user's hands and facilitate multi-party conversations using the mobile device. A typical speakerphone system for a mobile device is controlled by hardware and/or software mechanisms which require the user to make physical contact with the mobile device. When operating the mobile device in hands free mode, the user must manually activate the speakerphone system to engage in a conversation, and then deactivate the speakerphone system when finished with the conversation. Even if the user is holding the device, the manual steps of activating and deactivating the speakerphone system can be annoying to the user.

SUMMARY

[0004] A speakerphone system integrated in a mobile device is automatically controlled based on the current state of the mobile device. In one implementation, the mobile device is controlled based on an orientation or position of the mobile device. In another implementation, the control of the speakerphone includes automatically controlling one or more graphical user interfaces associated with the speakerphone system.

DESCRIPTION OF DRAWINGS

[0005] FIGS. **1**A and **1**B illustrate an example speakerphone system for a mobile device which can be managed based on a current state of the mobile device.

[0006] FIG. **2** illustrates a graphical user interface for the example mobile device.

[0007] FIG. **3** is a block diagram of an example implementation of the mobile device of FIG. **2**.

[0008] FIG. **4** illustrates an example process for managing a mobile device's speakerphone system based on a current state of the mobile device.

[0009] FIG. **5** illustrates an example data structure for mapping mobile device states to speakerphone control actions.

DETAILED DESCRIPTION

Speakerphone System Overview

[0010] FIGS. **1**A and **1**B illustrate an example speakerphone system for a mobile device **100** which can be managed based on a current state of the mobile device **100**. The mobile device **100** can be, for example, a handheld computer, a personal digital assistant, a cellular telephone, a network appliance, a camera, a smart phone, an enhanced general packet radio service (EGPRS) mobile phone, a network base station, a media player, a navigation device, an email device, a game console, or a combination of any two or more of these data processing devices or other data processing devices. The mobile device **100** can have an speakerphone system associated with the mobile device **100**, e.g., an integrated speaker in the mobile device **100**, or an external speaker wirelessly connected to the mobile device **100**. The speakerphone system can include a microphone **122** which can be arranged on a front or back side of the mobile device **100** to facilitate hands-free operation during a telephone conversation or playback of audio content (e.g., music, voicemail). In various implementations, the speakerphone system also includes a loudspeaker **124** to deliver and/or amplify voice to reach a user of the mobile device **100**.

[0011] The speakerphone system can be managed based on the current state of the mobile device **100**. In some implementations, the current state of the mobile device **100** can be determined using a reference frame and one or more sensors (e.g., accelerometer, gyro, light sensor, proximity sensor) integrated into the mobile device **100**. A "state" can be an orientation or position of the device with respect to the reference frame. For example, when the mobile device **100** is laid flat on a surface (e.g., the x-y plane) of a table top **140**, the speakerphone system can be activated to allow hands free operation. If the mobile device **100** is laying flat on a surface, an assumption can be made that the user intends to use the speakerphone system for hands free operation. Similarly, if the mobile device **100** is orientated substantially vertical (in the z-plane), an assumption can be made that the mobile device **100** is temporarily fixed in a docking or recharging device (as shown in FIG. **1**A), and the speakerphone system can be activated to allow hands free operation while docked and/or while recharging.

[0012] A "state" of the mobile device **100** can also be determined based solely on sensor inputs. For example, one or more sensors (e.g., proximity sensor **268**) on the front and/or back sides of the mobile device **100** can indicate a state of the mobile device **100**. For example, if a first proximity sensor on the back side of the mobile device **100** is triggered and a second proximity sensor on the front side of the mobile device **100** is not triggered, then an assumption can be made that the mobile device **100** is laying flat on a surface. Based on this assumption, the speakerphone system can be controlled (e.g., activated) to allow hands free operation. If the first proximity sensor and/or the second proximity sensor are triggered, then an assumption can be made that the mobile device **100** is being held by the user or is stored (e.g., stored in a bag or case). Based on this assumption, the speakerphone system can be controlled differently (e.g., deactivated).

[0013] In some implementations, a processor (e.g., processor **304**) in the mobile device **100** can use a state machine to maintain the current state of the mobile device **100**. The state machine can track various combinations of inputs which can cause a state change to occur. A control action can then be issued based on the current state of the mobile device **100** as indicated by the state machine. A control action can be activating or deactivating the speakerphone system, generating or adjusting a graphical user interface and/or any other suitable control action.

[0014] For example, a first state of the mobile device **100** can be defined by a first proximity sensor on the back side of the mobile device **100** sensing proximity to an object (e.g., a

table top surface) and a motion sensor not sensing motion of the mobile device **100** (e.g., acceleration is below a threshold value). The combination of these sensor inputs can place the state machine of the mobile device **100** into the first state. The first state can exist when the mobile device **100** is laying at rest, face up on a flat surface, for example. The control action can be activating the speakerphone system and adjusting the volume of the loudspeaker **124**. Another control action can be to generate a graphical user interface, as described in U.S. patent application Ser. No. 11/937,463.

[0015] A second state of the mobile device **100** can be defined by the motion sensor sensing motion (e.g., acceleration above a threshold value). Such motion can place the state machine into the second state. The second state can exist when a user has picked up the mobile device **100** from the surface to make a call, for example. The control action can be lowering the volume of the loudspeaker **124**. Other control actions are possible.

[0016] A third state of the mobile device **100** can be defined by a second proximity sensor located on the front side of the mobile device **100** sensing proximity to an object (e.g., the user's head) and the motion sensor not sensing motion of the mobile device **100** (e.g., acceleration is again below a threshold value). The combination of these sensor inputs can place the state machine of the mobile device **100** into the third state. The third state can exist when the user **110** has raised the mobile device **100** to the user's ear and the mobile device is no longer in motion. The control action can be deactivating the speakerphone system. Other control actions are possible.

[0017] It should be understood that any number of states and/or combinations of states can be defined and used to trigger control actions. The state machine can be implemented by a processor of the mobile device **100** (e.g., processor **304**). The processor can also determine appropriate control actions based on the current state of the mobile device **100** as determined by the state machine.

Example Mobile Device

[0018] FIG. **2** illustrates a graphical user interface for an example mobile device. As described in reference to FIG. **1**, the mobile device **100** typically includes a built-in microphone **122** and loudspeaker **124**. In some implementations, an up/down button **284** for volume control of the loudspeaker **124** and the microphone **122** can be included. The mobile device **100** can also include an on/off button **282** for a ring indicator of incoming phone calls. An audio jack **266** can also be included for use of headphones and/or a microphone.

[0019] In addition, as shown in FIG. **2**, the mobile device **100** can include a display **202**, which, in some implementations, is touch-sensitive. The touch-sensitive display **202** can implement liquid crystal display (LCD) technology, light emitting polymer display (LPD) technology, or some other display technology. The touch sensitive display **202** can be sensitive to haptic and/or tactile contact with a user.

[0020] In some implementations, the mobile device **100** can display one or more graphical user interfaces on the touch-sensitive display **202** for providing user access to various system objects and for conveying information to a user. In some implementations, the graphical user interfaces can include one or more display objects, e.g., **204** and **206**. In the example shown, the display objects **204** and **206**, are graphic representations of system objects. Some examples of system objects include device functions, applications, windows, files, alerts, events, or other identifiable system objects.

[0021] In some implementations, a proximity sensor **268** can be included to determine the current state of the mobile device **100** by detecting the user **110** positioning the mobile device **100** proximate to the user's ear, as described in reference to FIG. **1**. In some implementations, the graphical user interface can be resized to reduce the graphical representations of display objects **204** and **206**, e.g., graphical icons, and their corresponding touch areas (e.g., areas on the touch-sensitive display where a touch on the display **202** selects the graphical icons). In various implementations, an ambient light sensor **270** can also be used to determine the current state of the device. For example, the ambient light sensor **270** can sense when the mobile device **100** has been stored away. This sensor input can be used alone or in combination with other sensor inputs to determine the current state of the mobile device **100**.

[0022] In some implementations, the microphone **122** can be used as a volume sensor which can detect the user's voice volume. For example, when the volume level from the voice source exceeds a default value, an assumption can be made that the user is speaking directly into the microphone **122** while holding the mobile device **100** to their ear, resulting in the speakerphone system being deactivated, for example.

[0023] In some implementations, the ambient light sensor **270** can be utilized to facilitate adjusting the brightness of the display **202**, and an accelerometer **272** can be utilized to detect movement of the mobile device **100**, as indicated by the directional arrow **274**. Accordingly, the speakerphone system and a graphical user interface can be adjusted according to a detected orientation of the mobile device **100**.

[0024] In some implementations, the mobile device **100** includes circuitry and sensors for supporting a location determining capability, such as that provided by the global positioning system (GPS) or other positioning systems (e.g., systems using Wi-Fi access points, television signals, cellular grids, Uniform Resource Locators (URLs)). In some implementations, a positioning system (e.g., a GPS receiver) can be integrated into the mobile device **100** or provided as a separate device that can be coupled to the mobile device **100** through an interface (e.g., port device **290**) to provide access to location-based services. In some implementations, the mobile device **100** includes a gyroscopic sensor or other sensors that can be used to detect motion or orientation of the device with respect to a reference frame.

[0025] In some implementations, positioning sensors (e.g., an accelerometer **272**) can be used to compute an instantaneous coordinate frame of the mobile device **100**. For example, when the mobile device **100** is lying flat on a surface, an instantaneous coordinate frame centered on the mobile device **100** can be computed. For example, the z-axis can be perpendicular to the surface which can lie in the x-y plane in a right-handed coordinated system, as shown in FIG. **1**A. If the user **110** moves the mobile device **100** to the position and orientation shown in FIG. **1**B, then a trajectory for the mobile device **100** can be determined from the change in coordinates of the mobile device **100**. For example, in reference to FIGS. **1**A and **1**B, the mobile device's **100** coordinate frame in FIG. **1**A rotates by about ninety degrees with respect to the z-axis to change to a coordinate frame in FIG. **1**B while the user **110** is holding the mobile device **100**. Accordingly, the speakerphone system can be controlled according to the detected change of coordinate frames.

[0026] In some implementations, one or more sensors (e.g., a pressure sensor, temperature sensor) for detecting when a

user is holding or gripping the mobile device **100** can be integrated into a housing of the mobile device **100**. These sensors can detect when the mobile device **100** is gripped by a user, for example, by detecting a pressure exerted upon the body of the mobile device **100** or a partial temperature change (e.g., deviation from an ambient temperature) on the mobile device **100**.

[0027] In some implementations, the mobile device **100** can include a touch sensor, which detects a user entering input via the graphical user interface, resulting in the speakerphone system being activated, for example. The user input can be received by the mobile device **100** from the user touching the touch-sensitive display **202**, or from the user touching a keypad or a like device (not shown) associated with the mobile device **100**.

[0028] In some implementations, the mobile device **100** can include a time sensor (e.g., using the internal clock of the mobile device **100**), which detects a duration for a certain state (e.g., position, or orientation) of the mobile device **100**. The detected duration can be used to determine if a control action will be triggered, to prevent overly frequent, unnecessary responses to each state change. By way of illustration, if the state change does not exceed a certain amount of time, e.g., five seconds, an assumption can be made that the state change is temporal, and therefore no control action will be triggered in response. By contrast, if the state change lasts longer than five seconds, an assumption can be made that the state change will remain for a longer period, and thus a control action can be triggered accordingly.

[0029] The decision whether to trigger a corresponding control action can also be made upon detection of time in combination with a transition distance of the mobile device **100**, to enhance accuracy of the state determination. For example, in FIGS. **1**A and **1**B, if the mobile device **100** has been raised by the user **110** by twenty feet, for a interval exceeding five seconds, an assumption can be made that the user intends to use the handset for the telephone conversation. Accordingly, the speakerphone system can be deactivated in response to the assumption. Otherwise, the speakerphone system can remain unchanged until the state change is greater than a certain amount on time or distance.

[0030] In some implementations, a port device **290**, e.g., a Universal Serial Bus (USB) port, or a docking port, or some other wired port connection, can be included. The port device **290** can, for example, be utilized to establish a wired connection to other computing devices, such as other communication devices, network access devices, a personal computer, a printer, a display screen, or other processing devices capable of receiving and/or transmitting data. In some implementations, the port device **290** allows the mobile device **100** to synchronize with a host device using one or more protocols, such as, for example, the TCP/IP, HTTP, UDP and any other known protocol.

[0031] In some implementations, the mobile device **100** can have hardware connection sensors that detect whether the mobile device **100** is connected to any hardware devices via the port device **290**. When the mobile device **100** is being connected to hardware devices (e.g., a docking station or re-charger), it is more likely than not, a user of the mobile device **100** is not holding the handset, and thus the speakerphone system (e.g., the speaker volume and/or microphone sensitivity), and graphical user interface can be adjusted accordingly.

[0032] The mobile device **100** can also include a camera lens and sensor **280**. In some implementations, the camera lens and sensor **280** can be located on the back surface of the mobile device **100**. The camera can capture still images and/or video. In some implementations, the images captured by the camera can be used to measure proximity to a user or if the mobile device **100** is held by the user and the speakerphone system and graphical user interface can be activated or adjusted accordingly.

[0033] The mobile device **100** can also include one or more wireless communication subsystems, such as an 802.11b/g communication device **186**, and/or a Bluetooth™ communication device **188**. Other communication protocols can also be supported, including other 802.x communication protocols (e.g., WiMax, Wi-Fi, 3G), code division multiple access (CDMA), global system for mobile communications (GSM), Enhanced Data GSM Environment (EDGE), etc.

Example Mobile Device Architecture

[0034] FIG. **3** is a block diagram of an example implementation **300** of the mobile device **100** of FIG. **1**. The mobile device **100** can include a memory interface **302**, one or more data processors, image processors and/or central processing units **304**, and a peripherals interface **306**. The memory interface **302**, the one or more processors **304** and/or the peripherals interface **306** can be separate components or can be integrated in one or more integrated circuits. The various components in the mobile device **100** can be coupled by one or more communication buses or signal lines.

[0035] Sensors, devices, and subsystems can be coupled to the peripherals interface **306** to facilitate multiple functionalities. For example, a motion sensor **310**, a light sensor **312**, and a proximity sensor **314** can be coupled to the peripherals interface **306** to facilitate the orientation, lighting, and proximity functions described with respect to FIG. **2**. A hardware connection sensor **318** can be coupled to the peripherals interface **306**, to facilitate determining a state of connecting the mobile device **100** to any hardware, e.g., a docking station, a charger, a personal computer, etc. A gripping sensor **319** can be coupled to the peripherals interface **306**, to determine if the mobile device **100** is being gripped. In various implementation, a gripping sensor can include a temperature sensor, and/or a pressure sensor. Further, a touch sensor **321** can be coupled to the peripherals interface **306**, to detect if a user is touching user input interface, e.g., a touch screen or a keypad. A time sensor **323** can also be coupled to the peripherals interface **306**, to detect a duration of a certain state of the mobile device **100**. Other sensors **316** can also be connected to the peripherals interface **306**, such as a positioning system (e.g., GPS receiver), a temperature sensor, a biometric sensor, a gyroscope, or other sensing device, to facilitate related functionalities.

[0036] A camera subsystem **320** and an optical sensor **322**, e.g., a charged coupled device (CCD) or a complementary metal-oxide semiconductor (CMOS) optical sensor, can be utilized to facilitate camera functions, such as recording photographs and video clips.

[0037] Communication functions can be facilitated through one or more wireless communication subsystems **324**, which can include radio frequency receivers and transmitters and/or optical (e.g., infrared) receivers and transmitters. The specific design and implementation of the communication subsystem **324** can depend on the communication network(s) over which the mobile device **100** is intended to

operate. For example, a mobile device **100** may include communication subsystems **324** designed to operate over a GSM network, a GPRS network, an EDGE network, a Wi-Fi or WiMax network, and a Bluetooth™ network. In particular, the wireless communication subsystems **324** may include hosting protocols such that the device **100** may be configured as a base station for other wireless devices.

[0038] An audio subsystem **326** can be coupled to a loudspeaker **124**, and microphone **122** to facilitate voice-enabled functions, for example, hands-free functionalities, voice recognition, voice replication, digital recording, and telephony functions.

[0039] The I/O subsystem **340** can include a touch screen controller **342** and/or other input controller(s) **344**. The touch-screen controller **342** can be coupled to a touch screen **346**. The touch screen **346** and touch screen controller **342** can, for example, detect contact and movement or break thereof using any of a plurality of touch sensitivity technologies, including but not limited to capacitive, resistive, infrared, and surface acoustic wave technologies, as well as other proximity sensor arrays or other elements for determining one or more points of contact with the touch screen **346**.

[0040] The other input controller(s) **344** can be coupled to other input/control devices **348**, such as one or more buttons, rocker switches, thumb-wheel, infrared port, USB port, and/or a pointer device such as a stylus. The one or more buttons (not shown) can include an up/down button for volume control of the speaker **126** and loudspeaker **124** and/or the microphone **122**.

[0041] In some implementations, the mobile device **100** can present recorded audio and/or video files, such as MP3, AAC, and MPEG files. In some implementations, the mobile device **100** can include the functionality of an MP3 player, such as an iPod™. The mobile device **100** may, therefore, include a 36-pin connector that is compatible with the iPod. Other input/output and control devices can also be used.

[0042] The memory interface **302** can be coupled to memory **350**. The memory **350** can include high-speed random access memory and/or non-volatile memory, such as one or more magnetic disk storage devices, one or more optical storage devices, and/or flash memory (e.g., NAND, NOR). The memory **350** can store an operating system **352**, such as Darwin, RTXC, LINUX, UNIX, OS X, WINDOWS, or an embedded operating system such as VxWorks. The operating system **352** may include instructions for handling basic system services and for performing hardware dependent tasks. In some implementations, the operating system **352** can be a kernel (e.g., UNIX kernel).

[0043] The memory **350** may also store communication instructions **354** to facilitate communicating with one or more additional devices, one or more computers and/or one or more servers. The memory **350** may include graphical user interface instructions **356** to facilitate graphic user interface processing; sensor processing instructions **358** to facilitate sensor-related processing and functions; phone instructions **360** to facilitate phone-related processes and functions; electronic messaging instructions **362** to facilitate electronic-messaging related processes and functions; web browsing instructions **364** to facilitate web browsing-related processes and functions; media processing instructions **366** to facilitate media processing-related processes and functions; GPS/navigation instructions **368** to facilitate GPS and navigation-related processes and instructions; camera instructions **370** to facilitate camera-related processes and functions; GUI adjustment instructions **373** to facilitate adjustment of graphical user interfaces and user interface elements in response to sensor data; and/or other software instructions **372** to facilitate other processes and functions.

[0044] In addition, the memory **350** can store audio management instructions **376** to facilitate functions managing audio subsystem, including the loudspeaker **124**, and the microphone **122**. In some implementations, the audio management instructions **376** are operable to toggle the speakerphone system and adjust speaker volume and/or microphone sensitivity, in response to the sensor processing instructions **358**.

[0045] The memory **350** may also store other software instructions (not shown), such as web video instructions to facilitate web video-related processes and functions; and/or web shopping instructions to facilitate web shopping-related processes and functions. In some implementations, the media processing instructions **366** are divided into audio processing instructions and video processing instructions to facilitate audio processing-related processes and functions and video processing-related processes and functions, respectively. An activation record and International Mobile Equipment Identity (IMEI) **374** or similar hardware identifier can also be stored in memory **350**.

[0046] Each of the above identified instructions and applications can correspond to a set of instructions for performing one or more functions described above. These instructions need not be implemented as separate software programs, procedures, or modules. The memory **350** can include additional instructions or fewer instructions. Furthermore, various functions of the mobile device **100** may be implemented in hardware and/or in software, including in one or more signal processing and/or application specific integrated circuits.

Example Process of Controlling Speakerphone System

[0047] FIG. **4** illustrates an example process **400** for managing a mobile device's speakerphone system based on a current state of the mobile device **100**. For convenience, the process **400** is described below in reference to FIGS. **1-3** (e.g., a mobile device **100**, a speakerphone system, and other components that perform the process **400**).

[0048] In some implementations, the process **400** can begin when input from one or more sensors on the mobile device are used to determine a current state of the mobile device (**410**). An example state can be a change of the mobile device's position or orientation relative to a user of the mobile device or a reference frame. The one or more sensors (e.g., accelerometer **272**, motion sensor **310**, proximity sensor **314**, gyroscope) can detect changes in position and orientation of the mobile device, including the magnitude of those changes. In some implementations, the determining can include detecting and determining two or more different states based on inputs from two or more different sensors. For example, the mobile device can detect that the mobile device is being held or gripped, and also that the sound as well as the light sensors indicate proximity, to cross-check and/or determine a level of proximity and/or motion of the device.

[0049] The current state or a sequence of states are used to determine a control action (**420**). Some examples of control actions include activating and deactivating a speakerphone system and/or generating or adjusting one or more graphical user interfaces of the mobile device. The control action can

then be implemented by one or more components of the mobile device (**430**) to, for example, automatically control a speakerphone system of the mobile device or generate and/or adjust graphical user interfaces of the mobile device.

Example of Mapping States to Control Actions

[0050] FIG. **5** illustrates an example data structure **500** for mapping mobile device states to speakerphone control actions. The mobile device **100** can use the data structure **500** to map the current state to one or more control actions. The states can be determined based on sensor inputs, as described in reference to FIGS. **1-4**, and mapped to control actions which can be applied to the speakerphone system, a graphical user interface and any other feature, peripheral, application of the mobile device **100**. Based on the target of a control action, the control actions can be implemented by sensor processing instructions **358**, audio management instructions **376** and/or GUI adjustment instructions **373**. In some implementations, the mobile device **100** can include a user-settable option to enable or disable control actions.

[0051] Referring to FIG. **5**, the current state can be any desired state of the mobile device **100**, including but not limited to: the mobile device **100** being orienting towards or away from a user; the mobile device **100** being in proximity or within a distance to a user; the mobile device **100** being gripped or released by a user; the mobile device **100** being connected or disconnected to hardware device(s) (e.g., a docking station); the device **100** being held at a certain angle with reference to an instantaneous coordinate frame; volume levels received at the microphone **122**; the device **100** receiving input from user interface or not; and other events that tend to denote a change of position, orientation, or state of the mobile device **100**.

[0052] In various implementations, a control action applied to the speakerphone system can account for the magnitude of the determined event. For example, the sensitivity of the microphone **122** and/or the volume of the loudspeaker **124** can be adjusted in correspondence with the proximity change, thus guaranteeing optimal voice quality. As another example, an angle at which the mobile device **100** is being held can determine the angle of the speakerphone system relative to the ground, and correspondingly, the reception and transmission of sound waves by the speakerphone system can be affected by the angle relative to the ground. A control action can be made that accounts for this angle change. For example, if the mobile device **100** is held at an angle more parallel than perpendicular with a plane (e.g., the ground), the control action can increase the sensitivity and/or volume of the speakerphone system to optimize sending and receiving sound waves.

[0053] In some implementations, a control action can include resizing of one or more graphical user interfaces displayed on the mobile device **110**, such as resizing of display objects **204** or **206** and their corresponding touch areas, shifting a graphical user interface or user interface elements in the graphical user interface, changing of a sensitivity level of the touch-sensitive display, and/or adjusting and enlarging of the target touch area of a user interface element based on an angle at which the device is being held, such as, for example, described in U.S. patent application Ser. No. 11/937,463.

[0054] In some implementations, a control action can include adjusting a parameter by a predefined amount or percentage. For example, a speaker's volume can be attenuated by a predetermined amount of decibels or a predetermined percentage of the original volume of the speaker. In some other implementations, the amount of an adjustment is based on the amount of detected motion, amount of detected acceleration, amount of change in orientation from a starting position, or the like. For example, if the amount of acceleration from rest is small, the amount of change of the speaker's volume is small as well.

[0055] In some implementations, the amount of adjustment can be based on user preferences. For example, the user can configure (in a device options and settings interface, for example) a maximum allowable amount (e.g., a percentage) for a type of adjustment. In some implementations, the user can toggle the automatic control of the speaker system through the graphical user interface.

[0056] In some implementations, a control action can include interrupting actions initiated by the user with additional confirmation steps. Rather than activating/deactivating or adjusting the speakerphone system by some amount, for example, the device can add confirmation dialogs or question interfaces to the user interface flow for particular actions. As an example, if a user attempts to make a call on device **100** while connecting the device **100** to a personal computer is detected, the device **100** can display a confirmation dialog box displaying and asking the user whether to activate the speakerphone system. The confirmation dialog box can have relatively large target touch areas for "Yes" and "No" buttons for the user to select to confirm or decline to activate speakerphone.

[0057] In some implementations, the mobile device **100** "learns" particular characteristics or patterns of the state of the device and/or the user's interactions with the device **100** in view of the state to determine which control action should be issued. By way of illustration, the mobile device **100** can have a learning mode, where the device **100** can "learn" by recording a detected state of the device **100**, e.g., a trajectory of a motion, or a signature of proximity. Further, the device **100** can compare its state detected from the sensor input to the one or more patterns already stored in the device **100**, e.g., a signature of a bouncing motion while the user is walking, a signature of a change in orientation, a trajectory while the user is picking up and raising the device **100**, etc. If the detected state matches one of the patterns, the mobile device **100** can apply to the speakerphone system and/or graphical user interface the corresponding control action to the matching pattern. In some scenarios, the device **100** can apply the control action based on the closest pattern determined from the comparison.

[0058] In various implementations, the patterns that can be compared to the detected state are related to detected volume levels, detected gripping, detected proximity, detected user input, or other states that can be associated with patterns. In some implementation, the patterns can be configured or modified by the user or by learning from the user's past preference of a control action given a detected state. In some implementations, the patterns and the control action account for the magnitude of the state, e.g., the level of detected volume, or the distance of the motion.

[0059] In some implementations, the device **100** includes an indicator, e.g., a light indicator, to signify that an adjustment to the speakerphone system is being made. For example, the light indicator can show different colors to signify different adjustments to the speakerphone system that are being made. In some implementations, a control action can include changing lighting of the display of the device **100**, providing

a user a better vision of the graphical user interface. In various implementations, the different lighting of the display can indicate that some changes to the speakerphone system are being made.

[0060] The disclosed and other embodiments and the functional operations described in this specification can be implemented in digital electronic circuitry, or in computer software, firmware, or hardware, including the structures disclosed in this specification and their structural equivalents, or in combinations of one or more of them. The disclosed and other embodiments can be implemented as one or more computer program products, i.e., one or more modules of computer program instructions encoded on a computer-readable medium for execution by, or to control the operation of, data processing apparatus. The computer-readable medium can be a machine-readable storage device, a machine-readable storage substrate, a memory device, a composition of matter effecting a machine-readable propagated signal, or a combination of one or more them. The term "data processing apparatus" encompasses all apparatus, devices, and machines for processing data, including by way of example a programmable processor, a computer, or multiple processors or computers. The apparatus can include, in addition to hardware, code that creates an execution environment for the computer program in question, e.g., code that constitutes processor firmware, a protocol stack, a database management system, an operating system, or a combination of one or more of them. A propagated signal is an artificially generated signal, e.g., a machine-generated electrical, optical, or electromagnetic signal, that is generated to encode information for transmission to suitable receiver apparatus.

[0061] A computer program (also known as a program, software, software application, script, or code) can be written in any form of programming language, including compiled or interpreted languages, and it can be deployed in any form, including as a stand-alone program or as a module, component, subroutine, or other unit suitable for use in a computing environment. A computer program does not necessarily correspond to a file in a file system. A program can be stored in a portion of a file that holds other programs or data (e.g., one or more scripts stored in a markup language document), in a single file dedicated to the program in question, or in multiple coordinated files (e.g., files that store one or more modules, sub-programs, or portions of code).

[0062] The processes and logic flows described in this specification can be performed by one or more programmable processors executing one or more computer programs to perform functions by operating on input data and generating output. The processes and logic flows can also be performed by, and apparatus can also be implemented as, special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application-specific integrated circuit).

[0063] Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and any one or more processors of any kind of digital computer. Generally, a processor will receive instructions and data from a read-only memory or a random access memory or both. The essential elements of a computer are a processor for performing instructions and one or more memory devices for storing instructions and data. Generally, a computer will also include, or be operatively coupled to receive data from or transfer data to, or both, one or more mass storage devices for storing data, e.g., magnetic, magneto-optical disks, or optical disks. However, a computer need not have such devices. Computer-readable media suitable for storing computer program instructions and data include all forms of non-volatile memory, media and memory devices, including by way of example semiconductor memory devices, e.g., EPROM, EEPROM, and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto-optical disks; and CD-ROM and DVD-ROM disks. The processor and the memory can be supplemented by, or incorporated in, special purpose logic circuitry.

[0064] To provide for interaction with a user, the disclosed embodiments can be implemented on a computer having a display device, e.g., a CRT (cathode ray tube), LCD (liquid crystal display) monitor, touch sensitive device or display, for displaying information to the user and a keyboard and a pointing device, e.g., a mouse or a trackball, by which the user can provide input to the computer. Other kinds of devices can be used to provide for interaction with a user as well; for example, feedback provided to the user can be any form of sensory feedback, e.g., visual feedback, auditory feedback, or tactile feedback; and input from the user can be received in any form, including acoustic, speech, or tactile input.

[0065] While this specification contains many specifics, these should not be construed as limitations on the scope of what being claims or of what may be claimed, but rather as descriptions of features specific to particular embodiments. Certain features that are described in this specification in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable subcombination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a subcombination or variation of a subcombination.

[0066] Similarly, while operations are depicted in the drawings in a particular order, this should not be understand as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Moreover, the separation of various system components in the embodiments described above should not be understood as requiring such separation in all embodiments, and it should be understood that the described program components and systems can generally be integrated together in a single software product or packaged into multiple software products.

[0067] Thus, particular embodiments have been described. Other embodiments are within the scope of the following claims.

What is claimed is:

1. A method comprising:

detecting a current state of a mobile device;

determining a control action associated with the current state; and

automatically controlling a speakerphone system associated with the mobile device based on the control action.

2. The method of claim 1, wherein detecting the current state includes receiving at least one sensor input related to acceleration, proximity, orientation, rotation, angle, connection to one or more hardware devices, gripping, time, distance, touch for user input, or volume levels.

3. The method of claim 1, further comprising:

receiving user input to activate or deactivate the automatic control of the speakerphone system.

4. The method of claim 1, further comprising:

prompting for user input to accept the determined control action associated with the current state.

5. The method of claim 1, wherein detecting the current state comprises:

obtaining information from a state machine.

6. The method of claim 1, wherein controlling the speakerphone system, further comprises:

activating or deactivating the speakerphone system.

7. The method of claim 1, wherein controlling the speakerphone system, further comprises:

automatically adjusting a sensitivity of a microphone or loudspeaker volume.

8. The method of claim 1, wherein controlling the speakerphone system, further comprises:

generating or adjusting a graphical user interface of the mobile device.

9. The method of claim 8, wherein generating or adjusting the graphical user interface, further comprises:

changing a brightness of a display presenting the graphical user interface.

10. The method of claim 8, wherein generating or adjusting the graphical user interface, further comprises:

resizing of elements displayed on the graphical user interface.

11. The method of claim 1, wherein controlling the speakerphone system, further comprises:

automatically adjusting the speakerphone system based on a predetermined amount or percentage.

12. The method of claim 1, wherein controlling the speakerphone system, further comprises:

automatically adjusting the speakerphone system based on detected magnitude associated with the current state.

13. The method of claim 1, further comprising:

learning based on the previous detected state or determined control action.

14. The method of claim 1, further comprising:

comparing one or more patterns to the detected current state; and

automatically controlling the speakerphone system based on the comparison.

15. The method of claim 1, further comprising:

indicating on the mobile device that the speakerphone system is active.

16. A system comprising:

a processor:

a computer-readable medium coupled to the processor and operable for storing instructions, which when executed by the processor, causes the processor to perform operations comprising:

detecting a current state of a mobile device;

determining a control action associated with the current state; and

automatically controlling a speakerphone system associated with the mobile device based on the control action.

17. The system of claim 16, wherein detecting the current state includes receiving at least one sensor input related to acceleration, proximity, orientation, rotation, angle, connection to one or more hardware devices, gripping, time, distance, touch for user input, or volume levels.

18. The system of claim 16, wherein controlling the speakerphone system, further comprises:

activating or deactivating the speakerphone system.

19. The system of claim 16, wherein controlling the speakerphone system, further comprises:

automatically adjusting a sensitivity of a microphone or loudspeaker volume.

20. The system of claim 16, wherein controlling the speakerphone system, further comprises:

generating or adjusting a graphical user interface of the mobile device.

21. A computer-readable medium operable for storing instruction, which when executed by a processor, causes the processor to perform operations comprising:

detecting a current state of a mobile device;

determining a control action associated with the current state; and

automatically controlling a speakerphone system associated with the mobile device based on the control action.

22. The system of claim 21, wherein detecting the current state includes receiving at least one sensor input related to acceleration, proximity, orientation, rotation, angle, connection to one or more hardware devices, gripping, time, distance, touch for user input, or volume levels.

23. The computer-readable medium of claim 21, wherein controlling the speakerphone system, further comprises:

activating or deactivating the speakerphone system.

24. The computer-readable medium of claim 21, wherein controlling the speakerphone system, further comprises:

automatically adjusting a sensitivity of a microphone or loudspeaker volume.

25. The computer-readable medium of claim 21, wherein controlling the speakerphone system, further comprises:

generating or adjusting a graphical user interface of the mobile device.

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