US010553209B2

(12) **United States Patent**
Gruber et al.

(10) **Patent No.: US 10,553,209 B2**
(45) **Date of Patent: Feb. 4, 2020**

(54) **SYSTEMS AND METHODS FOR HANDS-FREE NOTIFICATION SUMMARIES**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 865 days.

(21) Appl. No.: **14/210,183**

(22) Filed: **Mar. 13, 2014**

(65) **Prior Publication Data**

US 2014/0195252 A1 Jul. 10, 2014

Related U.S. Application Data

(63) Continuation-in-part of application No. 13/250,947, filed on Sep. 30, 2011, which is a continuation-in-part (Continued)

(51) **Int. Cl.**
G10L 25/48 (2013.01)
G10L 15/22 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G10L 15/22*** (2013.01); *G06F 17/279* (2013.01); *G10L 15/1822* (2013.01); *G10L 2015/088* (2013.01)

(58) **Field of Classification Search**
CPC G10L 15/22; G10L 2015/088; G10L 15/1822; G10L 25/48; G06F 17/279
(Continued)

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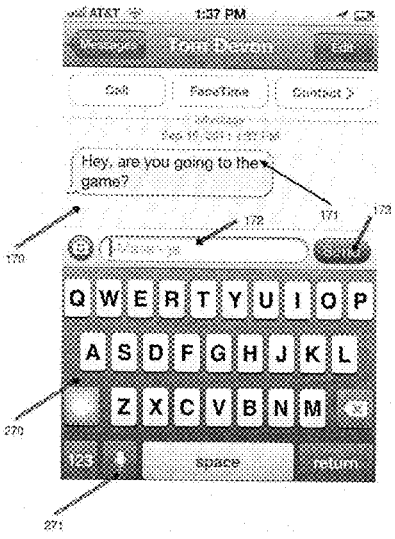
(57) **ABSTRACT**

A method includes outputting an alert corresponding to an information item. In some implementations, the alert is a sound. In some implementations, the alert is ambiguous (e.g., the sound indicates several possible information items). The method further includes receiving a speech input after outputting the alert. The method further includes determining whether the speech input includes a request for information about the alert. The method further includes, in response to determining that the speech input includes a request for information about the alert, providing a first speech output including information about the alert.

32 Claims, 17 Drawing Sheets



Related U.S. Application Data

of application No. 12/987,982, filed on Jan. 10, 2011, now Pat. No. 9,318,108.

(60) Provisional application No. 61/798,600, filed on Mar. 15, 2013, provisional application No. 61/493,201, filed on Jun. 3, 2011, provisional application No. 61/295,774, filed on Jan. 18, 2010.

(51) **Int. Cl.**

G06F 17/27	(2006.01)
G10L 15/08	(2006.01)
G10L 15/18	(2013.01)

(58) **Field of Classification Search**

USPC 704/275

See application file for complete search history.

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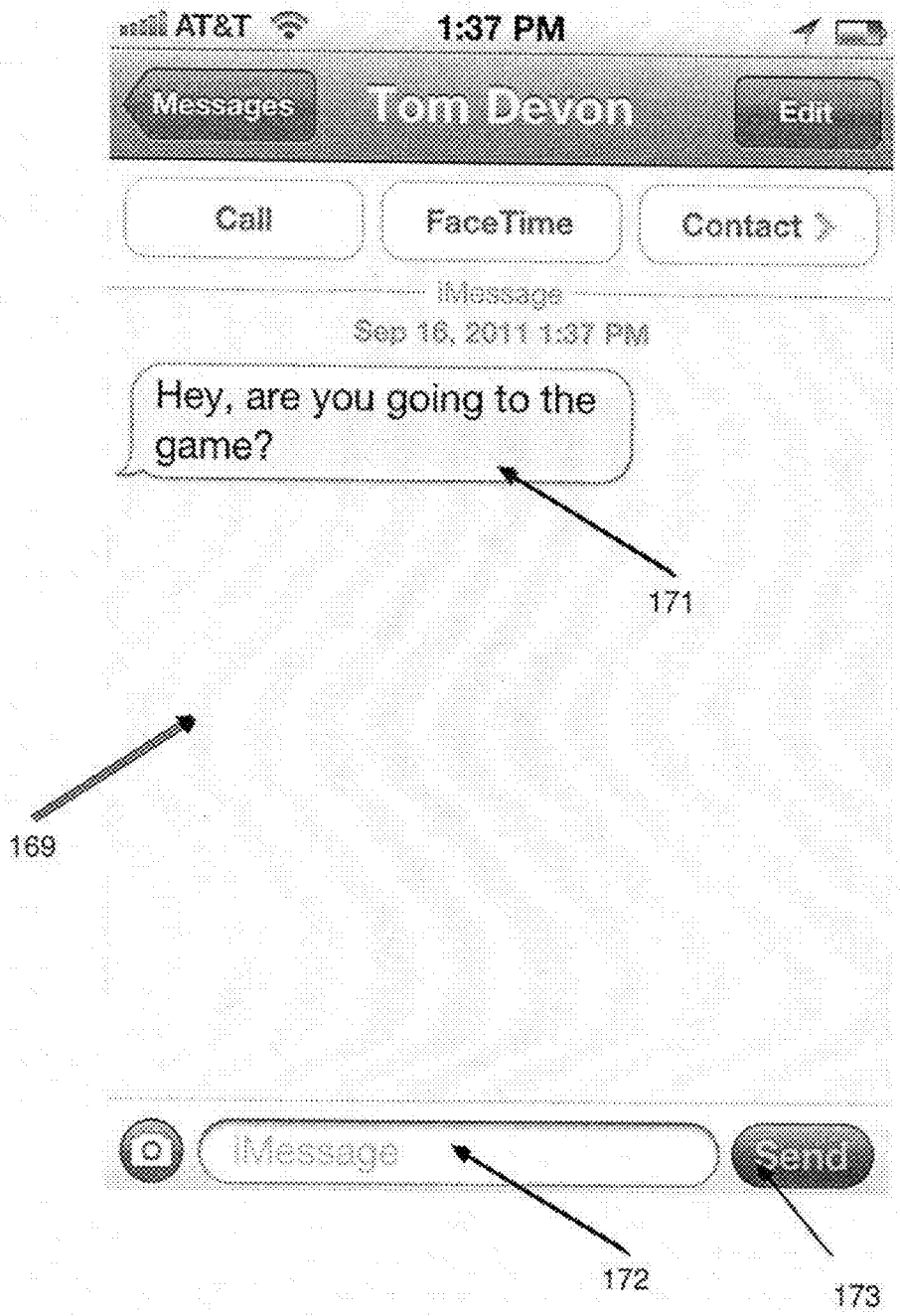

FIG. 1
(PRIOR ART)

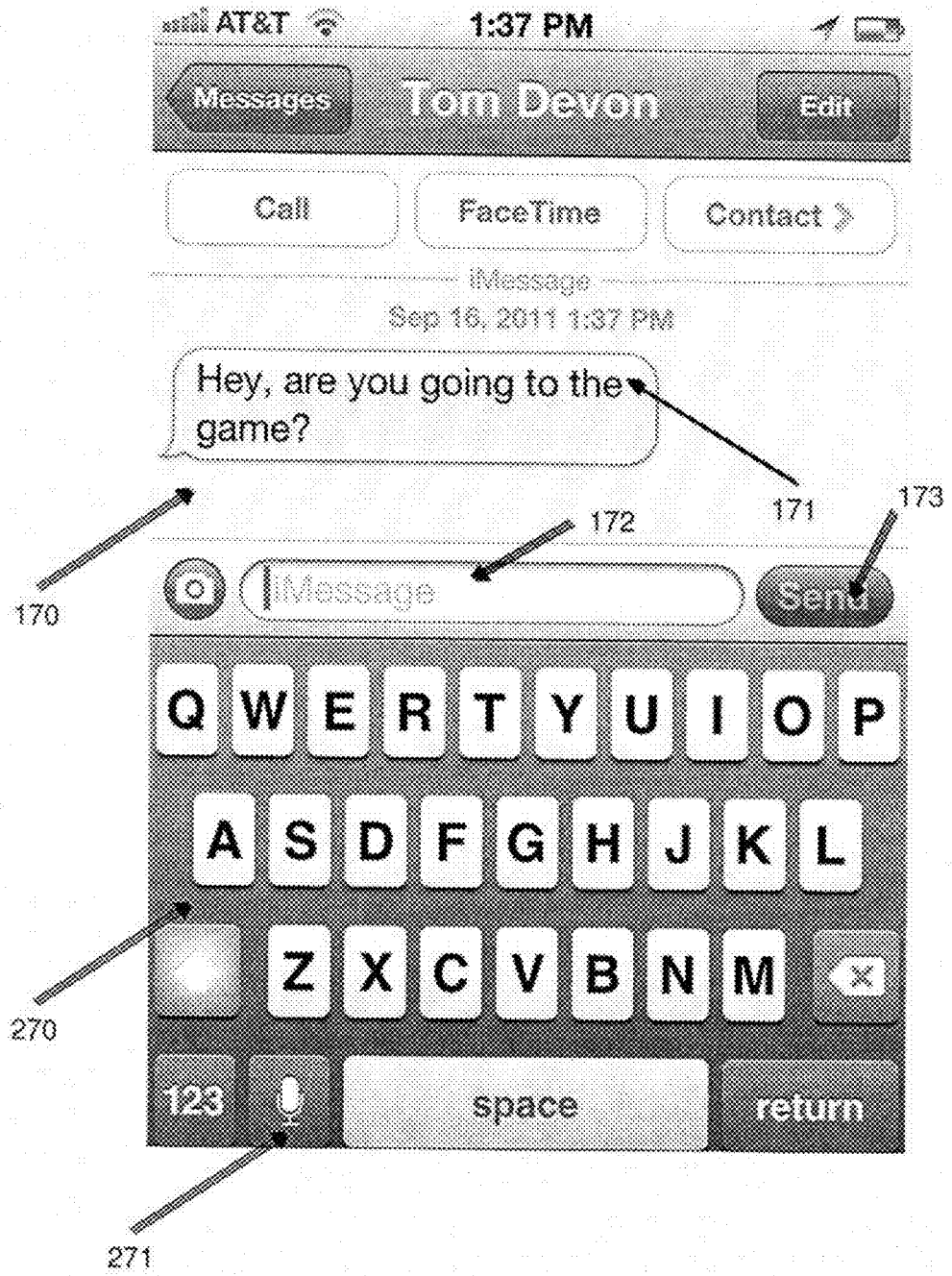
AT&T
1:37 PM
Messages
Tom Devon
Edit
Call
FaceTime
Contact
iMessage
Sep 16, 2011 1:37 PM
Hey, are you going to the game?
171
173
172
170
iMessage
Send
Q W E R T Y U I O P
A S D F G H J K L
Z X C V B N M
270
123
space
return
271

FIG. 2

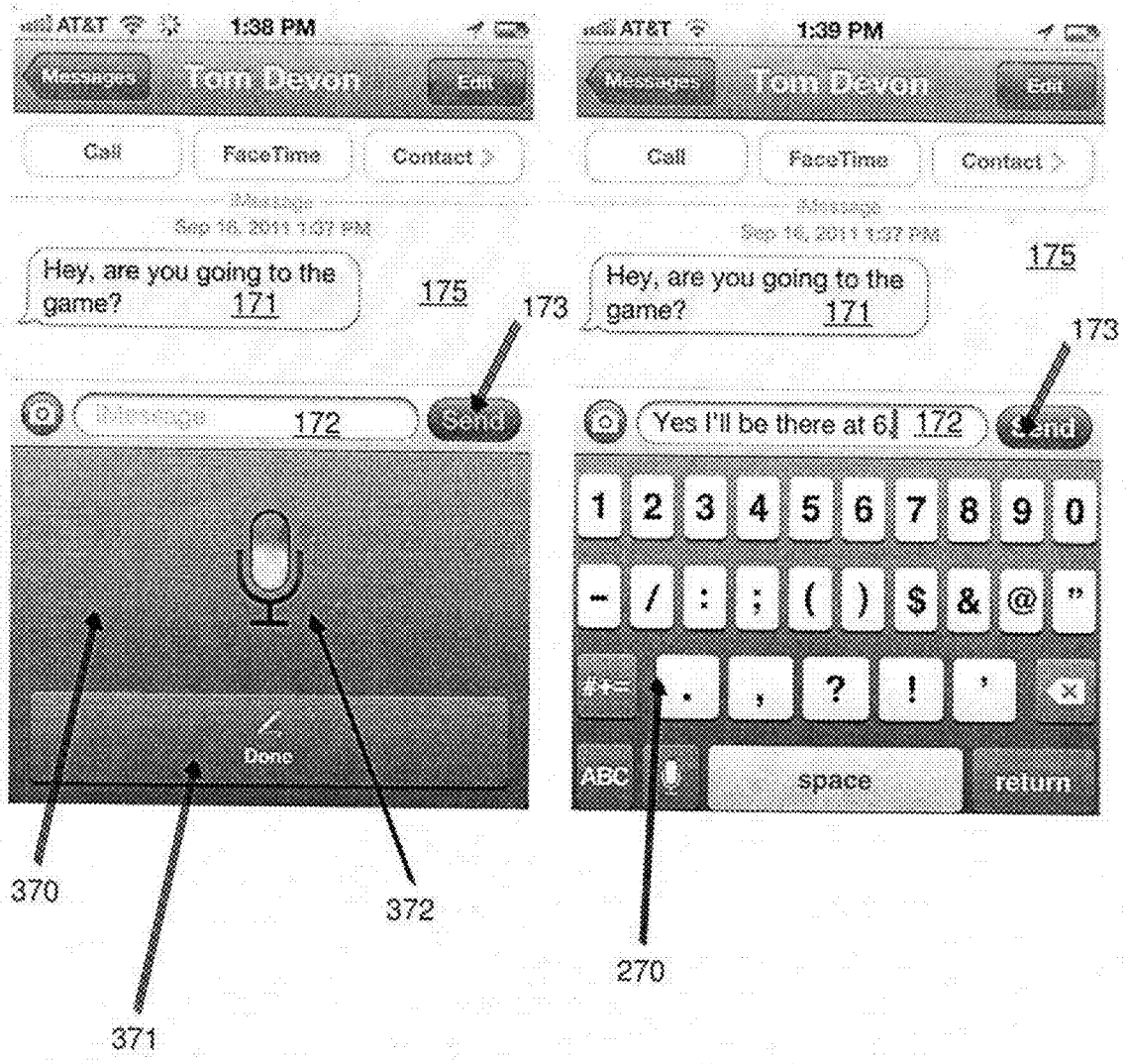
AT&T
1:38 PM
Messages
Tom Devon
Edit
Call
FaceTime
Contact
Hey, are you going to the game? 171
175
173
Message
172
Send
Done
370
371
372
AT&T
1:39 PM
Messages
Tom Devon
Edit
Call
FaceTime
Contact
Hey, are you going to the game? 171
175
173
Yes I'll be there at 6 172
Send
1 2 3 4 5 6 7 8 9 0
- / : ; ( ) $ & @ "
#+= . , ? ! '
ABC
space
return
270

FIG. 3A FIG. 3B

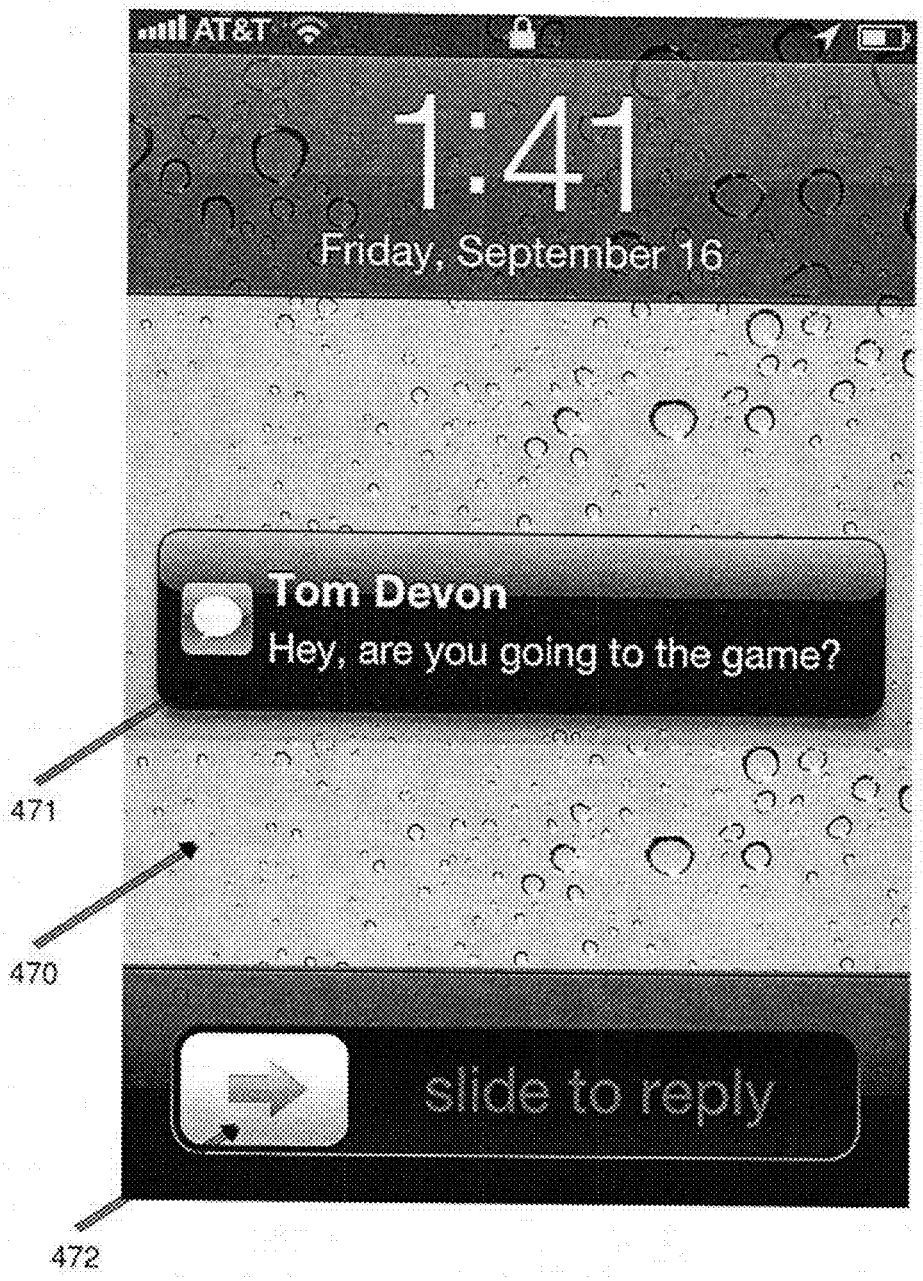
AT&T
1:41
Friday, September 16
Tom Devon
Hey, are you going to the game?
slide to reply
471
470
472

FIG. 4

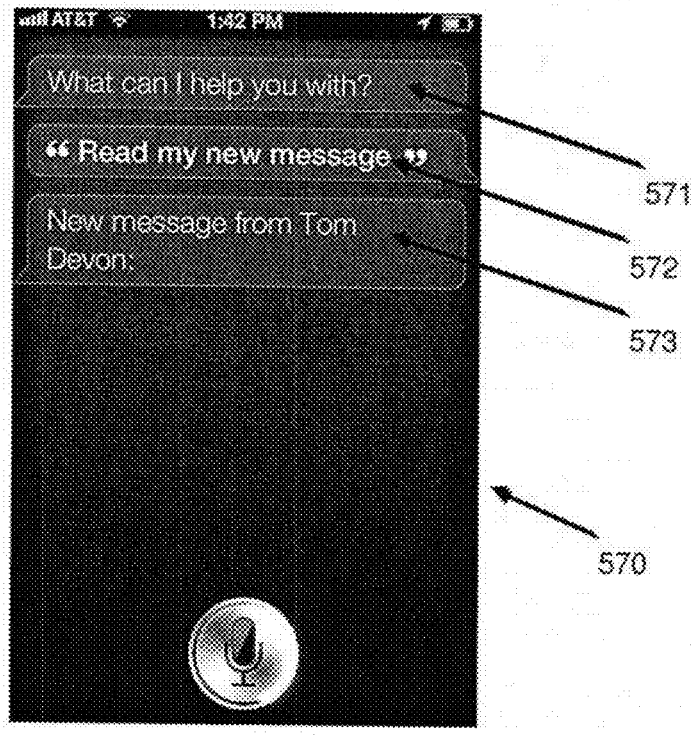
AT&T
1:42 PM
What can I help you with?
“Read my new message”
New message from Tom Devon:
571
572
573
570

FIG. 5A

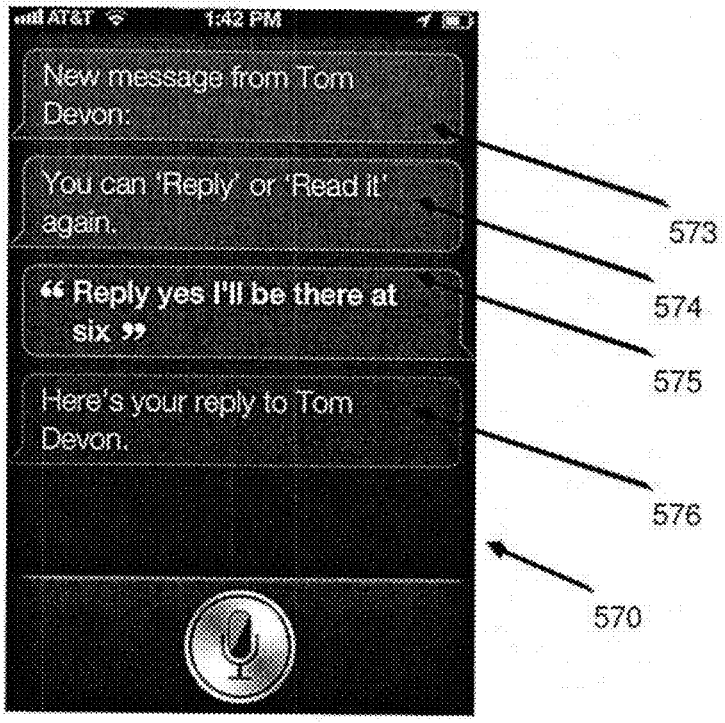
AT&T
1:42 PM
New message from Tom Devon:
You can 'Reply' or 'Read it' again.
“Reply yes I'll be there at six”
Here's your reply to Tom Devon.
573
574
575
576
570

FIG. 5B


AT&T
1:42 PM
Here's your reply to Tom Devon.
To: Tom Devon
Yes I'll be there at six
Cancel
Send
576
577
578
579
570

FIG. 5C

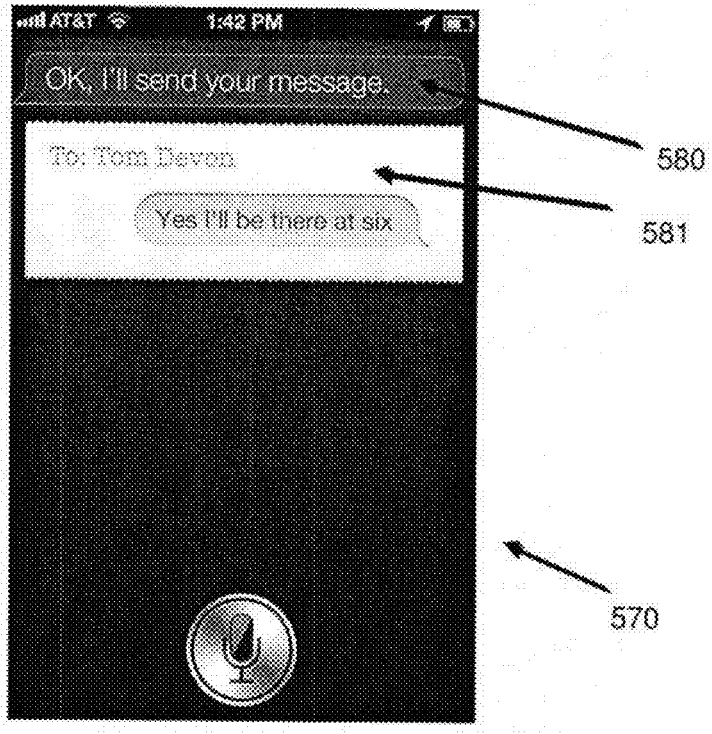
AT&T
1:42 PM
OK, I'll send your message.
To: Tom Devon
Yes I'll be there at six
580
581
570

FIG. 5D

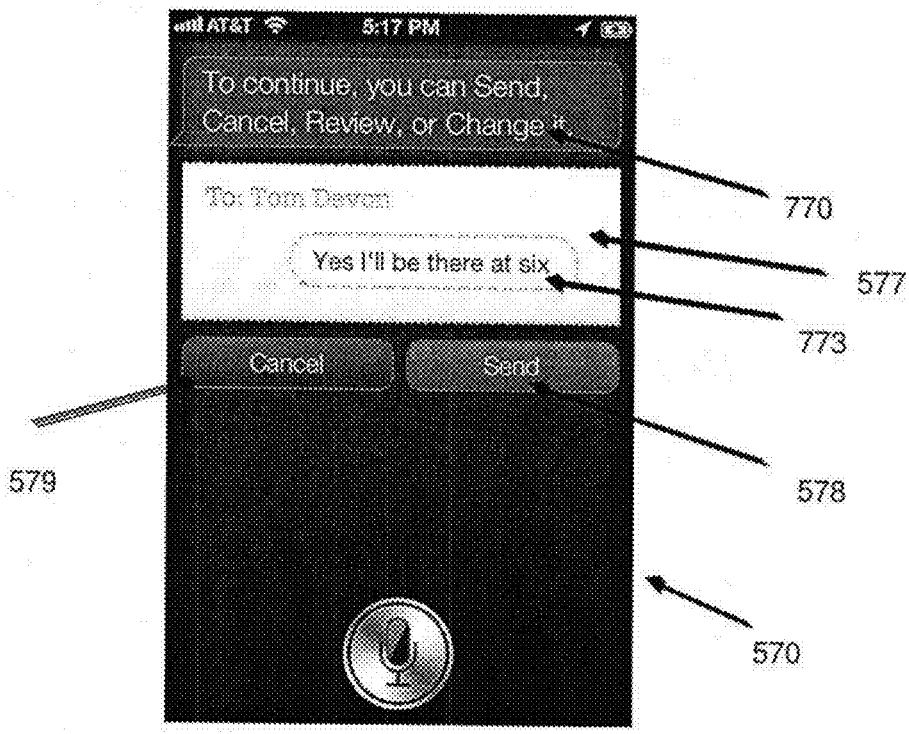
AT&T
5:17 PM
To continue, you can Send, Cancel, Review, or Change it.
To: Tom Devon
Yes I'll be there at six
Cancel
Send
770
577
773
579
578
570

FIG. 6A

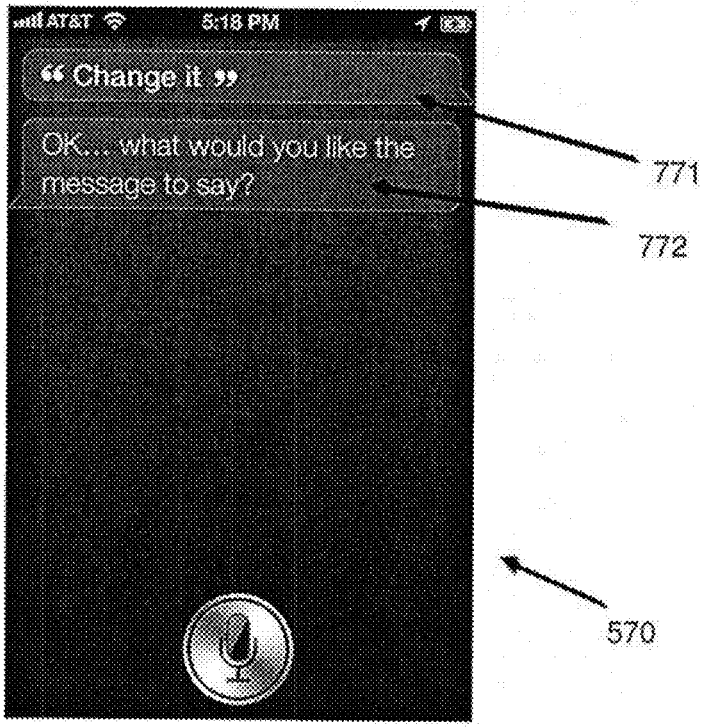
AT&T
5:18 PM
“Change it.”
OK... what would you like the message to say?
771
772
570

FIG. 6B


AT&T
5:18 PM
I updated your message. Ready to send it?
To: Tom Devon
I might be late I'll call you
Cancel
Send
770
577
579
578
570

FIG. 6C

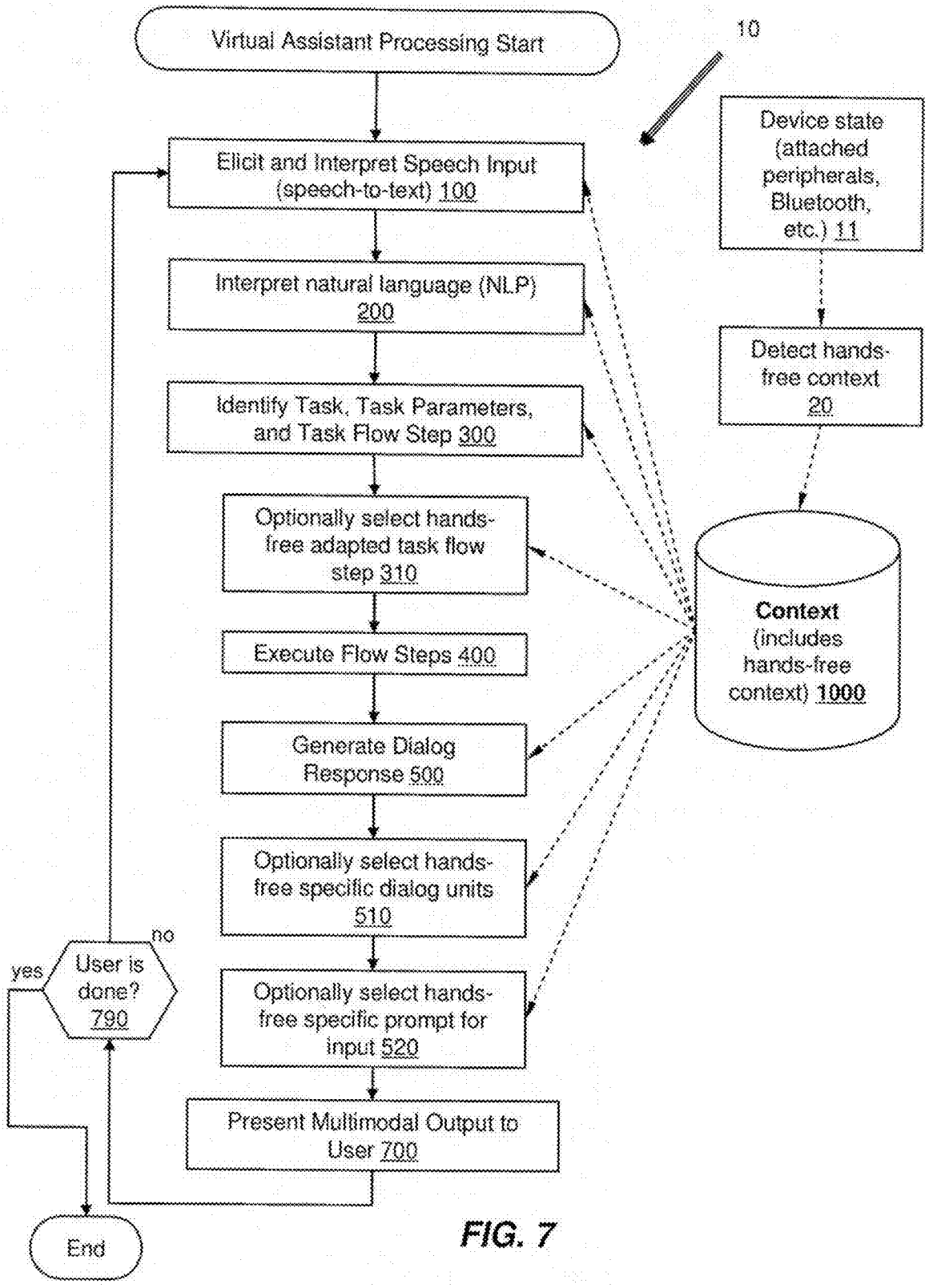
Virtual Assistant Processing Start
10
Device state (attached peripherals, Bluetooth, etc.) 11
Elicit and Interpret Speech Input (speech-to-text) 100
Interpret natural language (NLP) 200
Detect hands-free context 20
Identify Task, Task Parameters, and Task Flow Step 300
Optionally select hands-free adapted task flow step 310
Context (includes hands-free context) 1000
Execute Flow Steps 400
Generate Dialog Response 500
Optionally select hands-free specific dialog units 510
no
yes
User is done? 790
Optionally select hands-free specific prompt for input 520
Present Multimodal Output to User 700
End

FIG. 7

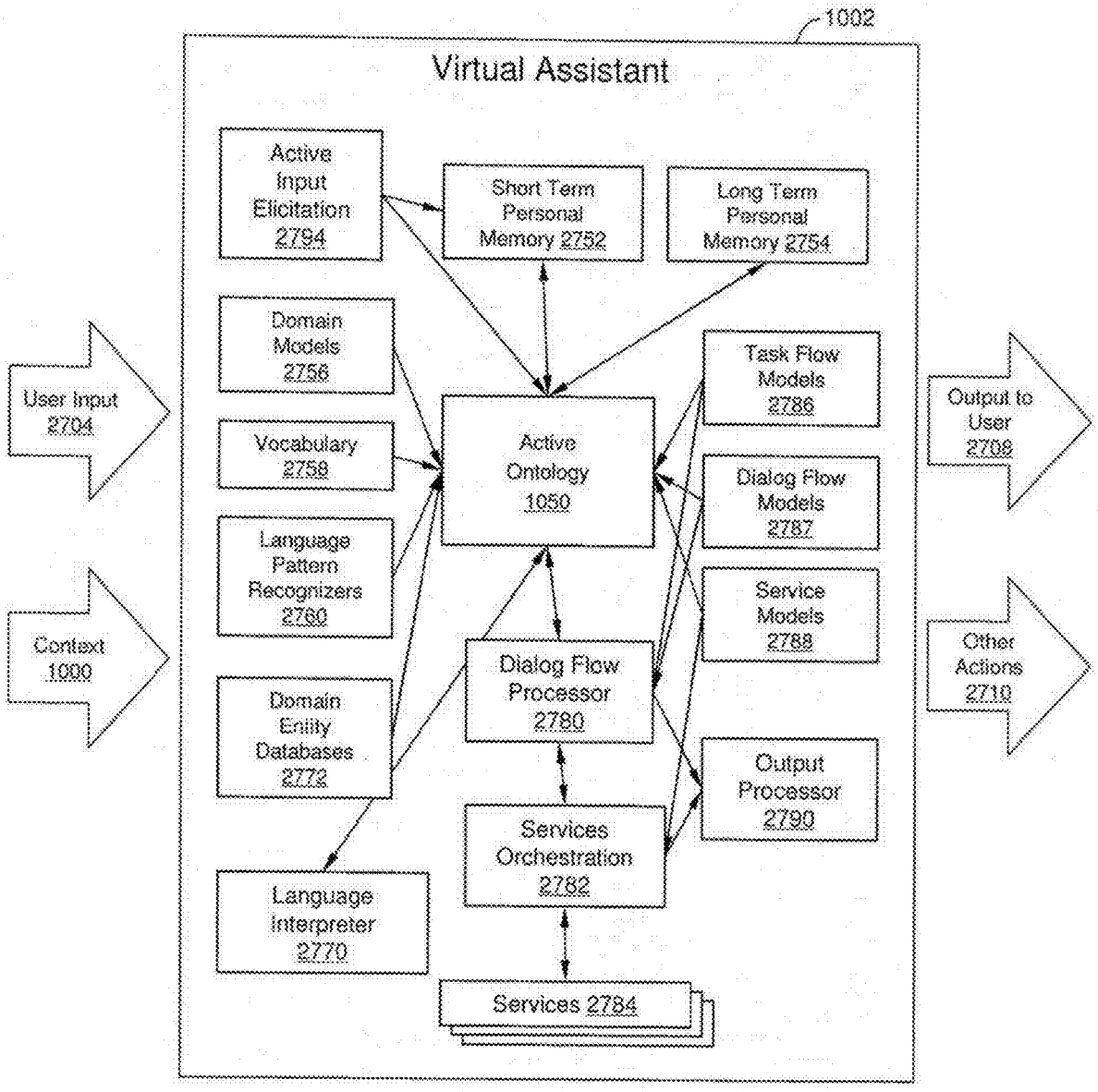
1002
Virtual Assistant
Active Input Elicitation 2794
Short Term Personal Memory 2752
Long Term Personal Memory 2754
Domain Models 2756
Vocabulary 2758
Language Pattern Recognizers 2760
Domain Entity Databases 2772
Language Interpreter 2770
Active Ontology 1050
Dialog Flow Processor 2780
Services Orchestration 2782
Services 2784
Task Flow Models 2786
Dialog Flow Models 2787
Service Models 2788
Output Processor 2790
User Input 2704
Context 1000
Output to User 2708
Other Actions 2710

FIG. 8

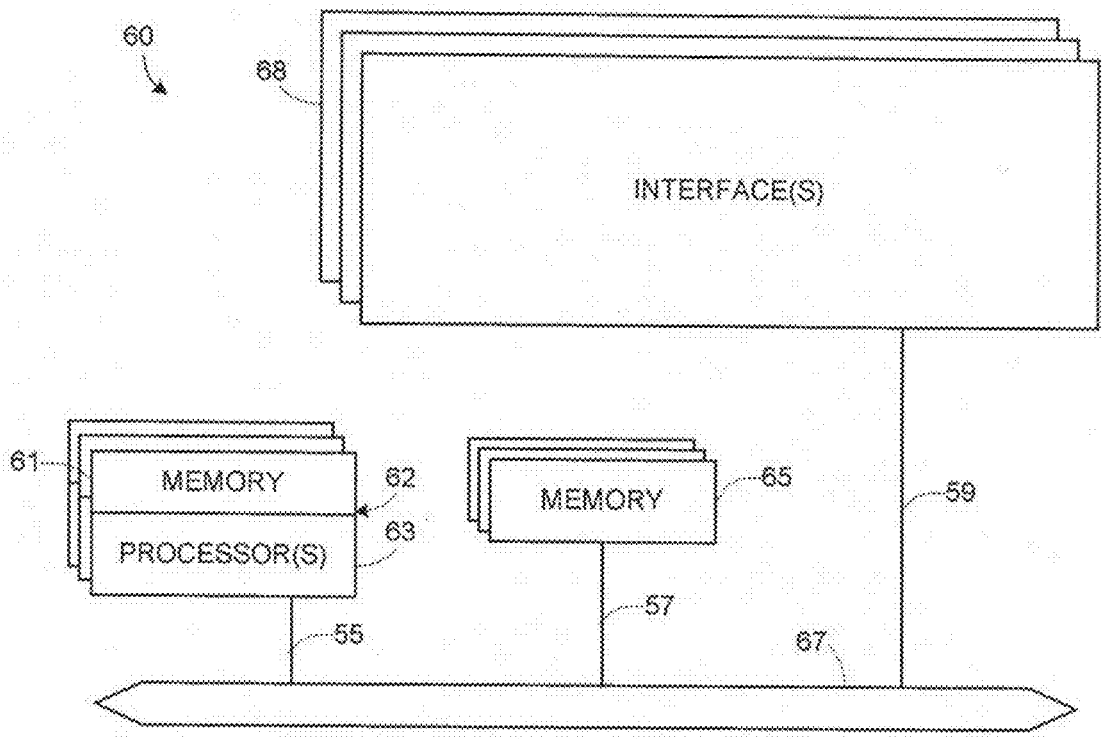
60
68
INTERFACE(S)
61
MEMORY
62
PROCESSOR(S)
63
MEMORY
65
59
57
55
67

FIG. 9

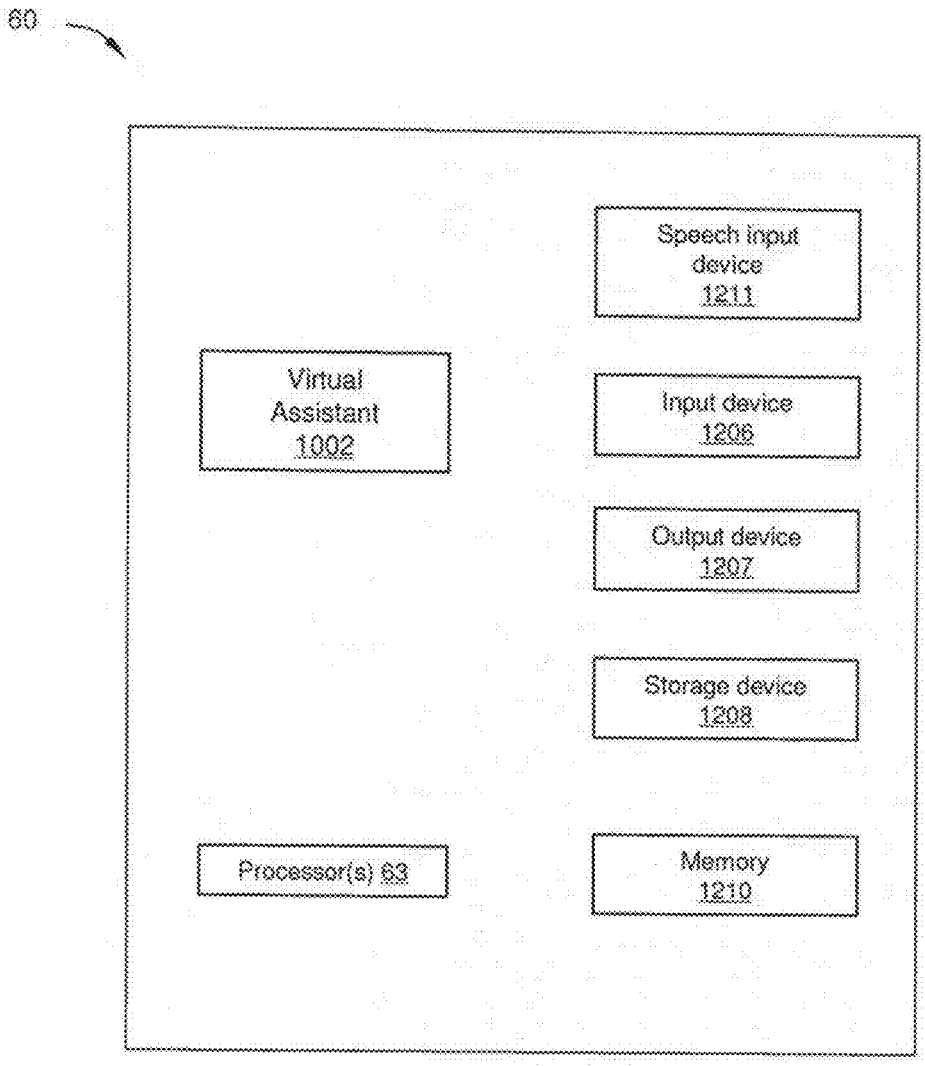
60
Speech input device 1211
Virtual Assistant 1002
Input device 1206
Output device 1207
Storage device 1208
Processor(s) 63
Memory 1210

FIG. 10

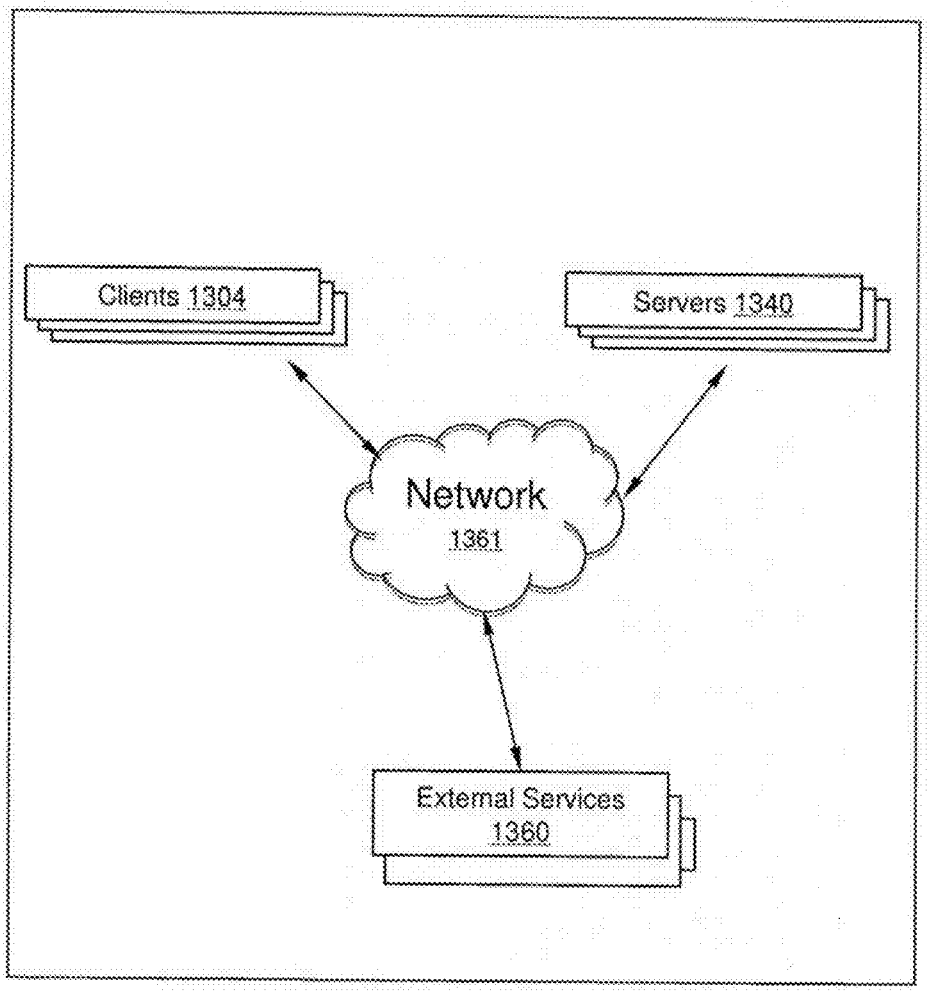
Clients 1304
Servers 1340
Network
1361
External Services
1360

FIG. 11

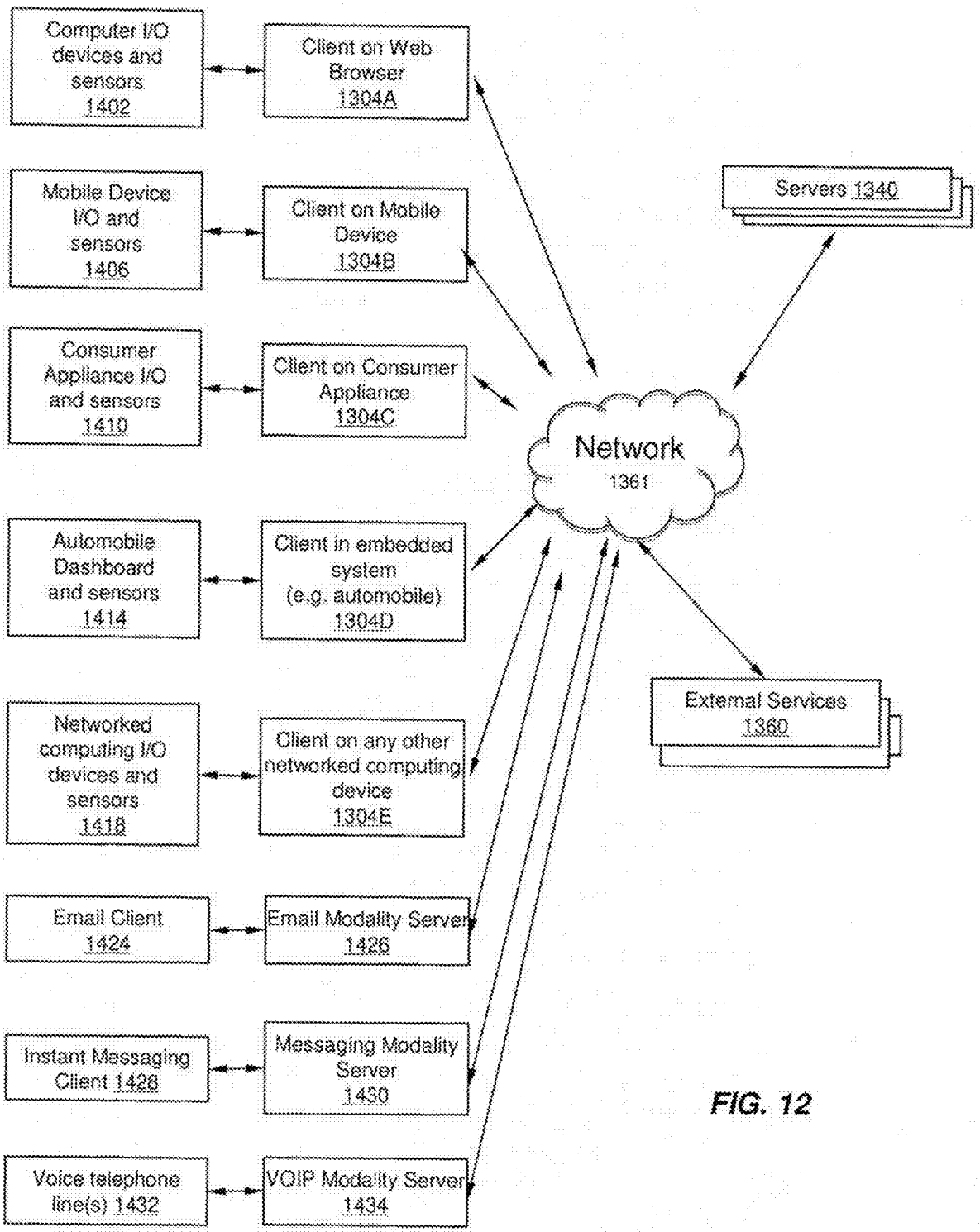
Computer I/O devices and sensors 1402
Client on Web Browser 1304A
Mobile Device I/O and sensors 1406
Client on Mobile Device 1304B
Consumer Appliance I/O and sensors 1410
Client on Consumer Appliance 1304C
Automobile Dashboard and sensors 1414
Client in embedded system (e.g. automobile) 1304D
Networked computing I/O devices and sensors 1418
Client on any other networked computing device 1304E
Email Client 1424
Email Modality Server 1426
Instant Messaging Client 1428
Messaging Modality Server 1430
Voice telephone line(s) 1432
VOIP Modality Server 1434
Network 1361
Servers 1340
External Services 1360

FIG. 12

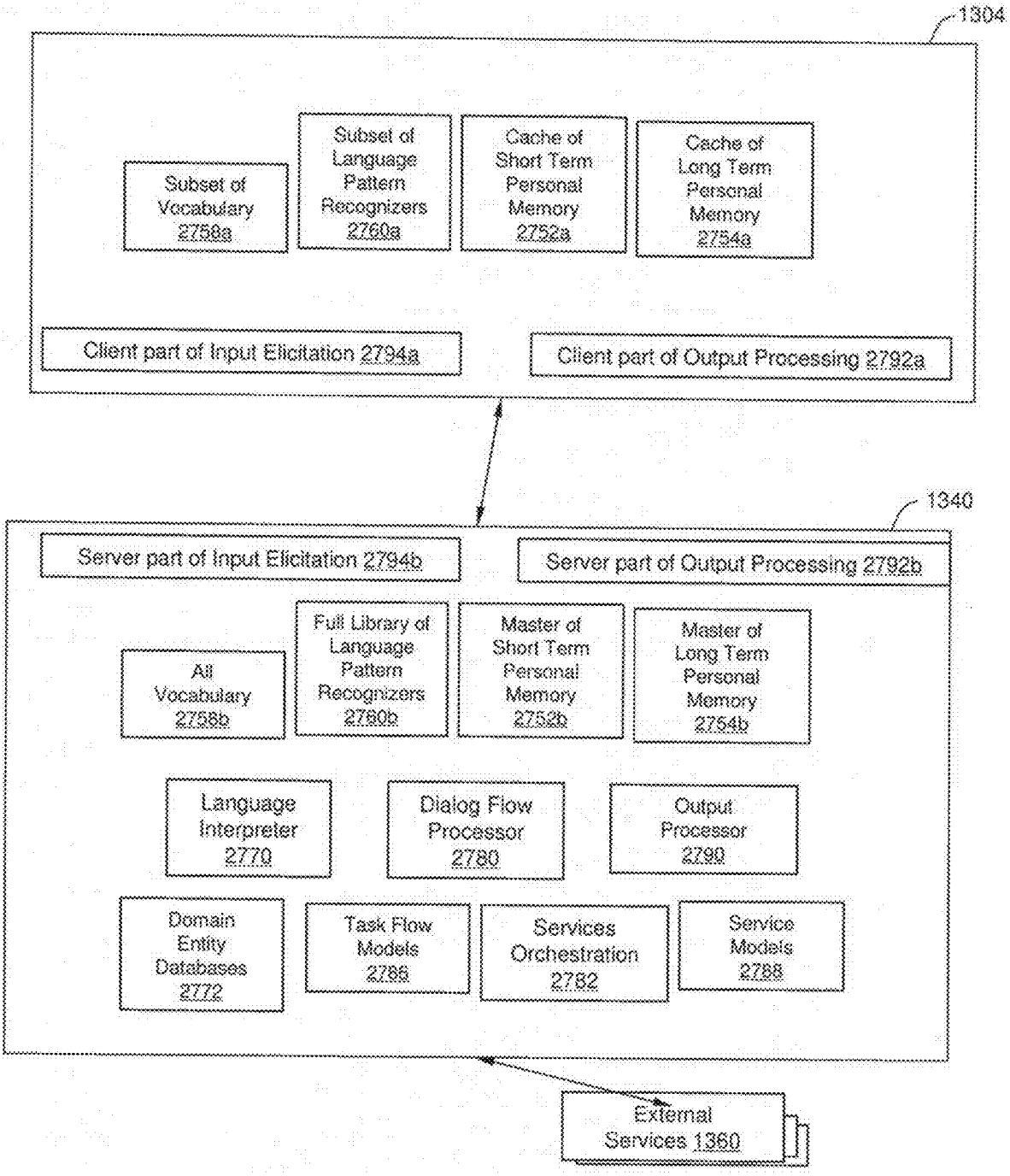
1304
Subset of Vocabulary 2758a
Subset of Language Pattern Recognizers 2760a
Cache of Short Term Personal Memory 2752a
Cache of Long Term Personal Memory 2754a
Client part of Input Elicitation 2794a
Client part of Output Processing 2792a
1340
Server part of Input Elicitation 2794b
Server part of Output Processing 2792b
All Vocabulary 2758b
Full Library of Language Pattern Recognizers 2760b
Master of Short Term Personal Memory 2752b
Master of Long Term Personal Memory 2754b
Language Interpreter 2770
Dialog Flow Processor 2780
Output Processor 2790
Domain Entity Databases 2772
Task Flow Models 2786
Services Orchestration 2782
Service Models 2788
External Services 1360

FIG. 13

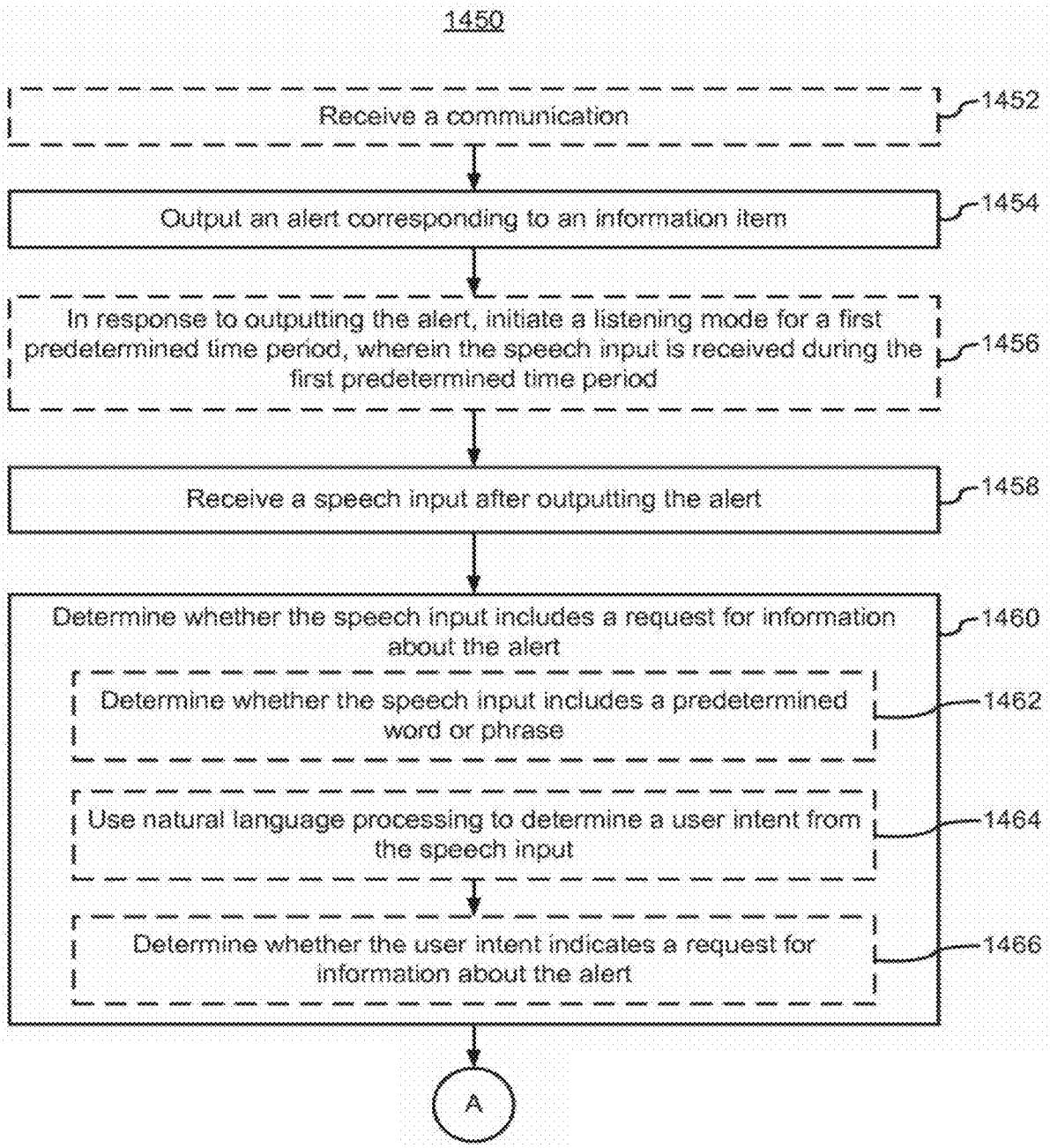
1450
Receive a communication
1452
Output an alert corresponding to an information item
1454
In response to outputting the alert, initiate a listening mode for a first predetermined time period, wherein the speech input is received during the first predetermined time period
1456
Receive a speech input after outputting the alert
1458
Determine whether the speech input includes a request for information about the alert
1460
Determine whether the speech input includes a predetermined word or phrase
1462
Use natural language processing to determine a user intent from the speech input
1464
Determine whether the user intent indicates a request for information about the alert
1466
A

Figure 14A

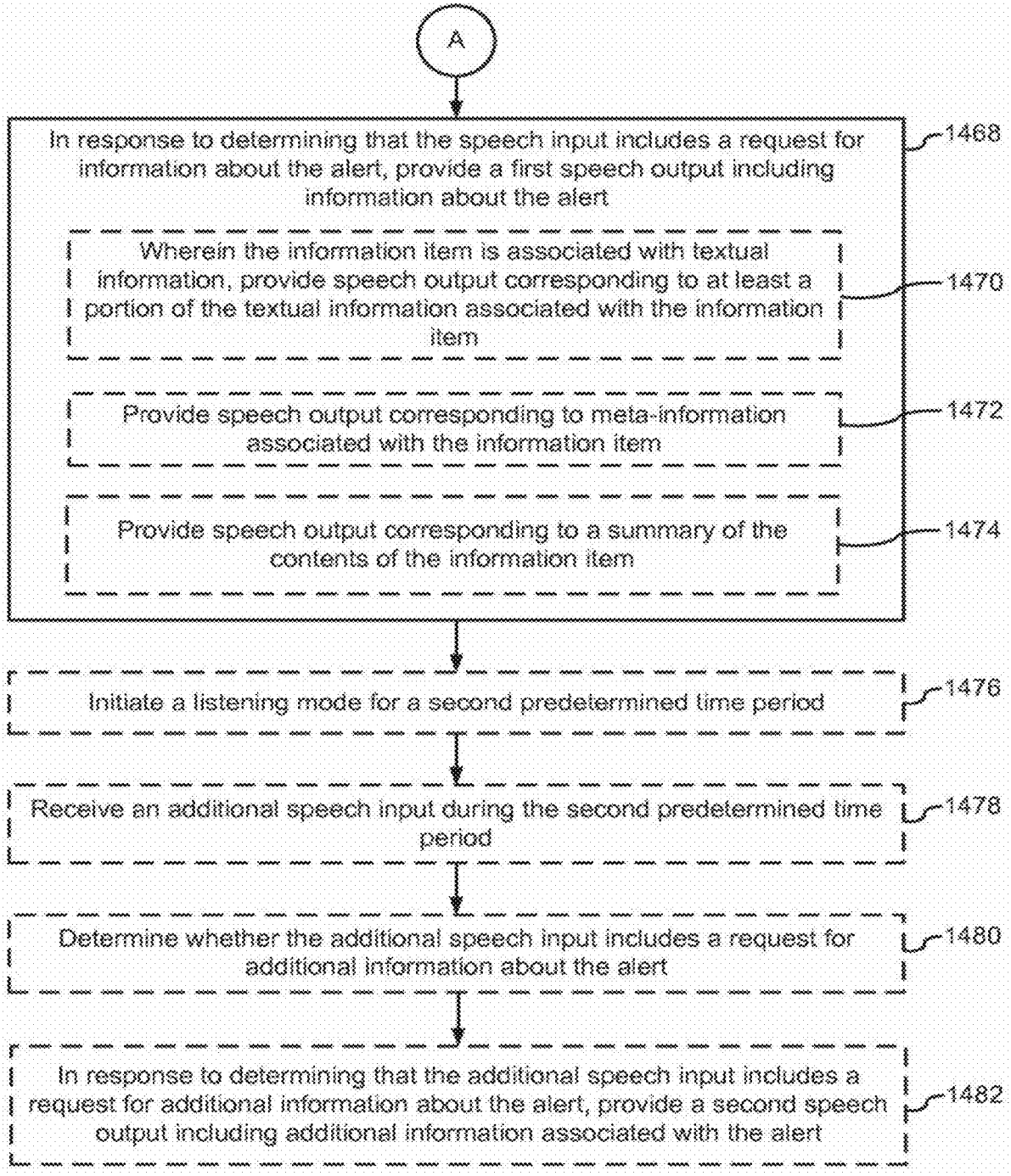
A
In response to determining that the speech input includes a request for information about the alert, provide a first speech output including information about the alert
1468
Wherein the information item is associated with textual information, provide speech output corresponding to at least a portion of the textual information associated with the information item
1470
Provide speech output corresponding to meta-information associated with the information item
1472
Provide speech output corresponding to a summary of the contents of the information item
1474
Initiate a listening mode for a second predetermined time period
1476
Receive an additional speech input during the second predetermined time period
1478
Determine whether the additional speech input includes a request for additional information about the alert
1480
In response to determining that the additional speech input includes a request for additional information about the alert, provide a second speech output including additional information associated with the alert
1482

Figure 14B

SYSTEMS AND METHODS FOR HANDS-FREE NOTIFICATION SUMMARIES

RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application Ser. No. 61/798,600, entitled "Systems And Methods For Hands-Free Notification Summaries," filed Mar. 15, 2013, the disclosure of which is hereby incorporated by reference in its entirety. This application is further a continuation-in-part of U.S. Utility application Ser. No. 13/250,947, entitled "Automatically Adapting User Interfaces for Hands-Free Interaction," filed Sep. 30, 2011, which claims priority to U.S. Provisional Application Ser. No. 61/493,201, filed Jun. 3, 2011, which claims priority to U.S. application Ser. No. 12/987,982, filed Jan. 10, 2011, which claims priority to U.S. Provisional Application No. 61/295,774, filed Jan. 18, 2010, the disclosures of which are incorporated herein by reference for all purposes.

This application is also related to U.S. Application Ser. No. 61/657,744, filed Jun. 9, 2012, entitled "Automatically Adapting User Interfaces for Hands-Free Interaction," which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

The present invention relates to multimodal user interfaces, and more specifically to user interfaces that provide speech outputs relating to alerts.

BACKGROUND OF THE INVENTION

Many existing operating systems and devices use voice input as a modality by which the user can control operation. One example is voice command systems, which map specific verbal commands to operations, for example to initiate dialing of a telephone number by speaking the person's name. Another example is Interactive Voice Response (IVR) systems, which allow people to access static information over the telephone, such as automated telephone service desks.

Many voice command and IVR systems are relatively narrow in scope and can only handle a predefined set of voice commands. In addition, their output is often drawn from a fixed set of responses.

An intelligent automated assistant, also referred to herein as a virtual assistant, is able to provide an improved interface between human and computer, including the processing of natural language input. Such an assistant allows users to interact with a device or system using natural language, in spoken and/or text forms. Such an assistant interprets user inputs, operationalizes the user's intent into tasks and parameters to those tasks, executes services to support those tasks, and produces output that is intelligible to the user.

Virtual assistants are capable of using general speech and natural language understanding technology to recognize a greater range of input, enabling generation of a dialog with the user. Some virtual assistants can generate output in a combination of modes, including verbal responses and written text, and can also provide a graphical user interface (GUI) that permits direct manipulation of on-screen elements. However, the user may not always be in a situation where he or she can (or wants to) take advantage of such visual output or direct manipulation interfaces. For example, the user may be driving or operating machinery, may have a sight disability, may simply have left the device that provides the virtual assistant in a pocket or out of reach, or may simply not want to pick the device up.

Any situation in which a user has limited or no ability (or desire) to read a screen or interact with a device via contact (including using a keyboard, mouse, touch screen, pointing device, and the like) is referred to herein as a "hands-free context". For example, in situations where the user is attempting to operate a device while driving, as mentioned above, the user can hear audible output and respond using their voice, but for safety reasons should not read fine print, tap on menus, or enter text.

Hands-free contexts present special challenges to the builders of complex systems such as virtual assistants. Users demand full access to features of devices whether or not they are in a hands-free context. However, failure to account for particular limitations inherent in hands-free operation can result in situations that limit both the utility and the usability of a device or system, and can even compromise safety by causing a user to be distracted from a primary task such as operating a vehicle.

SUMMARY

According to various embodiments of the present invention, a user interface for a system such as a virtual assistant is automatically adapted for hands-free use. A hands-free context is detected via automatic or manual means, and the system adapts various stages of a complex interactive system to modify the user experience to reflect the particular limitations of such a context. The system of the present invention thus allows for a single implementation of a virtual assistant or other complex system to dynamically offer user interface elements and to alter user interface behavior to allow hands-free use without compromising the user experience of the same system for hands-on use.

For example, in various embodiments, the system of the present invention provides mechanisms for adjusting the operation of a virtual assistant so that it provides output in a manner that allows users to complete their tasks without having to read details on a screen. Furthermore, in various embodiments, the virtual assistant can provide mechanisms for receiving spoken input as an alternative to reading, tapping, clicking, typing, or performing other functions often achieved using a graphical user interface.

In various embodiments, the system of the present invention provides underlying functionality that is identical to (or that approximates) that of a conventional graphical user interface, while allowing for the particular requirements and limitations associated with a hands-free context. More generally, the system of the present invention allows core functionality to remain substantially the same, while facilitating operation in a hands-free context. In some embodiments, systems built according to the techniques of the present invention allow users to freely choose between hands-free mode and conventional ("hands-on") mode, in some cases within a single session. For example, the same interface can be made adaptable to both an office environment and a moving vehicle, with the system dynamically making the necessary changes to user interface behavior as the environment changes.

According to various embodiments of the present invention, any of a number of mechanisms can be implemented for adapting operation of a virtual assistant to a hands-free context. In various embodiments, the virtual assistant is an intelligent automated assistant as described in U.S. Utility application Ser. No. 12/987,982 for "Intelligent Automated Assistant," filed Jan. 10, 2011, the entire disclosure of which

is incorporated herein by reference. Such an assistant engages with the user in an integrated, conversational manner using natural language dialog, and invokes external services when appropriate to obtain information or perform various actions.

According to various embodiments of the present invention, a virtual assistant may be configured, designed, and/or operable to detect a hands-free context and to adjust its operation accordingly in performing various different types of operations, functionalities, and/or features, and/or to combine a plurality of features, operations, and applications of an electronic device on which it is installed. In some embodiments, a virtual assistant of the present invention can detect a hands-free context and adjust its operation accordingly when receiving input, providing output, engaging in dialog with the user, and/or performing (or initiating) actions based on discerned intent.

Actions can be performed, for example, by activating and/or interfacing with any applications or services that may be available on an electronic device, as well as services that are available over an electronic network such as the Internet. In various embodiments, such activation of external services can be performed via application programming interfaces (APIs) or by any other suitable mechanism(s). In this manner, a virtual assistant implemented according to various embodiments of the present invention can provide a hands-free usage environment for many different applications and functions of an electronic device, and with respect to services that may be available over the Internet. As described in the above-referenced related application, the use of such a virtual assistant can relieve the user of the burden of learning what functionality may be available on the device and on web-connected services, how to interface with such services to get what he or she wants, and how to interpret the output received from such services; rather, the assistant of the present invention can act as a go-between between the user and such diverse services.

In addition, in various embodiments, the virtual assistant of the present invention provides a conversational interface that the user may find more intuitive and less burdensome than conventional graphical user interfaces. The user can engage in a form of conversational dialog with the assistant using any of a number of available input and output mechanisms, depending in part on whether a hands-free or hands-on context is active. Examples of such input and output mechanisms include, without limitation, speech, graphical user interfaces (buttons and links), text entry, and the like. The system can be implemented using any of a number of different platforms, such as device APIs, the web, email, and the like, or any combination thereof. Requests for additional input can be presented to the user in the context of a conversation presented in an auditory and/or visual manner. Short and long term memory can be engaged so that user input can be interpreted in proper context given previous events and communications within a given session, as well as historical and profile information about the user.

In various embodiments, the virtual assistant of the present invention can control various features and operations of an electronic device. For example, the virtual assistant can call services that interface with functionality and applications on a device via APIs or by other means, to perform functions and operations that might otherwise be initiated using a conventional user interface on the device. Such functions and operations may include, for example, setting an alarm, making a telephone call, sending a text message or email message, adding a calendar event, and the like. Such functions and operations may be performed as add-on functions in the context of a conversational dialog between a user and the assistant. Such functions and operations can be specified by the user in the context of such a dialog, or they may be automatically performed based on the context of the dialog. One skilled in the art will recognize that the assistant can thereby be used as a mechanism for initiating and controlling various operations on the electronic device. By collecting contextual evidence that contributes to inferences about the user's current situation, and by adjusting operation of the user interface accordingly, the system of the present invention is able to present mechanisms for enabling hands-free operation of a virtual assistant to implement such a mechanism for controlling the device.

In accordance with some implementations, a method is provided that allows the virtual assistant to provide additional information about alerts in response to speech inputs received after the alert is issued. In some implementations, the method is performed at an electronic device having one or more processors and memory storing one or more programs for execution by the one or more processors. The method includes outputting an alert corresponding to an information item; receiving a speech input after outputting the alert; determining whether the speech input includes a request for information about the alert; and in response to determining that the speech input includes a request for information about the alert, providing a first speech output including information about the alert. In some implementations, the information item is associated with one of the group consisting of: a calendar alert; a reminder alert; and an application alert. In some implementations, the alert is an audible alert. In some implementations, the alert is a tactile alert. In some implementations, the alert includes both audio and tactile aspects.

In some implementations, the method includes, in response to outputting the alert, initiating a listening mode for a first predetermined time period, wherein the speech input is received during the first predetermined time period. In some implementations, no audio prompt indicating initiation of the listening mode is provided upon initiation of the listening mode.

In some implementations, determining whether the speech input includes the request for information about the alert comprises determining whether the speech input includes a predetermined word or phrase. In some implementations, the predetermined word or phrase is one of a plurality of predetermined words or phrases that indicate a user request for information about an alert. In some implementations, determining whether the speech input includes a request for information about the alert comprises: using natural language processing to determine a user intent from the speech input; and determining whether the user intent indicates a request for information about the alert.

In some implementations, the method further includes, prior to outputting the alert, receiving a communication, wherein the information item is associated with the communication. In some implementations, the communication is selected from the group consisting of: a text message; a telephone call; a videotelephony call; a voicemail; and an email.

In some implementations, the information item is associated with textual information. In some implementations, providing the first speech output includes providing speech output corresponding to at least a portion of the textual information associated with the information item.

In some implementations, providing the first speech output includes providing speech output corresponding to meta-information associated with the information item. In some

implementations, the meta-information is an indication of a source of the information item. In some implementations, the indication of the source of the information item includes a name of an application that issued the information item. In some implementations, the information item corresponds to a communication, and the meta-information is a name of a sender of the communication. In some implementations, the meta-information is an indication of a class of the information item.

In some implementations, providing the first speech output further includes providing speech output corresponding to a summary of the contents of the information item.

In some implementations, the information item is an alert from an information service. In some implementations, the information service is a social networking service, and the information item is a notification of social networking activity. In some implementations, the information service is associated with an application that is installed on the electronic device.

In some implementations, the method further includes, after providing the first speech output, initiating a listening mode for a second predetermined time period; receiving an additional speech input during the second predetermined time period; determining whether the additional speech input includes a request for additional information about the alert; and in response to determining that the additional speech input includes a request for additional information about the alert, providing a second speech output including additional information associated with the alert. In some implementations, the alert corresponds to a communication, the first speech output includes a name of a sender of the communication, and the second speech output includes at least a content portion of the communication.

In accordance with some implementations, an electronic device includes one or more processors, memory, and one or more programs; the one or more programs are stored in the memory and configured to be executed by the one or more processors and the one or more programs include instructions for performing the operations of any of the methods and/or techniques described herein. In accordance with some implementations, a computer readable storage medium has stored therein instructions, which, when executed by an electronic device, cause the device to perform the operations of any of the methods and/or techniques described herein. In accordance with some implementations, an electronic device includes means for performing the operations of any of the methods and/or techniques described herein. In accordance with some implementations, an information processing apparatus, for use in an electronic device includes means for performing the operations of any of the methods and/or techniques described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings illustrate several embodiments of the invention and, together with the description, serve to explain the principles of the invention according to the embodiments. One skilled in the art will recognize that the particular embodiments illustrated in the drawings are merely exemplary, and are not intended to limit the scope of the present invention.

FIG. **1** is a screen shot illustrating an example of a hands-on interface for reading a text message, according to the prior art.

FIG. **2** is a screen shot illustrating an example of an interface for responding to a text message.

FIGS. **3**A and **3**B are a sequence of screen shots illustrating an example wherein a voice dictation interface is used to reply to a text message.

FIG. **4** is a screen shot illustrating an example of an interface for receiving a text message, according to one embodiment.

FIGS. **5**A through **5**D are a series of screen shots illustrating an example of operation of a multimodal virtual assistant according to an embodiment of the present invention, wherein the user receives and replies to a text message in a hands-free context.

FIGS. **6**A through **6**C are a series of screen shots illustrating an example of operation of a multimodal virtual assistant according to an embodiment of the present invention, wherein the user revises a text message in a hands-free context.

FIG. **7** is a flow diagram depicting a method of operation of a virtual assistant that supports dynamic detection of and adaptation to a hands-free context, according to one embodiment.

FIG. **8** is a block diagram depicting an example of a virtual assistant system according to one embodiment.

FIG. **9** is a block diagram depicting a computing device suitable for implementing at least a portion of a virtual assistant according to at least one embodiment.

FIG. **10** is a block diagram depicting an architecture for implementing at least a portion of a virtual assistant on a standalone computing system, according to at least one embodiment.

FIG. **11** is a block diagram depicting an architecture for implementing at least a portion of a virtual assistant on a distributed computing network, according to at least one embodiment.

FIG. **12** is a block diagram depicting a system architecture illustrating several different types of clients and modes of operation.

FIG. **13** is a block diagram depicting a client and a server, which communicate with each other to implement the present invention according to one embodiment.

FIGS. **14**A and **14**B are flow diagrams depicting a method of operation of a virtual assistant, according to one embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENTS

According to various embodiments of the present invention, a hands-free context is detected in connection with operations of a virtual assistant, and the user interface of the virtual assistant is adjusted accordingly, so as to enable the user to interact with the assistant meaningfully in the hands-free context.

For purposes of the description, the term "virtual assistant" is equivalent to the term "intelligent automated assistant", both referring to any information processing system that performs one or more of the functions of:

- interpreting human language input, in spoken and/or text form; operationalizing a representation of user intent into a form that can be executed, such as a representation of a task with steps and/or parameters;
- executing task representations, by invoking programs, methods, services, APIs, or the like; and
- generating output responses to the user in language and/or graphical form.

An example of such a virtual assistant is described in related U.S. Utility application Ser. No. 12/987,982 (which has been incorporated by reference, above).

Various techniques will now be described in detail with reference to example embodiments as illustrated in the accompanying drawings. In the following description, numerous specific details are set forth in order to provide a thorough understanding of one or more aspects and/or features described or reference herein. It will be apparent, however, to one skilled in the art, that one or more aspects and/or features described or reference herein may be practiced without some or all of these specific details. In other instances, well known process steps and/or structures have not been described in detail in order to not obscure some of the aspects and/or features described or reference herein.

One or more different inventions may be described in the present application. Further, for one or more of the invention(s) described herein, numerous embodiments may be described in this patent application, and are presented for illustrative purposes only. The described embodiments are not intended to be limiting in any sense. One or more of the invention(s) may be widely applicable to numerous embodiments, as is readily apparent from the disclosure. These embodiments are described in sufficient detail to enable those skilled in the art to practice one or more of the invention(s), and it is to be understood that other embodiments may be utilized and that structural, logical, software, electrical and other changes may be made without departing from the scope of the one or more of the invention(s). Accordingly, those skilled in the art will recognize that the one or more of the invention(s) may be practiced with various modifications and alterations. Particular features of one or more of the invention(s) may be described with reference to one or more particular embodiments or figures that form a part of the present disclosure, and in which are shown, by way of illustration, specific embodiments of one or more of the invention(s). It should be understood, however, that such features are not limited to usage in the one or more particular embodiments or figures with reference to which they are described. The present disclosure is neither a literal description of all embodiments of one or more of the invention(s) nor a listing of features of one or more of the invention(s) that must be present in all embodiments.

Headings of sections provided in this patent application and the title of this patent application are for convenience only, and are not to be taken as limiting the disclosure in any way.

Devices that are in communication with each other need not be in continuous communication with each other, unless expressly specified otherwise. In addition, devices that are in communication with each other may communicate directly or indirectly through one or more intermediaries.

A description of an embodiment with several components in communication with each other does not imply that all such components are required. To the contrary, a variety of optional components are described to illustrate the wide variety of possible embodiments of one or more of the invention(s).

Further, although process steps, method steps, algorithms or the like may be described in a sequential order, such processes, methods and algorithms may be configured to work in any suitable order. In other words, any sequence or order of steps that may be described in this patent application does not, in and of itself, indicate a requirement that the steps be performed in that order. Further, some steps may be performed simultaneously despite being described or implied as occurring non-simultaneously (e.g., because one step is described after the other step). Moreover, the illustration of a process by its depiction in a drawing does not imply that the illustrated process is exclusive of other variations and modifications thereto, does not imply that the illustrated process or any of its steps are necessary to one or more of the invention(s), and does not imply that the illustrated process is preferred.

When a single device or article is described, it will be readily apparent that more than one device/article (whether or not they cooperate) may be used in place of a single device/article. Similarly, where more than one device or article is described (whether or not they cooperate), it will be readily apparent that a single device/article may be used in place of the more than one device or article.

The functionality and/or the features of a device may be alternatively embodied by one or more other devices that are not explicitly described as having such functionality/features. Thus, other embodiments of one or more of the invention(s) need not include the device itself.

Techniques and mechanisms described or reference herein will sometimes be described in singular form for clarity. However, it should be noted that particular embodiments include multiple iterations of a technique or multiple instantiations of a mechanism unless noted otherwise.

Although described within the context of technology for implementing an intelligent automated assistant, also known as a virtual assistant, it may be understood that the various aspects and techniques described herein may also be deployed and/or applied in other fields of technology involving human and/or computerized interaction with software.

Hardware Architecture

Generally, the virtual assistant techniques disclosed herein may be implemented on hardware or a combination of software and hardware. For example, they may be implemented in an operating system kernel, in a separate user process, in a library package bound into network applications, on a specially constructed machine, and/or on a network interface card. In a specific embodiment, the techniques disclosed herein may be implemented in software such as an operating system or in an application running on an operating system.

Software/hardware hybrid implementation(s) of at least some of the virtual assistant embodiment(s) disclosed herein may be implemented on a programmable machine selectively activated or reconfigured by a computer program stored in memory. Such network devices may have multiple network interfaces which may be configured or designed to utilize different types of network communication protocols. A general architecture for some of these machines may appear from the descriptions disclosed herein. According to specific embodiments, at least some of the features and/or functionalities of the various virtual assistant embodiments disclosed herein may be implemented on one or more general-purpose network host machines such as an end-user computer system, computer, network server or server system, mobile computing device (e.g., personal digital assistant, mobile phone, smartphone, laptop, tablet computer, or the like), consumer electronic device, music player, or any other suitable electronic device, router, switch, or the like, or any combination thereof. In at least some embodiments, at least some of the features and/or functionalities of the various virtual assistant embodiments disclosed herein may be implemented in one or more virtualized computing environments (e.g., network computing clouds, or the like).

Referring now to FIG. **9**, there is shown a block diagram depicting a computing device **60** suitable for implementing at least a portion of the virtual assistant features and/or functionalities disclosed herein. Computing device **60** may be, for example, an end-user computer system, network server or server system, mobile computing device (e.g.,

personal digital assistant, mobile phone, smartphone, laptop, tablet computer, or the like), consumer electronic device, music player, or any other suitable electronic device, or any combination or portion thereof. Computing device **60** may be adapted to communicate with other computing devices, such as clients and/or servers, over a communications network such as the Internet, using known protocols for such communication, whether wireless or wired.

In one embodiment, computing device **60** includes central processing unit (CPU) **62**, interfaces **68**, and a bus **67** (such as a peripheral component interconnect (PCT) bus). When acting under the control of appropriate software or firmware, CPU **62** may be responsible for implementing specific functions associated with the functions of a specifically configured computing device or machine. For example, in at least one embodiment, a user's personal digital assistant (PDA) or smartphone may be configured or designed to function as a virtual assistant system utilizing CPU **62**, memory **61**, **65**, and interface(s) **68**. In at least one embodiment, the CPU **62** may be caused to perform one or more of the different types of virtual assistant functions and/or operations under the control of software modules/components, which for example, may include an operating system and any appropriate applications software, drivers, and the like.

CPU **62** may include one or more processor(s) **63** such as, for example, a processor from the Motorola or Intel family of microprocessors or the MIPS family of microprocessors. In some embodiments, processor(s) **63** may include specially designed hardware (e.g., application-specific integrated circuits (ASICs), electrically erasable programmable read-only memories (EEPROMs), field-programmable gate arrays (FPGAs), and the like) for controlling the operations of computing device **60**. In a specific embodiment, a memory **61** (such as non-volatile random access memory (RAM) and/or read-only memory (ROM)) also forms part of CPU **62**. However, there are many different ways in which memory may be coupled to the system. Memory block **61** may be used for a variety of purposes such as, for example, caching and/or storing data, programming instructions, and the like.

As used herein, the term "processor" is not limited merely to those integrated circuits referred to in the art as a processor, but broadly refers to a microcontroller, a microcomputer, a programmable logic controller, an application-specific integrated circuit, and any other programmable circuit.

In one embodiment, interfaces **68** are provided as interface cards (sometimes referred to as "line cards"). Generally, they control the sending and receiving of data packets over a computing network and sometimes support other peripherals used with computing device **60**. Among the interfaces that may be provided are Ethernet interfaces, frame relay interfaces, cable interfaces, DSL interfaces, token ring interfaces, and the like. In addition, various types of interfaces may be provided such as, for example, universal serial bus (USB), Serial, Ethernet, Firewire, PCI, parallel, radio frequency (RF), Bluetooth™, near-field communications (e.g., using near-field magnetics), 802.11 (WiFi), frame relay, TCP/IP, ISDN, fast Ethernet interfaces, Gigabit Ethernet interfaces, asynchronous transfer mode (ATM) interfaces, high-speed serial interface (HSSI) interfaces, Point of Sale (POS) interfaces, fiber data distributed interfaces (FDDIs), and the like. Generally, such interfaces **68** may include ports appropriate for communication with the appropriate media. In some cases, they may also include an independent processor and, in some instances, volatile and/or non-volatile memory (e.g., RAM).

Although the system shown in FIG. **9** illustrates one specific architecture for a computing device **60** for implementing the techniques of the invention described herein, it is by no means the only device architecture on which at least a portion of the features and techniques described herein may be implemented. For example, architectures having one or any number of processors **63** can be used, and such processors **63** can be present in a single device or distributed among any number of devices. In one embodiment, a single processor **63** handles communications as well as routing computations. In various embodiments, different types of virtual assistant features and/or functionalities may be implemented in a virtual assistant system which includes a client device (such as a personal digital assistant or smartphone running client software) and server system(s) (such as a server system described in more detail below).

Regardless of network device configuration, the system of the present invention may employ one or more memories or memory modules (such as, for example, memory block **65**) configured to store data, program instructions for the general-purpose network operations and/or other information relating to the functionality of the virtual assistant techniques described herein. The program instructions may control the operation of an operating system and/or one or more applications, for example. The memory or memories may also be configured to store data structures, keyword taxonomy information, advertisement information, user click and impression information, and/or other specific non-program information described herein.

Because such information and program instructions may be employed to implement the systems/methods described herein, at least some network device embodiments may include nontransitory machine-readable storage media, which, for example, may be configured or designed to store program instructions, state information, and the like for performing various operations described herein. Examples of such nontransitory machine-readable storage media include, but are not limited to, magnetic media such as hard disks, floppy disks, and magnetic tape; optical media such as CD-ROM disks; magneto-optical media such as floptical disks, and hardware devices that are specially configured to store and perform program instructions, such as read-only memory devices (ROM), flash memory, memristor memory, random access memory (RAM), and the like. Examples of program instructions include both machine code, such as produced by a compiler, and files containing higher level code that may be executed by the computer using an interpreter.

In one embodiment, the system of the present invention is implemented on a standalone computing system. Referring now to FIG. **10**, there is shown a block diagram depicting an architecture for implementing at least a portion of a virtual assistant on a standalone computing system, according to at least one embodiment. Computing device **60** includes processor(s) **63** which run software for implementing multimodal virtual assistant **1002**. Input device **1206** can be of any type suitable for receiving user input, including for example a keyboard, touchscreen, mouse, touchpad, trackball, five-way switch, joystick, and/or any combination thereof. Device **60** can also include speech input device **1211**, such as for example a microphone. Output device **1207** can be a screen, speaker, printer, and/or any combination thereof. Memory **1210** can be random-access memory having a structure and architecture as are known in

the art, for use by processor(s) **63** in the course of running software. Storage device **1208** can be any magnetic, optical, and/or electrical storage device for storage of data in digital form; examples include flash memory, magnetic hard drive, CD-ROM, and/or the like.

In another embodiment, the system of the present invention is implemented on a distributed computing network, such as one having any number of clients and/or servers. Referring now to FIG. **11**, there is shown a block diagram depicting an architecture for implementing at least a portion of a virtual assistant on a distributed computing network, according to at least one embodiment.

In the arrangement shown in FIG. **11**, any number of clients **1304** are provided; each client **1304** may run software for implementing client-side portions of the present invention. In addition, any number of servers **1340** can be provided for handling requests received from clients **1304**. Clients **1304** and servers **1340** can communicate with one another via electronic network **1361**, such as the Internet. Network **1361** may be implemented using any known network protocols, including for example wired and/or wireless protocols.

In addition, in one embodiment, servers **1340** can call external services **1360** when needed to obtain additional information or refer to store data concerning previous interactions with particular users. Communications with external services **1360** can take place, for example, via network **1361**. In various embodiments, external services **1360** include web-enabled services and/or functionality related to or installed on the hardware device itself. For example, in an embodiment where assistant **1002** is implemented on a smartphone or other electronic device, assistant **1002** can obtain information stored in a calendar application ("app"), contacts, and/or other sources.

In various embodiments, assistant **1002** can control many features and operations of an electronic device on which it is installed. For example, assistant **1002** can call external services **1360** that interface with functionality and applications on a device via APIs or by other means, to perform functions and operations that might otherwise be initiated using a conventional user interface on the device. Such functions and operations may include, for example, setting an alarm, making a telephone call, sending a text message or email message, adding a calendar event, and the like. Such functions and operations may be performed as add-on functions in the context of a conversational dialog between a user and assistant **1002**. Such functions and operations can be specified by the user in the context of such a dialog, or they may be automatically performed based on the context of the dialog. One skilled in the art will recognize that assistant **1002** can thereby be used as a control mechanism for initiating and controlling various operations on the electronic device, which may be used as an alternative to conventional mechanisms such as buttons or graphical user interfaces.

For example, the user may provide input to assistant **1002** such as "I need to wake tomorrow at 8 am". Once assistant **1002** has determined the user's intent, using the techniques described herein, assistant **1002** can call external services **1340** to interface with an alarm clock function or application on the device. Assistant **1002** sets the alarm on behalf of the user. In this manner, the user can use assistant **1002** as a replacement for conventional mechanisms for setting the alarm or performing other functions on the device. If the user's requests are ambiguous or need further clarification, assistant **1002** can use the various techniques described herein, including active elicitation, paraphrasing, suggestions, and the like, and which may be adapted to a hands-free context, so that the correct services **1340** are called and the intended action taken. In one embodiment, assistant **1002** may prompt the user for confirmation and/or request additional context information from any suitable source before calling a service **1340** to perform a function. In one embodiment, a user can selectively disable assistant's **1002** ability to call particular services **1340**, or can disable all such service-calling if desired.

The system of the present invention can be implemented with any of a number of different types of clients **1304** and modes of operation. Referring now to FIG. **12**, there is shown a block diagram depicting a system architecture illustrating several different types of clients **1304** and modes of operation. One skilled in the art will recognize that the various types of clients **1304** and modes of operation shown in FIG. **12** are merely exemplary, and that the system of the present invention can be implemented using clients **1304** and/or modes of operation other than those depicted. Additionally, the system can include any or all of such clients **1304** and/or modes of operation, alone or in any combination. Depicted examples include:

Computer devices with input/output devices and/or sensors **1402**. A client component may be deployed on any such computer device **1402**. At least one embodiment may be implemented using a web browser **1304**A or other software application for enabling communication with servers **1340** via network **1361**. Input and output channels may of any type, including for example visual and/or auditory channels. For example, in one embodiment, the system of the invention can be implemented using voice-based communication methods, allowing for an embodiment of the assistant for the blind whose equivalent of a web browser is driven by speech and uses speech for output.

Mobile Devices with I/O and sensors **1406**, for which the client may be implemented as an application on the mobile device **1304**B. This includes, but is not limited to, mobile phones, smartphones, personal digital assistants, tablet devices, networked game consoles, and the like.

Consumer Appliances with I/O and sensors **1410**, for which the client may be implemented as an embedded application on the appliance **1304**C.

Automobiles and other vehicles with dashboard interfaces and sensors **1414**, for which the client may be implemented as an embedded system application **1304**D. This includes, but is not limited to, car navigation systems, voice control systems, in-car entertainment systems, and the like.

Networked computing devices such as routers **1418** or any other device that resides on or interfaces with a network, for which the client may be implemented as a device-resident application **1304**E.

Email clients **1424**, for which an embodiment of the assistant is connected via an Email Modality Server **1426**. Email Modality server **1426** acts as a communication bridge, for example taking input from the user as email messages sent to the assistant and sending output from the assistant to the user as replies.

Instant messaging clients **1428**, for which an embodiment of the assistant is connected via a Messaging Modality Server **1430**. Messaging Modality server **1430** acts as a communication bridge, taking input from the user as messages sent to the assistant and sending output from the assistant to the user as messages in reply.

Voice telephones **1432**, for which an embodiment of the assistant is connected via a Voice over Internet Protocol (VoIP) Modality Server **1430**. VoIP Modality server **1430** acts as a communication bridge, taking input from the user

as voice spoken to the assistant and sending output from the assistant to the user, for example as synthesized speech, in reply.

For messaging platforms including but not limited to email, instant messaging, discussion forums, group chat sessions, live help or customer support sessions and the like, assistant **1002** may act as a participant in the conversations. Assistant **1002** may monitor the conversation and reply to individuals or the group using one or more the techniques and methods described herein for one-to-one interactions.

In various embodiments, functionality for implementing the techniques of the present invention can be distributed among any number of client and/or server components. For example, various software modules can be implemented for performing various functions in connection with the present invention, and such modules can be variously implemented to run on server and/or client components.

In the example of FIG. **13**, input elicitation functionality and output processing functionality are distributed among client **1304** and server **1340**, with client part of input elicitation **2794***a* and client part of output processing **2792***a* located at client **1304**, and server part of input elicitation **2794***b* and server part of output processing **2792***b* located at server **1340**. The following components are located at server **1340**:

complete vocabulary **2758***b;*
complete library of language pattern recognizers **2760***b;*
master version of short term personal memory **2752***b;*
master version of long term personal memory **2754***b.*

In one embodiment, client **1304** maintains subsets and/or portions of these components locally, to improve responsiveness and reduce dependence on network communications. Such subsets and/or portions can be maintained and updated according to well-known cache management techniques. Such subsets and/or portions include, for example:

subset of vocabulary **2758***a;*
subset of library of language pattern recognizers **2760***a;*
cache of short term personal memory **2752***a;*
cache of long term personal memory **2754***a.*

Additional components may be implemented as part of server **1340**, including for example:

language interpreter **2770**;
dialog flow processor **2780**;
output processor **2790**;
domain entity databases **2772**;
task flow models **2786**;
services orchestration **2782**;
service capability models **2788**.

Server **1340** obtains additional information by interfacing with external services **1360** when needed.

Conceptual Architecture

Referring now to FIG. **8**, there is shown a simplified block diagram of a specific example embodiment of multimodal virtual assistant **1002**. As described in greater detail in related U.S. utility applications referenced above, different embodiments of multimodal virtual assistant **1002** may be configured, designed, and/or operable to provide various different types of operations, functionalities, and/or features generally relating to virtual assistant technology. Further, as described in greater detail herein, many of the various operations, functionalities, and/or features of multimodal virtual assistant **1002** disclosed herein may enable or provide different types of advantages and/or benefits to different entities interacting with multimodal virtual assistant **1002**. The embodiment shown in FIG. **8** may be implemented using any of the hardware architectures described above, or using a different type of hardware architecture.

For example, according to different embodiments, multimodal virtual assistant **1002** may be configured, designed, and/or operable to provide various different types of operations, functionalities, and/or features, such as, for example, one or more of the following (or combinations thereof):

- automate the application of data and services available over the Internet to discover, find, choose among, purchase, reserve, or order products and services. In addition to automating the process of using these data and services, multimodal virtual assistant **1002** may also enable the combined use of several sources of data and services at once. For example, it may combine information about products from several review sites, check prices and availability from multiple distributors, and check their locations and time constraints, and help a user find a personalized solution to their problem.
- automate the use of data and services available over the Internet to discover, investigate, select among, reserve, and otherwise learn about things to do (including but not limited to movies, events, performances, exhibits, shows and attractions); places to go (including but not limited to travel destinations, hotels and other places to stay, landmarks and other sites of interest, and the like); places to eat or drink (such as restaurants and bars), times and places to meet others, and any other source of entertainment or social interaction that may be found on the Internet.
- enable the operation of applications and services via natural language dialog that are otherwise provided by dedicated applications with graphical user interfaces including search (including location-based search); navigation (maps and directions); database lookup (such as finding businesses or people by name or other properties); getting weather conditions and forecasts, checking the price of market items or status of financial transactions; monitoring traffic or the status of flights; accessing and updating calendars and schedules; managing reminders, alerts, tasks and projects; communicating over email or other messaging platforms; and operating devices locally or remotely (e.g., dialing telephones, controlling light and temperature, controlling home security devices, playing music or video, and the like). In one embodiment, multimodal virtual assistant **1002** can be used to initiate, operate, and control many functions and apps available on the device.
- offer personal recommendations for activities, products, services, source of entertainment, time management, or any other kind of recommendation service that benefits from an interactive dialog in natural language and automated access to data and services.

According to different embodiments, at least a portion of the various types of functions, operations, actions, and/or other features provided by multimodal virtual assistant **1002** may be implemented at one or more client systems(s), at one or more server system(s), and/or combinations thereof.

According to different embodiments, at least a portion of the various types of functions, operations, actions, and/or other features provided by multimodal virtual assistant **1002** may use contextual information in interpreting and operationalizing user input, as described in more detail herein.

For example, in at least one embodiment, multimodal virtual assistant **1002** may be operable to utilize and/or generate various different types of data and/or other types of information when performing specific tasks and/or operations. This may include, for example, input data/information and/or output data/information. For example, in at least one embodiment, multimodal virtual assistant **1002** may be

operable to access, process, and/or otherwise utilize information from one or more different types of sources, such as, for example, one or more local and/or remote memories, devices and/or systems. Additionally, in at least one embodiment, multimodal virtual assistant **1002** may be operable to generate one or more different types of output data/information, which, for example, may be stored in memory of one or more local and/or remote devices and/or systems.

Examples of different types of input data/information which may be accessed and/or utilized by multimodal virtual assistant **1002** may include, but are not limited to, one or more of the following (or combinations thereof):

- Voice input: from mobile devices such as mobile telephones and tablets, computers with microphones, Bluetooth headsets, automobile voice control systems, over the telephone system, recordings on answering services, audio voicemail on integrated messaging services, consumer applications with voice input such as clock radios, telephone station, home entertainment control systems, and game consoles.
- Text input from keyboards on computers or mobile devices, keypads on remote controls or other consumer electronics devices, email messages sent to the assistant, instant messages or similar short messages sent to the assistant, text received from players in multiuser game environments, and text streamed in message feeds.
- Location information coming from sensors or location-based systems. Examples include Global Positioning System (GPS) and Assisted GPS (A-GPS) on mobile phones. In one embodiment, location information is combined with explicit user input. In one embodiment, the system of the present invention is able to detect when a user is at home, based on known address information and current location determination. In this manner, certain inferences may be made about the type of information the user might be interested in when at home as opposed to outside the home, as well as the type of services and actions that should be invoked on behalf of the user depending on whether or not he or she is at home.
- Time information from clocks on client devices. This may include, for example, time from telephones or other client devices indicating the local time and time zone. In addition, time may be used in the context of user requests, such as for instance, to interpret phrases such as "in an hour" and "tonight".
- Compass, accelerometer, gyroscope, and/or travel velocity data, as well as other sensor data from mobile or handheld devices or embedded systems such as automobile control systems. This may also include device positioning data from remote controls to appliances and game consoles.
- Clicking and menu selection and other events from a graphical user interface (GUI) on any device having a GUI. Further examples include touches to a touch screen.
- Events from sensors and other data-driven triggers, such as alarm clocks, calendar alerts, price change triggers, location triggers, push notification onto a device from servers, and the like.

The input to the embodiments described herein also includes the context of the user interaction history, including dialog and request history.

As described in the related U.S. utility applications referenced above, many different types of output data/information may be generated by multimodal virtual assistant **1002**. These may include, but are not limited to, one or more of the following (or combinations thereof):

- Text output sent directly to an output device and/or to the user interface of a device;
- Text and graphics sent to a user over email;
- Text and graphics send to a user over a messaging service;
- Speech output, which may include one or more of the following (or combinations thereof):
  - Synthesized speech;
  - Sampled speech;
  - Recorded messages;
  - Graphical layout of information with photos, rich text, videos, sounds, and hyperlinks (for instance, the content rendered in a web browser);
  - Actuator output to control physical actions on a device, such as causing it to turn on or off, make a sound, change color, vibrate, control a light, or the like;
  - Invoking other applications on a device, such as calling a mapping application, voice dialing a telephone, sending an email or instant message, playing media, making entries in calendars, task managers, and note applications, and other applications;
  - Actuator output to control physical actions to devices attached or controlled by a device, such as operating a remote camera, controlling a wheelchair, playing music on remote speakers, playing videos on remote displays, and the like.

It may be appreciated that the multimodal virtual assistant **1002** of FIG. **8** is but one example from a wide range of virtual assistant system embodiments which may be implemented. Other embodiments of the virtual assistant system (not shown) may include additional, fewer and/or different components/features than those illustrated, for example, in the example virtual assistant system embodiment of FIG. **8**.

Multimodal virtual assistant **1002** may include a plurality of different types of components, devices, modules, processes, systems, and the like, which, for example, may be implemented and/or instantiated via the use of hardware and/or combinations of hardware and software. For example, as illustrated in the example embodiment of FIG. **8**, assistant **1002** may include one or more of the following types of systems, components, devices, processes, and the like (or combinations thereof):

- One or more active ontologies **1050**;
- Active input elicitation component(s) **2794** (may include client part **2794***a* and server part **2794***b*);
- Short term personal memory component(s) **2752** (may include master version **2752***b* and cache **2752***a*);
- Long-term personal memory component(s) **2754** (may include master version **2754***b* and cache **2754***a*);
- Domain models component(s) **2756**;
- Vocabulary component(s) **2758** (may include complete vocabulary **2758***b* and subset **2758***a*);
- Language pattern recognizer(s) component(s) **2760** (may include full library **2760***b* and subset **2760***a*);
- Language interpreter component(s) **2770**;
- Domain entity database(s) **2772**;
- Dialog flow processor component(s) **2780**;
- Services orchestration component(s) **2782**;
- Services component(s) **2784**;
- Task flow models component(s) **2786**;
- Dialog flow models component(s) **2787**;
- Service models component(s) **2788**;
- Output processor component(s) **2790**.

In certain client/server-based embodiments, some or all of these components may be distributed between client **1304**

and server **1340**. Such components are further described in the related U.S. utility applications referenced above.

In one embodiment, virtual assistant **1002** receives user input **2704** via any suitable input modality, including for example touchscreen input, keyboard input, spoken input, and/or any combination thereof. In one embodiment, assistant **1002** also receives context information **1000**, which may include event context, application context, personal acoustic context, and/or other forms of context, as described in related U.S. Utility application Ser. No. 13/250,854, entitled "Using Context Information to Facilitate Processing of Commands in a Virtual Assistant," the entire disclosure of which is incorporated herein by reference. Context information **1000** also includes a hands-free context, if applicable, which can be used to adapt the user interface according to techniques described herein.

Upon processing user input **2704** and context information **1000** according to the techniques described herein, virtual assistant **1002** generates output **2708** for presentation to the user. Output **2708** can be generated according to any suitable output modality, which may be informed by the hands-free context as well as other factors, if appropriate. Examples of output modalities include visual output as presented on a screen, auditory output (which may include spoken output and/or beeps and other sounds), haptic output (such as vibration), and/or any combination thereof.

Additional details concerning the operation of the various components depicted in FIG. **8** are provided in related U.S. Utility application Ser. No. 12/987,982 (which has been incorporated by reference, above).

Adapting User Interfaces to a Hands-Free Context

For illustrative purposes, the invention is described herein by way of example. However, one skilled in the art will recognize that the particular input and output mechanisms depicted in the examples are merely intended to illustrate one possible interaction between the user and assistant **1002**, and are not intended to limit the scope of the invention as claimed. Furthermore, in alternative embodiments, the invention can be implemented in a device without necessarily involving a multimodal virtual assistant **1002**; rather, the functionality of the invention can be implemented directly in an operating system or application running on any suitable device, without departing from the essential characteristics of the invention as solely defined in the claims.

Referring now to FIG. **1**, there is shown a screen shot illustrating an example of a conventional hands-on interface **169** for reading a text message, according to the prior art. A graphical user interface (GUI) as shown in FIG. **1** generally requires the user to be able to read fine details, such as the message text shown in bubble **171**, and respond by typing in text field **172** and tapping send button **173**. In many devices, such actions require looking at and touching the screen, and are therefore impractical to perform in certain contexts, referred to herein as hands-free contexts.

Referring now to FIG. **2**, there is shown a screen shot illustrating an example of an interface **170** for responding to text message **171**. Virtual keyboard **270** is presented in response to the user tapping in text field **172**, permitting text to be entered in text field **172** by tapping on areas of the screen corresponding to keys. The user taps on send button **173** when the text message has been entered. If the user wishes to enter text by speaking, he or she taps on speech button **271**, which invokes a voice dictation interface for receiving spoken input and converting it into text. Thus, button **271** provides a mechanism by which the user can indicate that he or she is in a hands-free context.

Referring now to FIGS. **3**A and **3**B, there is shown a sequence of screen shots illustrating an example of an interface **175** wherein a voice dictation interface is used to reply to text message **171**. Screen **370** is presented, for example, after user taps on speech button **271**. Microphone icon **372** indicates that the device is ready to accept spoken input. The user inputs speech, which is received via speech input device **1211**, which may be a microphone or similar device. The user taps on Done button **371** to indicate that he or she has finished entering spoken input.

The spoken input is converted to text, using any well known speech-to-text algorithm or system. Speech-to-text functionality can reside on device **60** or on a server. In one embodiment, speech-to-text functionality is implemented using, for example, Nuance Recognizer, available from Nuance Communications, Inc. of Burlington, Mass.

As shown in FIG. **3**B, the results of the conversion can be shown in field **172**. Keyboard **270** can be presented, to allow the user to edit the generated text in field **172**. When the user is satisfied with the entered text, he or she taps on Send button **173** to cause the text message to be sent.

In the example described in connection with FIGS. **2**, **3**A, and **3**B, several operations require the user to look at the display screen and/or provide touch input. Such operations include:

- reading text message **171** on the display screen;
- touching button **271** to enter speech input mode;
- touching Done button **371** to indicate that speech input is finished;
- viewing the converted text generated from the user's spoken input;
- touching Send button **173** to send the message.

In one embodiment of the present invention, mechanisms for accepting and processing speech input are integrated into device **60** in a manner that reduces the need for a user to interact with a display screen and/or to use a touch interface when in a hands-free context. Accordingly, the system of the present invention is thus able to provide an improved user interface for interaction in a hands-free context.

Referring now to FIGS. **4** and **5**A through **5**D, there is shown a series of screen shots illustrating an example of an interface for receiving and replying to a text message, according to one embodiment wherein a hands-free context is recognized; thus, in this example, the need for the user to interact with the screen is reduced, in accordance with the techniques of the present invention.

In FIG. **4**, screen **470** depicts text message **471** which is received while device **60** is in a locked mode. The user can activate slider **472** to reply to or otherwise interact with message **471** according to known techniques. However, in this example, device **60** may be out of sight and/or out of reach, or the user may be unable to interact with device **60**, for example, if he or she is driving or engaged in some other activity. As described herein, multimodal virtual assistant **1002** provides functionality for receiving and replying to text message **471** in such a hands-free context.

In one embodiment, virtual assistant **1002** installed on device **60** automatically detects the hands-free context. Such detection may take place by any means of determining a scenario or situation where it may be difficult or impossible for the user to interact with the screen of device **60** or to properly operate the GUI.

For example and without limitation, determination of hands-free context can be made based on any of the following, singly or in any combination:

- data from sensors (including, for example, compass, accelerometer, gyroscope, speedometer, ambient light

sensor, BlueTooth connection detector, clock, WiFi signal detector, microphone, and the like);

determining that device **60** is in a certain geographic location, for example via GPS;

data from a clock (for example, hands-free context can be specified as being active at certain times of day and/or certain days of the week);

predefined parameters (for example, the user or an administrator can specify that hands-free context is active when any condition or combination of conditions is detected);

connection of Bluetooth or other wireless I/O devices (for example, if a connection with a BlueTooth-enabled interface of a moving vehicle is detected);

any other information that may indicate that the user is in a moving vehicle or driving a car;

presence or absence of attached peripherals, including headphones, headsets, things connected by adapter cables, and the like;

determining that the user is not in contact with or in close proximity to device **60**;

the particular signal used to trigger interaction with assistant **1002** (for example, a motion gesture in which the user holds the device to the ear, or the pressing of a button on a Bluetooth device, or pressing of a button on an attached audio device);

detection of specific words in a continuous stream of words (for example, assistant **1002** can be configured to be listening for commands, and to be invoked when the user calls its name or says some command such as "Computer!"; the particular command can indicate whether or not hands-free context is active.

In other embodiments, the user can manually indicate that hands-free context is active or inactive, and/or can schedule hands-free context to activate and/or deactivate at certain times of day and/or certain days of the week.

In one embodiment, upon receiving text message **470** while in hands-free context, multimodal virtual assistant **1002** causes device **60** to output an audio indication, such as a beep or tone, indicating receipt of a text message. As described above, the user can activate slider **472** to reply to or otherwise interact with message **471** according to known techniques (for example if hands-free mode was incorrectly detected, or if the user elects to stop driving or otherwise make him or herself available for hands-on interaction with device **60**). Alternatively, the user can engage in a spoken dialog with assistant **1002** to enable interaction with assistant **1002** in a hands-free manner.

In one embodiment, the user initiates the spoken dialog by any suitable mechanism appropriate to a hands-free context. For example, in an environment where the user is driving a BlueTooth-equipped vehicle, and device **60** is in communication with the vehicle, an easily-accessed button (for example, one mounted on the steering wheel of a car) may be available. Pressing the button initiates a spoken dialog with assistant **1002**, and allows the user to communicate with assistant **1002** via the BlueTooth connection and through a microphone and/or speaker installed in the vehicle. Alternatively, the user can initiate the spoken dialog by pressing a button on device **60** itself, or on a headset, or on any other peripheral device, or by performing some other distinctive action that signals to assistant **1002** that the user wishes to initiate a spoken dialog. As another example, the user can speak a command that is understood by assistant **1002** and that initiates the spoken dialog. One skilled in the art will recognize that many other techniques can be provided for allowing a user to easily initiate a spoken dialog with assistant **1002**. Preferably, the mechanism that is used for initiating the spoken dialog does not require hand-eye coordination on the part of the user, thus allowing the user to focus on a primary task, such as driving, and/or can be performed by an individual having a disability that prevents, hinders, restricts, or limits his or her ability to interact with a GUI such as depicted in FIGS. **2**, **3**A, and **3**B.

Once the spoken dialog has been initiated, assistant **1002** listens for spoken input. In one embodiment, assistant **1002** acknowledges the spoken input by some output mechanism that is easily detected by the user while in the hands-free context. An example is an audio beep or tone, and/or visual output on a vehicle dashboard that is easily seen by the user even while driving, and/or by some other mechanism. Spoken input is processed using known speech recognition techniques. Assistant **1002** then performs action(s) indicated by the spoken input. In one embodiment, assistant **1002** provides spoken output, which may be output via speakers (in device **60** or installed in the vehicle), headphones or the like, so as to continue the audio dialog with the user. For example, assistant **1002** can read content of text messages, email messages, and the like, and can provide options to the user in spoken form.

For example, if the user says "Read my new message", assistant **1002** may cause device **60** to emit an acknowledgement tone. Assistant may then **1002** emit spoken output such as "You have a new message from Tom Devon. It says: 'Hey, are you going to the game?'". Spoken output may be generated by assistant **1002** using any known technique for converting text to speech. In one embodiment, text-to-speech functionality is implemented using, for example, Nuance Vocalizer, available from Nuance Communications, Inc. of Burlington, Mass.

Referring now to FIG. **5**A, there is shown an example of a screen shot **570** showing output that may be presented on the screen of device **60** while the verbal interchange between the user and assistant **1002** is taking placing. In some hands-free situations, the user can see the screen but cannot easily touch it, for example if the output on the screen of device **60** is being replicated on a display screen of a vehicle's navigation system. Visual echoing of the spoken conversation, as depicted in FIGS. **5**A through **5**D, can help the user to verify that his or her spoken input has been properly and accurately understood by assistant **1002**, and can further help the user understand assistant's **1002** spoken replies. However, such visual echoing is optional, and the present invention can be implemented without any visual display on the screen of device **60** or elsewhere. Thus, the user can interact with assistant **1002** purely by spoken input and output, or by a combination of visual and spoken inputs and/or outputs.

In the example, assistant **1002** displays and speaks a prompt **571**. In response to user input, assistant **1002** repeats the user input **572**, on the display and/or in spoken form. Assistant then introduces **573** the incoming text message and reads it. In one embodiment, the text message may also be displayed on the screen.

As shown in FIG. **5**B, after reading the incoming message to the user, assistant **1002** then tells the user that the user can "reply or read it again" **574**. Again, such output is provided, in one embodiment, in spoken form (i.e., verbally). In this manner, the system of the present invention informs the user of available actions in a manner that is well-suited to the hands-free context, in that it does not require the user to look at text fields, buttons, and/or links, and does not require direct manipulation by touch or interaction with on-screen objects. As depicted in FIG. **5**B, in one embodiment the

spoken output is echoed **574** on-screen; however, such display of the spoken output is not required. In one embodiment, echo messages displayed on the screen scroll upwards automatically according to well-known mechanisms.

In the example, the user says "Reply yes I'll be there at six". As depicted in FIG. **5**B, in one embodiment the user's spoken input is echoed **575** so that the user can check that it has been properly understood. In addition, in one embodiment, assistant **1002** repeats the user's spoken input in auditory form, so that the user can verify understanding of his or her command even if he or she cannot see the screen. Thus, the system of the present invention provides a mechanism by which the user can initiate a reply command, compose a response, and verify that the command and the composed response were properly understood, all in a hands-free context and without requiring the user to view a screen or interact with device **60** in a manner that is not feasible or well-suited to the current operating environment.

In one embodiment, assistant **1002** provides further verification of the user's composed text message by reading back the message. In this example, assistant **1002** says, verbally, "Here's your reply to Tom Devon: 'Yes I'll be there at six.'". In one embodiment, the meaning of the quotation marks is conveyed with changes in voice and/or prosody. For example, the string "Here's your reply to Tom Devon" can be spoken in one voice, such as a male voice, while the string "Yes I'll be there at six" can be spoken in another voice, such as a female voice. Alternatively, the same voice can be used, but with different prosody to convey the quotation marks.

In one embodiment, assistant **1002** provides visual echoing of the spoken interchange, as depicted in FIGS. **5**B and **5**C. FIGS. **5**B and **5**C show message **576** echoing assistant's **1002** spoken output of "Here's your reply to Tom Devon". FIG. **5**C shows a summary **577** of the text message being composed, including recipient and content of the message. In FIG. **5**C, previous messages have scrolled upward off the screen, but can be viewed by scrolling downwards according to known mechanisms. Send button **578** sends the message; cancel button **579** cancels it. In one embodiment, the user can also send or cancel the message by speaking a keyword, such as "send" or "cancel". Alternatively, assistant **1002** can generate a spoken prompt, such as "Ready to send it?"; again, a display **570** with buttons **578**, **579** can be shown while the spoken prompt is output. The user can then indicate what he or she wishes to do by touching buttons **578**, **579** or by answering the spoken prompt. The prompt can be issued in a format that permits a "yes" or "no" response, so that the user does not need to use any special vocabulary to make his or her intention known.

In one embodiment, assistant **1002** can confirm the user's spoken command to send the message, for example by generating spoken output such as "OK, I'll send your message." As shown in FIG. **5**D, this spoken output can be echoed **580** on screen **570**, along with summary **581** of the text message being sent.

The spoken exchange described above, combined with optional visual echoing, illustrates an example by which assistant **1002** provides redundant outputs in a multimodal interface. In this manner, assistant **1002** is able to support a range of contexts including eyes-free, hands-free, and fully hands-on.

The example also illustrates mechanisms by which the displayed and spoken output can differ from one another to reflect their different contexts. The example also illustrates ways in which alternative mechanisms for responding are made available. For example, after assistant says "Ready to send it?" and displays screen **570** shown in FIG. **5**C, the user can say the word "send", or "yes", or tap on Send button **578** on the screen. Any of these actions would be interpreted the same way by assistant **1002**, and would cause the text message to be sent. Thus, the system of the present invention provides a high degree of flexibility with respect to the user's interaction with assistant **1002**.

Referring now to FIGS. **6**A through **6**C, there is shown a series of screen shots illustrating an example of operation of multimodal virtual assistant **1002** according to an embodiment of the present invention, wherein the user revises text message **577** in a hands-free context, for example to correct mistakes or add more content. In a visual interface involving direct manipulation, such as described above in connection with FIGS. **3**A and **3**B, the user might type on virtual keyboard **270** to edit the contents of text field **172** and thereby revise text message **577**. Since such operations may not be feasible in a hands-free context, multimodal virtual assistant **1002** provides a mechanism by which such editing of text message **577** can take place via spoken input and output in a conversational interface.

In one embodiment, once text message **577** has been composed (based, for example, on the user's spoken input), multimodal virtual assistant **1002** generates verbal output informing the user that the message is ready to be sent, and asking the user whether the message should be sent. If the user indicates, via verbal or direct manipulation input, that he or she is not ready to send the message, then multimodal virtual assistant **1002** generates spoken output to inform the user of available options, such as sending, canceling, reviewing, or changing the message. For example, assistant **1002** may say with "OK, I won't send it yet. To continue, you can Send, Cancel, Review, or Change it."

As shown in FIG. **6**A, in one embodiment multimodal virtual assistant **1002** echoes the spoken output by displaying message **770**, visually informing the user of the options available with respect to text message **577**. In one embodiment, text message **577** is displayed in editable field **773**, to indicate that the user can edit message **577** by tapping within field **773**, along with buttons **578**, **579** for sending or canceling text message **577**, respectively. In one embodiment, tapping within editable field **773** invokes a virtual keyboard (similar to that depicted in FIG. **3**B), to allow editing by direct manipulation.

The user can also interact with assistant **1002** by providing spoken input. Thus, in response to assistant's **1002** spoken message providing options for interacting with text message **577**, the user may say "Change it". Assistant **1002** recognizes the spoken text and responds with a verbal message prompting the user to speak the revised message. For example, assistant **1002** may say, "OK . . . What would you like the message to say?" and then starts listening for the user's response. FIG. **6**B depicts an example of a screen **570** that might be shown in connection with such a spoken prompt. Again, the user's spoken text is visually echoed **771**, along with assistant's **1002** prompt **772**.

In one embodiment, once the user has been prompted in this manner, the exact contents of the user's subsequent spoken input is interpreted as content for the text message, bypassing the normal natural language interpretation of user commands. User's spoken input is assumed to be complete either when a pause of sufficient length in the input is detected, or upon detection of a specific word indicating the input is complete, or upon detection that the user has pressed a button or activated some other command to indicate that he or she has finished speaking the text message. In one embodiment, assistant **1002** then repeats back the input text

message in spoken form, and may optionally echo it as shown in FIG. **6**C. Assistant **1002** offers a spoken prompt, such as "Are you ready to send it?", which may also be echoed **770** on the screen as shown in FIG. **6**C. The user can then reply by saying "cancel", "send", "yes", or "no", any of which are correctly interpreted by assistant **1002**. Alternatively, the user can press a button **578** or **579** on the screen to invoke the desired operation.

By providing a mechanism for modifying text message **577** in this manner, the system of the present invention, in one embodiment, provides a flow path appropriate to a hands-free context, which is integrated with a hands-on approach so that the user can freely choose the mode of interaction at each stage. Furthermore, in one embodiment assistant **1002** adapts its natural language processing mechanism to particular steps in the overall flow; for example, as described above, in some situations assistant **1002** may enter a mode where it bypasses normal natural language interpretation of user commands when the user has been prompted to speak a text message.

Even when a specific hands-free context is not detected there are circumstances in which it is beneficial to allow a user to interact with an electronic device without having to manually manipulate the device. For example, because mobile devices (on which virtual assistants may be provided) are capable of accessing information and receiving communications from so many sources, they frequently provide alerts to a user to indicate that some new information is available. Traditional examples include alerts (e.g., beeps, tones, vibrations, etc.) indicating to the user that an email, text message, or voice mail has been received. However, alerts may also be provided for alarms, calendar events, reminders, social networking services, installed applications, and the like. Because so many information sources can trigger an electronic device to issue an alert, it is difficult for a user to know what the alert might be signaling without turning on or looking at a screen and reading the information associated with the alert. This is especially true when multiple different types or sources of alerts use the same sound or tone. For example, if user's mobile phone outputs a certain beep, the user may not know whether the beep indicates a new text message, a new email, a reminder to pick up milk, or a notification that someone just "liked" one of the user's recent social networking posts. Thus, in certain eyes-free situations, it is advantageous to provide a way for a user to simply ask the device for more information about a recent alert, and have the device respond with audible information about the alert.

Accordingly, in some implementations (as discussed below with reference to FIGS. **14**A and **14**B), the device automatically (i.e., without human intervention) listens for a speech input requesting additional information about an alert after the alert is outputted. In some implementations, the device listens for a predetermined amount of time, such as 3 seconds, and then ceases listening. Thus, the user does not need to manually interact with the device (e.g., by looking at a screen and/or pressing buttons or touchscreen interface objects) to initiate a listening mode or otherwise initiate a virtual assistant. If the device detects such a speech input at this time, it provides a speech output including some information about the alert. In some implementations, the information provided includes the type of notification or communication that triggered the alert (e.g., "that was a text message," or "that was a calendar reminder"), a summary and/or paraphrase of the alert (e.g., "that was a text message from Tom Devon about the game"), etc. In some implementations, the device listens for an additional speech input (e.g., for a predetermined amount of time, such as 3 seconds) after it provides the information about the alert. Thus, a user can ask a follow up question or issue an additional command, such as "who is it from," "read it," "reply," and the like. Specific methods for providing information about alerts are discussed below with reference to FIGS. **14**A and **14**B.

Method

In one embodiment, multimodal virtual assistant **1002** detects a hands-free context and adapts one or more stages of its operation to modify the user experience for hands-free operation. As described above, detection of the hands-free context can be applied in a variety of ways to affect the operation of multimodal virtual assistant **1002**. Referring now to FIG. **7**, there is shown a flow diagram depicting a method **10** of operation of virtual assistant **1002** that supports dynamic detection of and adaptation to a hands-free context, according to one embodiment. Method **10** may be implemented in connection with one or more embodiments of multimodal virtual assistant **1002**. As depicted in FIG. **7**, the hands-free context can be used at various stages of processing in multimodal virtual assistant **1002**, according to one embodiment.

In at least one embodiment, method **10** may be operable to perform and/or implement various types of functions, operations, actions, and/or other features such as, for example, one or more of the following (or combinations thereof):

- Execute an interface control flow loop of a conversational interface between the user and multimodal virtual assistant **1002**. At least one iteration of method **10** may serve as a ply in the conversation. A conversational interface is an interface in which the user and assistant **1002** communicate by making utterances back and forth in a conversational manner.
- Provide executive control flow for multimodal virtual assistant **1002**. That is, the procedure controls the gathering of input, processing of input, generation of output, and presentation of output to the user.
- Coordinate communications among components of multimodal virtual assistant **1002**. That is, it may direct where the output of one component feeds into another, and where the overall input from the environment and action on the environment may occur.

In at least some embodiments, portions of method **10** may also be implemented at other devices and/or systems of a computer network.

According to specific embodiments, multiple instances or threads of method **10** may be concurrently implemented and/or initiated via the use of one or more processors **63** and/or other combinations of hardware and/or hardware and software. In at least one embodiment, one or more or selected portions of method **10** may be implemented at one or more client(s) **1304**, at one or more server(s) **1340**, and/or combinations thereof.

For example, in at least some embodiments, various aspects, features, and/or functionalities of method **10** may be performed, implemented and/or initiated by software components, network services, databases, and/or the like, or any combination thereof.

According to different embodiments, one or more different threads or instances of method **10** may be initiated in response to detection of one or more conditions or events satisfying one or more different types of criteria (such as, for example, minimum threshold criteria) for triggering initiation of at least one instance of method **10**. Examples of various types of conditions or events which may trigger initiation and/or implementation of one or more different

threads or instances of the method may include, but are not limited to, one or more of the following (or combinations thereof):

- a user session with an instance of multimodal virtual assistant **1002**, such as, for example, but not limited to, one or more of:
- a mobile device application starting up, for instance, a mobile device application that is implementing an embodiment of multimodal virtual assistant **1002**;
- a computer application starting up, for instance, an application that is implementing an embodiment of multimodal virtual assistant **1002**;
- a dedicated button on a mobile device pressed, such as a "speech input button";
- a button on a peripheral device attached to a computer or mobile device, such as a headset, telephone handset or base station, a GPS navigation system, consumer appliance, remote control, or any other device with a button that might be associated with invoking assistance;
- a web session started from a web browser to a website implementing multimodal virtual assistant **1002**;
- an interaction started from within an existing web browser session to a website implementing multimodal virtual assistant **1002**, in which, for example, multimodal virtual assistant **1002** service is requested;
- an email message sent to a modality server **1426** that is mediating communication with an embodiment of multimodal virtual assistant **1002**;
- a text message is sent to a modality server **1426** that is mediating communication with an embodiment of multimodal virtual assistant **1002**;
- a phone call is made to a modality server **1434** that is mediating communication with an embodiment of multimodal virtual assistant **1002**;
- an event such as an alert or notification is sent to an application that is providing an embodiment of multimodal virtual assistant **1002**;
- when a device that provides multimodal virtual assistant **1002** is turned on and/or started.

According to different embodiments, one or more different threads or instances of method **10** may be initiated and/or implemented manually, automatically, statically, dynamically, concurrently, and/or combinations thereof. Additionally, different instances and/or embodiments of method **10** may be initiated at one or more different time intervals (e.g., during a specific time interval, at regular periodic intervals, at irregular periodic intervals, upon demand, and the like).

In at least one embodiment, a given instance of method **10** may utilize and/or generate various different types of data and/or other types of information when performing specific tasks and/or operations, including detection of a hands-free context as described herein. Data may also include any other type of input data/information and/or output data/information. For example, in at least one embodiment, at least one instance of method **10** may access, process, and/or otherwise utilize information from one or more different types of sources, such as, for example, one or more databases. In at least one embodiment, at least a portion of the database information may be accessed via communication with one or more local and/or remote memory devices. Additionally, at least one instance of method **10** may generate one or more different types of output data/information, which, for example, may be stored in local memory and/or remote memory devices.

In at least one embodiment, initial configuration of a given instance of method **10** may be performed using one or more different types of initialization parameters. In at least one embodiment, at least a portion of the initialization parameters may be accessed via communication with one or more local and/or remote memory devices. In at least one embodiment, at least a portion of the initialization parameters provided to an instance of method **10** may correspond to and/or may be derived from the input data/information.

In the particular example of FIG. **7**, it is assumed that a single user is accessing an instance of multimodal virtual assistant **1002** over a network from a client application with speech input capabilities. In one embodiment, assistant **1002** is installed on device **60** such as a mobile computing device, personal digital assistant, mobile phone, smartphone, laptop, tablet computer, consumer electronic device, music player, or the like. Assistant **1002** operates in connection with a user interface that allows users to interact with assistant **1002** via spoken input and output as well as direct manipulation and/or display of a graphical user interface (for example via a touchscreen).

Device **60** has a current state **11** that can be analyzed to detect **20** whether it is in a hands-free context. A hands-free context can be detected **20**, based on state **11**, using any applicable detection mechanism or combination of mechanisms, whether automatic or manual. Examples are set forth above.

When hands-free context is detected **20**, that information is added to other contextual information **1000** that may be used for informing various processes of the assistant, as described in related U.S. Utility application Ser. No. 13/250,854 (which has been incorporated by reference, above).

Speech input is elicited and interpreted **100**. Elicitation may include presenting prompts in any suitable mode. Thus, depending on whether or not hands-free context is detected, in various embodiments, assistant **1002** may offer one or more of several modes of input. These may include, for example:

- an interface for typed input, which may invoke an active typed-input elicitation procedure;
- an interface for speech input, which may invoke an active speech input elicitation procedure.
- an interface for selecting inputs from a menu, which may invoke active GUI-based input elicitation.

For example, if a hands-free context is detected, speech input may be elicited by a tone or other audible prompt, and the user's speech may be interpreted as text. One skilled in the art will recognize, however, that other input modes may be provided.

The output of step **100** may be a set of candidate interpretations of the text of the input speech. This set of candidate interpretations is processed **200** by language interpreter **2770** (also referred to as a natural language processor, or NLP), which parses the text input and generates a set of possible semantic interpretations of the user's intent.

In step **300**, these representation(s) of the user's intent is/are passed to dialog flow processor **2780**, which implements an embodiment of a dialog and flow analysis procedure to operationalize the user's intent as task steps. Dialog flow processor **2780** determines which interpretation of intent is most likely, maps this interpretation to instances of domain models and parameters of a task model, and determines the next flow step in a task flow. If appropriate, one or more task flow step(s) adapted to hands-free operation is/are selected **310**. For example, as described above, the task flow step(s) for modifying a text message may be different when hands-free context is detected.

In step **400**, the identified flow step(s) is/are executed. In one embodiment, invocation of the flow step(s) is performed by services orchestration component **2782**, which invokes a

set of services on behalf of the user's request. In one embodiment, these services contribute some data to a common result.

In step **500**, a dialog response is generated. In one embodiment, dialog response generation **500** is influenced by the state of hands-free context. Thus, when hands-free context is detected, different and/or additional dialog units may be selected **510** for presentation using the audio channel. For example, additional prompts such as "Ready to send it?" may be spoken verbally and not necessarily displayed on the screen. In one embodiment, the detection of hands-free context can influence the prompting for additional input **520**, for example to verify input.

In step **700**, multimodal output (which, in one embodiment includes verbal and visual content) is presented to the user, who then can optionally respond again using speech input.

If, after viewing and/or hearing the response, the user is done **790**, the method ends. If the user is not done, another iteration of the loop is initiated by returning to step **100**.

As described herein, context information **1000**, including a detected hands-free context, can be used by various components of the system to influence various steps of method **10**. For example, as depicted in FIG. **7**, context **1000**, including hands-free context, can be used at steps **100**, **200**, **300**, **310**, **500**, **510**, and/or **520**. One skilled in the art will recognize, however, that the use of context information **1000**, including hands-free context, is not limited to these specific steps, and that the system can use context information at other points as well, without departing from the essential characteristics of the present invention.

In addition, one skilled in the art will recognize that different embodiments of method **10** may include additional features and/or operations than those illustrated in the specific embodiment depicted in FIG. **7**, and/or may omit at least a portion of the features and/or operations of method **10** as illustrated in the specific embodiment of FIG. **7**.

Adaptation of steps **100**, **200**, **300**, **310**, **500**, **510**, and/or **520** to a hands-free context is described in more detail below.

Adapting Input Elicitation and Interpretation **100** to Hands-Free Context

Elicitation and interpretation of speech input **100** can be adapted to a hands-free context in any of several ways, either singly or in any combination. As described above, in one embodiment, if a hands-free context is detected, speech input may be elicited by a tone and/or other audible prompt, and the user's speech is interpreted as text. In general, multimodal virtual assistant **1002** may provide multiple possible mechanisms for audio input (such as, for example, Bluetooth-connected microphones or other attached peripherals), and multiple possible mechanisms for invoking assistant **1002** (such as, for example, pressing a button on a peripheral or using a motion gesture in proximity to device **60**). The information about how assistant **1002** was invoked and/or which mechanism is being used for audio input can be used to indicate whether or not hands-free context is active and can be used to alter the hands-free experience. More particularly, such information can be used to direct step **100** to use a particular audio path for input and output.

In addition, when hands-free context is detected, the manner in which audio input devices are used can be changed. For example, in a hands-on mode, the interface can require that the user press a button or make a physical gesture to cause assistant **1002** to start listening for speech input. In hands-free mode, by contrast, the interface can continuously prompt for input after every instance of output by assistant **1002**, or can allow continuous speech in both directions (allowing the user to interrupt assistant **1002** while assistant **1002** is still speaking).

Adapting Natural Language Processing **200** to Hands-Free Context

Natural Language Processing (NLP) **200** can be adapted to a hands-free context, for example, by adding support for certain spoken responses that are particularly well-suited to hands-free operation. Such responses can include, for example, "yes", "read the message" and "change it". In one embodiment, support for such responses can be provided in addition to support for spoken commands that are usable in a hands-on situation. Thus, for example, in one embodiment, a user may be able to operate a graphical user interface by speaking a command that appears on a screen (for example, when a button labeled "Send" appears on the screen, support may be provided for understanding the spoken word "send" and its semantic equivalents). In a hands-free context, additional commands can be recognized to account for the fact that the user may not be able to view the screen.

Detection of a hands-free context can also alter the interpretation of words by assistant **1002**. For example, in a hands-free context, assistant **1002** can be tuned to recognize the command "quiet!" and its semantic variants, and to turn off all audio output in response to such a comment. In a non-hands-free context, such a command might be ignored as not relevant.

Adapting Task Flow **300** to Hands-Free Context

Step **300**, which includes identifying task(s) associated with the user's intent, parameter(s) for the task(s) and/or task flow steps **300** to execute, can be adapted for hands-free context in any of several ways, singly or in combination.

In one embodiment, one or more additional task flow step(s) adapted to hands-free operation is/are selected **310** for operation. Examples include steps to review and confirm content verbally. In addition, in a hands-free context, assistant **1002** can read lists of results that would otherwise be presented on a display screen. Verbal commands can be provided for interacting with individual items in the list. For example, if several incoming text messages are to be presented to the user, and a hands-free context is detected, then identified task flow steps can include reading aloud each text message individually, and pausing after each message to allow the user to provide a spoken command.

In one embodiment, task flows can be modified for hands-free context. For example, the task flow for taking notes in a notes application might normally involve prompting for content and immediately adding it to a note. Such an operation might be appropriate in a hands-on environment in which content is immediately shown in the visual interface and immediately available for modification by direct manipulation. However, when a hands-free context is detected, the task flow can be modified, for example to verbally review the content and allow for modification of content before it is added to the note. This allows the user to catch speech dictation errors before they are stored in the permanent document.

In one embodiment, hands-free context can also be used to limit the tasks that are allowed at a given time. For example, a policy can be implemented to disallow the playing videos when the user's device is in hands-free context, or a specific hands-free context such as driving a vehicle.

In one embodiment, assistant **1002** can make available entire domains of discourse and/or tasks that are only applicable in a hands-free context. Examples include accessibility modes such as those designed for people with limited

eyesight or limited use of their hands. These accessibility modes include commands that are implemented as hands-free alternatives for operating an arbitrary GUI on a given application platform, for example to recognize commands such as "press the button" or "scroll up" are. Other tasks that are may be applicable only in hands-free modes include tasks related to the hands-free experience itself, such as "use my car's Bluetooth kit" or "slow down [the Text to Speech Output]".

Adapting Dialog Generation **500** to Hands-Free Context

In various embodiments, any of a number of techniques can be used for modifying dialog generation **500** to adapt to a hands-free context.

In a hands-on interface, assistant's **1002** interpretation of the user's input can be echoed in writing; however such feedback may not be visible to the user when in a hands-free context. Thus, in one embodiment, when a hands-free context is detected, assistant **1002** uses Text-to-Speech (TTS) technology to paraphrase the user's input. Such paraphrasing can be selective; for example, prior to sending a text message, assistant **1002** can speak the text message so that a user can verify its contents even if he or she cannot see the display screen.

The determination as to when to paraphrase the user's speech, and which parts of the speech to paraphrase, can be driven by task- and/or flow-specific dialogs. For example, in response to a user's spoken command such as "read my new message", in one embodiment assistant **1002** does not paraphrase the command, since it is evident from assistant's **1002** response (reading the message) that the command was understood. However, in other situations, such as when the user's input is not recognized in step **100** or understood in step **200**, assistant **1002** can attempt to paraphrase the user's spoken input so as to inform the user why the input was not understood. For example, assistant **1002** might say "I didn't understand 'reel my newt massage'. Please try again."

In one embodiment, the verbal paraphrase of information can combine dialog templates with personal data on a device. For example, when reading a text message, in one embodiment assistant **1002** uses a spoken output template with variables of the form, "You have a new message from $person. It says $message." The variables in the template can be substituted with user data and then turned into speech by a process running on device **60**. In one embodiment wherein the invention is implemented in a client/server environment, such a technique can help protect the privacy of users while still allowing personalization of output, since the personal data can remain on device **60** and can be filled in upon receipt of an output template from the server.

In one embodiment, when hands-free context is detected, different and/or additional dialog units specifically tailored to hands-free contexts may be selected **510** for presentation using the audio channel. The code or rules for determining which dialog units to select can be sensitive to the particulars of the hands-free context. In this manner, a general dialog generation component can be adapted and extended to support various hands-free variations without necessarily building a separate user experience for different hands-free situations.

In one embodiment, the same mechanism that generates text and GUI output units can be annotated with texts that are tailored for an audio (spoken word) output modality. For example:

- In one embodiment, a dialog generation component can be adapted for a hands-free context by reading some of its written dialog responses verbatim over TTS.
- In one embodiment, a dialog generation component can be adapted for a hands-free context by reading some of its written dialog responses verbatim over TTS, and using TTS variants for other dialog responses.
- In one embodiment, such annotations support a variable substitution template mechanism which segregates user data from dialog generation.
- In one embodiment, graphical user interface elements can be annotated with text that indicates how they should be verbally paraphrased over TTS.
- In one embodiment, TTS texts can be tuned so that the voice, speaking rate, pitch, pauses, and/or other parameters are used to convey verbally what would otherwise be conveyed in punctuation or visual rendering. For example, the voice that is used when repeating back the user's words can be a different voice, or can use different prosody, than that used for other dialog units. As another example, the voice and/or prosody can differ depending on whether content or instructions are being spoken. As another example, pauses can be inserted between sections of text with different meanings, to aid in understanding. For example, when paraphrasing a message and asking for confirmation, a pause might be inserted between the paraphrase of the content "Your message reads . . . " and the prompt for confirmation "Ready to send it?"

In one embodiment, non-hands free contexts can be enhanced using similar mechanisms of using TTS as described above for hands-free contexts. For example, a dialog can generate verbal-only prompts in addition to written text and GUI elements. For example, in some situations, assistant **1002** can say, verbally, "Shall I send it?" to augment the onscreen display of a Send button. In one embodiment, the TTS output used for both hands-free and non-hands-free contexts can be tailored for each case. For example, assistant **1002** may use longer pauses when in the hands-free context.

In one embodiment, the detection of hands-free context can also be used to determine whether and when to automatically prompt the user for a response. For example, when interaction between assistant **1002** and user is synchronous in nature, so that one party speaks while the other listens, a design choice can be made as to whether and when assistant **1002** should automatically start listening for a speech input from the user after assistant **1002** has spoken. The specifics of the hands-free context can be used to implement various policies for this auto-start-listening property of a dialog. Examples include, without limitation:

- Always auto-start-listening;
- Only auto-start-listening when in a hands-free context;
- Only auto-start-listening for certain task flow steps and dialog states;
- Only auto-start-listening for certain task flow steps and dialog states in a hands-free context.

In other embodiments, detection of a hands-free context can also affect choices with regard to other parameters of a dialog, such as, for example:

- the length of lists of options to offer the user; whether to read lists;
- whether to ask questions with single or multiple valued answers;
- whether to prompt for data that can only be given using a direct manipulation interface.

Thus, in various embodiments, a hands-free context, once detected, is a system-side parameter that can be used to adapt various processing steps of a complex system such as multimodal virtual assistant **1002**. The various methods

described herein provide ways to adapt general procedures of assistant **1002** for hands-free contexts to support a range of user experiences from the same underlying system.

Turning to FIG. **14**, a method **1450** is provided for providing information about an alert. In some implementations, the method **1450** is performed at an electronic device having one or more processors and memory storing one or more programs for execution by the one or more processors. In some implementations, the electronic device is a personal digital assistant, mobile phone, smartphone, laptop, tablet computer, consumer electronic device, music player, or the like. While the method is described as being performed on an electronic device, it will be understood that the method (and the individual steps thereof) may be performed by more than one electronic device, including combinations of one or more server computers and one or more client computers and/or handheld devices.

The electronic device outputs an alert corresponding to an information item (**1454**). In some implementations, the alert is an audible alert (e.g., a beep, tone, ring, chime, etc.). In some implementations, the alert is a tactile alert (e.g., a vibration), or both. In some implementations, the alert is ambiguous as to the type of information item that it indicates, such as when one type of alert is associated with a plurality of different possible information items. For example, incoming text messages, emails, and application notifications may all cause the same sound to be output as an alert, in which case the user will not know which type of information item caused the alert.

In some implementations, the information item is associated with textual information. For example, in some implementations, the information item is an email, text message, a transcribed voicemail message, a calendar alert, a reminder alert, or an application alert (e.g., an alert of any kind issued by an application installed on the electronic device). As described below, the textual information associated with the information item may be provided to the user as speech output (e.g., using text-to-speech techniques) upon a request by the user for additional information about the alert.

In some implementations, the information item is a notification from an application installed on the electronic device and/or information service associated with an application installed on the electronic device. For example, in some implementations, the information item is a news article or a blog post. In some implementations, the information service is a social networking service, and the information item is a notification of social networking activity. In such cases, the textual content may include the content of a social networking post, the author of a post, a summary of the post, or any other textual content.

In some implementations, information items are provided to an alert handling module or routine of the electronic device, and the alert handling module or routine determines what alert is to be provided to the user (if any) for that particular information item, and how the contents of the information item are to be presented upon request (if at all).

In some implementations, prior to outputting the alert at step (**1454**), the electronic device receives a communication (**1452**). In some implementations, the communication is a text message (e.g., an SMS message or an IMESSAGE), an email, a video telephony call (e.g., FACETIME), or a telephone call. In some implementations, the alert and the information item correspond to the communication. For example, the alert signifies that the communication has been received and/or detected, and the information item corresponds to the contents of the communication itself (e.g., the body and/or subject of an email, the body of a text message, the contents of a transcribed voicemail, etc.).

The electronic device receives a speech input after outputting the alert (**1458**). In some implementations, the speech input corresponds to a request for additional information about the alert. For example, as described below, the speech input corresponds to a predetermined word or phrase that indicates that the user wants the electronic device to provide additional information about the alert.

In some implementations, in response to outputting the alert (and before the speech input is received at step (**1458**)), the electronic device initiates a listening mode for a first predetermined time period, and the speech input is received during the first predetermined time period (**1456**). The listening mode corresponds to a state in which the electronic device is monitoring and/or analyzing audio that is received by a microphone or transducer on the device. In some implementations, the predetermined time period is 2 seconds or less, 3 seconds or less, 5 seconds or less, 10 seconds or less, or any other appropriate duration.

In some implementations, under normal operating conditions, a listening mode is preceded by a sound or other indication so that the user knows that the device is listening. However, in some implementations, when a listening mode is initiated after outputting an alert, no audio prompt indicating initiation of the listening mode is provided when the listening mode is initiated at step (**1456**). This serves to differentiate the listening mode that is active after an alert is issued (e.g., a post-alert listening mode) from a listening mode that is active when a fully operative instance of a virtual assistant is active. In particular, in some implementations, the post-alert listening mode is configured to respond only to speech inputs that include requests for additional information about the alert. On the other hand, when a fully operative instance of a virtual assistant is active, the virtual assistant may process any and all speech inputs in order to identify a user intent and take some action based on the input. Because of the conversational nature of the virtual assistant described herein (and in the related U.S. utility applications that have been incorporated by reference, above), inadvertent activation of a fully operative instance can be a nuisance, as the assistant may interrupt the user to request additional information. For example, if a fully operative instance of the virtual assistant were activated after an alert, it may pickup an unintended portion of a conversation such as " . . . to pick up dinner . . . . " Thereafter, it may respond with an output such as "I found several restaurants close to you. Shall I read them to you?" Because the user was not, in fact, addressing the virtual assistant, this interruption could be confusing and annoying. Thus, by not providing a prompt that the user will associate with the virtual assistant (or by providing a different prompt), and because the virtual assistant will not respond to speech inputs that do not request additional information about the alert, the user will not be confused as to why the assistant has been initiated, or feel compelled to be silent during the listening mode in order to prevent the virtual assistant from processing speech inputs that are not meant for the assistant.

In some implementations, a listening mode is already active on the device when an alert is provided, such that the user can simply speak a command after an alert has been outputted to receive additional information about the alert. This may occur, for example, when a hands-free context was previously determined (e.g., when the user is driving and a hands-free mode has been activated).

In some implementations, the electronic device includes a low-power voice or sound trigger so that the device is effectively always listening for a predetermined trigger word. In such cases, the listening mode can be activated in response to detecting the trigger word. For example, after an alert, a user may speak the phrase "Hey, SIRI, what was that?" In this case, the phrase "Hey, SIRI" is the trigger that initiates the listening mode, and the question "what was that" is the speech input corresponding to a request for additional information about the alert.

The electronic device determines whether the speech input includes a request for information about the alert (**1460**). Thus, the electronic device differentiates between inadvertent speech inputs that may be received after an alert has been output (e.g., an unrelated conversation, background noise, etc.) and those that are intended by a user to elicit additional information about the alert (e.g., "what was that" or "read that to me").

In some implementations, determining whether the speech input includes the request for information about the alert includes determining whether the speech input includes a predetermined word or phrase (**1462**). In some implementations, the electronic device is configured to respond to a single predetermined word or phrase, such as "SIRI, what was that?" In some implementations, the predetermined word or phrase is one of a plurality of predetermined words or phrases that indicate a user request for information about an alert. For example, the electronic device may be configured to respond to any of "What?," "SRI, what was that?," and "Read that to me" (and/or other appropriate words or phrases). In some implementations, the predetermined word or phrase is selected by the user, either from a list of predefined options provided by the electronic device, or by speaking (or otherwise entering) any desired word or phrase.

In some implementations, determining whether the speech input includes a request for information about the alert includes using natural language processing to determine a user intent from the speech input (**1464**). In some implementations, natural language processing is performed by one or more components of a virtual assistant (e.g., as described in greater detail in U.S. Utility application Ser. No. 12/987,982, which has been incorporated by reference, above). In some implementations, determining whether the speech input includes a request for information about the alert further includes determining whether the user intent (identified at step (**1464**), above) indicates a request for information about the alert (**1466**). Thus, the user does not need to output a specific, predetermined word or phrase. Rather, the user can simply speak any command, and the electronic device (and/or other associated electronic devices) will attempt to determine the intent of the input. For example, the electronic device may determine that the inputs "huh?" and "what was that?" indicate a request for additional information about a recent alert. If the determined intent does not indicate such a request, the electronic device ignores the request. Specifically, because the input was received after the electronic device output the alert (**1458**), the device will only take action in response to requests for additional information about the alert, and will ignore requests that represent any other user intent. This helps prevent the device from taking actions based on inadvertent speech inputs received by the device after an alert has been outputted (e.g., snippets of conversation that were occurring when the alert was outputted but were not meant to invoke any action by the virtual assistant).

Method **1450** continues on FIG. **14**B. In response to determining that the speech input includes a request for information about the alert, the electronic device provides a first speech output including information about the alert (**1468**). As noted above, the alert is associated with an information item. Thus, in some implementations, the speech output includes information that is included in and/or derived from the information item.

In some implementations, where the information item is associated with textual information, providing the first speech output includes providing speech output corresponding to at least a portion of the textual information associated with the information item (**1470**). For example, if the information item is a text message, the speech output includes at least some of the contents of the text message. If the information item is an email message, the speech output includes at least some of the body or the subject of the email. If the information item is a notification from an application or an information source (e.g., a notification of social networking activity), the speech output includes at least a portion of text associated with the notification (e.g., "Bob commented on your post, saying 'Nice picture.'"). In some implementations, applications and/or information services that can cause an alert to be outputted provide to the device specific textual information that is to be provided in response to a request for additional information about the alert. Thus, the electronic device need not determine what information to provide, but rather simply produces the speech output (e.g., using text-to-speech techniques) using the information provided by the application or information service.

In some implementations, the information item includes meta-information. Meta-information includes information that is relevant to the information item but is not the actual message that is intended to be provided to the user. For example, as described below, meta-information includes a source of the information item, a time of receipt and/or creation of the information item, a class of the information item, an author/addressee of a communication (e.g., a sender of and/or any addressee of an email or text message), and the like. In some implementations, providing the first speech output includes providing speech output corresponding to meta-information associated with the information item (**1472**). As noted above, in some implementations, the meta-information is an indication of a source of the information item. In some implementations, the indication of the source of the information item includes a name of an application that issued the information item. For example, a speech output from a particular application may be "that was a notification from the [Application Name] application."

As noted above, in some implementations, the information item corresponds to a communication, such as an email, text message, voicemail (e.g., transcribed voice mail), incoming telephone call, and the like. In some implementations, where the information item corresponds to a communication, and the meta-information is a name of a sender of the communication. Thus, for example, if an alert is provided for a received text message, the speech output includes the name of the sender (e.g., "That was a text message from Tom Devon.").

In some implementations, the meta-information provided in the speech output is an indication of a class of the information item. For example, classes of information items include emails, text messages, "person-to-person" messages, application notifications, calendar reminders, task list reminders, or other appropriate class. Individual information items can be associated with one or more classes.

In some implementations, information items that include messages from one person to another person are associated with a particular class (e.g., a "person-to-person" message class), and speech outputs for information items of that class always include predetermined information, such as the

sender/author of the message. Thus, a user can receive useful information related to person-to-person messages (e.g., "that was a comment on your [Social Network] post by your friend Bob"), even when the information item originates from a source that would usually result in a generic speech output (e.g., "that was a notification from [Social Network]").

In some implementations, providing the first speech output further includes providing speech output corresponding to a summary of the contents of the information item (**1474**). In some implementations, the summary includes information about the type of information item that caused the alert (e.g., "that was a reply to your email to Bob"). In some implementations, the summary includes a first portion of a message, a subject line of a message (e.g., an email), one or more keywords from a message (e.g., "It's from Tom Devon about the game"), and the like.

In some implementations, the electronic device, after providing the first speech output, initiates a listening mode for a second predetermined time period (**1476**). In some implementations, the second predetermined time period is 2 seconds or less, 3 seconds or less, 5 seconds or less, 10 seconds or less, or any other appropriate duration. Details about the listening mode are discussed above, for example, with respect to step (**1456**).

In some implementations, the electronic device receives an additional speech input during the second predetermined time period (**1478**).

In some implementations, the electronic device determines whether the additional speech input includes a request for additional information about the alert (**1480**). Techniques for determining whether a speech input includes a request for information about an alert are discussed above, for example, with respect to steps (**1460**)-(**1466**).

In some implementations, in response to determining that the additional speech input includes a request for additional information about the alert, the electronic device provides a second speech output including additional information associated with the alert (**1482**). For example, in some implementations, the alert corresponds to a communication, the first speech output includes a name of a sender of the communication (e.g., "that was a text message from Tom Devon"), and the second speech output includes at least a content portion of the communication (e.g., "he said 'Hey, are you going to the game?'"). In some implementations, the first speech output includes a name of an application and/or information source that issued a notification (e.g., "that was from [Social Network]"), and the second speech output includes at least a content portion of the notification (e.g., "Bob commented on your post. He said 'Nice picture.'").

In some implementations, instead of determining whether the speech input includes a request for information about the alert, the electronic device provides a speech output including information about the alert in response to receiving any sound input. Specifically, if the device receives an audio input after outputting the alert (e.g., at step (**1454**)), the device assumes that the user wants additional information about the alert. In some implementations, the audio input must satisfy a predetermined amplitude threshold in order for the device to provide an output in response thereto. For example, the audio input must be above a certain perceived volume level. Thus, background noise will not cause the speech output will to be provided.

In some implementations, the speech output is provided regardless of semantic content of the audio input. Thus, where the audio input corresponds to human speech (and thus may include semantic content), the speech output is provided even if the device cannot determine the meaning of the speech. Thus, for example, even if the user does not know or remember the predetermined word or phrase that the device is configured to recognize, the device assumes that the user is requesting additional information and still provides the speech output. Moreover, in implementations where the device uses natural language processing to determine the user's intent from a speech input, the speech output is still provided even if the device cannot determine the intent. These techniques can also help account for degraded audio reception caused by occlusion or obstruction of microphones and/or other audio pickup components, such as when the device is in a pocket or a bag. Specifically, the device will still provide a speech output even though it cannot determine the user's intent or positively identify whether the audio input includes a predetermined word or phrase.

In some implementations, after receiving the audio input, the device determines whether the audio input corresponds to a human voice, and the first speech output is provided also in response to determining that the audio input corresponds to a human voice. Accordingly, the device ignores non-speech noises (e.g., driving noises, music, noise due to the device moving around within a purse or pocket, etc.), thus further increasing the likelihood that the speech output is provided in response to an actual request for additional information.

Use Cases

The following use cases are presented as examples of operation of assistant **1002** in a hands-free context. One skilled in the art will recognize that the use cases are exemplary, and are presented for illustrative purposes only.

Phone Use Cases

In one embodiment, when in a hands-free context, assistant **1002** allows the user to can call anyone if the user can specify the person to be called without tapping or otherwise touching the device. Examples include calling by contact name, calling by phone number (digits recited by user), and the like. Ambiguity can be resolved by additional spoken prompts. Examples are shown below.

Example 1

Call a Contact, Unambiguous

User's spoken input: "Call Adam Smith"
Assistant's **1002** spoken output: "Calling Adam Smith, mobile."
Call is placed
Similar interaction would take place for any of the following use cases:
Call contact by Name ("call adam smith")
Call contact by Name, non-default phone number ("call adam smith mobile")
Call by Number ("call 800 555 1212")
Call contact by Relationship Alias ("call my mom")
Call contact by Location Alias ("phone home")
Call via FaceTime ("facetime adam smith")
Call back from context ("call him back")

Example 2

Cancel a Phone Call

User's spoken input: "Call Adam Smith"
Assistant's **1002** spoken output: "Calling Adam Smith, mobile."
User notes this is the wrong person to call; user single-presses home button to cancel the call, or says "Stop"
Call is canceled

Example 3

Call by name, ambiguous

User's spoken input: "Call Adam"
Assistant's **1002** spoken output: "I found multiple matches for <voice change> Adam"
Assistant's **1002** visual output: "1 found multiple matches for <voice change> Adam"
Assistant's **1002** spoken output: Read names
Assistant's **1002** visual output:
Disambiguation Menu
Adam Cheyer home
Adam Sandler home
Adam Smith mobile
User's spoken input: "Adam Cheyer"
Assistant's **1002** spoken output: "Calling Adam Cheyer"
Call is placed

Example 4

Call by Name, Doubly Ambiguous

User's spoken input: "Call Paul"
Assistant's **1002** spoken output: "I found multiple matches for <voice change> Paul"
Assistant's **1002** visual output: "I found multiple matches for <voice change> Paul"
Assistant's **1002** spoken output: Read names
Assistant's **1002** visual output:
Disambiguation Menu
Paul Holden home
Paul Marcos iPhone
Paul Marcos mobile
Paul Marcos home
Pablo Picasso home
User's spoken input: "Paul Marcos"
Assistant's **1002** spoken output: "Which number for Paul Marcos: iPhone, mobile, or home?"
Assistant's **1002** visual output: "Which number for Paul Marcos?"
Assistant's **1002** visual output:
Disambiguation Menu
Paul Marcos iPhone
Paul Marcos mobile
Paul Marcos home
User's spoken input: "mobile"
Assistant's **1002** spoken output: "Calling Paul Marcos <pause> mobile"
Call is placed

Example 5

Call a Business by Name, No Ambiguity

User's spoken input: "Call the Sony Metreon in San Francisco"
Assistant's **1002** spoken output: "I found AMC Loews Metreon 16 on Fourth Street"
Assistant's **1002** visual output: "I found AMC Loews Metreon 16 on Fourth Street"
Assistant's **1002** visual output:
Local Search Snippet
AMC Loews Metreon 16
101 Fourth St, San Francisco
(888) 262-4386
<Cancel button> <Call button>
Assistant's **1002** spoken output: "Shall I place the call?"
User's spoken input: "Call it"
Assistant's **1002** spoken output: "Calling AMC Loews Metreon 16"
Call is placed

Example 6

Call a Business by Name, Multiple Matches

User's spoken input: "Call Walgreens"
Assistant's **1002** spoken output: "I found several matches for <change voice> Walgreens"
Assistant's **1002** visual output: "I found several matches for <change voice> Walgreens"
Assistant's **1002** visual output:
List of Local Search Snippets
Walgreens Store Los Gatos
423 N Santa Cruz Ave, Los Gatos
Walgreens
1570 Campbell Ave, Campbell, Calif.
Walgreens
20011 Bollinger Rd, Cupertino, Calif.
Walgreens
1334 Saratoga Ave, San Jose, Calif.
Walgreens
2680 Union Ave, San Jose, Calif.
Assistant's **1002** spoken output: "Shall I read them to you?"
User's spoken input: "yes"
Assistant's **1002** spoken output: "Walgreens store los gatos on 423 North Santa Cruz Avenue in Los Gatos <pause>2. Walgreens on 1570 Campbell Avenue in Campbell <pause>3 . . . "
User's spoken input: "the one in Cupertino"
Assistant's **1002** spoken output: "Calling Walgreens in Cupertino"
Call is placed

Example 6

Make Scheduled Calls in Car

User starts driving home
Assistant **1002** issues tone of an In Car Reminder
Assistant's **1002** visual output:
Reminder Alert
Call Adam Smith
<Close button> <Call button>
User's spoken input: "Read it"
Assistant's **1002** spoken output: "You have a reminder to call Adam Smith"
User's spoken input: "Call him now"
Assistant's **1002** spoken output: "Calling Adam Smith, mobile"
Call is placed

Example 7

Play New Voicemails

User's spoken input: "play voicemail"
Assistant's **1002** spoken output: "You have three new voice mail messages"
Assistant **1002** plays voicemails, one at a time, with prompts"
SMS Text Messaging Use Cases

Example 8

Read a Single Text Message Alert

Assistant's **1002** audio output: Reads the alert or alerts; or generates sound indicating incoming text message
Assistant's **1002** visual output:
Text Message
Mary Richards
Are you free for dinner tonight?
<Close button> <Reply button>
User's spoken input: "read it"
Assistant's **1002** spoken output: "Message from Mary Richards <change of voice> are you free for dinner tonight?"

Example 9

Reply to Text Message (Continues from Example 8)

User's spoken input: "reply <pause> sure, how about 8?"
Assistant's **1002** spoken output: "Ready to reply to Mary Richards with the message <change of voice> sure how about 8"
Assistant's **1002** visual output:
To: Mary Richards
sure how about 8
<Cancel button> <Send button>
User's spoken input: "send it"
Assistant's **1002** audio output: "Sending"; or generates outgoing text message sound

Example 10

Send a Text Message to One Recipient

User's spoken input: "Tell Lisa that I'll be 15 minutes late"
Assistant's **1002** spoken output: "Ready to send a text to Lisa Gonzalez with the message <change of voice> I'll be 15 minutes late"
Assistant's **1002** visual output:
Text Message
To: Lisa Gonzalez
I'll be 15 minutes late
<Cancel button> <Send button>
User's spoken input: "send it"
Assistant's **1002** audio output: "Sending"; or generates outgoing text message sound

Example 11

Send a Text Message to One Recipient—Ambiguous

User's spoken input: "text to Adam with message Where is the meeting?"
Assistant's **1002** spoken output: "I found multiple matches for <voice change> Adam"
Assistant's **1002** spoken output: Read names
Assistant's **1002** visual output:
Disambiguation Menu
Adam Cheyer home
Adam Sandler home
Adam Smith mobile
User's spoken input: "Adam Cheyer"
Assistant's **1002** spoken output: "Adam Cheyer"
Assistant's **1002** visual output:
Text Message
To: Adam Cheyer
Where is the meeting?
<Cancel button> <Send button>
Assistant's **1002** spoken output: "Ready to send a text to Adam Cheyer with the message <change of voice> Where is the meeting?"
User's spoken input: "send it"
Assistant's **1002** audio output: "Sending"; or generates outgoing text message sound

Example 12

Read an SMS Message from Messages App

Assistant's **1002** visual output:
Text Message
Betty Joe Bialowski
You can call me Nancy
<Close button> <Reply button>
User's spoken input: "read it"
Assistant's **1002** spoken output: "Message from Betty Joe Bialowski <change voice> you can call me nancy"

Example 13

Reply in Context of Messages App (Continues from Example 12)

User's spoken input: "reply <pause> Hi Nancy"
Assistant's **1002** spoken output: "Ready to reply to Betty Joe Bialowski with the message <change of voice> Hi Nancy"
Assistant's **1002** visual output:
To: Betty Joe Bialowski
Hi Nancy
<Cancel button> <Send button>
User's spoken input: "send it"
Assistant's **1002** audio output: "Sending"; or generates outgoing text message sound

Example 14

Read all Unread SMS Messages

Assistant's **1002** visual output:
Melanie Haber (1)
Betty Joe Bialowski (3)
Audrey Farber (1)
User's spoken input: "Read my new messages"
Assistant's **1002** spoken output: "You have 4 new messages. From Melanie Haber <change voice> How about dinner? <pause> From Betty Joe Bialowski, you have 2 messages. <pause>1. <change voice> My name is MacGill. <pause>2. <change voice> I call myself Lill. "<pause>3. <change voice> you can call me nancy"

Example 15

Reply by Name in Context of Messages App

User's spoken input: "Tell Audrey that I'll be 15 minutes late"

Assistant's **1002** spoken output: "Ready to send a text to Audrey Farber with the message <change of voice> I'll be 15 minutes late"
Assistant's **1002** visual output:
Text Message
To: Audrey Farber
I'll be 15 minutes late
<Cancel button> <Send button>
Assistant's **1002** spoken output: "Shall I send it?"
User's spoken input: "yes"
Assistant's **1002** audio output: "Sending"; or generates outgoing text message sound

Example 16

Send a Text Message to Multiple Recipient

In one embodiment, this task is determined to be out of scope for hands-free context. Accordingly, assistant **1002** reverts to tapping for disambiguation.
User's spoken input: "Tell Lisa, Paul, and Nancy that I'll be 15 minutes late to our important meeting"
Assistant's **1002** spoken output: "Please select among these people"
Assistant's **1002** visual output: GUI to select multiple recipients
User selects recipients via GUI
Assistant's **1002** spoken output: "Ready to send a text to Lisa Gonzalez, Paul Marcos, and Audrey Farber with the message <change of voice> I'll be 15 minutes late to our important meeting"
Assistant's **1002** visual output:
Text Message
To: Lisa Gonzalez, Paul Marcos, Audrey Farber
I'll be 15 minutes late to our important meeting
<Cancel button> <Send button>
User's spoken input: "Send it"
Assistant's **1002** audio output: "Sending"; or generates outgoing text message sound

Alerts & Reminders Use Cases

Example 17

Read a Single Reminder Alert

Assistant **1002** issues reminder tone
Assistant's **1002** visual output:
Reminders
Call Mary Richards
<Close button> <Call button>
User's spoken input: "Read it"
Assistant's **1002** spoken output: "Reminder to call Mary Richards"

Example 18

Execute Reminder Alert (Continues from Example 17)

User's spoken input: "call her"
Assistant's **1002** spoken output: "Calling Mary Richards, mobile"
Call is placed

Example 19

Create a New Reminder with Alert

User's spoken input: "Remind me to call Bob Jones at 5 pm"
Assistant's **1002** spoken output: "Please confirm: reminder at 5 pm today to <change of voice> call Bob Jones"
Assistant's **1002** visual output:
Please confirm Reminder
Call Bob Jones
Reminder time: 5:00 pm today
<Cancel> <Save>
Pause
Assistant's **1002** spoken output: "Is this correct?"
User's spoken input: "yes, save it"
Assistant's **1002** spoken output: "Your reminder has been saved"

Example 20

Create a New Reminder with No Alert P1

User's spoken input: "Remind me to get bread" or "Remember to get bread"
Assistant's **1002** spoken output: "Please confirm: remember to get bread"
Assistant's **1002** visual output:
Please confirm reminder
get bread
<Cancel> <Save>
Pause
Assistant's **1002** spoken output: "Is this correct?"
User's spoken input: "yup"
Assistant's **1002** spoken output: "I added it to your to-do list"

Calendar Use Cases

Example 21

Create a Simple Appointment (Description and Date/Time Given)

User's spoken input: "Schedule a meeting at 2 tomorrow to plan the company picnic"
Assistant's **1002** spoken output: "I put it on your calendar for 2 PM tomorrow"
Assistant's **1002** visual output:
description: Plan the company picnic
when: tomorrow at 2 PM

Example 22

Create a Simple Appointment (No Description Given)

User's spoken input: "Meet with Carol at 2 tomorrow"
Assistant's **1002** spoken output: "I put it on your calendar for 2 PM tomorrow"
Assistant's **1002** visual output:
description: Meeting
when: tomorrow at 2 PM

Example 23

Create a Simple Appointment (No Time Given)

User's spoken input: "Dentist appointment next Thursday"
Assistant's **1002** spoken output: "What time next Thursday?"

User's spoken input: "3 o'clock"
Assistant's **1002** spoken output: "I put it on your calendar for 3 PM next Thursday"
Assistant's **1002** visual output:
description: Dentist appointment
when: next Thursday—3 pm

Example 24

Create a Simple Appointment (No Date or Time Given)

User's spoken input: "Schedule a meeting to plan the company picnic"
Assistant's **1002** spoken output: "When would you like to have the meeting?"
Assistant's **1002** visual output: editable appointment form
User's spoken input: "Tuesday at 3 o'clock"
Assistant's **1002** spoken output: "I put it on your calendar for 3 PM on Tuesday"
Assistant's **1002** visual output:
description: meeting to plan the company picnic
when: Tuesday—3 pm

One skilled in the art will recognize that the above examples are merely illustrative of the use of hands-free context in particular situations. Additional uses include, for example, maps, playing media such as music, and the like.

The present invention has been described in particular detail with respect to possible embodiments. Those of skill in the art will appreciate that the invention may be practiced in other embodiments. First, the particular naming of the components, capitalization of terms, the attributes, data structures, or any other programming or structural aspect is not mandatory or significant, and the mechanisms that implement the invention or its features may have different names, formats, or protocols. Further, the system may be implemented via a combination of hardware and software, as described, or entirely in hardware elements, or entirely in software elements. Also, the particular division of functionality between the various system components described herein is merely exemplary, and not mandatory; functions performed by a single system component may instead be performed by multiple components, and functions performed by multiple components may instead be performed by a single component.

In various embodiments, the present invention can be implemented as a system or a method for performing the above-described techniques, either singly or in any combination. In another embodiment, the present invention can be implemented as a computer program product comprising a nontransitory computer-readable storage medium and computer program code, encoded on the medium, for causing a processor in a computing device or other electronic device to perform the above-described techniques.

Reference in the specification to "one embodiment" or to "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiments is included in at least one embodiment of the invention. The appearances of the phrase "in one embodiment" in various places in the specification are not necessarily all referring to the same embodiment.

Some portions of the above are presented in terms of algorithms and symbolic representations of operations on data bits within a memory of a computing device. These algorithmic descriptions and representations are the means used by those skilled in the data processing arts to most effectively convey the substance of their work to others skilled in the art. An algorithm is here, and generally, conceived to be a self-consistent sequence of steps (instructions) leading to a desired result. The steps are those requiring physical manipulations of physical quantities. Usually, though not necessarily, these quantities take the form of electrical, magnetic or optical signals capable of being stored, transferred, combined, compared and otherwise manipulated. It is convenient at times, principally for reasons of common usage, to refer to these signals as bits, values, elements, symbols, characters, terms, numbers, or the like. Furthermore, it is also convenient at times, to refer to certain arrangements of steps requiring physical manipulations of physical quantities as modules or code devices, without loss of generality.

It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise as apparent from the following discussion, it is appreciated that throughout the description, discussions utilizing terms such as "processing" or "computing" or "calculating" or "displaying" or "determining" or the like, refer to the action and processes of a computer system, or similar electronic computing module and/or device, that manipulates and transforms data represented as physical (electronic) quantities within the computer system memories or registers or other such information storage, transmission or display devices.

Certain aspects of the present invention include process steps and instructions described herein in the form of an algorithm. It should be noted that the process steps and instructions of the present invention can be embodied in software, firmware and/or hardware, and when embodied in software, can be downloaded to reside on and be operated from different platforms used by a variety of operating systems.

The present invention also relates to an apparatus for performing the operations herein. This apparatus may be specially constructed for the required purposes, or it may comprise a general-purpose computing device selectively activated or reconfigured by a computer program stored in the computing device. Such a computer program may be stored in a computer readable storage medium, such as, but is not limited to, any type of disk including floppy disks, optical disks, CD-ROMs, magnetic-optical disks, read-only memories (ROMs), random access memories (RAMs), EPROMs, EEPROMs, magnetic or optical cards, application specific integrated circuits (ASICs), or any type of media suitable for storing electronic instructions, and each coupled to a computer system bus. Further, the computing devices referred to herein may include a single processor or may be architectures employing multiple processor designs for increased computing capability.

The algorithms and displays presented herein are not inherently related to any particular computing device, virtualized system, or other apparatus. Various general-purpose systems may also be used with programs in accordance with the teachings herein, or it may prove convenient to construct more specialized apparatus to perform the required method steps. The required structure for a variety of these systems will be apparent from the description provided herein. In addition, the present invention is not described with reference to any particular programming language. It will be appreciated that a variety of programming languages may be used to implement the teachings of the present invention as described herein, and any references above to specific languages are provided for disclosure of enablement and best mode of the present invention.

Accordingly, in various embodiments, the present invention can be implemented as software, hardware, and/or other elements for controlling a computer system, computing device, or other electronic device, or any combination or plurality thereof. Such an electronic device can include, for example, a processor, an input device (such as a keyboard, mouse, touchpad, trackpad, joystick, trackball, microphone, and/or any combination thereof), an output device (such as a screen, speaker, and/or the like), memory, long-term storage (such as magnetic storage, optical storage, and/or the like), and/or network connectivity, according to techniques that are well known in the art. Such an electronic device may be portable or nonportable. Examples of electronic devices that may be used for implementing the invention include: a mobile phone, personal digital assistant, smartphone, kiosk, desktop computer, laptop computer, tablet computer, consumer electronic device, consumer entertainment device; music player; camera; television; set-top box; electronic gaming unit; or the like. An electronic device for implementing the present invention may use any operating system such as, for example, iOS or MacOS, available from Apple Inc. of Cupertino, Calif., or any other operating system that is adapted for use on the device.

While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of the above description, will appreciate that other embodiments may be devised which do not depart from the scope of the present invention as described herein. In addition, it should be noted that the language used in the specification has been principally selected for readability and instructional purposes, and may not have been selected to delineate or circumscribe the inventive subject matter. Accordingly, the disclosure of the present invention is intended to be illustrative, but not limiting, of the scope of the invention, which is set forth in the claims.

We claim:

1. A computer-implemented method for providing information about an alert, comprising:

at a system having one or more processors and memory storing one or more programs for execution by the one or more processors:

outputting, via an output device, an alert corresponding to an information item, wherein the alert is one of a plurality of types of alert the system is configured to output;

receiving, via a microphone, a speech input after outputting the alert;

determining whether the speech input includes a request for information about the alert; and

in response to determining that the speech input includes a request for information about the alert, providing a first speech output including information about the alert to disambiguate the alert, wherein the information about the alert includes at least one of the type of notification corresponding to the alert, the type of communication corresponding to the alert, and a paraphrase of the alert.

2. The method of claim **1**, further comprising, in response to outputting the alert, initiating a listening mode for a first predetermined time period, wherein the speech input is received during the first predetermined time period.

3. The method of claim **2**, wherein no audio prompt indicating initiation of the listening mode is provided upon initiation of the listening mode.

4. The method of claim **2**, further comprising:

after providing the first speech output, initiating a listening mode for a second predetermined time period;

receiving an additional speech input during the second predetermined time period; determining whether the additional speech input includes a request for additional information about the alert; and

in response to determining that the additional speech input includes a request for additional information about the alert, providing a second speech output including additional information associated with the alert.

5. The method of claim **4**, wherein the alert corresponds to a communication, the first speech output includes a name of a sender of the communication, and the second speech output includes at least a content portion of the communication.

6. The method of claim **1**, wherein determining whether the speech input includes the request for information about the alert comprises determining whether the speech input includes a predetermined word or phrase.

7. The method of claim **6**, wherein the predetermined word or phrase is one of a plurality of predetermined words or phrases that indicate a user request for information about an alert.

8. The method of claim **1**, wherein determining whether the speech input includes a request for information about the alert comprises:

using natural language processing to infer a user intent from the speech input; and

determining whether the user intent indicates a request for information about the alert.

9. The method of claim **1**, further comprising, prior to outputting the alert, receiving the communication, wherein the information item is associated with the communication.

10. The method of claim **9**, wherein the communication is selected from the group consisting of: a text message; a telephone call; a videotelephony call; a voicemail; and an email.

11. The method of claim **1**, wherein the information item is associated with one of the group consisting of: a calendar alert; a reminder alert; and an application alert.

12. The method of claim **1**, wherein the information item is associated with textual information, and wherein providing the first speech output includes providing speech output corresponding to at least a portion of the textual information associated with the information item.

13. The method of claim **1**, wherein providing the first speech output includes providing speech output corresponding to meta-information associated with the information item, and wherein the meta-information is an indication of a source of the information item.

14. The method of claim **1**, wherein providing the first speech output further includes providing speech output corresponding to a summary of the contents of the information item.

15. The method of claim **1**, wherein the information item is an alert from an information service.

16. The method of claim **15**, wherein the information service is a social networking service, and the information item is a notification of social networking activity.

17. A computer-implemented method for providing information about an alert, comprising:

at a system having one or more processors and memory storing one or more programs for execution by the one or more processors:

outputting, via an output device, an alert corresponding to an information item, wherein the alert is one of a plurality of types of alert the system is configured to output;

receiving, via a microphone, an audio input after outputting the alert; and

in response to receiving the audio input, providing a first speech output including information about the alert to disambiguate the alert, wherein the information about the alert includes at least one of the type of notification corresponding to the alert, the type of communication corresponding to the alert, and a paraphrase of the alert.

18. The method of claim **17**, wherein the audio input satisfies an amplitude threshold.

19. The method of claim **17**, wherein the audio input corresponds to human speech, and the first speech output is provided regardless of semantic content of the audio input.

20. The method of claim **17**, further comprising, after receiving the audio input, determining whether the audio input corresponds to a human voice, wherein the first speech output is provided in response to determining that the audio input corresponds to a human voice.

21. An electronic device, comprising one or more processors and memory storing one or more programs for execution by the one or more processors, the one or more programs including instructions for:

outputting, via an output device, an alert corresponding to an information item, wherein the alert is one of a plurality of types of alert the system is configured to output;

receiving, via a microphone, a speech input after outputting the alert;

determining whether the speech input includes a request for information about the alert; and

in response to determining that the speech input includes a request for information about the alert, providing a first speech output including information about the alert to disambiguate the alert, wherein the information about the alert includes at least one of the type of notification corresponding to the alert, the type of communication corresponding to the alert, and a paraphrase of the alert.

22. The electronic device of claim **21**, further comprising instructions for, in response to outputting the alert, initiating a listening mode for a first predetermined time period, wherein the speech input is received during the first predetermined time period.

23. The electronic device of claim **21**, wherein determining whether the speech input includes the request for information about the alert comprises determining whether the speech input includes a predetermined word or phrase.

24. The electronic device of claim **21**, wherein providing the first speech output further includes providing speech output corresponding to a summary of the contents of the information item.

25. The electronic device of claim **21**, wherein the information item is an alert from an information service.

26. The electronic device of claim **25**, wherein the information service is a social networking service, and the information item is a notification of social networking activity.

27. A non-transitory computer-readable storage medium storing one or more programs for execution by the one or more processors, the one or more programs including instructions for:

outputting, via an output device, an alert corresponding to an information item, wherein the alert is one of a plurality of types of alert the system is configured to output;

receiving, via a microphone, a speech input after outputting the alert;

determining whether the speech input includes a request for information about the alert; and

in response to determining that the speech input includes a request for information about the alert, providing a first speech output including information about the alert to disambiguate the alert, wherein the information about the alert includes at least one of the type of notification corresponding to the alert, the type of communication corresponding to the alert, and a paraphrase of the alert.

28. The computer-readable storage medium of claim **27**, further comprising instructions for, in response to outputting the alert, initiating a listening mode for a first predetermined time period, wherein the speech input is received during the first predetermined time period.

29. The computer-readable storage medium of claim **27**, wherein determining whether the speech input includes the request for information about the alert comprises determining whether the speech input includes a predetermined word or phrase.

30. The computer-readable storage medium of claim **27**, wherein providing the first speech output further includes providing speech output corresponding to a summary of the contents of the information item.

31. The computer-readable storage medium of claim **27**, wherein the information item is an alert from an information service.

32. The computer-readable storage medium of claim **31**, wherein the information service is a social networking service, and the information item is a notification of social networking activity.

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