ASSIGNMENT

WHEREAS, Yuanpei Cao, Wei Ji, Huifan Qu, Shengquan Yan, Shuohao Zhang and Ying Zhang (hereinafter the "Undersigned") have made one or more inventions and other subject matter (hereinafter collectively referred to as the "Invention"); as described in the patent application filed on October 11, 2024, assigned PCT application serial number PCT/CN2024/124145, and titled INTERACTIVE STORY-BASED AUTHENTICATION.

FOR GOOD AND VALUABLE CONSIDERATION, the receipt, sufficiency, and adequacy of which are hereby acknowledged by the Undersigned, the Undersigned do hereby irrevocably and unconditionally:

CONVEY, ASSIGN, AND TRANSFER to Airbnb, Inc. (the "Assignee"), a corporation of the State of Delaware, having a place of business at 888 Brannan St, San Francisco, CA 94103, the Undersigned's entire right, title, and interest for the United States and all foreign countries and jurisdictions in and to:

the Invention which is disclosed in the above-identified application or applications;

such application or applications, and all divisional, continuing (including continuation-in-part), substitute, renewal, reissue, and all other applications for a patent or patents which have been or shall be filed in the United States (including all provisional and non-provisional applications), and in all foreign countries and jurisdictions based in whole or in part on any of such Invention (including any application for a utility model or an innovation patent application);

all original and reissued patents which have been or shall be issued in the United States and all foreign countries and jurisdictions based in whole or in part on any of such Invention;

including the right to claim priority to the above-identified patent application or applications in relation to subject matter based in whole or in part on the above-identified patent application or applications and any of the foregoing including the right to file foreign applications under the provisions of any convention or treaty;

and including the right to all causes of action, remedies, and other enforcement rights related to the above-identified application or applications, including without limitation the right to sue for past, present, or future infringement, misappropriation, or violation of any and all rights related to the above-identified patent application or applications and any of the foregoing, including the right to obtain and collect damages for past, present, or future infringement;

AUTHORIZE AND REQUEST the issuing authority to issue any and all United States and foreign patents granted on such Invention to the Assignee;

AUTHORIZE AND REQUEST that any attorney associated with U.S. Patent and Trademark Office (USPTO) Customer No. 195447 may (directly or through his/her designee) delete, insert, or alter any information related to the above-identified patent application or applications or any of the foregoing, after execution of this Assignment;

WARRANT AND COVENANT that no assignment, grant, mortgage, license or other agreement affecting the rights and property herein conveyed has been or shall be made to others by the Undersigned, and that the full right to convey the same as herein expressed is possessed by the Undersigned;

COVENANT, that when requested and without compensation, but at the expense of the Assignee, in order to carry out in good faith the intent and purpose of this Assignment, the Undersigned shall (1) execute all provisional, non-provisional, divisional, continuing (including continuation-in-part), substitute, renewal, reissue, and all other patent applications for the Invention; (2) execute all rightful oaths, declarations, assignments, powers of attorney and other papers for the Invention; (3) communicate to the Assignee all facts known to the Undersigned relating to the Invention and the history thereof; (4) cooperate with the Assignee in any interference, reexamination, reissue, opposition, dispute, or litigation involving any of the applications or patents for the Invention; and (5) take such further actions as the Assignee shall reasonably consider necessary or desirable for vesting title to such Invention in the Assignee, or for securing, maintaining and enforcing proper patent protection for the Invention;

COVENANT, that should any provision of this agreement be held unenforceable by an authority of competent jurisdiction, such a ruling shall not affect the validity and enforceability of the remaining provisions.

THIS AGREEMENT IS TO BE BINDING on the heirs, assigns, representatives, and successors of the Undersigned, and is to extend to the benefit of the successors, assigns, and nominees of the Assignee.

AGREED as of the date of my signature below:

北京集佳知识产权代理有限公司
UNITALEN ATTORNEYS AT LAW

UNITALEN

7th FLOOR, SCITECH PLACE, NO. 22 JIAN GUO MEN WAI AVENUE, CHAOYANG DISTRICT, BEIJING, 100004 P. R. CHINA

TELEPHONE：+86-10-59208888
FACSIMILE: +86-10-85110966 / 85110968

Attn.:Beth Moon
Schwegman Lundberg & Woessner, P.A
Schwegman, Lundberg & Woessner, P.A. 1600 TCF Tower 121 South Eighth Street Minneapolis, MN 55402
Tel: (612) 349-9583
Fax: (612) 339-3061
Email: cnslwrequest@unitalen.com
BMoon@slwip.com
cc: SLW@blackhillsip.com;
GGotfried@slwip.com;
RPacheco@slwip.com;
request@slwip.com

October 11, 2024

Via Email

Re: Filing Report (Your Ref.:4794.398WO1; Unitalen Ref.:OP241427)

Dear Beth Moon,

We are pleased to report that the above-identified international application has been filed electronically before CNIPA. The brief information is as follows:

International application No.:	PCT/CN2024/124145
International filing date:	October 11, 2024
Earliest Priority date claimed:	None
Applicants:	CAO, Yuanpei et al.
Title of the invention:	INTERACTIVE STORY-BASED AUTHENTICATION
Your Ref.:	4794.398WO1
Our Ref.:	OP241427

Thank you for entrusting us with this application. Enclosed please find the (1) Receipt of Electronic Submission issued by CNIPA, (2) PCT request Form and (3) a copy of the Specification as filed for your record.

Regarding Foreign Filing License:

Under Article 19 of the Chinese Patent Law, if the patent application related invention was made in China, the applicant is required to obtain a foreign filing license before making any foreign filings. The foreign filing license will be in Form PCT/RO/105, which will be normally issued by CNIPA within 2-4 weeks after international filing date.

For completing this application, we still need the following document(s):

Power of Attorney, which could be submitted within 2 months after receiving a Notification for submitting the missing part from CNIPA. We hereby enclose the form of Power of Attorney (POA) for your convenience. Please send **a scanned copy of signed document** back to us at your earliest convenience.

We will keep you informed of the development of this case without delay. Should you have any questions or requirements, please do not hesitate to contact us.

Sincerely yours,

Yue CHENG (Ms.) for
Deshan LI (Mr.)
Patent Attorney, Partner
Unitalen Attorneys at Law
Attachment

INTERACTIVE STORY-BASED AUTHENTICATION

TECHNICAL FIELD

[0001] The present disclosure generally relates to special-purpose machines that manage data processing and improvements to such variants, and to the technologies by which such special-purpose machines become improved compared to other special-purpose machines for performing authentication.

BACKGROUND

[0002] Network site users can create content for viewing and interaction by other network site users (e.g., booking, registering, subscribing, viewing of listings). The posted content can be updated, created, or deleted, and it can be computationally challenging for a network site to return valid search results to network site users searching for content (e.g., listings for reservations) with specified parameters (e.g., dates, categories, prices, quantity). For example, if there are a large number of users posting and updating content and also a large number of users submitting complex searches for the posted content, any delay in computation due to query complexity may cause inaccurate results to be returned and cause large computational resource consumption (e.g., processing, memory, network overhead).

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] Various ones of the appended drawings merely illustrate examples of the present disclosure and should not be considered as limiting its scope.

[0004] FIG. 1 is a block diagram illustrating a communication session system implemented in a networked environment, according to some examples.

[0005] FIG. 2 shows an example of functional engines of a communication session system, according to some examples.

[0006] FIG. 3 shows a listings network site user interface generated by the listing network platform and communication session system, according to some examples.

[0007] FIG. 4 shows a prompt framework used by the communication session system, according to some examples.

[0008] FIG. 5 shows an example user interface for the communication session system, according to some examples.

[0009] FIG. 6 shows a diagram of a flow of operations of the communication session system, according to some examples.

[0010] FIG. 7 illustrates a method to perform authentication, in accordance with some examples.

[0011] FIG. 8 is a block diagram illustrating an architecture of software, according to some examples.

[0012] FIG. 9 illustrates a diagrammatic representation of a machine in the form of a computer system within which a set of instructions may be executed for causing the machine to perform any one or more of the methodologies discussed herein, according to some examples.

DETAILED DESCRIPTION

[0013] The description that follows includes systems, methods, techniques, instruction sequences, and computing machine program products that embody illustrative examples of the disclosure. In the following description, for the purposes of explanation, numerous specific details are set forth in order to provide an understanding of various examples of the inventive subject matter. It will be evident, however, to those skilled in the art, that examples of the inventive subject matter may be practiced without these specific details. In general, well-known instruction instances, protocols, structures, and techniques are not necessarily shown in detail.

[0014] Conventional authentication systems for customer support channels, particularly in the context of Interactive Voice Response (IVR) systems, have been plagued by inefficiencies and resource waste. These systems typically rely on external two-factor verification methods, such as sending SMS text messages or application (app) push notifications containing authentication links. While widely adopted in the industry, this approach presents several challenges and areas for improvement. One significant issue is the interruption of call flow. Users are required to pause their interaction with the IVR system to check and act upon an SMS or app notification, disrupting the continuity of the customer support experience and potentially frustrating users. This interruption not only wastes time but also diminishes the overall quality of the customer service interaction.

[0015] Furthermore, these systems are heavily dependent on external factors, such as the user's ability to access another device or multitask during the call. This dependence introduces vulnerabilities, as the effectiveness of the authentication process is contingent on

factors outside the control of the support system. For instance, users may face difficulties if they are in areas with poor network coverage or if they are using a device different from the one registered with their account. Another inefficiency lies in the connectivity requirements of these systems. The necessity for users to click a link presupposes a stable Internet connection, which may not always be available, such as if the user is calling without Wi-Fi or sufficient mobile data. This limitation can lead to failed authentication attempts and increased customer frustration, resulting in a waste of both user and company resources.

[0016] The reliance on device-specific authentication methods also introduces limitations. The process assumes that the user is calling from a phone number registered with their account. However, if a user is calling from a different device (e.g., a friend's phone during a trip), the authentication process could be disrupted, leading to a less seamless experience and potentially requiring additional resources to verify the user's identity. In cases where the initial IVR-based verification fails, many systems resort to manual verification by customer support ambassadors. This process often involves searching for previously verified phone numbers to send verification codes or asking users questions related to their personal details and recent activities. This manual intervention not only increases the workload for customer support staff but also introduces delays in the resolution process, further wasting resources and potentially damaging customer satisfaction. These inefficiencies collectively contribute to a suboptimal user experience, increased operational costs, and potential security vulnerabilities.

[0017] To address these technical problems, the disclosed techniques provide a more streamlined, user-friendly, and resource-efficient authentication process that can adapt to various user scenarios while maintaining a high level of security. Specifically, the disclosed network site allows a user to interact in a communication session with an agent (e.g., a smart virtual agent) on the listing network site in real time. Namely, the network site can receive a user interaction in a communication session with an agent of a listing network platform. The network site performs verification and authentication of the user using past user interactions without having to necessarily perform two-factor authentication. For example, the network site generates a prompt using a profile associated with the user on the network platform (e.g., listing network platform) representing past user interactions with the network platform. The network site processes the prompt by a generative machine learning (ML) model (e.g., one or more large language models (LLMs)) to generate a message that includes a query (e.g., a question or multiple questions) about a portion of the past user interactions (e.g., questions about one or more past reservations). The network site presents

the message by the agent of the network platform to the user in a user interface of the listing network platform and authenticates the user at least in part based on a response received from the user based on the message presented by the agent that includes the query about the portion of the past user interactions. This, in effect, reduces the amount of computational resources needed to be dedicated and consumed by a given user interface channel (e.g., associated with a human agent), which frees up such resources for other tasks and satisfying other search requests.

[0018] With reference to FIG. 1, an example of a high-level client-server–based network architecture 100 is shown. A networked system 102, in the example form of a network-based listing services system, provides server-side functionality via a network 104 (e.g., the Internet or wide area network (WAN)) to one or more client devices 110. In some implementations, a user (e.g., user 106) interacts with the networked system 102 and/or a third-party server 130 that hosts a social network platform 131 using the client device 110.

[0019] FIG. 1 illustrates, for example, a web client 112 (e.g., a browser), a client application 114, and a programmatic client 116 executing on the client device 110. The client device 110 can include a web client 112, a client application 114, and/or a programmatic client 116 alone, together, or in any suitable combination. Although FIG. 1 shows one client device 110, in other implementations, the network architecture 100 includes multiple client devices 110.

[0020] In various implementations, the client device 110 (also referred to as a user device) can include a computing device that includes at least a display and communication capabilities that provide access to the networked system 102 via the network 104. The client device 110 includes, but is not limited to, a remote device, work station, computer, general purpose computer, Internet appliance, hand-held device, wireless device, portable device, wearable computer, cellular or mobile phone, Personal Digital Assistant (PDA), smart phone, tablet, ultrabook, netbook, laptop, desktop, multi-processor system, microprocessor-based or programmable consumer electronics, game console, set-top box (STB), network personal computer (PC), mini-computer, and so forth. In an example, the client device 110 comprises one or more of a touch screen, accelerometer, gyroscope, biometric sensor, camera, microphone, Global Positioning System (GPS) device, and the like.

[0021] The client device 110 can implement a first user interaction channel (e.g., an IVR system or telephone communication channel) and also a second user interaction channel (e.g., a graphical user interface (GUI) of a client application 114) that communicates over a

network, such as the Internet, with a remote server. While the disclosed techniques generally refer to telephone or voice-only based communication channels as the "first user interaction channel" and a client application 114 GUI-based communications through a network as the "second user interaction channel," in some cases the second user interaction channel can perform the functions and take the place of the first user interaction channel and the first user interaction channel can perform the functions and take the place of the second user interaction channel. The first user interaction channel can correspond to an IVR service of a communication session system 150 (which is discussed in more detail in connection with FIG. 2).

[0022] The client device 110 communicates with the network 104 via a wired or wireless connection. For example, one or more portions of the network 104 comprises an ad hoc network, an intranet, an extranet, a Virtual Private Network (VPN), a Local Area Network (LAN), a wireless LAN (WLAN), a WAN, a wireless WAN (WWAN), a Metropolitan Area Network (MAN), a portion of the Internet, a portion of the Public Switched Telephone Network (PSTN), a cellular telephone network, a wireless network, a Wireless Fidelity (WI-FI®) network, a Worldwide Interoperability for Microwave Access (WiMax) network, another type of network, or any suitable combination thereof. In communicating with the network 104 through the first user interaction channel, the client device 110 may only send audio or voice data to the network 104. In communicating with the network 104 through the second user interaction channel, the client device 110 may send data representing selections on a GUI, image content, and/or audio or voice data to the network 104.

[0023] In some examples, the client device 110 includes one or more of the applications (also referred to as "apps") such as, but not limited to, web browsers, book reader apps (operable to read e-books), media apps (operable to present various media forms including audio and video), fitness apps, biometric monitoring apps, messaging apps, electronic mail (email) apps, e-commerce site apps (also referred to as "marketplace apps"), and reservation applications for temporary stays or experiences at hotels, motels, or residences managed by other end users (e.g., a posting end user who owns a home and rents out the entire home or private room). In some implementations, the client applications 114 include various components operable to present information to the user and communicate with the networked system 102. In some examples, if the e-commerce site application is included in the client device 110, then this application is configured to locally provide the user interface and at least some of the functionalities with the application configured to communicate with the networked system 102, on an as-needed basis, for data or processing capabilities not

locally available (e.g., access to a database of items available for sale, to authenticate a user, to verify a method of payment). Conversely, if the e-commerce site application is not included in the client device 110, the client device 110 can use its web browser to access the e-commerce site (or a variant thereof) hosted on the networked system 102.

[0024] The web client 112 accesses the various systems of the networked system 102 via the web interface supported by a web server 122. Similarly, the programmatic client 116 and client application 114 access the various services and functions provided by the networked system 102 via the programmatic interface provided by an Application Program Interface (API) server 120.

[0025] Users (e.g., the user 106) can include a person, a machine, or other means of interacting with the client device 110. In some examples, the user 106 is not part of the network architecture 100, but interacts with the network architecture 100 via the client device 110 or another means. For instance, the user 106 provides input (e.g., touch screen input or alphanumeric input) to the client device 110 and the input is communicated to the networked system 102 via the network 104 by way of the second user interaction channel. In this instance, the networked system 102, in response to receiving the input from the user 106, communicates information to the client device 110 via the network 104 to be presented to the user 106. In this way, the user 106 can interact with the networked system 102 using the client device 110. As another example, the user 106 provides input (e.g., speech input) to the client device 110 and the input is communicated to the networked system 102 via the network 104 in the form of audio packets or audio data by way of the first user interaction channel.

[0026] The API server 120 and the web server 122 are coupled to, and provide programmatic and web interfaces respectively to, one or more application servers 140. The application servers 140 may host a listing network platform 142 (also referred to as a network platform) and a communication session system 150, each of which includes one or more modules/components or applications and each of which can be embodied as hardware, software, firmware, or any combination thereof. The application servers 140 are, in turn, shown to be coupled to one or more database servers 124 that facilitate access to one or more information storage repositories or databases 126. In an example, the databases 126 are storage devices that store information to be posted (e.g., inventory, image data, catalog data) to the listing network platform 142. The databases 126 also store digital goods

information, user profiles, and various other data used by the listing network platform 142 in accordance with some examples.

[0027] The listing network platform 142 provides a number of publication functions and listing services to the users who access the networked system 102. While the listing network platform 142 is shown in FIG. 1 to form part of the networked system 102, it will be appreciated that, in alternative examples, the listing network platform 142 may form part of a web service that is separate and distinct from the networked system 102. In some implementations, the communication session system 150 provides functionality to provide a smart or intelligent virtual agent that is controlled by one or more LLMs or one or more generative machine learning (ML) models to provide intelligent and automated responses to user queries or requests and perform intelligent and seamless authentication of the user based on historical interactions of the user, as discussed in further detail below. In some cases, the communication session system 150 uses the intelligent virtual agent to only provide a greeting message (e.g., a first initial message presented to a user upon receiving a request from the user to engage in the communication session). Then, the communication session system 150 uses a standard chatbot and default responses to address further inquiries. In some cases, the communication session system 150 continues to use the multiple LLMs or multiple generative ML models to respond continuously to subsequent user queries or requests. The communication session system 150 can, after initially establishing a communication session with the user 106, perform authentication using one or more techniques. For example, the communication session system 150 can authenticate the user by evaluating and scoring responses received from the user to queries or questions generated by the communication session system 150 (e.g., one or more LLMs), evaluating a voice signature of the user 106, and/or performing two-factor authentication of the user 106.

[0028] While the client-server–based network architecture 100 shown in FIG. 1 employs a client-server architecture, the disclosed techniques are not limited to such an architecture, and can equally be implemented in a distributed, or peer-to-peer, architecture system, for example. The various systems of the application servers 140 (e.g., the listing network platform 142 and communication session system 150) may also be implemented as standalone software programs, which do not necessarily have networking capabilities.

[0029] The listing network platform 142 can be hosted on dedicated or shared server machines that are communicatively coupled to enable communications between server machines. The components themselves are communicatively coupled (e.g., via appropriate

interfaces) to each other and to various data sources, so as to allow information to be passed between the applications or so as to allow the applications to share and access common data. Furthermore, the components access one or more databases 126 via the database servers 124. The listing network platform 142 provides a number of publishing and listing mechanisms whereby a seller (also referred to as a "first user," posting user, host) may list (or publish information concerning) goods or services for sale or barter; a buyer (also referred to as a "second user," searching user, guest) can express interest in or indicate a desire to purchase or barter such goods or services; and a transaction (such as a trade) may be completed pertaining to the goods or services. In some cases, the listing network platform 142 provides a publishing and listing platform whereby a host can make an accommodation available for a guest to reserve for any number of nights. The guest can select the accommodation and request to stay at the accommodation for a certain period of time. This is referred to as a reservation. Following the stay, information is stored in the guest profile and the host profile identifying the accommodation and the duration of stay.

[0030] FIG. 2 shows example functional engines of the communication session system 150, according to some examples. As illustrated, the communication session system 150 includes a user interaction channel 202 that is used to receive and provide inputs/outputs to a user 201, a generative ML model component 205, the database 126, a speech recognition engine 232, a communication session system 206, and/or a text to speech engine 234.

[0031] In some examples, the user 201 may desire to perform some action with the listing network platform 142 or request to initiate a communication session with the listing network platform 142 to assist with performing the action. For example, the user may desire to search for a listing for a reservation, modify one or more reservations held by the listing network platform 142, list a reservation on the listing network platform 142, communicate with a host of a listing on the listing network platform 142, request a refund for a reservation or cancel the reservation on the listing network platform 142, pay for services on the listing network platform 142, and/or to perform any other available function on the listing network platform 142. The listing network platform 142 can maintain a profile for the user 201 on the database 126 that stores various personal information about the user including historical interactions the user had with the listing network platform 142 and behaviors of the user on the listing network platform 142. The communication session system 206 and the generative ML model component 205 can use the profile for the user 201 to generate responses intelligently that are included in messages presented by an agent to the user via the user interaction channel 202. In some cases, the communication session

system 206 and the generative ML model component 205 can the profile information to formulate questions to present to the user 201 and to evaluate responses or answers received from the user 201 to those questions to perform authentication. After the user 201 is authenticated, the listing network platform 142 can enable the user 201 to perform any desired action on the listing network platform 142.

[0032] The user 201 may initiate contact with the listing network platform 142 through any number of user interaction channels, such as the user interaction channel 202 and/or a second user interaction channel. For example, the user 201 can establish the user interaction channel 202 with the listing network platform 142 by placing a telephone call using the client device 110 to a service phone number associated with the listing network platform 142. In response to receiving the telephone call, the listing network platform 142 searches a database that associates a telephone number of the client device 110 with an account of the user 201 on the listing network platform 142. Specifically, the listing network platform 142 receives the phone call and route the phone number of the client device 110 to a session management component of the communication session system 206. The session management component searches the database 126 to locate an account associated with the phone number on the listing network platform 142.

[0033] Once the session management component locates the account, the session management component retrieves a profile for the user 201 on the listing network platform 142 from the database 126 and provides access to the profile to the generative ML model component 205 (which can implement one or more machine learning models and/or LLMs). The generative ML model component 205 generates an intelligent message for presentation through an audible prompt on the client device 110 via the user interaction channel 202 or a visual prompt through another interaction channel. The message can include a question or set of questions about information stored in the profile.

[0034] The user interaction channel 202 receives verbal or audible input from the user 201 via the user interaction channel 202 (or textual responses through a graphical user interface) in response to presenting the message to the user 201. The communication session system 206 can convert the verbal input to text (e.g., using the speech recognition engine 232) and then communicate with the generative ML model component 205 to generate an additional message that responds to the verbal or audible input received from the user 201. Specifically, the generative ML model component 205 receives an additional prompt that requests the generative ML model component 205 to evaluate the response received from the user 201 to

the message with the question. The generative ML model component 205 determine whether the response received matches information stored in the profile. The generative ML model component 205 then generates a response that indicates whether the user 201 has successfully been authenticated. If so, the generative ML model component 205 instructs the communication session system 206 to allow the user 201 to perform one or more other operations or actions in the listing network platform 142.

[0035] In some examples, the communication session is initially started with the programmatic client 116, and the messages provided by the generative ML model component 205 are presented through the user interaction channel 202 on the programmatic client 116. For example, FIG. 3 shows a listings network site user interface 300 (e.g., mobile application user interface, web browser user interface) generated by the listing network platform 142 and communication session system 150, according to some examples. The user interface 300 can be presented by the programmatic client 116 implemented on the client device 110. As illustrated, the user interface 300 includes a search field 310, a filters menu element 315 (e.g., place type, amenities), and a search button 320. The user enters a listings query into the search field 310, such as a search for temporary housing in San Francisco, and a category limitation from the filters menu element 315 of "Entire Place" (e.g., the user seeks to rent the entire residence for said dates, as opposed to renting a private room in another person's residence). The user can customize the query directly using terms input into the search field 310 or filters listed via selection of the filters menu element 315. Further, the user can select dates using a dates drop-down element 317 to select a specific date range for the temporary stay. For example, the user can select the dates drop-down element 317 and a pop-up calendar (not depicted in FIG. 3) to specify the stay in San Francisco is to be specifically from July 16, 2021 to July 18, 2021.

[0036] Upon submitting the query (e.g., via selection of the search button 320, or automatically upon selecting a combined listings element 313 (split stays option) or dates drop-down element 317), a communication is sent from the programmatic client 116. The communication session system 150 generates an output that includes a results display of the listings matching the query and transmits the output via the programmatic client 116. The results are then displayed in the listings results area 305. The user can then select the listings or navigate to additional pages via page navigational elements 325. In some examples, the user interface 300 includes a set of combined listings 323 together with individual listings displayed in the results area 305. The combined listings 323 can be positioned within the display in a dedicated area, on top of the individual listings, between

two individual listings, and/or underneath the individual listings. In some examples, the combined listings 323 are provided in response to receiving input that selects the combined listings element 313. In some examples, the combined listings 323 are presented automatically without receiving input that selects the combined listings element 313.

[0037] In some examples, the combined listings 323 are displayed in different slots or portions of the display relative to other individual listings on the basis of the type of client device being used to access the system. For example, on a mobile device, the combined listings 323 can be placed in slots 8, 6, 9, and 12 on the first page, and on a desktop computer, the same combined listings 323 may be presented in slots 8, 9, 14, and 20 for better visual balance. As referred to herein, the term "slots" means an area of a display in which a category is presented. In some cases, the combined listings 323 are excluded from being presented for last minute stays, such as if the travel dates are within 48 hours of check in or starting the trip. In some examples, the combined listings 323 include individual listings of destinations or stays that are at least two hours driving distance apart but no more than 10 hours driving distance apart. In some examples, the combined listings 323 excludes repeating pairs of the same individual listings. In some examples, the combined listings 323 relate to pairs of individual listings from different neighborhoods and locations. In such cases, neighborhoods and listings can be repeated across pairs of combined listings 323.

[0038] The user interface 300 includes an option 390 to initiate a communication session for performing authentication to enable the user 201 to reserve an accommodation or listing. In response to receiving selection of the option 390, the programmatic client 116 transmits data to the communication session system 150 requesting that a virtual agent respond to requests from the user. The communication session system 150, in response to receiving the indication that the option 390 was selected, identifies a profile associated with the account for which the user interface 300 is presented. The communication session system 150 presents a message that includes a query or question that is unique and tailored to the user based on past interactions the user had with the listing network platform 142.

[0039] Referring back to FIG. 2, the generative ML model component 205 can implement one or more LLMs or any other suitable artificial neural network or convolutional neural network. The one or more LLMs can receive a prompt that includes instructions for retrieving or identifying relevant portions of a user profile that correspond to past interactions the user had with the listing network platform 142 (e.g., past reservations the user made with the listing network platform 142). In some cases, the prompt can include a

time period, such as a prior two-week period. The one or more LLMs can process the profile and only focus on activity that occurred within the specified time period. The generative ML model component 205 can extract, in real time, data from the profile representing past user interactions with the network platform. This information is used by the generative ML model component 205 to generate, in real time, a prompt using the extracted information, such as a prompt to generate a message with a query about a portion of the past user interactions.

[0040] The generative ML model component 205 implements one or more LLMs or suitable artificial/convolutional neural networks designed to process prompts and user profile data. These LLMs receive prompts containing instructions for retrieving relevant portions of a user's profile, focusing on past interactions with the listing network platform 142. Prompts may include a specified time period to narrow the scope of data extraction. The generative ML model component 205 extracts data from the user profile in real-time, targeting information representing past user interactions with the network platform. When a time period is specified, the LLMs process the profile data with a focus on activity within that timeframe, including efficient indexing and filtering mechanisms. Using the extracted information, the generative ML model component 205 generates a new prompt in real-time, designed to create a message querying about specific portions of the user's past interactions. The entire process, from receiving the initial prompt to generating the new prompt, occurs in real-time, to provide a highly optimized processing pipeline with minimal latency. The system has robust data integration capabilities to quickly access and process user profile information from the platform's databases. Given its real-time nature, the system is designed to handle multiple concurrent requests efficiently, providing a sophisticated AI system capable of quickly extracting relevant user data, processing it through advanced language models, and generating contextually appropriate prompts for further interaction.

[0041] The one or more LLMs can be trained on massive text datasets, often containing billions of words. The goal of this training is to teach the one or more LLMs the statistical relationships between words and language concepts found in the texts. The one or more LLMs can include neural networks, consisting of artificial neurons arranged in layers. Each neuron assigns weights to input words to predict the next word in a sequence. The training process tunes these weights through an algorithm called back-propagation and gradient descent. With enough training examples, the first LLM can learn nuanced patterns in language and generate coherent, human-like text.

[0042] During training, the one or more LLMs are shown text excerpts (e.g., from profiles of various users), asked to predict the next word, and then corrected on its guess. Over many iterations across the training dataset, prediction errors are progressively reduced as the one or more LLMs adjust its internal weights. Once trained, the one or more LLMs can generate text by being given a prompt and predicting the most statistically likely next words (e.g., the words from a profile that match the prompt indicating a request to retrieve relevant information from the profile). The training process allows the one or more LLMs to develop a substantial understanding of language structure and semantics.

[0043] In some examples, the communication session system 150 retrieves a profile for the user 201 from the database 126 and obtains information or activity that is associated with timestamps that are less than or equal to the prior time period. For example, the communication session system 150 retrieves activity that occurred within two months prior to a current date. The communication session system 150 can provide that portion of the profile together with a prompt to a query generation component 214.

[0044] For example, the query generation component 214 generates the prompt 400, shown in FIG. 4. The prompt 400 can include a first portion 410 with a default prompt retrieved from the database 126 with instructions to generate a set of questions based on a profile. The prompt 400 can be modified to include a second portion 420 with custom information included in the profile.

[0045] For example, the prompt 400 can include the first portion 410 with an instruction indicating that the query generation component 214 is a validator within an authentication system and is provided with some information about a user, such as personal information, reservation details, and experience history. The first portion 410 includes in the instruction a request to generate verification questions to complete the knowledge-based authentication process keeping in mind that the questions need to be open-ended, can be fake questions built with incorrect information, need to avoid disclosing sensitive or personal information about the user, and need to be brief in case they are presented audibly.

[0046] The second portion 420 can include various information retrieved from the profile of the user 201. For example, the information can include a name of the user, an email address, a registration date, and a set of one or more previous stays or reservations the user made with the listing network platform 142 or listings the user created with the listing network platform 142.

[0047] The query generation component 214 generates the prompt 400 or receives the prompt from the communication session system 206 and processes the prompt 400 to generate a message for presentation to the user 201. The message is provided to the communication session system 206, which can process the message by the text to speech engine 234 to generate speech representing the message. The speech is then presented to the user 201 on the client device 110, such as by the virtual agent, audibly including the message generated by the query generation component 214 that includes the question or questions about the profile of the 201. In some cases, the message is presented textually to the user 201, in which case the text to speech engine 234 is not utilized to convert the message to speech.

[0048] In some examples, the communication session system 150 receives additional input from the user after the virtual agent presents the message to the user 201 with the question or query about the profile. In response to receiving the additional input (e.g., a response from the user 201 to the question posed by the message presented by the virtual agent), the communication session system 150 processes the additional input by speech recognition engine 232 to convert the verbal input that includes the response to textual form. If the response from the user 201 was received textually, this operation is skipped. The textual form of the response received from the user 201 is provided from the communication session system 206 to a response analysis component 218.

[0049] The response analysis component 218 accesses a prompt with instructions to evaluate a question generated by the query generation component 214 using a profile of a user and confirm whether a response received from the user matches the information stored in the profile. Namely, the response analysis component 218 processes the prompt to score the response based on how well the answer received from the user 201 to the response to the query generated by the query generation component 214. The score associated with the response can be generated based on a difficulty level associated with the query generated by the query generation component 214. The query generation component 214 can assign different difficulty levels to the set of questions and can provide that level to the response analysis component 218. The response analysis component 218 can determine whether the score associated with the response transgresses a threshold score. Based on determining whether the score associated with the response transgresses the threshold score, the response analysis component 218 can control the communication session system 206 to either provide an additional message to the user 201 with an additional question generated by the query generation component 214 or authenticate the user 201 through other means, such as

performing two-factor authentication, and/or inform the communication session system 206 that the user has successfully been authenticated to allow the user 201 to perform other actions on the listing network platform 142.

[0050] The scoring mechanism for the response analysis component 218 can be implemented using a sophisticated natural language processing (NLP) and machine learning approach. The system can employ a combination of semantic similarity algorithms, such as cosine similarity or Word Mover's Distance, to compare the user's response with the expected answer derived from their profile. To account for variations in language and phrasing, the system can utilize word embeddings or more advanced language models like BERT or GPT to capture the semantic meaning of responses. The difficulty level assigned by the query generation component 214 could be incorporated as a weighting factor in the scoring algorithm, with more difficult questions potentially having a higher impact on the overall score. To handle nuanced responses, the system can implement a multi-faceted scoring approach, evaluating different aspects of the answer such as factual correctness, relevance, and completeness. This could involve breaking down the expected answer into key components and scoring each separately. The system could also employ a machine learning model trained on a dataset of user responses and their corresponding correctness ratings to predict the likelihood of a response being genuine. To ensure robustness, the scoring mechanism can incorporate anomaly detection techniques to identify unusual patterns in responses that could indicate potential fraud attempts. The final score could be calculated using a weighted sum or more complex ensemble method that combines these various factors, with the weights potentially adjusted dynamically based on historical performance data to optimize the system's accuracy over time.

[0051] In some cases, the score for the response is further based on a voice signature of the user 201. For example, the communication session system 206 provides a portion of voice input received from the user 201 to a biometrics component 220. The biometrics component 220 generates a voice signature based on the portion of the voice input. The biometrics component 220 accesses a previously stored voice profile for the user 201 from the database 126 (e.g., the voice profile (voice biometrics profile) can be stored as part of the user profile). The biometrics component 220 compares the voice signature that is generated based on the portion of the voice input to a signature stored in the voice profile. The biometrics component 220 generates a score representing how well the two signatures match and can provide that score to the response analysis component 218. The response analysis

component 218 can adjust the score of the response received from the user based on the score provided by the biometrics component 220.

[0052] In some examples, the response analysis component 218 determines that the scored response (with or without the adjustment for the voice signature) transgresses the threshold score. In such cases, the response analysis component 218 indicates to the communication session system 206 that the user has successfully been authenticated. In response, the communication session system 206 can present a message (verbally or visually) to the user 201 on the client device 110 indicating that the user 201 has been successfully authenticated.

[0053] In some examples, the response analysis component 218 determines that the scored response (with or without the adjustment for the voice signature) fails to transgress the threshold score. In such cases, the response analysis component 218 indicates to the communication session system 206 that the user has yet to be successfully authenticated. In response, the communication session system 206 can present a message (verbally or visually) to the user 201 on the client device 110 indicating that the user 201 has not been successfully authenticated. The communication session system 206 communicates with the query generation component 214 to generate and/or obtain a previously generated additional question or query based on the user's past interactions with the listing network platform 142. The communication session system 206 again sends a message to the user 201 that includes the additional question or query and receives an additional response from the user 201. The communication session system 206 provides that response to the response analysis component 218 to recompute a score (with or without the adjustment for the voice signature). In response to determining that the additional question score still fails to transgress the threshold score, the response analysis component 218 can instruct the communication session system 206 to authenticate the user 201 through other means, such as using two-factor authentication or authentication using a live agent or representative.

[0054] In some cases, the communication session system 206 provides the initial or subsequent responses received from the user 201 to a sentiment analysis component 222. The sentiment analysis component 222 can implement an LLM that is prompted to evaluate the response and generate a score representing sentiment or level of urgency of the user 201. The sentiment analysis component 222 processes the response(s) received from the user 201 and generates a score indicating the level or urgency. In response to determining that the score indicating the level of urgency transgresses a threshold level of urgency, the communication session system 206 can immediately establish a communication session

between the user 201 and a live agent (or perform authentication using two-factor authentication) and skip authenticating the user by checking whether the response includes a correct answer to the question posed by the query generation component 214 using the response analysis component 218.

[0055] For example, as shown in FIG. 5, the communication session system 150 can receive a phone call 500 from the user. The communication session system 150 generates a message 510 for presentation to the user verbally on the phone call. The message 510 is generated based on the generative ML model component 205 using the profile information associated with the user. The message 510 can be used to authenticate the user by asking the user questions about the user's past or historical interactions with the listing network platform 142 and evaluating the accuracy of the user's response. Namely, the message 510 can ask the user in which city the user stayed on a particular month of the year, where the user stayed in a particular trip, what kind of property the user stayed in a particular trip, which date the user registered the account, and/or other questions. The user can answer one or more of the questions and the generative ML model component 205 generates a score indicating how accurate the answer matches the question and the information stored in the profile.

[0056] To give a specific example?, the generative ML model component 205 accesses the profile for the user and determines that the user had a prior reservation for a beach house in Malibu, checking in on July 5th and checking out on July 10th. In response, the generative ML model component 205 can generate a set of questions to present in the message 510, such as: “Can you tell us about the type of property you stayed in during your last visit to Malibu?” and/or "What were your check-in and check-out dates for your recent stay in Malibu?" The questions are uniquely generated based on the user's traveling history, as well as personal info, ensuring a personalized authentication process that is difficult for impostors to bypass. The conversational, story-based approach reduces user friction and enhances engagement, improving overall satisfaction with the customer support interaction.

[0057] The generative ML model component 205 interprets user responses contextually, allowing for a degree of flexibility in answers and enabling the system to request clarification when needed. The generative ML model component 205 receives the response to the questions in the message 510 (e.g., the user responds with a particular date or range of dates relating to the stay in Malibu). Based on the response, the generative ML model component 205 generates a score. For example, if the user responds with a particular month

that matches the month associated with the trip to Malibu, the generative ML model component 205 generates a first score. For example, if the user responds with a particular date in the correct month that matches the month but not the day associated with the trip to Malibu, the generative ML model component 205 generates a second score. For example, if the user responds with a particular date in the correct month that matches the month and the day associated with the trip to Malibu, the generative ML model component 205 generates a third score. The third score can be greater than the second score which can be greater than the first score. This way, the level of accuracy in the user's response controls the score for the response. If the response is very accurate with a high score, no additional questions need to be answered and the user is automatically authenticated. If the response has a medium accuracy score, one or more additional questions may need to be answered before successfully authenticating the user.

[0058] As another example, the generative ML model component 205 crafts an interactive story that incorporates details from the user's booking history. For example, the generative ML model component 205 might ask, "Can you tell us about the Airbnb experience you booked during your stay in Hawaii last December?" The user responds with details about the surfing lesson he booked through the listing network platform 142 which aligns with the information on his profile. Authentication can be successful based on the user's answers and voiceprint matching the stored data, confirming his identity. In such cases, the communication session system 150 then allows the user to proceed with his inquiry or transaction.

[0059] FIG. 6 shows a diagram of a flow of operations of the communication session system 150, according to some examples. Namely, as shown in FIG. 6, operations of a service-based system architecture implemented by the communication session system 150 for an Interactive Story-Based Authentication System with Integrated Voice Recognition are provided. The diagram 636 of FIG. 6 depicts the flow of operations of a single interaction during the authentication process, showcasing the interconnected components and their roles in facilitating secure user verification.

[0060] The process begins when a customer (e.g., user 624) initiates an inbound phone call at operation 638 to be authenticated. This call is received by the IVR 626, which serves as the primary interface for user interaction. Upon receiving the call, the IVR 626 communicates with Internal Services 628 (e.g., the generative ML model component 205, database 126, and/or communication session system 206) to gather relevant information at

operation 640 about the user, such as reservation details and personal information at operation 642.

[0061] With this collected data, the IVR 626 at operation 644 then prepares prompts for question generation and sends them to the generative ML model component 205 (e.g., the one or more LLMs 630) at operation 646. The generative ML model component 205 processes the information and generates tailored authentication questions based on the user's history and current context at operation 648. Once the questions are generated, they are sent back to the IVR system in text format at operation 650. The Text to Speech Engine 632 then converts this text into an audio stream at operation 652, which is subsequently played to the user through the IVR 626 at operation 654.

[0062] The user's verbal response is captured as an audio stream at operation 656 and processed by the Speech Recognition Engine 634 at operation 658, which converts the speech into text at operation 660. This text is then sent back to the LLM for analysis and validation at operation 662. Based on the user's response, the LLM 630 determines the next step in the authentication process. It may approve the authentication, reject it, request more information, or initiate a second round of questioning at operation 664. This decision is communicated back to the IVR 626, which then proceeds accordingly. In some cases, the IVR 626 communicates the authentication result to the user 624 at operation 666.

[0063] Throughout this process, the system maintains a continuous flow of information between its various components, ensuring a seamless and secure authentication experience. The architecture's design allows for dynamic, context-aware questioning and real-time voice analysis, significantly enhancing the security and efficiency of the authentication process compared to traditional methods.

[0064] FIG. 7 illustrates a routine 700 (method or process) in accordance with some examples. The operations discussed in connection with FIG. 7 can be performed sequentially, in parallel, and in any suitable order.

[0065] In operation 712, routine 700 receives, by a network site, a user interaction in a communication session with an agent of a network platform, as discussed above.

[0066] In operation 714, routine 700 generates a prompt using a profile associated with the user on the network platform representing past user interactions with the network platform, as discussed above.

[0067] In operation 716, routine 700 processes the prompt by a generative machine learning model to generate a message comprising a query about a portion of the past user interactions, as discussed above.

[0068] In operation 718, routine 700 presents the message by the agent of the network platform to the user in a user interface of the listing network platform, as discussed above.

[0069] In operation 720, routine 700 authenticates the user at least in part based on a response received from the user based on the message presented by the agent that includes the query about the portion of the past user interactions, as discussed above.

[0070] **FIG. 8** is a block diagram 800 illustrating an architecture of software 802, which can be installed on any one or more of the devices described above. FIG. 8 is merely a non-limiting example of a software architecture, and it will be appreciated that many other architectures can be implemented to facilitate the functionality described herein. In various examples, the software 802 is implemented by hardware such as a machine 838 of FIG. 8 that includes processors 840, memory 842, and input/output (I/O) components 844. In this example architecture, the software 802 can be conceptualized as a stack of layers where each layer may provide a particular functionality. For example, the software 802 includes layers such as an operating system 804, libraries 806, frameworks 808, and applications 810. Operationally, the applications 810 invoke API calls 812 through the software stack and receive messages 814 in response to the API calls 812, consistent with some examples.

[0071] In various implementations, the operating system 804 manages hardware resources and provides common services. The operating system 804 includes, for example, a kernel 820, services 822, and drivers 824. The kernel 820 acts as an abstraction layer between the hardware and the other software layers, consistent with some examples. For example, the kernel 820 provides memory management, processor management (e.g., scheduling), component management, networking, and security settings, among other functionality. The services 822 can provide other common services for the other software layers. The drivers 824 are responsible for controlling or interfacing with the underlying hardware, according to some examples. For instance, the drivers 824 can include display drivers, camera drivers, BLUETOOTH® or BLUETOOTH® Low Energy drivers, flash memory drivers, serial communication drivers (e.g., Universal Serial Bus (USB) drivers), WI-FI® drivers, audio drivers, power management drivers, and so forth.

[0072] In some examples, the libraries 806 provide a low-level common infrastructure utilized by the applications 810. The libraries 806 can include system libraries 830 (e.g., C

standard library) that can provide functions such as memory allocation functions, string manipulation functions, mathematic functions, and the like. In addition, the libraries 806 can include API libraries 832 such as media libraries (e.g., libraries to support presentation and manipulation of various media formats such as Moving Picture Experts Group-4 (MPEG4), Advanced Video Coding (H.264 or AVC), Moving Picture Experts Group Layer-3 (MP3), Advanced Audio Coding (AAC), Adaptive Multi-Rate (AMR) audio codec, Joint Photographic Experts Group (JPEG or JPG), or Portable Network Graphics (PNG)), graphics libraries (e.g., an OpenGL framework used to render in two dimensions (2D) and three dimensions (3D) in a graphic content on a display), database libraries (e.g., SQLite to provide various relational database functions), web libraries (e.g., WebKit to provide web browsing functionality), and the like. The libraries 806 can also include a wide variety of other libraries 834 to provide many other APIs to the applications 810.

[0073] The frameworks 808 provide a high-level common infrastructure that can be utilized by the applications 810, according to some examples. For example, the frameworks 808 provide various GUI functions, high-level resource management, high-level location services, and so forth. The frameworks 808 can provide a broad spectrum of other APIs that can be utilized by the applications 810, some of which may be specific to a particular operating system or platform.

[0074] In an example, the applications 810 include a home application 850, a contacts application 852, a browser application 854, a book reader application 856, a location application 858, a media application 860, a messaging application 862, a game application 864, and a broad assortment of other applications such as a third-party application 866. According to some examples, the applications 810 are programs that execute functions defined in the programs. Various programming languages can be employed to create one or more of the applications 810, structured in a variety of manners, such as object-oriented programming languages (e.g., Objective-C, Java, Kotlin, Ruby, or C++) or procedural programming languages (e.g., C or assembly language). In a specific example, the third-party application 866 (e.g., an application developed using the ANDROID™ or IOS™ software development kit (SDK) by an entity other than the vendor of the particular platform) may be mobile software running on a mobile operating system such as IOS™, ANDROID™, WINDOWS® Phone, or another mobile operating system. In this example, the third-party application 866 can invoke the API calls 812 provided by the operating system 804 to facilitate the functionality described herein.

[0075] FIG. 9 illustrates a diagrammatic representation of a machine 900 in the form of a computer system within which a set of instructions may be executed for causing the machine to perform any one or more of the methodologies discussed herein, according to an example. Specifically, FIG. 9 shows a diagrammatic representation of the machine 900 in the example form of a computer system, within which instructions 916 (e.g., software, a program, an application, an applet, an app, or other executable code) for causing the machine 900 to perform any one or more of the methodologies discussed herein may be executed. The instructions 916 transform the general, non-programmed machine 900 into a particular machine 900 programmed to carry out the described and illustrated functions in the manner described. In alternative examples, the machine 900 operates as a standalone device or may be coupled (e.g., networked) to other machines. In a networked deployment, the machine 900 may operate in the capacity of a server machine or a client machine in a server-client network environment, or as a peer machine in a peer-to-peer (or distributed) network environment. The machine 900 may comprise, but not be limited to, a server computer, a client computer, a PC, a tablet computer, a laptop computer, a netbook, an STB, a PDA, an entertainment media system, a cellular telephone, a smart phone, a mobile device, a wearable device (e.g., a smart watch), a smart home device (e.g., a smart appliance), other smart devices, a web appliance, a network router, a network switch, a network bridge, or any machine capable of executing the instructions 916, sequentially or otherwise, that specify actions to be taken by the machine 900. Further, while only a single machine 900 is illustrated, the term "machine" shall also be taken to include a collection of machines 900 that individually or jointly execute the instructions 916 to perform any one or more of the methodologies discussed herein.

[0076] The machine 900 may include processors 910, memory 930, and I/O components 950, which may be configured to communicate with each other such as via a bus. In an example, the processors 910 (e.g., a Central Processing Unit (CPU), a Reduced Instruction Set Computing (RISC) processor, a Complex Instruction Set Computing (CISC) processor, a Graphics Processing Unit (GPU), a Digital Signal Processor (DSP), an ASIC, a Radio-Frequency Integrated Circuit (RFIC), another processor, or any suitable combination thereof) may include, for example, a processor 912 and a processor 914 that may execute the instructions 916. The term "processor" is intended to include multi-core processors that may comprise two or more independent processors (sometimes referred to as "cores") that may execute instructions contemporaneously. Although FIG. 9 shows multiple processors 910, the machine 900 may include a single processor with a single core, a single processor

with multiple cores (e.g., a multi-core processor), multiple processors with a single core, multiple processors with multiples cores, or any combination thereof.

[0077] The memory 930 may include a main memory 932, a static memory 934, and a storage unit 936, all accessible to the processors 910 such as via the bus. The main memory 932, the static memory 934, and storage unit storage unit 936 store the instructions 916 embodying any one or more of the methodologies or functions described herein. The instructions 916 may also reside, completely or partially, within the main memory 932, within the static memory 934, within the storage unit 936, within at least one of the processors 910 (e.g., within the processor's cache memory), or any suitable combination thereof, during execution thereof by the machine 900.

[0078] The I/O components 950 may include a wide variety of components to receive input, provide output, produce output, transmit information, exchange information, capture measurements, and so on. The specific I/O components 950 that are included in a particular machine will depend on the type of machine. For example, portable machines such as mobile phones will likely include a touch input device or other such input mechanisms, while a headless server machine will likely not include such a touch input device. It will be appreciated that the I/O components 950 may include many other components that are not shown in FIG. 9. The I/O components 950 are grouped according to functionality merely for simplifying the following discussion and the grouping is in no way limiting. In various examples, the I/O components 950 may include output components 952 and input components 954. The output components 952 may include visual components (e.g., a display such as a plasma display panel (PDP), a light emitting diode (LED) display, a liquid crystal display (LCD), a projector, or a cathode ray tube (CRT)), acoustic components (e.g., speakers), haptic components (e.g., a vibratory motor, resistance mechanisms), other signal generators, and so forth. The input components 954 may include alphanumeric input components (e.g., a keyboard, a touch screen configured to receive alphanumeric input, a photo-optical keyboard, or other alphanumeric input components), point-based input components (e.g., a mouse, a touchpad, a trackball, a joystick, a motion sensor, or another pointing instrument), tactile input components (e.g., a physical button, a touch screen that provides location and/or force of touches or touch gestures, or other tactile input components), audio input components (e.g., a microphone), and the like.

[0079] In further examples, the I/O components 950 may include biometric components 956, motion components 958, environmental components 960, or position components 962,

among a wide array of other components. For example, the biometric components 956 may include components to detect expressions (e.g., hand expressions, facial expressions, vocal expressions, body gestures, or eye tracking), measure biosignals (e.g., blood pressure, heart rate, body temperature, perspiration, or brain waves), identify a person (e.g., voice identification, retinal identification, facial identification, fingerprint identification, or electroencephalogram-based identification), and the like. The motion components 958 may include acceleration sensor components (e.g., accelerometer), gravitation sensor components, rotation sensor components (e.g., gyroscope), and so forth. The environmental components 960 may include, for example, illumination sensor components (e.g., photometer), temperature sensor components (e.g., one or more thermometers that detect ambient temperature), humidity sensor components, pressure sensor components (e.g., barometer), acoustic sensor components (e.g., one or more microphones that detect background noise), proximity sensor components (e.g., infrared sensors that detect nearby objects), gas sensors (e.g., gas detection sensors to detect concentrations of hazardous gases for safety or to measure pollutants in the atmosphere), or other components that may provide indications, measurements, or signals corresponding to a surrounding physical environment. The position components 962 may include location sensor components (e.g., a GPS receiver component), altitude sensor components (e.g., altimeters or barometers that detect air pressure from which altitude may be derived), orientation sensor components (e.g., magnetometers), and the like.

[0080] Communication may be implemented using a wide variety of technologies. The I/O components 950 may include communication components 964 operable to couple the machine 900 to a network 980 or devices via a coupling 973 and a coupling, respectively. For example, the communication components 964 may include a network interface component or another suitable device to interface with the network 980. In further examples, the communication components 964 may include wired communication components, wireless communication components, cellular communication components, Near Field Communication (NFC) components, Bluetooth® components (e.g., Bluetooth® Low Energy), Wi-Fi® components, and other communication components to provide communication via other modalities. The devices 970 may be another machine or any of a wide variety of peripheral devices (e.g., a peripheral device coupled via a USB).

[0081] Moreover, the communication components 964 may detect identifiers or include components operable to detect identifiers. For example, the communication components 964 may include Radio Frequency Identification (RFID) tag reader components, NFC smart

tag detection components, optical reader components (e.g., an optical sensor to detect one-dimensional bar codes such as Universal Product Code (UPC) bar code, multi-dimensional bar codes such as Quick Response (QR) code, Aztec code, Data Matrix, Dataglyph, MaxiCode, PDF417, Ultra Code, UCC RSS-2D bar code, and other optical codes), or acoustic detection components (e.g., microphones to identify tagged audio signals). In addition, a variety of information may be derived via the communication components 964, such as location via Internet Protocol (IP) geolocation, location via Wi-Fi® signal triangulation, location via detecting an NFC beacon signal that may indicate a particular location, and so forth.

[0082] The various memories (e.g., memory 930, main memory 932, static memory 934, and/or memory of the processor(s) processors 910) and/or storage unit 936 may store one or more sets of instructions and data structures (e.g., software) embodying or utilized by any one or more of the methodologies or functions described herein. These instructions (e.g., the instructions 916), when executed by processor(s) 910, cause various operations to implement the disclosed examples.

[0083] As used herein, the terms "machine-storage medium," "device-storage medium," and "computer-storage medium" mean the same thing and may be used interchangeably in this disclosure. The terms refer to a single or multiple storage devices and/or media (e.g., a centralized or distributed database, and/or associated caches and servers) that store executable instructions and/or data. The terms shall accordingly be taken to include, but not be limited to, solid-state memories, and optical and magnetic media, including memory internal or external to processors. Specific examples of machine-storage media, computer-storage media and/or device-storage media include non-volatile memory, including by way of example semiconductor memory devices, e.g., erasable programmable read-only memory (EPROM), electrically erasable programmable read-only memory (EEPROM), FPGA, and flash memory devices; magnetic disks such as internal hard disks and removable disks; magneto-optical disks; and CD-ROM and DVD-ROM disks. The terms "machine-storage media," "computer-storage media," and "device-storage media" specifically exclude carrier waves, modulated data signals, and other such media, at least some of which are covered under the term "signal medium" discussed below.

[0084] In various examples, one or more portions of the network 980 may be an ad hoc network, an intranet, an extranet, a VPN, an LAN, a WLAN, a WAN, a WWAN, an MAN, the Internet, a portion of the Internet, a portion of the PSTN, a plain old telephone service

(POTS) network, a cellular telephone network, a wireless network, a Wi-Fi® network, another type of network, or a combination of two or more such networks. For example, the network 980 or a portion of the network 980 may include a wireless or cellular network, and the coupling 982 may be a Code Division Multiple Access (CDMA) connection, a Global System for Mobile communications (GSM) connection, or another type of cellular or wireless coupling. In this example, the coupling 982 may implement any of a variety of types of data transfer technology, such as Single Carrier Radio Transmission Technology (1xRTT), Evolution-Data Optimized (EVDO) technology, General Packet Radio Service (GPRS) technology, Enhanced Data rates for GSM Evolution (EDGE) technology, third Generation Partnership Project (3GPP) including 3G, fourth-generation wireless (4G) networks, Universal Mobile Telecommunications System (UMTS), High Speed Packet Access (HSPA), Worldwide Interoperability for Microwave Access (WiMAX), Long Term Evolution (LTE) standard, others defined by various standard-setting organizations, other long-range protocols, or other data transfer technology.

[0085] The instructions 916 may be transmitted or received over the network 980 using a transmission medium via a network interface device (e.g., a network interface component included in the communication 964 components) and utilizing any one of a number of well-known transfer protocols (e.g., hypertext transfer protocol (HTTP)). Similarly, the instructions 916 may be transmitted or received using a transmission medium via the coupling (e.g., a peer-to-peer coupling) to the devices 972. The terms "transmission medium" and "signal medium" mean the same thing and may be used interchangeably in this disclosure. The terms "transmission medium" and "signal medium" shall be taken to include any intangible medium that is capable of storing, encoding, or carrying the instructions 916 for execution by the machine 900, and includes digital or analog communications signals or other intangible media to facilitate communication of such software. Hence, the terms "transmission medium" and "signal medium" shall be taken to include any form of modulated data signal, carrier wave, and so forth. The term "modulated data signal" means a signal that has one or more of its characteristics set or changed in such a matter as to encode information in the signal.

[0086] In view of the disclosure above, various examples are set forth below. It should be noted that one or more features of an example, taken in isolation or combination, should be considered within the disclosure of this application.

[0087] Example 1. A method comprising: receiving, by a network site, a user interaction in a communication session with a virtual agent of a network platform; identifying a set of past user interactions stored in a profile on the network platform the user performed within a specified period of time; extracting, in real time, data from a profile representing past user interactions with the network platform; generating, in real time, a prompt using the data extracted from the profile; processing the prompt by a generative machine learning model to generate a message comprising a query about a portion of the past user interactions; presenting, on an output device, the message by the virtual agent of the network platform to the user in a user interface of the network platform; and authenticating the user at least in part based on a response received, in real time, from the user based on the message presented by the virtual agent that includes the query about the portion of the past user interactions.

[0088] Example 2. The method of Example 1, wherein the agent comprises a virtual agent of a listing network platform for reserving one or more accommodations, wherein the machine learning model comprises one or more large language models (LLMs).

[0089] Example 3. The method of any one of Examples 1-2, wherein the communication session comprises an interactive voice response (IVR) communication session.

[0090] Example 4. The method of any one of Examples 1-3, wherein the communication session comprises an online chat communication session.

[0091] Example 5. The method of any one of Examples 1-4, further comprising: generating an additional prompt based on the response received from the user and the profile, the additional prompt comprising an instruction to verify whether the response correctly answers the query; and processing, by the generative machine learning model, the additional prompt to generate an output representing accuracy of the response.

[0092] Example 6. The method of any one of Examples 1-5, further comprising: presenting the output to the user.

[0093] Example 7. The method of any one of Examples 1-6, further comprising: transcribing voice input comprising the response into textual form; and generating the additional prompt using the textual form of the response.

[0094] Example 8. The method of any one of Examples 1-7, wherein the query comprises one or more targeted authentication questions about the profile.

[0095] Example 9. The method of any one of Examples 1-8, further comprising: adding, to the prompt, reservation activity information representing one or more reservations associated with the user corresponding to a specified time period.

[0096] Example 10. The method of any one of Examples 1-9, wherein the profile comprises behavior data associated with the user, a name of the user, destination and check-in information associated with one or more past reservations, content of a conversation between the user and a host of the one or more reservations, and search activity performed by the user on the network platform.

[0097] Example 11. The method of any one of Examples 1-10, further comprising: scoring the response received from the user based on one or more factors, the one or more factors comprising a level of difficulty associated with the query.

[0098] Example 12. The method of any one of Examples 1-11, further comprising: accessing a voice biometrics profile associated with the user; generating a voice signature based on the response received from the user; and comparing the voice signature to the voice biometrics profile to authenticate the user.

[0099] Example 13. The method of any one of Examples 1-12, further comprising: scoring the response received from the user based on a level of confidence computed in response to comparing the voice signature to the voice biometrics profile.

[0100] Example 14. The method of any one of Examples 1-13, further comprising: comparing the scored response to a threshold; and determining whether the scored response transgresses the threshold.

[0101] Example 15. The method of any one of Examples 1-14, further comprising: in response to determining that the scored response transgresses the threshold, enabling the user to complete one or more interactions with the network platform based on being an authenticated user.

[0102] Example 16. The method of any one of Examples 1-15, further comprising: in response to determining that the scored response fails to transgress the threshold, generating an additional prompt using the profile associated with the user on the network platform representing past user interactions with the network platform; processing the additional prompt by the generative machine learning model to generate an additional message comprising an additional query about an additional portion of the past user interactions; presenting the additional message by the agent of the network platform to the user in the user interface of the network platform; and authenticating the user at least in part based on

an additional response received from the user based on the additional message presented by the agent.

[0103] Example 17. The method of any one of Examples 1-16, further comprising: in response to determining that the scored response fails to transgress the threshold, authenticating the user based on a different authentication protocol comprising two-factor authentication.

[0104] Example 18. The method of any one of Examples 1-17, further comprising: processing verbal input received from the user in the communication session by the generative machine learning model to compute a level of urgency associated with the user; determining that the level of urgency transgresses an urgency threshold; and in response to determining that the level of urgency transgresses the urgency threshold, establishing a communication session with a live agent instead of authenticating the user based on responses to queries about the past user interactions.

[0105] The terms "machine-readable medium," "computer-readable medium," and "device-readable medium" mean the same thing and may be used interchangeably in this disclosure. The terms are defined to include both machine-storage media and transmission media. Thus, the terms include both storage devices/media and carrier waves/modulated data signals.

[0106] Any biometric data collected by the biometric components is captured and stored only with user approval and deleted on user request. Further, such biometric data may be used for very limited purposes, such as identification verification. To ensure limited and authorized use of biometric information and other personally identifiable information (PII), access to this data is restricted to authorized personnel only, if at all. Any use of biometric data may strictly be limited to identification verification purposes, and the data is not shared or sold to any third party without the explicit consent of the user. In addition, appropriate technical and organizational measures are implemented to ensure the security and confidentiality of this sensitive information.

What is claimed is:

1. A method comprising:

receiving, by a network site, a user interaction in a communication session with a virtual agent of a network platform;

identifying a set of past user interactions stored in a profile on the network platform the user performed within a specified period of time;

extracting, in real time, data from a profile representing past user interactions with the network platform;

generating, in real time, a prompt using the data extracted from the profile;

processing the prompt by a generative machine learning model to generate a message comprising a query about a portion of the past user interactions;

presenting, on an output device, the message by the virtual agent of the network platform to the user in a user interface of the network platform; and

authenticating the user at least in part based on a response received, in real time, from the user based on the message presented by the virtual agent that includes the query about the portion of the past user interactions.

2. The method of claim 1, wherein the virtual agent is associated with a listing network platform for reserving one or more accommodations, wherein the machine learning model comprises one or more large language models (LLMs).

3. The method of claim 1, wherein the communication session comprises an interactive voice response (IVR) communication session.

4. The method of claim 1, wherein the communication session comprises an online chat communication session.

5. The method of claim 1, further comprising:

generating an additional prompt based on the response received from the user and the profile, the additional prompt comprising an instruction to verify whether the response correctly answers the query; and

processing, by the generative machine learning model, the additional prompt to generate an output representing accuracy of the response.

6. The method of claim 5, further comprising:

presenting the output to the user.

7. The method of claim 5, further comprising:

transcribing voice input comprising the response into textual form; and

generating the additional prompt using the textual form of the response.

8. The method of claim 1, wherein the query comprises one or more targeted authentication questions about the profile.

9. The method of claim 1, further comprising:

adding, to the prompt, reservation activity information representing one or more reservations associated with the user corresponding to a specified time period.

10. The method of claim 1, wherein the profile comprises behavior data associated with the user, a name of the user, destination and check-in information associated with one or more past reservations, content of a conversation between the user and a host of the one or more reservations, and search activity performed by the user on the network platform.

11. The method of claim 1, further comprising:

scoring the response received from the user based on one or more factors, the one or more factors comprising a level of difficulty associated with the query.

12. The method of claim 11, further comprising:

accessing a voice biometrics profile associated with the user;

generating a voice signature based on the response received from the user; and

comparing the voice signature to the voice biometrics profile to authenticate the user.

13. The method of claim 12, further comprising:

scoring the response received from the user based on a level of confidence computed in response to comparing the voice signature to the voice biometrics profile.

14. The method of claim 11, further comprising:

comparing the scored response to a threshold; and

determining whether the scored response transgresses the threshold.

15. The method of claim 14, further comprising:

in response to determining that the scored response transgresses the threshold, enabling the user to complete one or more interactions with the network platform based on being an authenticated user.

16. The method of claim 14, further comprising:

in response to determining that the scored response fails to transgress the threshold, generating an additional prompt using the profile associated with the user on the network platform representing past user interactions with the network platform;

processing the additional prompt by the generative machine learning model to generate an additional message comprising an additional query about an additional portion of the past user interactions;

presenting the additional message by the agent of the network platform to the user in the user interface of the network platform; and

authenticating the user at least in part based on an additional response received from the user based on the additional message presented by the agent.

17. The method of claim 14, further comprising:

in response to determining that the scored response fails to transgress the threshold, authenticating the user based on a different authentication protocol comprising two-factor authentication.

18. The method of claim 1, further comprising:

processing verbal input received from the user in the communication session by the generative machine learning model to compute a level of urgency associated with the user;

determining that the level of urgency transgresses an urgency threshold; and

in response to determining that the level of urgency transgresses the urgency threshold, establishing a communication session with a live agent instead of authenticating the user based on responses to queries about the past user interactions.

19. A system comprising:

one or more processors of a machine; and

a memory storing instruction that, when executed by the one or more processors, cause the machine to perform operations comprising:

receiving, by a network site, a user interaction in a communication session with a virtual agent of a network platform;

identifying a set of past user interactions stored in a profile on the network platform the user performed within a specified period of time;

extracting, in real time, data from a profile representing past user interactions with the network platform;

generating, in real time, a prompt using the data extracted from the profile;

processing the prompt by a generative machine learning model to generate a message comprising a query about a portion of the past user interactions;

presenting, on an output device, the message by the virtual agent of the network platform to the user in a user interface of the network platform; and

authenticating the user at least in part based on a response received, in real time, from the user based on the message presented by the virtual agent that includes the query about the portion of the past user interactions.

20. A machine-readable storage device embodying instructions that, when executed by a machine, cause the machine to perform operations comprising:

receiving, by a network site, a user interaction in a communication session with a virtual agent of a network platform;

identifying a set of past user interactions stored in a profile on the network platform the user performed within a specified period of time;

extracting, in real time, data from a profile representing past user interactions with the network platform;

generating, in real time, a prompt using the data extracted from the profile;

processing the prompt by a generative machine learning model to generate a message comprising a query about a portion of the past user interactions;

presenting, on an output device, the message by the virtual agent of the network platform to the user in a user interface of the network platform; and

authenticating the user at least in part based on a response received, in real time, from the user based on the message presented by the virtual agent that includes the query about the portion of the past user interactions.

ABSTRACT

A system is described for authenticating a user using a large language model (LLM). The system receives, by a network site, a user interaction in a communication session with an agent of a network platform. The system generates a prompt using a profile associated with the user on the network platform representing past user interactions with the network platform. The system processes the prompt by a generative machine learning model to generate a message comprising a query about a portion of the past user interactions. The system presents the message by the agent of the network platform to the user in a user interface of the network platform and authenticates the user at least in part based on a response received from the user based on the message presented by the agent that includes the query about the portion of the past user interactions.

Figure 7

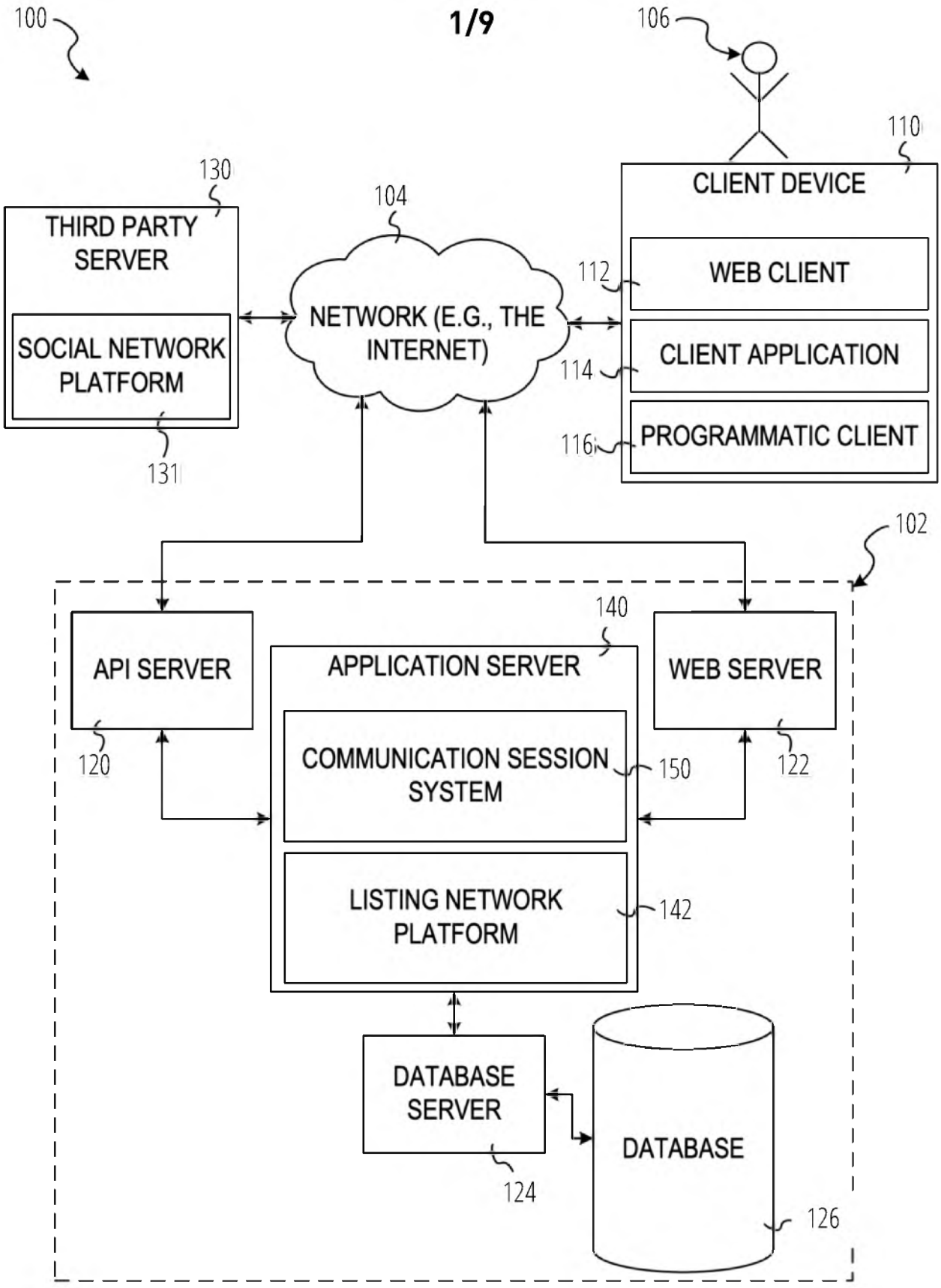
100
106
110
CLIENT DEVICE
130
THIRD PARTY SERVER
104
NETWORK (E.G., THE INTERNET)
112
WEB CLIENT
SOCIAL NETWORK PLATFORM
114
CLIENT APPLICATION
116
PROGRAMMATIC CLIENT
131
102
140
API SERVER
APPLICATION SERVER
WEB SERVER
120
COMMUNICATION SESSION SYSTEM
150
122
LISTING NETWORK PLATFORM
142
DATABASE SERVER
DATABASE
124
126

FIG. 1

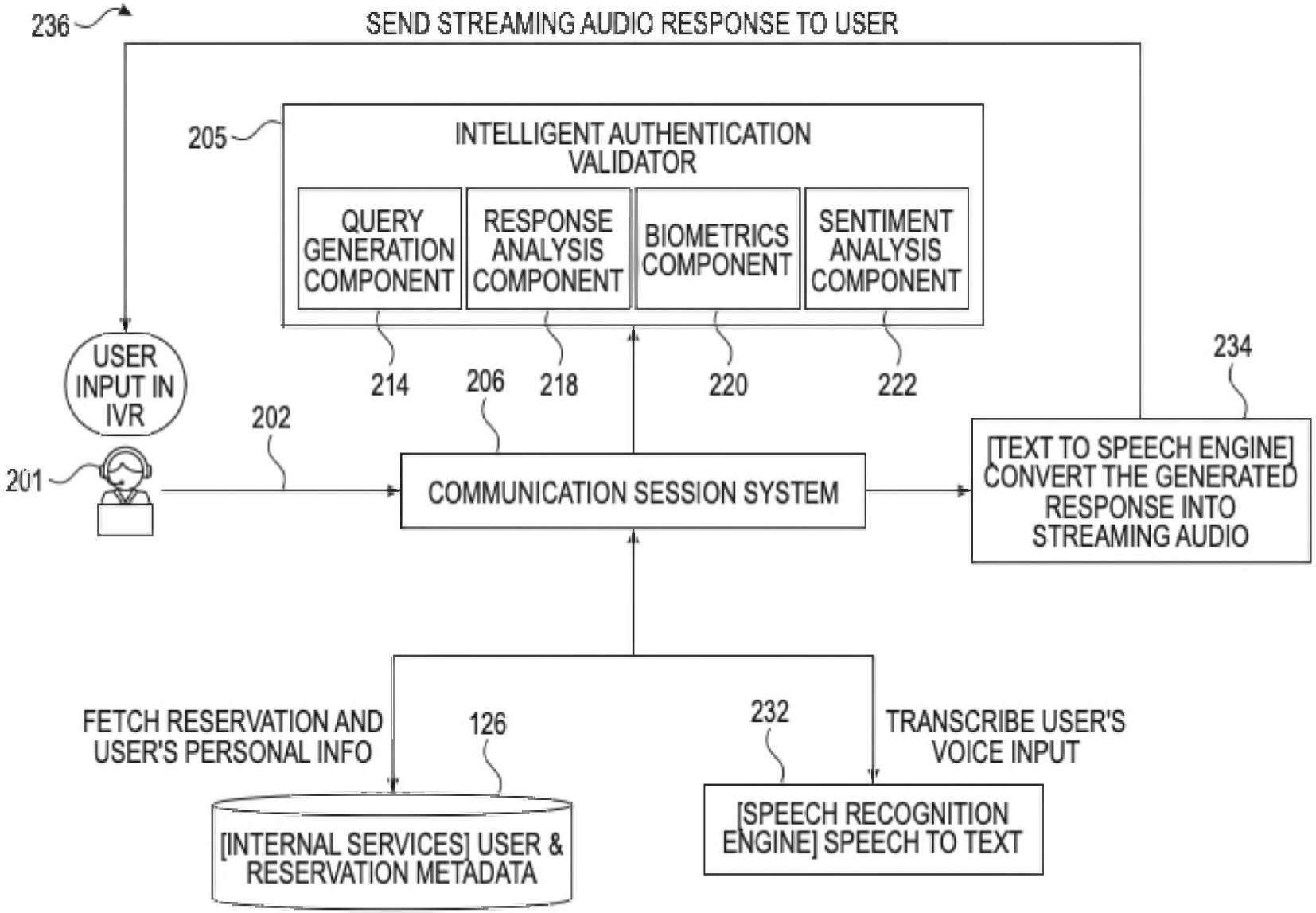
236
SEND STREAMING AUDIO RESPONSE TO USER
205
INTELLIGENT AUTHENTICATION VALIDATOR
QUERY GENERATION COMPONENT
RESPONSE ANALYSIS COMPONENT
BIOMETRICS COMPONENT
SENTIMENT ANALYSIS COMPONENT
214
206
218
220
222
234
USER INPUT IN IVR
202
201
COMMUNICATION SESSION SYSTEM
[TEXT TO SPEECH ENGINE] CONVERT THE GENERATED RESPONSE INTO STREAMING AUDIO
FETCH RESERVATION AND USER'S PERSONAL INFO
126
232
TRANSCRIBE USER'S VOICE INPUT
[INTERNAL SERVICES] USER & RESERVATION METADATA
[SPEECH RECOGNITION ENGINE] SPEECH TO TEXT

FIG. 2

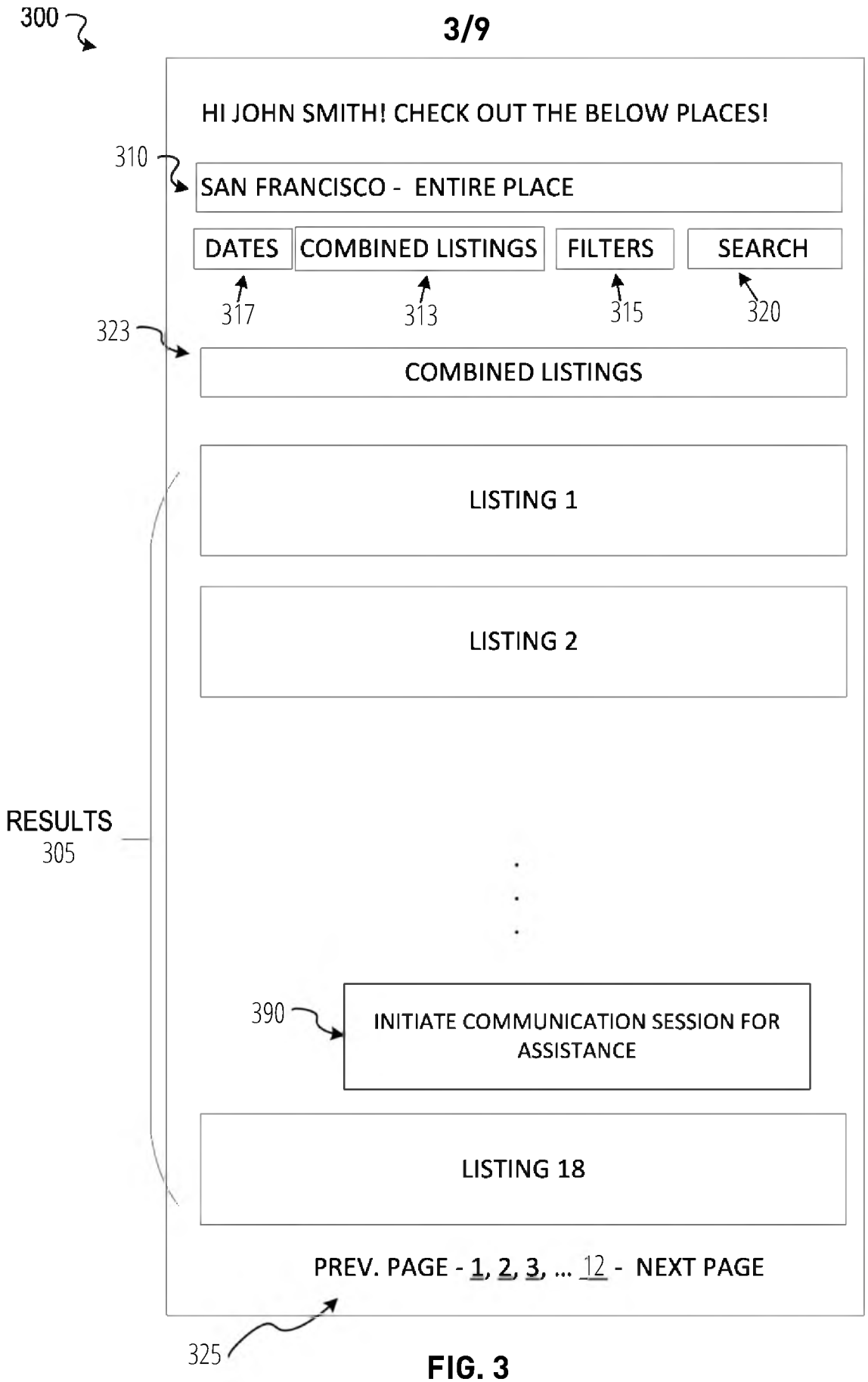
300
HI JOHN SMITH! CHECK OUT THE BELOW PLACES!
310
SAN FRANCISCO - ENTIRE PLACE
DATES
COMBINED LISTINGS
FILTERS
SEARCH
317
313
315
320
323
COMBINED LISTINGS
LISTING 1
LISTING 2
RESULTS
305
390
INITIATE COMMUNICATION SESSION FOR ASSISTANCE
LISTING 18
PREV. PAGE - 1, 2, 3, ... 12 - NEXT PAGE
325

FIG. 3

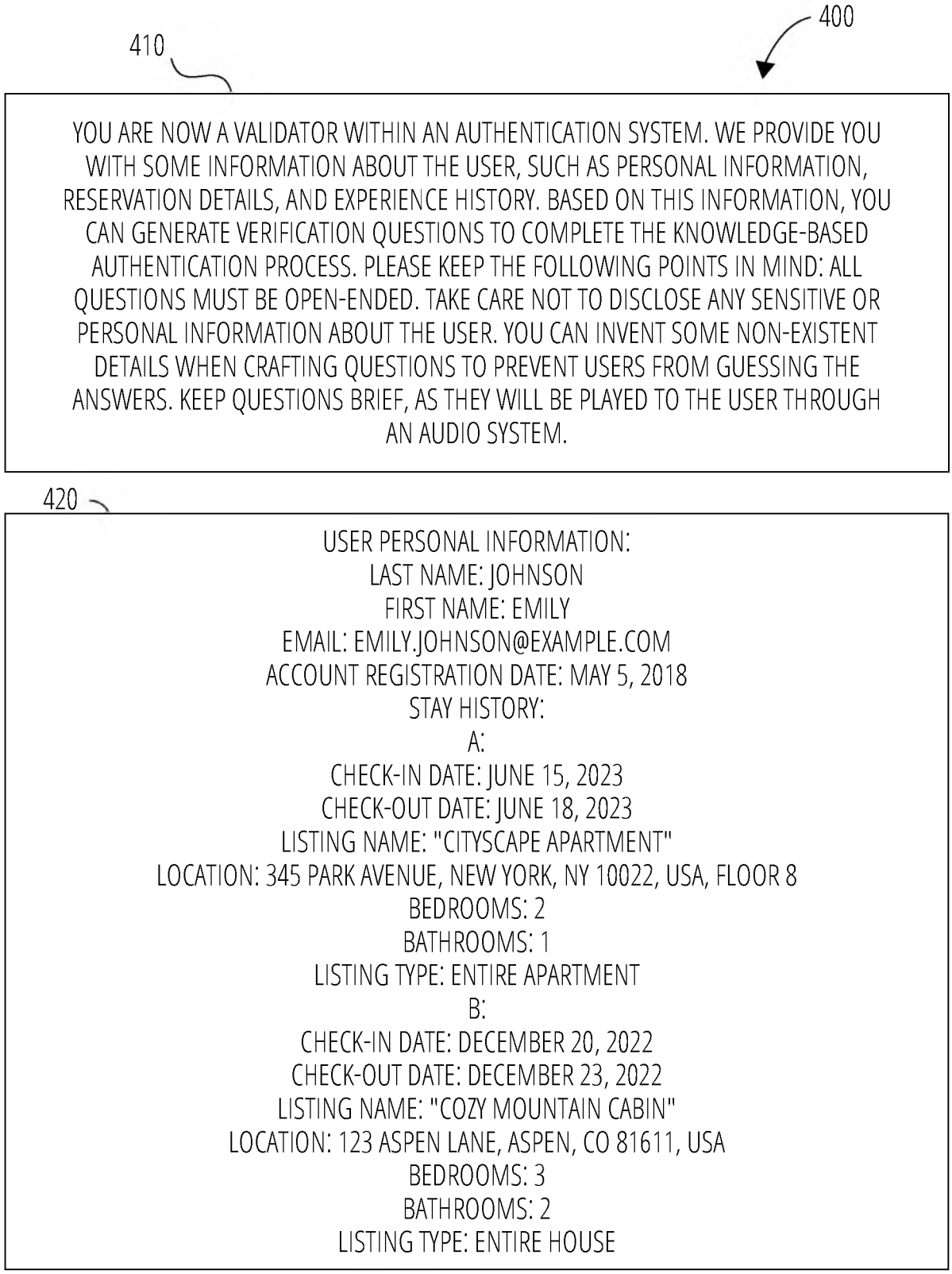
400
410
YOU ARE NOW A VALIDATOR WITHIN AN AUTHENTICATION SYSTEM. WE PROVIDE YOU WITH SOME INFORMATION ABOUT THE USER, SUCH AS PERSONAL INFORMATION, RESERVATION DETAILS, AND EXPERIENCE HISTORY. BASED ON THIS INFORMATION, YOU CAN GENERATE VERIFICATION QUESTIONS TO COMPLETE THE KNOWLEDGE-BASED AUTHENTICATION PROCESS. PLEASE KEEP THE FOLLOWING POINTS IN MIND: ALL QUESTIONS MUST BE OPEN-ENDED. TAKE CARE NOT TO DISCLOSE ANY SENSITIVE OR PERSONAL INFORMATION ABOUT THE USER. YOU CAN INVENT SOME NON-EXISTENT DETAILS WHEN CRAFTING QUESTIONS TO PREVENT USERS FROM GUESSING THE ANSWERS. KEEP QUESTIONS BRIEF, AS THEY WILL BE PLAYED TO THE USER THROUGH AN AUDIO SYSTEM.
420
USER PERSONAL INFORMATION:
LAST NAME: JOHNSON
FIRST NAME: EMILY
EMAIL: EMILY.JOHNSON@EXAMPLE.COM
ACCOUNT REGISTRATION DATE: MAY 5, 2018
STAY HISTORY:
A:
CHECK-IN DATE: JUNE 15, 2023
CHECK-OUT DATE: JUNE 18, 2023
LISTING NAME: "CITYSCAPE APARTMENT"
LOCATION: 345 PARK AVENUE, NEW YORK, NY 10022, USA, FLOOR 8
BEDROOMS: 2
BATHROOMS: 1
LISTING TYPE: ENTIRE APARTMENT
B:
CHECK-IN DATE: DECEMBER 20, 2022
CHECK-OUT DATE: DECEMBER 23, 2022
LISTING NAME: "COZY MOUNTAIN CABIN"
LOCATION: 123 ASPEN LANE, ASPEN, CO 81611, USA
BEDROOMS: 3
BATHROOMS: 2
LISTING TYPE: ENTIRE HOUSE

FIG. 4

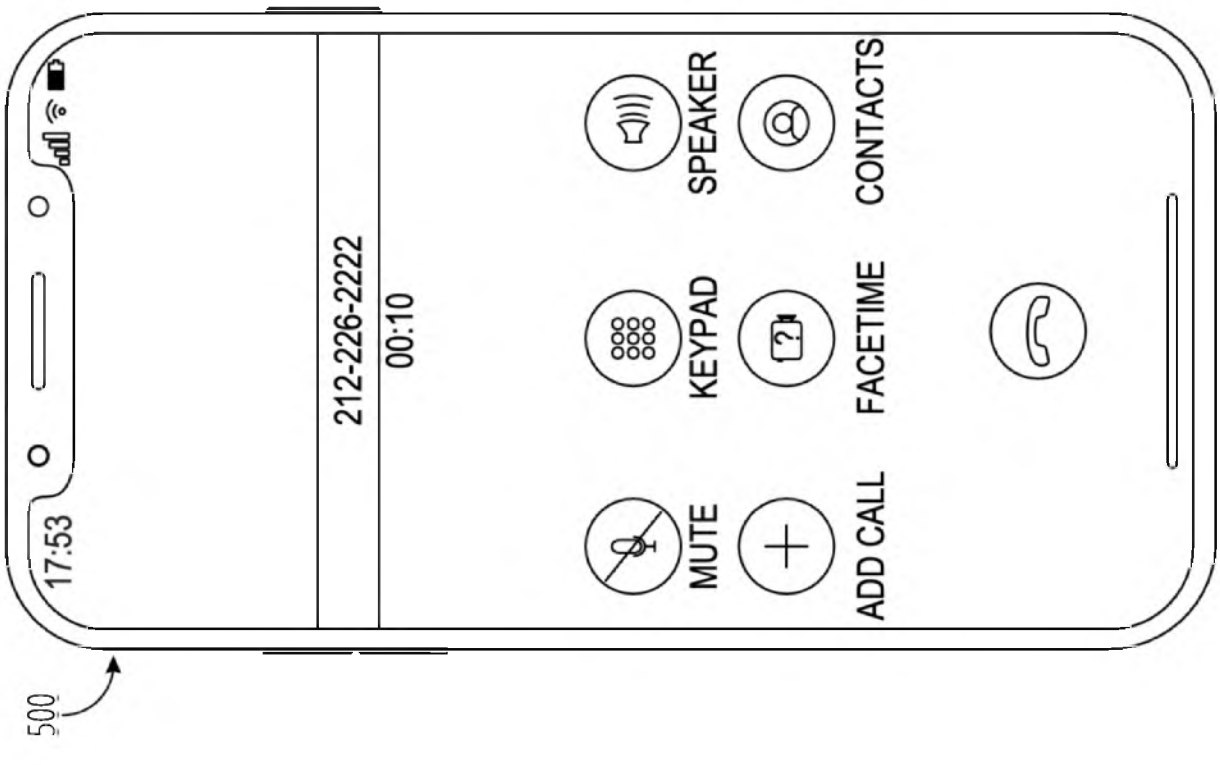
500
17:53
212-226-2222
00:10
MUTE
KEYPAD
SPEAKER
ADD CALL
FACETIME
CONTACTS
510
WHICH CITY DID YOU VISIT FOR YOUR STAY IN DECEMBER 2021? (GENERATED BASE ON FAKE INFO)
HOW MANY BEDROOMS WERE THERE IN YOUR ACCOMMODATION DURING YOUR STAY IN ASPEN, COLORADO?
DURING YOUR APRIL 2022 TRIP TO CALIFORNIA, WHERE DID YOU STAY?
WHAT TYPE OF PROPERTY DID YOU STAY IN FOR YOUR JUNE 2023 VISIT?
WHICH DATE DID YOU REGISTER YOUR ACCOUNT?

FIG. 5

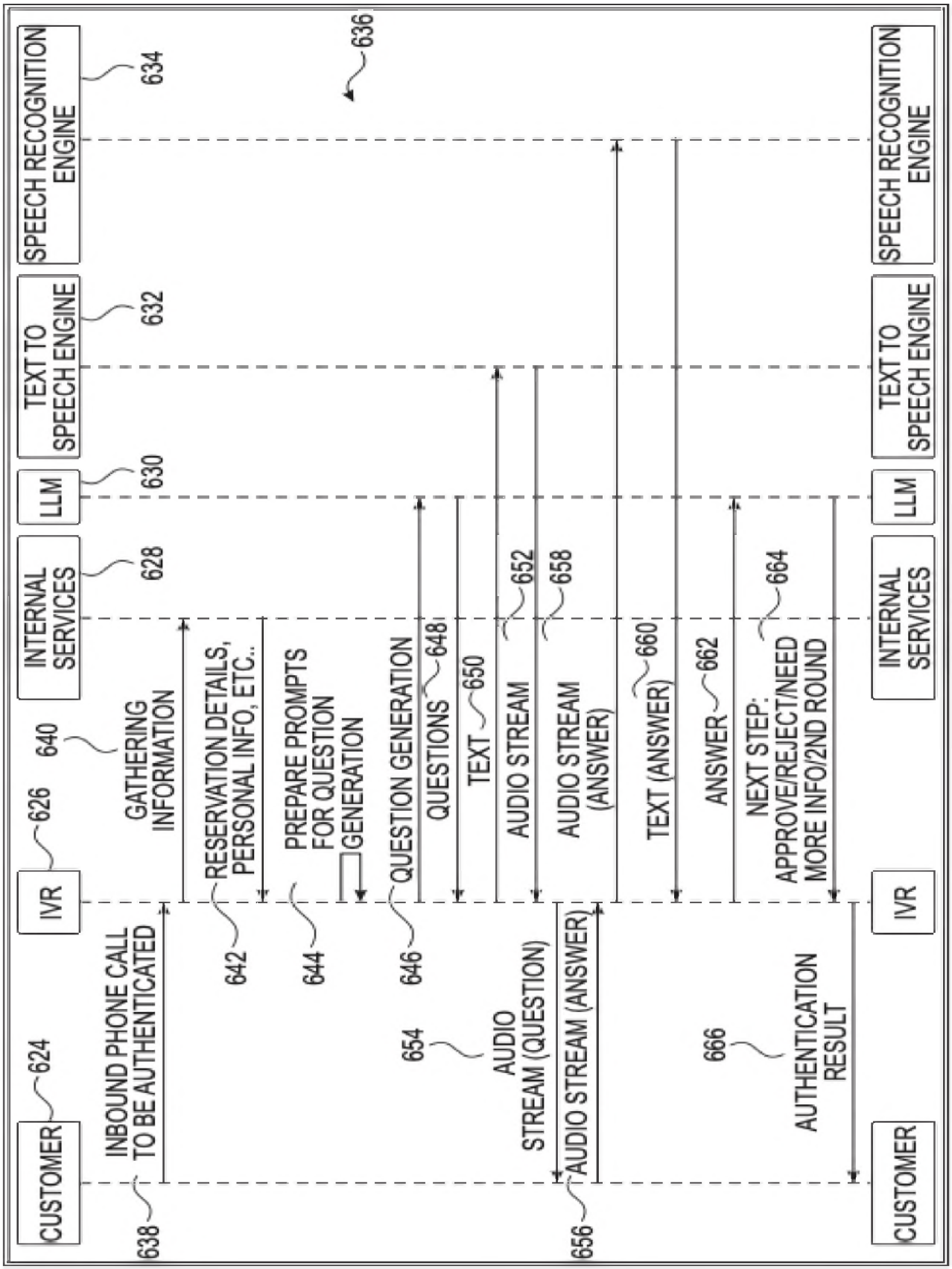
CUSTOMER
624
IVR
626
INTERNAL SERVICES
628
LLM
630
TEXT TO SPEECH ENGINE
632
SPEECH RECOGNITION ENGINE
634
636
638
INBOUND PHONE CALL TO BE AUTHENTICATED
640
GATHERING INFORMATION
642
RESERVATION DETAILS, PERSONAL INFO, ETC..
644
PREPARE PROMPTS FOR QUESTION GENERATION
646
QUESTION GENERATION
648
QUESTIONS
650
TEXT
652
AUDIO STREAM
654
AUDIO STREAM (QUESTION)
656
AUDIO STREAM (ANSWER)
658
AUDIO STREAM (ANSWER)
660
TEXT (ANSWER)
662
ANSWER
664
NEXT STEP: APPROVE/REJECT/NEED MORE INFO/2ND ROUND
666
AUTHENTICATION RESULT
CUSTOMER
IVR
INTERNAL SERVICES
LLM
TEXT TO SPEECH ENGINE
SPEECH RECOGNITION ENGINE

FIG. 6

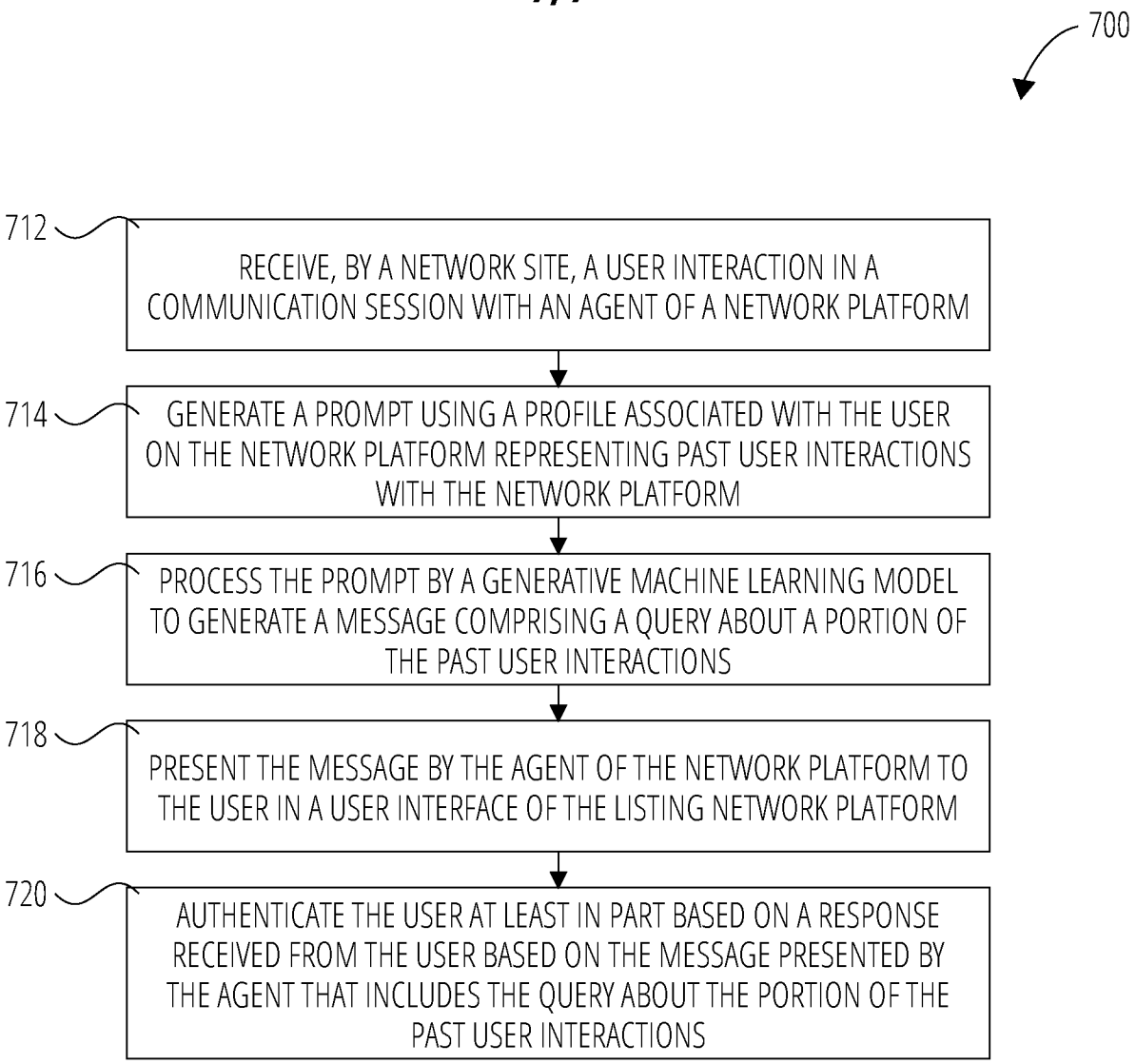
700
712
RECEIVE, BY A NETWORK SITE, A USER INTERACTION IN A COMMUNICATION SESSION WITH AN AGENT OF A NETWORK PLATFORM
714
GENERATE A PROMPT USING A PROFILE ASSOCIATED WITH THE USER ON THE NETWORK PLATFORM REPRESENTING PAST USER INTERACTIONS WITH THE NETWORK PLATFORM
716
PROCESS THE PROMPT BY A GENERATIVE MACHINE LEARNING MODEL TO GENERATE A MESSAGE COMPRISING A QUERY ABOUT A PORTION OF THE PAST USER INTERACTIONS
718
PRESENT THE MESSAGE BY THE AGENT OF THE NETWORK PLATFORM TO THE USER IN A USER INTERFACE OF THE LISTING NETWORK PLATFORM
720
AUTHENTICATE THE USER AT LEAST IN PART BASED ON A RESPONSE RECEIVED FROM THE USER BASED ON THE MESSAGE PRESENTED BY THE AGENT THAT INCLUDES THE QUERY ABOUT THE PORTION OF THE PAST USER INTERACTIONS

FIG. 7

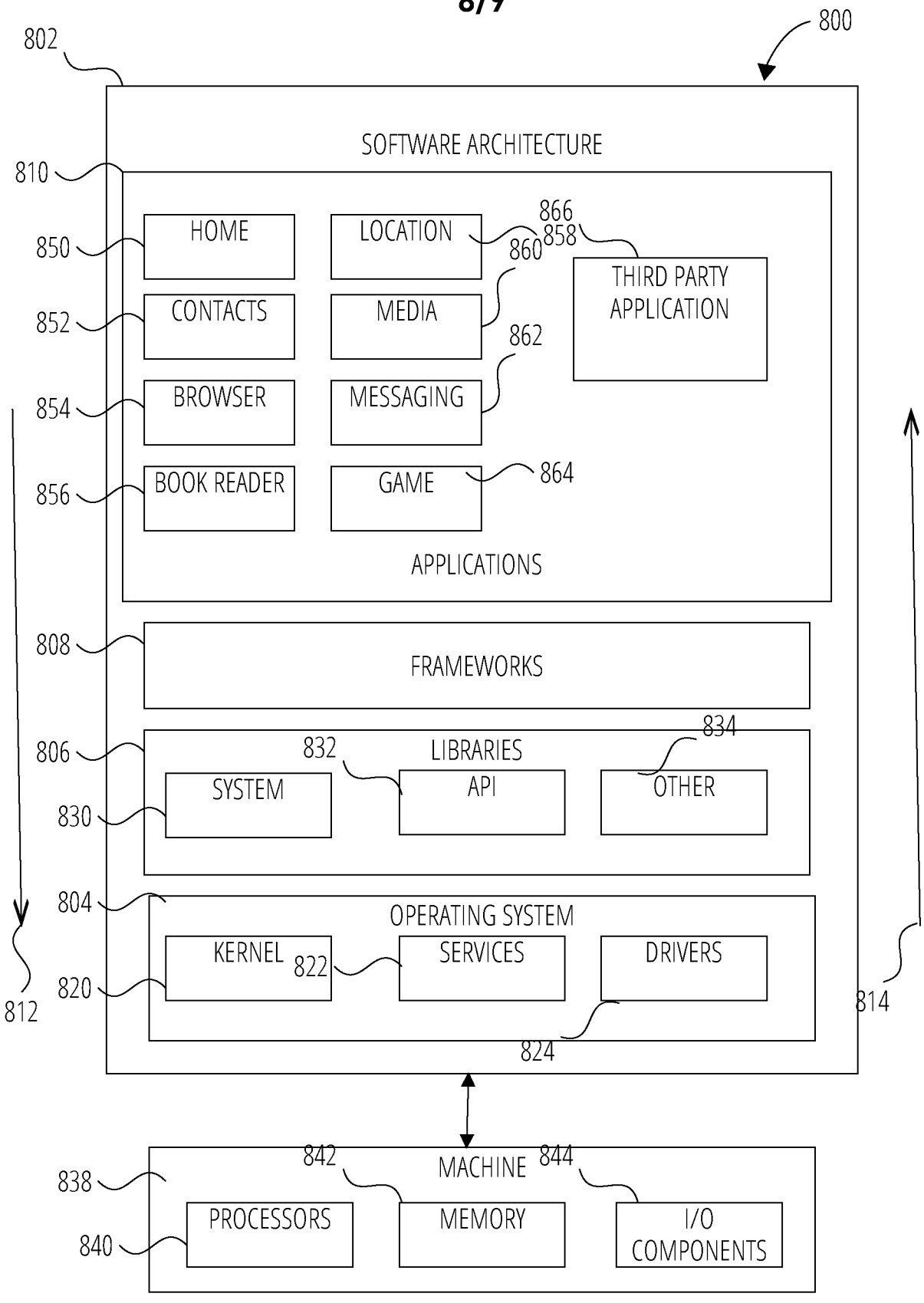
800
802
SOFTWARE ARCHITECTURE
810
HOME
LOCATION
866
858
850
860
THIRD PARTY APPLICATION
CONTACTS
MEDIA
852
862
BROWSER
MESSAGING
854
BOOK READER
GAME
864
856
APPLICATIONS
808
FRAMEWORKS
806
832
LIBRARIES
834
SYSTEM
API
OTHER
830
804
OPERATING SYSTEM
KERNEL
822
SERVICES
DRIVERS
820
812
814
824
838
842
MACHINE
844
PROCESSORS
MEMORY
I/O COMPONENTS
840

FIG. 8

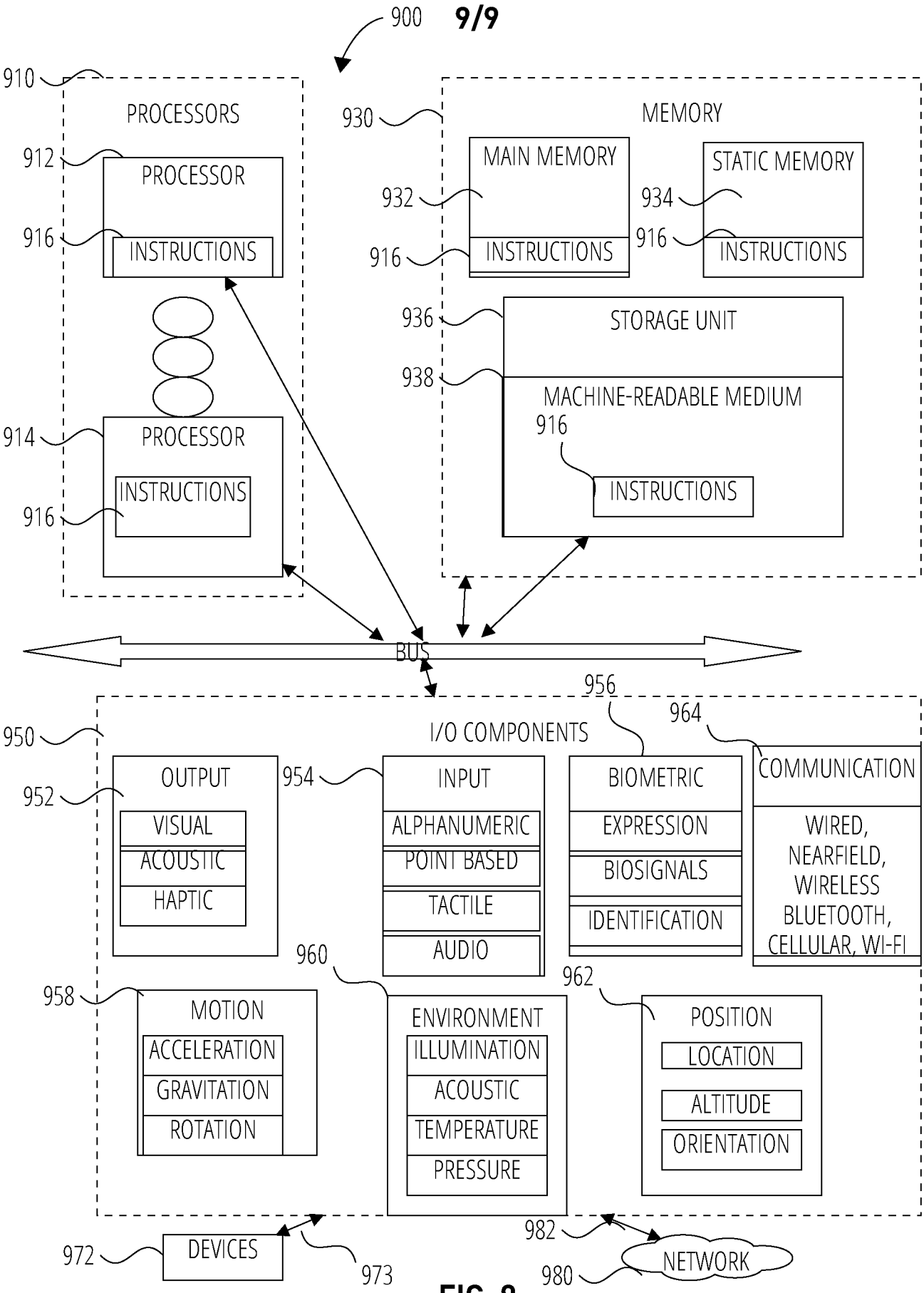
900
910
PROCESSORS
912
PROCESSOR
916
INSTRUCTIONS
914
PROCESSOR
INSTRUCTIONS
916
930
MEMORY
MAIN MEMORY
932
916
INSTRUCTIONS
STATIC MEMORY
934
916
INSTRUCTIONS
936
STORAGE UNIT
938
MACHINE-READABLE MEDIUM
916
INSTRUCTIONS
BUS
956
964
950
I/O COMPONENTS
OUTPUT
952
VISUAL
ACOUSTIC
HAPTIC
954
INPUT
ALPHANUMERIC
POINT BASED
TACTILE
AUDIO
BIOMETRIC
EXPRESSION
BIOSIGNALS
IDENTIFICATION
COMMUNICATION
WIRED,
NEARFIELD,
WIRELESS
BLUETOOTH,
CELLULAR, WI-FI
960
962
958
MOTION
ACCELERATION
GRAVITATION
ROTATION
ENVIRONMENT
ILLUMINATION
ACOUSTIC
TEMPERATURE
PRESSURE
POSITION
LOCATION
ALTITUDE
ORIENTATION
982
972
DEVICES
973
NETWORK
980

FIG. 9