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(54) **NON-CONTACT STRESS ASSESSMENT DEVICES**

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(51) **Int. Cl.**

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| ***H04M 3/51*** | (2006.01) |
| ***G06T 7/00*** | (2006.01) |

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

CPC ..... ***H04M 3/5175*** (2013.01); ***G06T 7/0012*** (2013.01); *G06T 2207/10016* (2013.01); *G06T 2207/10024* (2013.01); *G06T 2207/30088* (2013.01)

(58) **Field of Classification Search**

CPC ..... H04M 3/5175
USPC ..... 379/265.01–265.14, 266.01–266.1, 309
See application file for complete search history.

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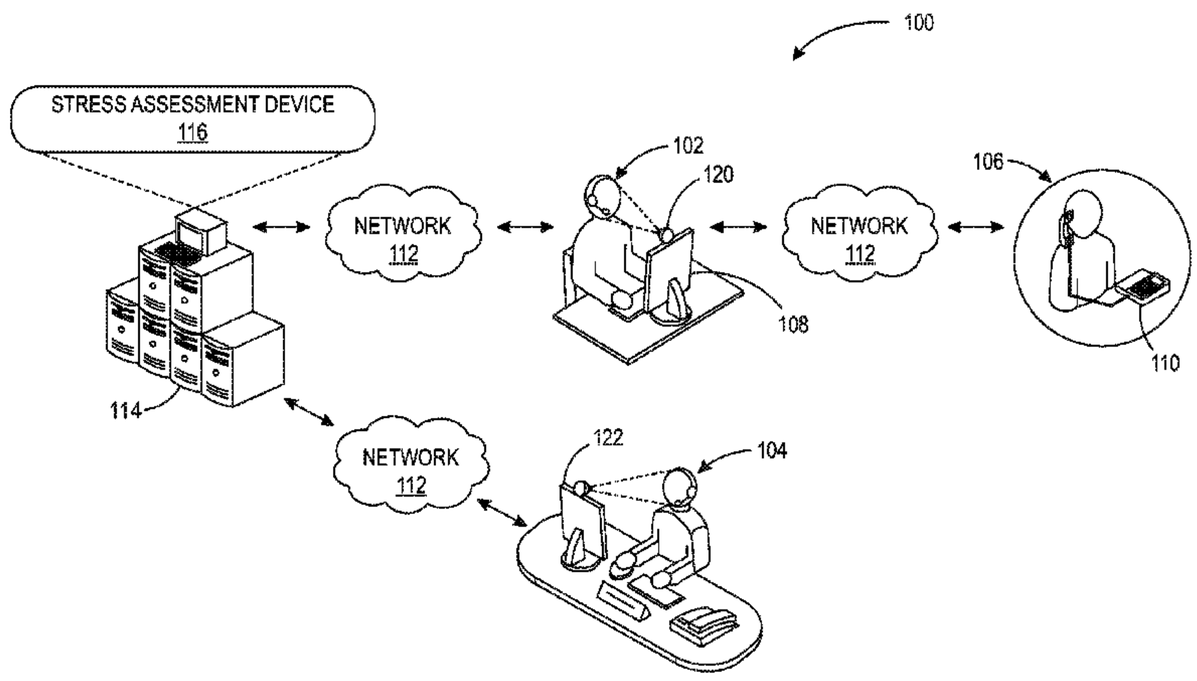
(57) **ABSTRACT**

Embodiments of a system are disclosed for stress assessment of a call center agent while interacting with a customer. The system is for use with a communication network. The system includes a stress assessment device and an agent device that includes an imaging unit. The agent device is configured to capture video of a target region of exposed skin of the agent using the imaging unit, collect customer interaction data based on interaction with a customer device over the communication network, and communicate the captured video and the customer interaction data to the stress assessment device. The stress assessment device is configured to passively estimate agent stress-level based on the received video, and generate feedback to the agent based on correlation between the customer interaction data and the estimated stress-level over a predefined time interval.

**36 Claims, 7 Drawing Sheets**



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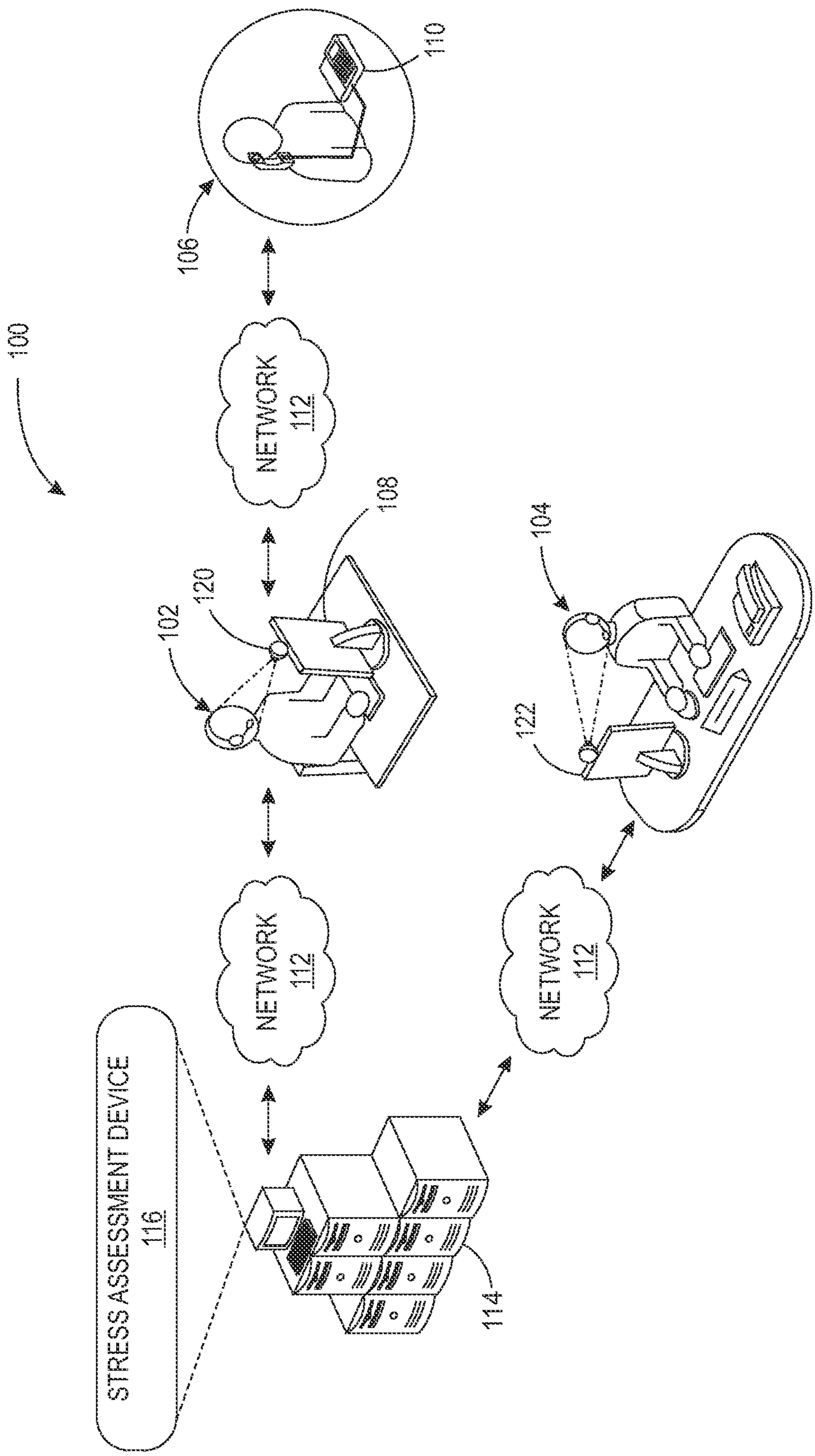
100
STRESS ASSESSMENT DEVICE
116
NETWORK
112
NETWORK
112
NETWORK
112
NETWORK
112
102
120
108
104
122
106
110
114

FIG. 1

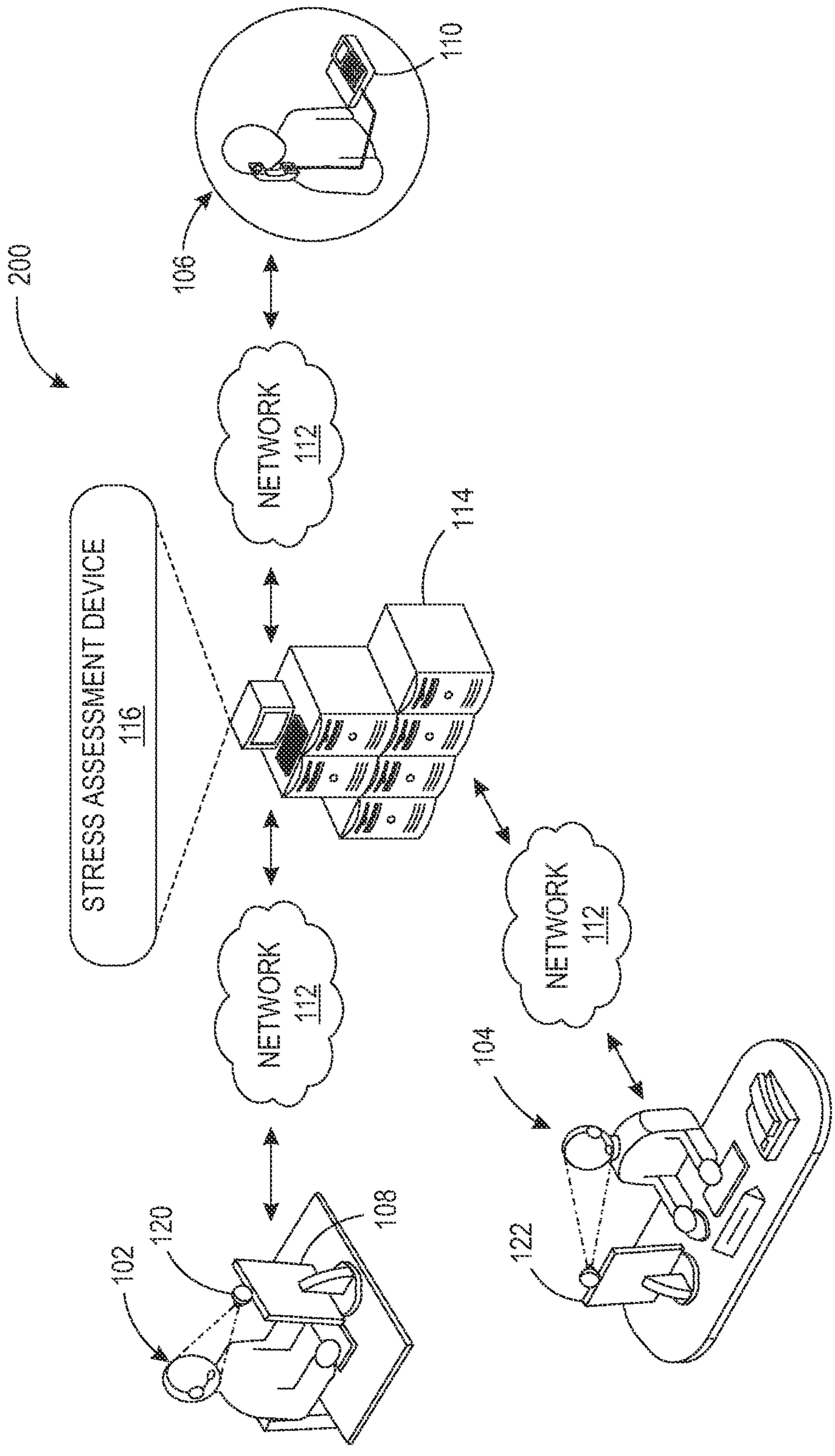
110
106
200
NETWORK 112
STRESS ASSESSMENT DEVICE 116
114
NETWORK 112
NETWORK 112
104
NETWORK 112
108
120
102
122

FIG. 2

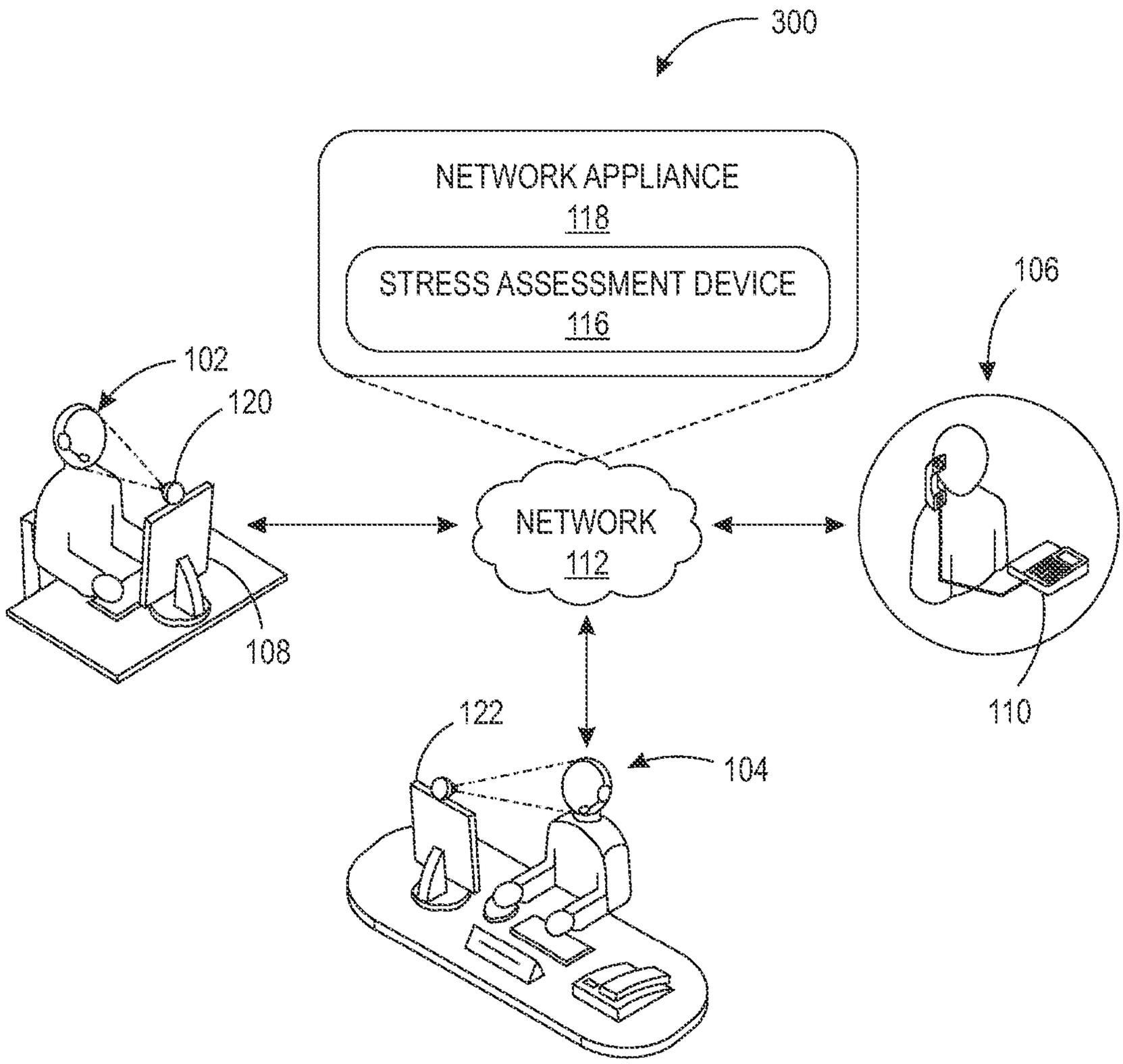
300
NETWORK APPLIANCE
118
STRESS ASSESSMENT DEVICE
116
102
120
106
NETWORK
112
108
110
122
104

FIG. 3

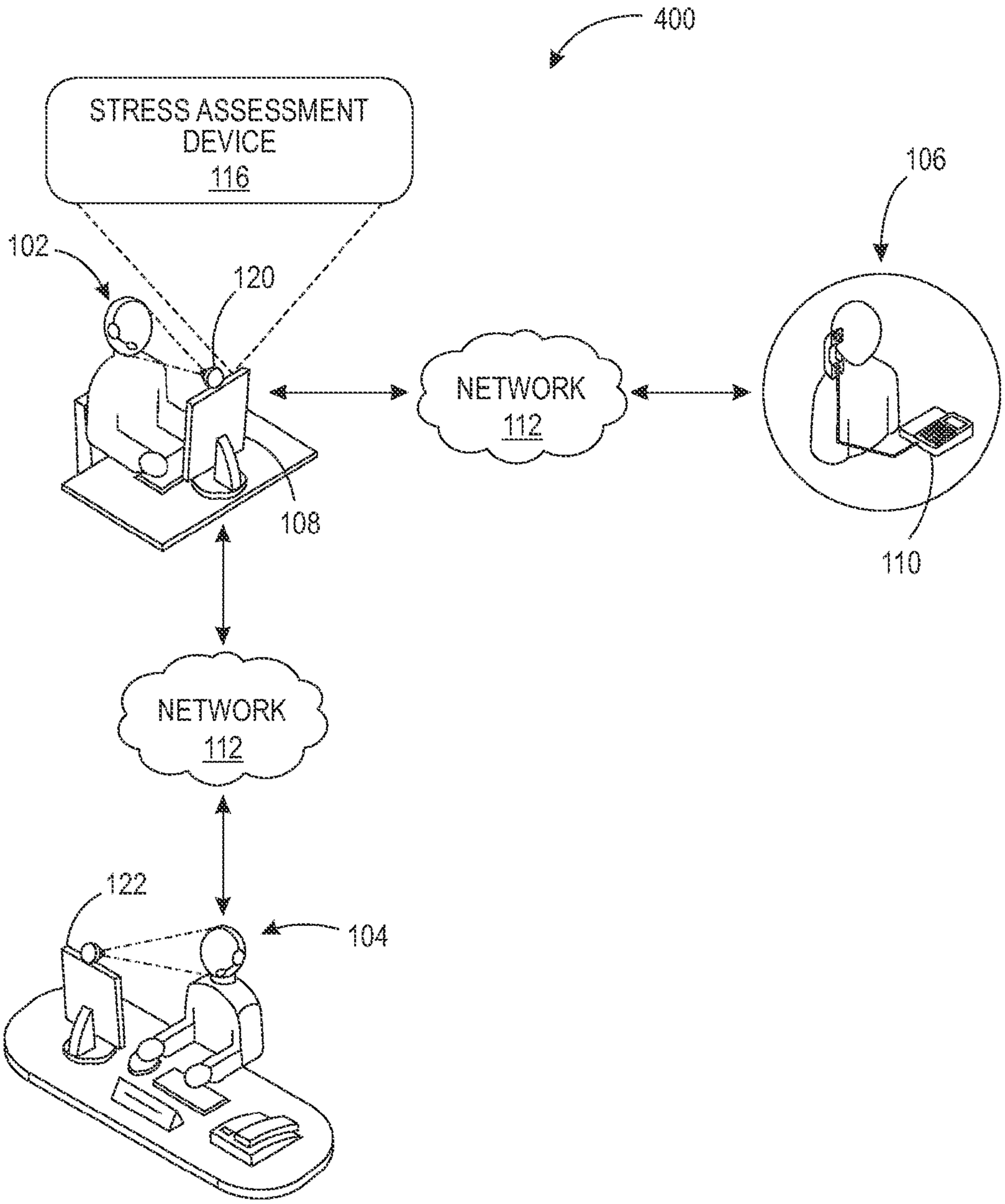
400
STRESS ASSESSMENT DEVICE
116
102
120
106
NETWORK
112
108
110
NETWORK
112
122
104

FIG. 4

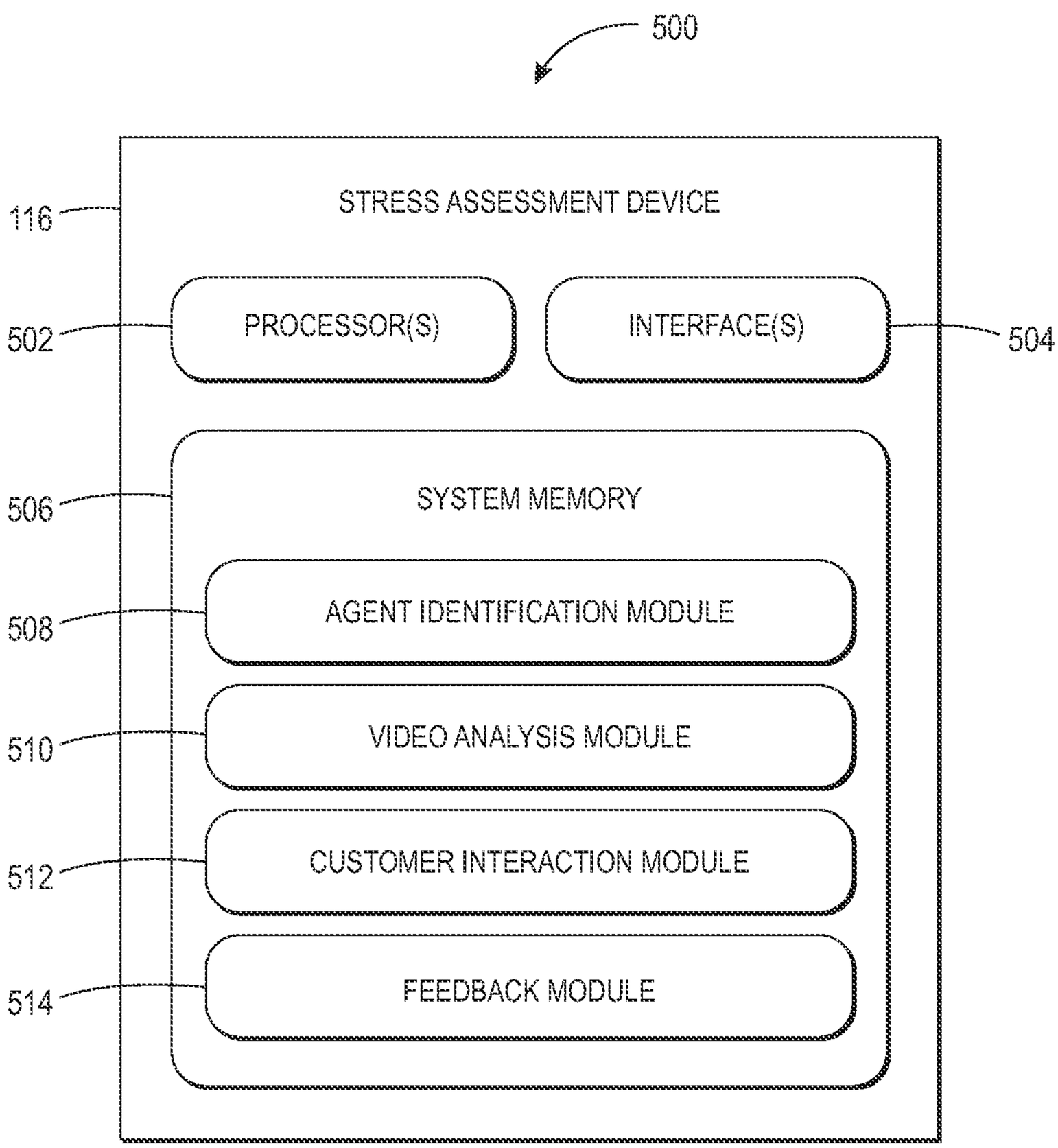
500
116
STRESS ASSESSMENT DEVICE
502
PROCESSOR(S)
INTERFACE(S)
504
506
SYSTEM MEMORY
508
AGENT IDENTIFICATION MODULE
510
VIDEO ANALYSIS MODULE
512
CUSTOMER INTERACTION MODULE
514
FEEDBACK MODULE

FIG. 5

600

| NAME | FREQUENCY (Hz) | ASSOCIATIONS WITH |
|---|---|---|
| HR (HEART RATE) | 0.7-4<br>(UPPER LIMIT: >1.6 IN SICK INFANTS) | CARDIAC PULSE |
| HF (HIGH FREQUENCY) | 0.15-0.4 | PARASYMPATHETIC |
| LF (LOW FREQUENCY) | 0.04-0.15 | SYMPATHETIC AND PARASYMPATHETIC |
| VLF (VERY LOW FREQUENCY) | 0.003-0.04 | NOT WELL DEFINED |
| ULF (ULTRA LOW FREQUENCY) | <0.003 | DAY AND NIGHT DIFFERENCES |
| RR (RESPIRATION RATE) | 0.2-0.7 | PULMONARY VENTILATION |

FIG. 6

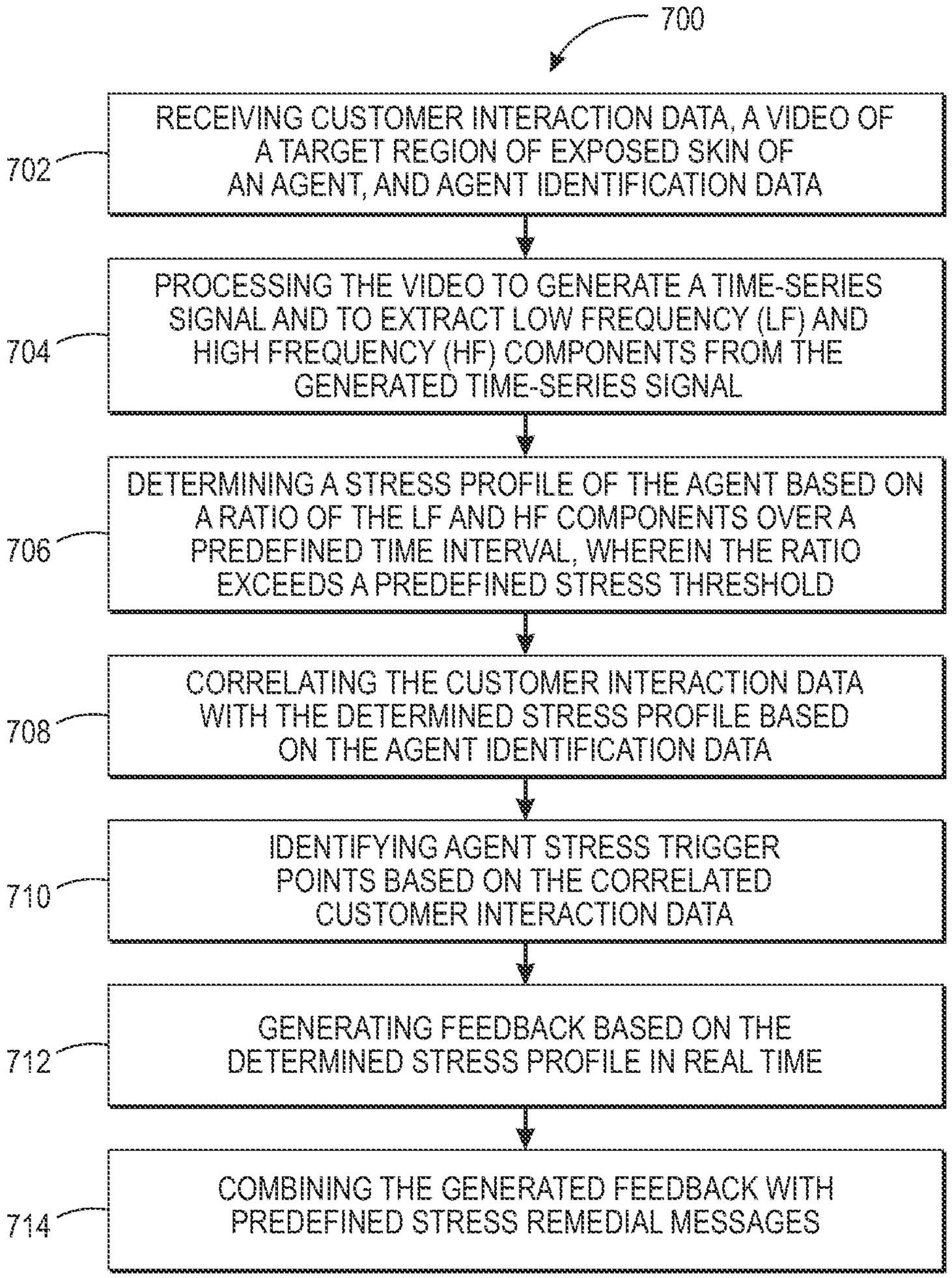
700
RECEIVING CUSTOMER INTERACTION DATA, A VIDEO OF A TARGET REGION OF EXPOSED SKIN OF AN AGENT, AND AGENT IDENTIFICATION DATA
702
PROCESSING THE VIDEO TO GENERATE A TIME-SERIES SIGNAL AND TO EXTRACT LOW FREQUENCY (LF) AND HIGH FREQUENCY (HF) COMPONENTS FROM THE GENERATED TIME-SERIES SIGNAL
704
DETERMINING A STRESS PROFILE OF THE AGENT BASED ON A RATIO OF THE LF AND HF COMPONENTS OVER A PREDEFINED TIME INTERVAL, WHEREIN THE RATIO EXCEEDS A PREDEFINED STRESS THRESHOLD
706
CORRELATING THE CUSTOMER INTERACTION DATA WITH THE DETERMINED STRESS PROFILE BASED ON THE AGENT IDENTIFICATION DATA
708
IDENTIFYING AGENT STRESS TRIGGER POINTS BASED ON THE CORRELATED CUSTOMER INTERACTION DATA
710
GENERATING FEEDBACK BASED ON THE DETERMINED STRESS PROFILE IN REAL TIME
712
COMBINING THE GENERATED FEEDBACK WITH PREDEFINED STRESS REMEDIAL MESSAGES
714

FIG. 7

# NON-CONTACT STRESS ASSESSMENT DEVICES

## TECHNICAL FIELD

The presently disclosed subject matter relates to call center technologies, and more particularly to non-contact stress assessment technologies.

## BACKGROUND

The human body experiences stress due to a wide range of physiological and psychological external stimuli. Stress enables an active physiological response of the body to the external stimuli in a timely fashion. However, an abnormal increase in stress may compromise long-term health and disrupt the body's ability to respond to events that require a quick physical response, such as quickly pulling a hand away from a hot flame.

In a call center environment, agents often experience stress when communicating with customers for various reasons. For example, agents may experience stress when dealing with irate customers, or when the agent's role is either in conflict or ambiguous. Agent role conflict occurs when an agent has conflicting objectives to meet, such as where the agent is evaluated on the number of calls answered in a day. However, the agent may be simultaneously expected to resolve each caller's query/concern, which may result in calls lasting longer and thus decreasing the number of calls answered in a day. Agent role ambiguity occurs when the agent is either unaware of an appropriate action for a customer query, or lacks sufficient information for resolving the query. For example, customer complaints are usually related to inherent issues with respect to a client's product or service, over which the agent has little or no control (e.g., outage in access to a website due to annual maintenance). In another example, the agent may not have enough information to resolve a customer concern (e.g., the troubleshooting manual does not cover a particular type of problem).

## SUMMARY

Various measures are traditionally applied in a call center to improve customer care, as well as each agent's efficiency and work satisfaction. A few examples of these measures include collection of data related to audio analysis of the call, agent-generated call summaries, customer-provided feedback, and interactive voice response (IVR) call routing. The collected data is manually analyzed, such as by a supervisor, to identify customer issues and agent performance areas that need improvement. This data can also be used to help the agent by either reducing the agent call flow or to provide relevant assistance to the agent. The time delay due to offline analyses of the collected data impedes or prevents the supervisor from effectively monitoring multiple calls in a live environment to ensure or enhance customer satisfaction. Additionally, the agent's stress-level during a customer call is not taken into consideration to perform the above analyses. As a result, the related art fails to provide appropriate long-term remedial solutions for the agent to improve performance and work satisfaction.

It may therefore be beneficial to provide a reliable solution that provides real-time feedback on an interaction between an agent and a customer based on the agent stress-level during a live customer call.

One exemplary embodiment includes a system for stress assessment of a call center agent while interacting with a customer. The system is for use with a communication network. The system includes a stress assessment device and an agent device that includes an imaging unit. The agent device is configured to: (1) capture video of a target region of exposed skin of the agent using the imaging unit; (2) collect customer interaction data based on interaction with a customer device over the communication network; and (3) communicate the captured video and the customer interaction data to the stress assessment device. The stress assessment device is configured to: (1) passively estimate agent stress-level in real-time based on the received video; and (2) generate feedback to the agent based on correlation between the customer interaction data and the estimated stress-level over a predefined time interval.

Another exemplary embodiment includes a device for generating feedback to a call center agent during communication with a customer. The device includes a video analysis module, a customer interaction module, and a feedback module. The video analysis module receives a video of a target region of exposed skin of the agent. The video analysis module is configured to passively estimate stress-level of the agent based on the received video over a predefined time interval. The customer interaction module for receiving data collected based communication between the agent and the customer. The customer interaction module is configured to correlate the data with the estimated stress-level over the predefined time interval. The feedback module configured to generate feedback to the agent in real-time based on the estimated stress-level exceeding a predefined stress threshold. The generated feedback includes suggestive messages based on the correlated data.

Yet another exemplary embodiment includes a method for generating feedback during interaction between an agent and a customer. The method includes receiving customer interaction data and video of a target region of exposed skin of the agent. The method also includes processing the video to generate a time-series signal and to extract low frequency and high frequency components from the generated time-series signal. The method further includes determining stress profile of the agent based on a ratio of the low frequency components and the high frequency components of the integrated power spectrum of the time-series signal over a predefined time interval, such that the ratio exceeds a predefined stress threshold. The method furthermore includes correlating the customer interaction data with the determined stress profile, and identifying agent stress-trigger points based on the correlated customer interaction data. The method also includes generating feedback based on the determined stress profile in real-time. The generated feedback includes suggestive predefined remedial messages based on the identified agent stress-trigger points.

Still another exemplary embodiment includes a computer-readable medium comprising computer-executable instructions for generating feedback during interaction between an agent and a customer. The computer-readable medium including instructions for receiving customer interaction data and video of a target region of exposed skin of the agent, and processing the video to generate a time-series signal and to extract low frequency and high frequency components from the time-series signal. The computer-readable medium also includes instructions for determining stress profile of the agent based on a ratio of the low frequency components and the high frequency components of the integrated power spectrum of the time-series signal over a predefined time interval such that the ratio exceeds a predefined stress threshold. The computer-readable medium further includes instructions for correlating the customer interaction data with the determined

stress profile, and identifying agent stress-trigger points based on the correlated customer interaction data. The computer-readable medium also includes instructions for generating feedback based on the determined stress profile in real-time. The generated feedback includes suggestive predefined remedial messages based on the identified agent stress-trigger points.

Other and further aspects and features of the disclosure will be evident from reading the following detailed description of the embodiments, which are intended to illustrate, not limit, the present disclosure.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1-4** illustrate exemplary network environments including a stress assessment device, according to embodiments of the present disclosure;

FIG. **5** illustrates an exemplary stress assessment device, according to an embodiment of the present disclosure;

FIG. **6** is a table summarizing spectral components of various heart rate (HR) signals for explanatory purposes; and

FIG. **7** illustrate an exemplary method for implementing the stress assessment device of FIG. **5**, according to an embodiment of the present disclosure.

## DETAILED DESCRIPTION

The following detailed description is made with reference to the figures. Exemplary embodiments are described to illustrate the disclosure, not to limit its scope, which is defined by the claims. Those of ordinary skill in the art will recognize a number of equivalent variations in the description that follows.

## NON-LIMITING DEFINITIONS

In various embodiments of the present disclosure, definitions of one or more terms that will be used in the document are provided below.

A "video" is a time-varying sequence of images captured of a subject of interest using a video camera capable of acquiring a video signal over at least one data acquisition (imaging) channels. The video may also contain other components such as, audio, time reference signals, and the like.

A "time-series signal" refers to a time varying signal generated from images of the captured video. Time-series signals may be generated in real-time from a streaming video as in the case of continuous call center agent monitoring. The time-series signal may be obtained directly from the data acquisition channel of the video camera used to capture the video of the subject of interest. The time-series signal may be retrieved from a remote device such as a computer workstation over a wired or wireless network or obtained on a continuous basis from a video stream.

"Cardiac pulse" is a pressure wave that is generated by the subject's heart (in systole) as the heart pushes a volume of blood into the arterial pathway. Arterial movement, as a result of this pressure wave, can be sensed by tactile and electronic methods. A frequency range of the cardiac pulse is the pulse rate measured over time, typically recorded in beats per minute (bpm) with upper and lower limits. The frequency range of the human cardiac pulse is between about 40 bpm to 240 bpm. A resting adult human, typically aged 18+ years has a heart rate of 60 to 100 bpm. For an adult athlete, the resting heart rate will be 40 to 60 bpm. The frequency range of the cardiac pulse for animals also varies in a similar manner. For example, a cat has a cardiac pulse of 120 to 140 bpm, a mouse has a cardiac pulse of 450 to 750 bpm and an elephant has a cardiac pulse of 25 to 35 bpm. Each species has its own cardiac pulse frequency range and thus its own "normal" heart rate. Cardiac output, i.e., the volume of blood the heart can pump in one minute which is expressed in L/min (~5.6 L/min for an adult human male and 4.9 L/min for an adult human female) and is proportional to heart rate.

The numerous references in the disclosure to a stress assessment device are intended to cover any and/or all devices capable of performing respective operations on the person in a customer-interacting environment relevant to the applicable context, regardless of whether or not the same are specifically provided.

## EXEMPLARY EMBODIMENTS

FIGS. **1-4** illustrate exemplary network environments including a stress assessment device **116**, according to some exemplary embodiments of the present disclosure. Some embodiments are disclosed in the context of network environments that represent a communication pathway for a call center to enhance interaction among a call center agent **102**, a call center supervisor **104**, and a customer **106**. However, other embodiments can be applied in the context of other business scenarios involving interactions between different entities including customers, employees, colleagues, vendors, consultants, and so on. Examples of such scenarios include, but are not limited to, bank agents handling customer account workflows or related processes, hospital agents handling patient documents (such as in the context of new patients in emergency situations), healthcare professionals handling patient interactions in a tele-health environment, retail agents handling customer's return counters, teachers or students handling coursework, etc.

The agent **102** and the customer **106** may communicate with each other using an agent device **108** and a customer device **110**, respectively, in different network environments. The agent device **108** may be implemented as any of a variety of computing devices, including, for example, a server, a desktop PC, a notebook, a workstation, a personal digital assistant (PDA), a mainframe computer, a mobile computing device, an internet appliance, and so on. The agent device **108** is configured to exchange at least one of text messages, audio interaction data (e.g., voice calls, recorded audio messages, etc.), and video interaction data (e.g., video calls, recorded video messages, etc.) with the customer device **110**, or in any combination thereof. The customer device **110** may include calling devices (e.g., a telephone, an internet phone, etc.), texting devices (e.g., a pager), or computing devices including those mentioned above.

In a first exemplary network environment **100** (FIG. **1**), the agent device **108** may be configured to interact directly with the customer device **110** via a network **112**. The network **112** may be a wireless or a wired network, or a combination thereof. The network **112** may be a collection of individual networks, interconnected with each other and functioning as a single large network (e.g., the Internet or an intranet). Examples of the network **112** include, but are not limited to, local area network (LAN), wide area network (WAN), cable/telephone network, satellite network, and so on.

The agent device **108** may collect a variety of customer interaction data during communication with the customer device **110**. For example, the agent device **108** may be installed with a known, related art or later developed interactive voice response (IVR) system (not shown). The IVR system interfaces with the customer device **110** before the customer **106** can interact with the agent **102** through various

modes, such as text messages, audio interactions (e.g., voice calls, recorded audio messages, etc.), and video interactions (e.g., video calls, recorded video messages, etc.). However, in a second exemplary network environment **200** (FIG. **2**), the agent device **108** may be configured to interact with the customer device **110** via a server **114**. The server **114** may connect the agent device **108** to the customer device **110** over the network **112**. Optionally, the IVR system may be installed on the server **114** for interfacing with the customer device **110**. The server **114** may be implemented as any of a variety of computing devices including, for example, a general purpose computing device, multiple networked servers (arranged in clusters or as a server farm), a mainframe, or so forth.

The customer **106** may submit voice inputs or dual tone multi-frequency (DTMF) tone inputs to the IVR system using the customer device **110** in response to prerecorded or dynamically generated audio messages in the IVR system. Subsequently, the customer **106** may be routed via the IVR system to the agent device **108** for interacting with the agent **102**. However, other examples may include one or more agent devices configured to establish a direct communication with the customer devices for exchanging text messages, audio interaction data, and video interaction data without the IVR system. The agent device **108** may convey the customer interaction data including the text messages, the audio interaction data, and the video interaction data conducted between the customer **106** and the agent **102** (or the supervisor **104**), agent-generated customer call summaries after communication with the customer **106**, customer-provided feedback and customer's responses to the IVR audio messages, to the server **114**. The agent device **108** is configured to provide agent identification data along with the customer interaction data to the server **114**. Examples of the agent identification data include, but are not limited to, agent login ID, agent name, IP address of the agent device **108**, and so on. In some embodiments, the agent device **108** may tag the agent identification data with the customer interaction data. The server **114** includes a stress assessment device **116** for analyzing the customer interaction data received from the agent device **108** (FIG. **1**) or the customer device **110** (FIG. **2**). Along with the customer interaction data, the server **114** also receives the corresponding agent identification data from the agent device **108**.

Similar to the network environment **100** (FIG. **1**), a third exemplary network environment **300** (FIG. **3**) may implement the agent device **108** to interact with the customer device **110** over the network **112**. In one embodiment, the network **112** may be established using a network appliance **118** that may be integrated with the stress assessment device **116**. In other embodiments, the network appliance **118** may be preconfigured or dynamically configured to include the stress assessment device **116** integrated with other devices. For example, the stress assessment device **116** may be integrated with the agent device **108**. The agent device **108** may include a module (not shown) that enables the agent device **108** being introduced to the network appliance **118**, thereby enabling the network appliance **118** to invoke the stress assessment device **116** as a service. Examples of the network appliance **118** include, but not limited to, a DSL modem, a wireless access point, a router, and a gateway for implementing the stress assessment device **116**.

The stress assessment device **116** may represent any of a wide variety of devices that provide services for the network **112**. The stress assessment device **116** may be implemented as a standalone and dedicated "black box" including hardware and installed software, where the hardware is closely matched to the requirements and/or functionality of the software. The stress assessment device **116** may enhance or increase the functionality and/or capacity of the network **112** to which it is connected. The stress assessment device **116** may be configured, for example, to perform e-mail tasks, security tasks, network management tasks including IP address management, and other tasks. In some embodiments, the stress assessment device **116** is configured not to expose its operating system or operating code to an end user, and does not include related art I/O devices, such as a keyboard or display. The stress assessment device **116** of some embodiments may, however, include software, firmware or other resources that support remote administration and/or maintenance of the stress assessment device **116**. Alternatively, as shown in a fourth exemplary network environment **400** (FIG. **4**), the stress assessment device **116** may be integrated with, or installed on, the agent device **108** that directly communicates with the customer device **110** over the network **112**. The stress assessment device **116**, discussed below in greater detail, may be configured to estimate stress-levels of multiple agents, such as the agent **102**, upon receiving their videos and generate feedback on real-time or at predetermined intervals to corresponding agents about the estimated stress-levels.

Further, the agent device **108** may include an imaging unit **120**, such as a camera, operating in communication with the agent device **108**. In a first example, the imaging unit **120** includes a color video camera such as an HD webcam with at least one imaging channel for capturing color values for pixels corresponding generally to the primary visible colors (typically RGB). In a second example, the imaging unit **120** is an infrared camera with at least one imaging channel for measuring pixel intensity values in the near-infrared (NIR) wavelength range. In a third example, the imaging unit **120** is a hybrid device capable of capturing both color and NIR video. In a fourth example, the imaging unit **120** is a multi/hyper spectral camera device capable of capturing images at multiple wavelength bands.

The imaging unit **120** may be configured for capturing video of the agent **102** being monitored. The imaging unit **120** may be rotatable about a fixed support, such as the agent device **108**, so that a field of view of the imaging unit **120** is directed to a region of interest on the agent's body with exposed skin area. The region of interest is an unobstructed area of a region of agent's skin where a photoplethysmograph (PPG) signal (discussed later in greater detail) of the agent **102** can be registered. Such regions may be identified in image frames of the captured video using, for example, object identification, pixel classification, material analysis, texture identification, pattern recognition methods, etc. The region of interest on the agent's body may be exposed to the ambient surroundings. The region of interest that is chosen for analysis is relatively small, for example, the forehead, middle of the chest, etc., rather than the entire visible region of the agent's body, to reduce or avoid variability in analyses that may be caused by anatomical and physiological functions or movements of various body parts. The imaging unit **120** may simultaneously monitor multiple agents based on the field of view and resolution of the unit **120**.

The imaging unit **120** provides the captured video of the region of interest (ROI) to the agent device **108**. The agent device **108** combines the captured video with the agent identification data and sends both the captured video and the agent identification data to the stress assessment device **116**. The stress assessment device **116** receives the agent's ROI video and processes it to generate a time-series signal containing a photoplethysmograph (PPG) signal for analyses. The stress assessment device **116** is configured to provide real-time

feedback to the agent device **108** or a supervisor device **122** associated with the supervisor **104** based on the agent stress exceeding a predefined threshold during a live customer interaction. The stress assessment device **116** analyzes the generated time-series signal to estimate the stress-levels of the agent **102** 'passively' through any known, related art or later developed non-contact mechanisms, while a customer-agent interaction is in progress. For example, heart rate variability (HRV) is a common measure that may be used for evaluating agent stress by determining state of the autonomic nervous system (ANS) of the agent **102**. The ANS is represented by the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS) of the agent **102**. HRV is the beat-to-beat time variation in heartbeat and is modulated by changes in the balance between influences of the SNS and the PNS. Such changes occur based on the response of the agent's body to stress by releasing hormones, such as epinephrine and cortisol, which in turn lead to increase in heartbeat, tightening of muscles, and increase in blood pressure. HRV is also useful for diagnosis of various diseases and health conditions such as diabetic neuropathy, cardio vascular disease, myocardial infraction, fatigue, sleep problems, psychiatric disorders, psychological disorders, etc.

In an embodiment, the stress assessment device **116** extracts and analyses a ratio of low-frequency (LF) and high-frequency (HF) components of the integrated power spectrum of the generated time-series signal. When the LF/HF ratio is greater than a stress threshold value, for example, a value '1', the agent's SNS is more dominant and hence indicates that the agent **102** is under stress. Accordingly, the stress assessment device **116** generates feedback to the agent device **108** (or the supervisor device **122**), as identified by the agent identification data, so that the agent **102** or the supervisor **104** may take appropriate action to reduce the agent stress. Additionally, an increasing level of agent stress based on the increasing LF/HF ratio may be assessed with respect to multiple predefined stress thresholds to create a stress profile for each agent **102** in real-time. Whenever the LF/HF ratio exceeds each of the predefined stress thresholds, feedback may be generated by the stress assessment device **116**, discussed later in greater detail. Such stress profiles of different agents may be used, such as by the supervisor **104**, for various purposes. For example, the agent stress profiles may assist the supervisor **104** to identify a set of agents that may be appropriate for: (1) a particular customer concern or issue; (2) further training on particular customer concerns or issues; (3) customer concerns or issues that need better training material for the agents, and so on. Such analyses of the time-series signal enables the integration of multiple sources of data, such as the agent's body motion; the customer's audio responses to the agent **102** or the IVR system; color or textual changes in the exposed skin area of the agent **102**; etc., to enhance diagnosis of HRV and interactions with other effects of ANS.

Further, the stress assessment device **116** is configured to analyze the customer interaction data based on various parameters. Examples of these parameters include, but are not limited to, key words (e.g., 'hello', 'late', 'hurry', etc.), generic terms of interest (e.g., 16-character alphanumeric customer ID, 10-digit phone number, etc.), sentiment-intensive words (e.g., 'hate', 'irritate', etc.), user selections on the IVR system to identify a broad topic of a customer-agent conversation, customer-agent voice-over that may be indicative of impatience and irritation for the customer **106**, and other finer aspects of the customer-agent interaction.

The stress assessment device **116** then correlates the analyzed customer interaction data for each parameter with the determined stress profile for each agent **102** based on the agent identification data to identify stress-trigger points. The stress assessment device **116** is configured to generate predefined suggestive remedial messages based on the identified stress-trigger points. The stress assessment device **116** may be configured to communicate, either automatically or upon request, the predefined remedial messages along with the feedback, or otherwise, to the corresponding agent device **108** and/or the supervisor device **122**. The predefined suggestive remedial messages assist the agent **102** and the supervisor **104** on-the-fly to undertake appropriate actions to reduce agent stress during live communication with the customer **106**.

FIG. **5** includes an exemplary stress assessment device according to an embodiment of the present disclosure. The stress assessment device **116** includes one or more processors **502**, one or more interfaces **504**, and a system memory **506** including an agent identification module **508**, a video analysis module **510**, a customer interaction module **512**, and a feedback module **514**.

The stress assessment device **116**, in one embodiment, is a hardware device with at least one processor executing machine readable program instructions for analyzing received videos such that the agent's stress-level can be determined to generate feedback. Such a system may include, in whole or in part, a software application working alone or in conjunction with one or more hardware resources. Such software applications may be executed by the processors on different hardware platforms or emulated in a virtual environment. Aspects of the stress assessment device **116** may leverage off-the-shelf software available in the art, related art, or developed later.

The processor(s) **502** may include, for example, microprocessors, microcomputers, microcontrollers, digital signal processors, central processing units, state machines, logic circuits, and/or any devices that manipulate signals based on operational instructions. Among other capabilities, the processor(s) **502** are configured to fetch and execute computer readable instructions in the memory.

The interface(s) **504** may include a variety of software interfaces, for example, application programming interface; hardware interfaces, for example, cable connectors; or both. The interface(s) **504** facilitate (1) receiving the video of the region of interest on the agent's body, the customer interaction data, and agent identification data, and (2) reliably transmitting feedback to the agent device **108** and/or the supervisor device **122**.

The agent identification module **508** stores different types of data to identify each of the agents, such as the agent **102**, interacting with the customer **106**. Examples of the data include, but are not limited to, employment data (e.g., agent name, agent employee ID, designation, tenure, experience, previous organization, supervisor name, supervisor employee ID, etc.), demographic data (e.g., gender, race, age, education, accent, income, nationality, ethnicity, area code, zip code, marital status, job status, etc.), psychographic data (e.g., introversion, sociability, aspirations, hobbies, etc.), system access data (e.g., login ID, password, biometric data, etc.) and other business-relevant data about each of the call center agents. Some embodiments may include the agent identification module **508** to store similar data for a supervisor, such as the supervisor **104**.

The video analysis module **510** receives the agent's ROI video and the corresponding agent identification data from the imaging unit **120** via the agent device **108**. In one embodiment, the received agent's ROI video is processed by the video analysis module **510** to isolate a bodily vascular network using various techniques known in the art, related art, or

developed later. The bodily vascular network may be identified in the ROI video based on, for example, color, spatial features, material identification, and the like, to obtain a time-series signal. The obtained time-series signal is normalized and filtered to remove undesirable frequencies. The resulting time-series signal for different bodily vascular regions includes the sum total of volumetric pressure changes within those regions. Arterial pulsations include a dominant component of these signals. The time-series signal includes a PPG signal that correlates to the agent's cardiac pulse pressure wave. The PPG signal may be de-trended to remove slow non-stationary frequency components from the time-series signal such that a nearly stationary PPG signal, and hence a nearly stationary time-series signal, can be obtained.

The video analysis module **510** extracts the low frequency and high frequency components from the time-series signal over a predefined time interval. The video analysis module **510** also computes a ratio of the low and high frequency (LF/HF ratio) of the integrated power spectrum of the corresponding time-series signal. The LF/HF ratio provides a measure of the agent's estimated HRV for that predefined time interval. The estimated HRV is then used to assess the level of agent stress.

The LF and HF components are related, in different degrees, to different components of the cardio-vascular control system as shown in a table **600** (FIG. **6**). The table **600** also shows different frequency components for normal healthy humans. The HF component, which has a peak at respiratory frequency, corresponds to respiratory sinus arrhythmia (RSA) and reflects parasympathetic influence on the heart through efferent vagal activity. The LF component, including fluctuations below 0.15 Hz and usually centered at about 0.1 Hz, is mediated by both cardiac vagal and sympathetic nerves. Hence, the LF/HF ratio represents the sympatho-vagal interaction. The LF and HF components may be also expressed in normalized units as shown in Equations (1) and (2) to account for inter-individual differences amongst various LF components and the HF components within their respective frequency ranges. Such normalization of the LF and HF components also normalizes the differences in various imaging units.

$$LF_n = \frac{LF}{\text{Total Power} - VLF} \quad (1)$$

$$HF_n = \frac{HF}{\text{Total Power} - VLF} \quad (2)$$

In the Equations (1) and (2), the 'Total Power' refers to total power of the integrated spectrum containing the LF and HF components over the predefined time interval within the time-series signal; and 'VLF' refers to a very low frequency ranging from 0.003 Hz to 0.04 Hz over the predefined time interval within the time-series signal.

The LF/HF ratio exceeding a value '1' indicates abnormal stress-level of the agent **102**. The video analysis module **510** may include multiple stress threshold values that are compared to the computed value of LF/HF ratio for determining the level of agent stress. For example, a value of the LF/HF ratio between stress threshold values '1' to '2' may indicate low-level stress. Similarly, a value of the LF/HF ratio between the stress threshold values '2' and '3' may indicate mid-level stress, and that between the stress threshold values '3' and '4' may indicate high-level stress experienced by the agent **102**. The LF/HF ratio having a value less than the stress threshold value '1' corresponds to the influence of PNS indicating insignificant or normal-level agent stress.

Such non-contact estimation of HRV based on analyses of agent's ROI video to determine agent stress does not involve active involvement of the agent **102**, thereby minimizing the chances of agent pretense. This passive determination of the agent stress may be performed at night or day with or without the visible (ambient) illuminators since the imaging unit **120** can measure HR signals under IR illumination, which is not visible at night. Also, some visible illuminators (for example, incandescent lamps) have enough IR signals, and hence the imaging unit **120** in communication with the stress assessment device **116** can be used without any additional illuminators even if the analysis is required for the agent ROI video taken in dark or low-light environments.

The customer interaction module **512** receives the customer interaction data and the agent identification data from the agent device **108**. The customer interaction module **512** is configured to analyze the customer interaction data including at least one of customer-related actions including: (1) the customer's responses to the IVR system; (2) the text messages, the audio interactions, and the video interactions exchanged between the customer **106** and the agent **102** (or the supervisor **104**); (3) customer-provided feedback; and (4) a customer call summary created by the agent **102** based on the agent's interaction with the customer **106**, or in any combination thereof. In one example, the customer interaction module **512** may apply Automatic Speech Recognition (ASR) on the agent-customer conversation followed by text analysis of the ASR transcript to parse the conversation into different categories. The categorization may be performed on the basis of different parameters such as modeling the customer call flow (for example, which part of the call was 'greeting', 'query', 'closing' and so on), spotting key words or generic terms of interest (for example, 16-character alpha-numeric customer ID, 10-digit phone number), sentiment-intensive words (for example, 'hate', 'irritate', etc.), customer-agent voice-over (indicative of impatience and irritation on customer's side) and other finer aspects. In another example, the customer interaction module **512** may parse the customer's IVR responses to identify various aspects such as a broad topic of a customer call, the caller's state of mind (i.e., is the customer **106** agitated, in a hurry or calm), customer interaction history (i.e., number of times the customer **106** has called in the recent past, how much time the customer **106** has spent in traversing the IVR) and in many cases a fine grain sub-topic identification. The customer interaction module **512** identifies these parameters and aspects as the stress-trigger points responsible for causing agent tress.

Further, the customer interaction module **512** is configured to combine the customer interaction data with the agent stress profile determined by the video analysis module **510** based on the agent identification data. For example, customer interaction module **512** may correlate various customer-related actions with the time of high agent stress based on the agent login ID to derive insights into the stress-trigger points for the agent **102**, such as, (a) the agent **102** is more stressed during a 'query' period (such that a likely implication is that the access to database is slow or the script to identify a customer issue is not easy to follow) or during a 'resolution' period (such that a likely implication is that a manual provided for troubleshooting is not detailed enough or is faulty and needs revision); (b) the agent **102** is stressed by customer's language and tone (such that a likely implication is that the agent **102** needs training on 'how to empathize with the customer **106**' or that the call should be escalated); or (c) the agent **102** is highly stressed throughout the call (such that a likely impli-

cation is that the agent **102** has difficulty following a particular accent of the customer **106** or is not well versed in a particular customer-related topic). Such insights are also identified as the stress-trigger points for the agent **102** by the customer interaction module **512**. The customer interaction module **512** communicates the stress-trigger points to the feedback module **514**.

The feedback module **514** receives the stress-trigger points and is configured to provide feedback to at least one of the agent **102** and the supervisor **104** based on outputs of the video analysis module **510** and the customer interaction module **512**. In one example, the feedback module **514** may generate feedback, whenever the video analysis module **510** determines that the LF/HF ratio has exceeded one or more predefined stress threshold values indicating a stress pattern of the agent **102**. In another example, predefined suggestive remedial messages may be stored in the feedback module **514**. The predefined suggestive remedial messages may be created based on the identified stress-trigger points. The feedback module **514** may be configured to generate feedback including the predefined suggestive remedial messages to assist in reducing agent stress.

Additionally, the identified stress-trigger points may be retrieved from the feedback module **514** upon request. The retrieved stress-trigger points may be used by the supervisor **104** or the agent **102** offline for various purposes, such as to identify a set of agents that may be best suited for a particular customer-related topic, the agents who need further training on particular customer-related topics, those customer-related topics that need better training material, and so on.

FIG. **7** illustrates an exemplary method for implementing the stress assessment device **116**, according to an embodiment of the present disclosure. The exemplary method may be described in the general context of computer executable instructions. Generally, computer executable instructions can include routines, programs, objects, components, data structures, procedures, modules, functions, and the like that perform particular functions or implement particular abstract data types. The computer executable instructions can be stored on a computer readable medium, and installed or embedded in an appropriate device for execution.

The order in which the method is described is not intended to be construed as a limitation, and any number of the described method blocks can be combined or otherwise performed in any order to implement the method, or an alternate method. Additionally, individual blocks may be deleted from the method without departing from the spirit and scope of the present disclosure described herein. Furthermore, the method can be implemented in any suitable hardware, software, firmware, or combination thereof, that exists in the related art or that is later developed.

The method describes, without limitation, implementation of the exemplary stress assessment device **116** in a call center environment. One of skill in the art will understand that the method may be modified appropriately for implementation in a variety of other business scenarios including those related to medical services, hospitality, retail, banking services, and so on, without departing from the scope and spirit of the disclosure.

At step **702**, customer interaction data, video of a target region of exposed skin of an agent, and agent identification data is received. In case of a call center, the customer **106** may communicate with the call center agent **102** over the communication network **112**. Such communication may be established between the customer device **110** and the agent device **108** either directly or via an intermediate device such as the server **114**, the network appliance **118**, and so on. The customer **106** may manipulate the customer device **110** to communicate with the call center agent **102** via the agent device **108** through various modes. In a first mode, the customer **106** may communicate with the IVR system interfacing between the customer device **110** and the agent device **108**. The customer **106** may respond to various pre-recorded or dynamically-generated messages in the IVR system. Based on customer responses, the IVR system may route the customer **106** to the agent **102** for direct interaction. In a second mode, the agent device **108** may be configured to establish a direct connection with customer device **110** without intervention from the IVR system.

Once the agent device **108** is connected to the customer device **110**, the customer **106** may interact with the agent **102** through at least one of text messages, audio interaction data, video interaction data, or customer-provided feedback that is recorded by the agent device **108**. The agent **102** may use the agent device **108** to additionally prepare a summary of the audio interactions or the video interactions conducted with the customer **106**.

In a call center environment, such customer-agent interactions may be substantially predefined or scripted. For example, the agent **102** may have access to one or more scripts, for example, including dialogs and questions to ask the customer **106** during a customer call. The script may be available to the agent **102** in a physical version, such as on a physical paper, or in an electronic version stored on the agent device **108**. The electronic version of the script may be hyperlinked for directing the agent **102** to other scripts based on a customer's response to a previously asked question. For this, the agent **102** may enter the customer's response into the script or an associated scripting program, such as by pressing a predetermined button on the agent device **108** or by selecting a proper response from a list using a mouse or other pointing device (input code), on the agent device **108**. Depending upon the entered response, the script or the scripting program may display another script on the agent device **108**.

The agent device **108** may collect the customer interaction data including the customer's IVR responses, the text messages, the audio interaction data, the video interaction data, the customer-provided feedback and the call summaries, and convey them along with the agent identification data to the stress assessment device **116**. The stress assessment device **116** may be implemented as a standalone device, or integrated with at least one the agent device **108**, the server **114**, and the network appliance **118**.

Additionally, the agent device **108** includes the imaging unit **120** that is configured to monitor and capture a video of a target region of exposed skin of the agent **102**. The imaging unit **120** may include IR or NIR illuminators so that the video may be correctly captured even in dark or low light conditions. In an exemplary embodiment, the agent **102** may be continuously monitored by the imaging unit **120** that is configured to capture the video while the agent **102** is interacting with the customer **106**. For example, the imaging unit **120** may capture the video of the target region of exposed skin of the agent **102** during a voice call with the customer **106**. The captured video is in-sync with digitized audio data corresponding to such customer-agent interaction, thereby providing combined audio-video data for analysis. The agent device **108** communicates the captured video along with the agent identification data to the stress assessment device **116**.

The stress assessment device **116** includes the agent identification module **508**, the video analysis module **510**, the customer interaction module **512**, and the feedback module **514**. The video analysis module **510** is configured to receive

the captured video and the agent identification data. The customer interaction module **512** is configured to receive the customer interaction data and the agent identification data.

At step **704**, the received video is processed to generate a time-series signal and to extract the LF and the HF components from the generated time-series signal. The video analysis module **510** is configured to process the received video of the target region of the exposed skin of the agent **102** to isolate blood vessels in the agent's body depicted in the video based on different parameters using various techniques known in the art. Examples of these parameters include, but not limited to, color, spatial features, material identification, and the like. The isolated blood vessels are represented in the time-series signal for different bodily vascular regions captured in the video. If the agent **102** has high bodily motion, for example, during a conversation with the customer **106**, then motion isolation or motion compensation algorithms known in the art may be used to filter the time-series signal. The time-series signal includes the PPG signal having the LF and HF components. The video analysis module **510** is configured to apply appropriate hardware or software filters and extract the LF and the HF components from the integrated power spectrum of the time-series signal over a predefined interval, and computes the LF/HF ratio, which is a measure of the heart rate variability, and hence the stress, experienced by the agent **102**.

At step **706**, a stress profile of the agent **102** is determined based on the LF/HF ratio exceeding the predefined stress threshold. The video analysis module **510** is further configured to compare the value of LF/HF ratio to at least one predefined stress threshold value. The LF/HF ratio having a value greater than the predefined stress threshold value '1' indicates that the agent **102** is under stress. In contrast, the LF/HF ratio value less than the predefined stress threshold value '1' indicates that the agent **102** is experiencing no stress or normal stress that is required to keep the agent **102** active. Further, the video analysis module **510** may be configured to compare the LF/HF ratio with multiple predefined stress threshold values, each of which is equivalent to or exceeds the value '1'. Exemplary embodiments may include the video analysis module **510** to compare the LF/HF ratio with the stress threshold values '2', '3', and '4' to assess the level of stress experienced by the agent **102**. For example, the LF/HF ratio having a value between '1' and '2' may indicate low-level stress, the LF/HF ratio value between '2' and '3' may indicate medium-level stress, and the LF/HF ratio value between '3' and '4' may indicate high-level stress experienced by the agent **102**.

The video analysis module **510** is also configured to identify the agent **102** based on the agent identification data received from the agent device **108**. The video analysis module **510** compares the agent identification data such as the login ID, the IP address of the agent device **108**, etc., with the agent information in the agent identification module **508** to identify the agent **102**. The video analysis module **510** associates the identified agent **102** with the determined LF/HF ratio value to create a stress profile for that agent **102** in real-time. The agent stress profile is stored at the video analysis module **510**, which communicates the agent stress profile to the customer interaction module **512** and the feedback module **514**.

At step **708**, the customer interaction data is correlated with the stress profile of the agent **102** based on the agent identification data. The customer interaction module **512** is configured to receive the customer interaction data and the agent identification data from the agent device **108**. Similar to the video analysis module **510**, the customer interaction module **512** is configured to identify the agent **102** associated with the customer interaction data by comparing the received agent identification data with the agent **102** information stored in the agent identification module **508**. The customer interaction module **512** correlates the received customer interaction data with the received agent stress profile based on the agent identification data. Examples of the agent identification data may include, but are not limited to, agent **102** name, employee ID of the agent **102**, IP address of the agent device **108**, and so on.

At step **710**, agent stress-trigger points are identified in the correlated customer interaction data. The customer interaction module **512** is configured to analyze the correlated customer interaction data to determine the agent stress-trigger points that cause the LF/HF ratio for the identified agent **102** to at least become equivalent to or exceed the value '1', thereby indicating the agent **102** being abnormally stressed-out. Unlike conventional techniques, such analysis augments the agent stress profile corresponding to the agent's ROI video with the correlated customer interaction data for determining the agent stress-trigger points. The analysis may be performed in a variety of ways. In one example, the customer interaction module **512** may apply Automatic Speech Recognition (ASR) on the agent-customer conversation followed by text analysis of the ASR transcript to parse the conversation into different categories that may have caused the agent's stress to increase. The categorization may be performed on the basis of different parameters, such as those discussed above, that may have made the agent **102** to experience stress. In some embodiments, the determination of the stress-trigger points is assisted by scripted details (for example, dialogs, questions, etc.) in the customer interaction data. The customer interaction module **512** provides the identified stress-trigger points to the feedback module **514**.

At step **712**, feedback is generated based on the agent stress profile of the agent **102** in real-time. In one embodiment, the feedback module **514** is configured to receive the agent stress profile from the video analysis module **510**. When the agent stress profile indicates that the LF/HF ratio exceeds a predefined stress threshold value, such as, '1', '2', and so on, the feedback module **514** is configured to provide feedback to the corresponding agent **102** or to the supervisor **104** in real-time. Other embodiments may include the feedback module **514** configured to provide the feedback to the agent **102** or the supervisor **104** multiple times if the LF/HF ratio is equivalent to or above one or more predefined stress threshold values for a predetermined time. Additionally or alternatively, the feedback module **514** may be configured to provide the feedback to the agent **102** or the supervisor **104** when the LF/HF ratio reduces below one or more predefined stress threshold values.

The feedback may be provided in various forms including, but not limited to, an alert message, an audio indication such as a beep, and a visual indication such as a blinking light, or any combination thereof. The feedback indicates that the agent **102** is experiencing stress while interacting with the customer **106**. For example, when the agent **102** is communicating with an irate customer **106**, the agent **102** may experience abnormal stress. Upon detecting agent stress due to an increase in the LF/HF ratio beyond '1' as indicated in the agent stress profile, the feedback module **514** provides the feedback to the agent **102** and the supervisor **104** in real-time during a live customer interaction. In exemplary embodiments including those involving non-visual interactions, such as voice calls, between the agent **102** and the customer **106** in a live environment, the provided feedback assists the agent **102** to change the course of interaction whenever abnormal stress-level of the agent stress is determined. In some embodi-

ments, the feedback module **514** may provide the feedback to the supervisor **104** on the supervisor device **122** during an on-going customer-agent interaction. As a result, the supervisor **104** is able to effectively monitor multiple customer-agent interactions and provide relevant assistance to the agent **102** for ensuring or enhancing customer satisfaction.

At step **714**, the feedback is combined with suggestive stress-remedial messages based on the identified stress-trigger points. The feedback module **514** receives the stress-trigger points from the customer interaction module **512**. In one embodiment, the feedback module **514** is configured to provide predefined stress remedial messages with the feedback to the agent **102** based on the received stress-trigger points. The predefined stress remedial messages may assist the agent **102** during the live customer interaction to reduce agent stress. For example, the agent **102** may be experiencing stress due to lack of adequate information to address customer **106** needs. In response to an increasing agent stress, the feedback module **514** may provide the agent **102** with a link to a technical guide along with stress-indicating feedback to assist the agent **102** on-the-fly to successfully address the customer **106** needs and reduce agent stress. In another example, if the agent stress-level remains above the predefined stress threshold for a predefined duration during the customer call, the supervisor **104** may be alerted by sending feedback or the agent **102** may be prompted to escalate the call. Unlike the conventional offline analyses of the customer interaction data, the feedback module **514** analyzes the stress-trigger points to provide real-time appropriate feedback message during a live customer-agent interaction for mitigating agent stress and enhance customer satisfaction.

Other embodiments may include the feedback module **514** configured to provide stress-related data for each agent **102** on-demand for non-continuous monitoring of customer-agent interactions. In one example, the supervisor **104** may request for the agent stress-trigger points for a particular agent **102** across various customer calls to perform an aggregate-level stress analysis for the agent **102**. In another example, the supervisor **104** may request for stress-trigger points across a set of agents to identify high stress times and high stress agents for managing deputation of one or more supervisors. Such analysis of the stress-related data may assist the supervisor **104** to monitor long-term performance of one or more agents to improve call routing and to improve various resources, such as training, learning material, number of breaks, allocated projects of a particular type, etc., available to the agents.

The above description does not provide specific details of manufacture or design of the various components. Those of skill in the art are familiar with such details, and unless departures from those techniques are set out, techniques, known, related art or later developed designs and materials should be employed. Those in the art are capable of choosing suitable manufacturing and design details.

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the disclosure. It will be appreciated that several of the above-disclosed and other features and functions, or alternatives thereof, may be combined into other systems or applications. Various presently unforeseen or unanticipated alternatives, modifications, variations, or improvements therein may subsequently be made by those skilled in the art without departing from the scope of the present disclosure as encompassed by the following claims.

What is claimed is:

**1**. A system for stress assessment of a call center agent while interacting with a customer, the system for use with a communication network, the system comprising:

a stress assessment device; and

an agent device that includes an imaging unit, the device being configured to:

capture a video of a target region of exposed skin of the agent using the imaging unit;

collect customer interaction data based on interaction with a customer device over the communication network; and

communicate the captured video and the customer interaction data to the stress assessment device;

wherein the stress assessment device is configured to:

passively estimate agent stress-level based on the received video; and

generate feedback to the agent based on correlation between the customer interaction data and the estimated stress-level over a predefined time interval.

**2**. The system of claim **1**, wherein the agent stress-level is estimated in real-time.

**3**. The system of claim **1**, wherein the feedback is generated to the agent in real-time.

**4**. The system of claim **1**, wherein the stress assessment device is further configured to:

generate a time-series signal from the captured video, wherein the time-series signal includes at least one low frequency (LF) component and at least one high frequency (HF) component in the integrated power spectrum of the time-series signal over a predefined interval;

compute a ratio of the at least one LF component and the at least one HF component; and

estimate agent stress based on the ratio exceeding a predefined stress threshold.

**5**. The system of claim **4**, wherein the predefined stress threshold has one or more values, wherein at least one value of the predefined stress threshold is equal to one.

**6**. The system of claim **4**, wherein the ratio detects heart rate variability of the agent.

**7**. The system of claim **1**, wherein the stress assessment device is further configured to determine stress-trigger points from the customer interaction data for the agent.

**8**. The system of claim **1**, wherein the stress assessment device is further configured to generate a stress profile for the agent using the estimated agent stress-level.

**9**. The system of claim **1**, wherein the customer interaction data is correlated with the estimated stress-level based on agent identification data.

**10**. The system of claim **1**, wherein the agent device is further configured to:

generate agent identification data; and

communicate the generated agent identification data to the stress assessment device.

**11**. The system of claim **10**, wherein the agent identification data includes at least one of system login ID, system password, biometric data, name, and employee ID.

**12**. The system of claim **1**, wherein the generated feedback includes at least one of a message, an audio indication, and a visual indication.

**13**. The system of claim **1**, wherein the generated feedback includes at least one predefined stress remedial messages.

**14**. The system of claim **1**, wherein the customer interaction data includes at least one of customer responses to an interactive voice response (IVR) system, audio interactions, video interactions, text messages, call summaries, and customer-provided feedback, wherein the audio interactions include at least one of voice calls and recorded audio mes-

sages, and the video interactions include at least one of video calls and recorded video messages.

**15**. A device for generating feedback to a call center agent during communication with a customer, the device comprising:

a video analysis module for receiving a video of a target region of exposed skin of the agent, the video analysis module being configured to passively estimate stress-level of the agent based on the received video over a predefined time interval;

a customer interaction module for receiving data collected based communication between the agent and the customer, the customer interaction module being configured to correlate the data with the estimated stress-level over the predefined time interval; and

a feedback module configured to generate feedback to the agent after the estimated stress-level exceeds a predefined stress threshold, the generated feedback including predefined suggestive messages based on the correlated data.

**16**. The device of claim **15**, wherein the agent stress-level is estimated in real-time.

**17**. The device of claim **15**, wherein the feedback is generated in real-time.

**18**. The device of claim **15**, wherein the video analysis module is further configured to:

generate a time-series signal from the received video, wherein the time-series signal includes at least one low frequency (LF) component and at least one high frequency (HF) component in the integrated power spectrum over the predefined interval;

compute a ratio of the at least one LF component and the at least one HF component; and

estimate the stress-level based on the ratio exceeding the predefined stress threshold.

**19**. The device of claim **18**, wherein the predefined stress threshold has one or more values, wherein at least one value of the predefined stress threshold is equal to one.

**20**. The device of claim **18**, wherein the ratio detects heart rate variability of the agent.

**21**. The device of claim **15**, wherein the video analysis module is further configured to determine stress-trigger points from the received data for the agent.

**22**. The device of claim **15**, wherein the video analysis module is further configured to generate a stress profile for the agent using the estimated agent stress-level.

**23**. The device of claim **15**, wherein the received data is correlated with the estimated stress-level based on agent identification data.

**24**. The device of claim **23**, wherein the agent identification data includes at least one of system login ID, system password, biometric data, name, and employee ID.

**25**. The device of claim **15**, wherein the generated feedback includes at least one of a message, an audio indication, and a visual indication.

**26**. The device of claim **15**, wherein the received data includes at least one of customer responses to an interactive voice response (IVR) system, audio interactions, video interactions, text messages, call summaries, and customer-provided feedback, wherein the audio interactions include at least one of voice calls and recorded audio messages, and the video interactions include at least one of video calls and recorded video messages.

**27**. A method for generating feedback during interaction between an agent and a customer, the method comprising:

receiving customer interaction data and video of a target region of exposed skin of the agent;

processing the video to generate a time-series signal and to extract low frequency and high frequency components from the generated time-series signal;

determining stress profile of the agent based on a ratio of the low frequency components and the high frequency components of the integrated power spectrum of the time-series signal over a predefined time interval, wherein the ratio exceeds a predefined stress threshold;

correlating the customer interaction data with the determined stress profile;

identifying agent stress-trigger points based on the correlated customer interaction data; and

generating feedback based on the determined stress profile, wherein the feedback includes suggestive predefined remedial messages based on the identified agent stress-trigger points.

**28**. The method of claim **27**, further comprising:

receiving agent identification data; and

correlating the customer interaction data with the determined stress profile based on the received agent identification data.

**29**. The method of claim **27**, wherein the predefined stress threshold has one or more values, wherein at least one value of the predefined stress threshold is equal to one.

**30**. The method of claim **27**, wherein the stress profile of the agent is determined in real-time.

**31**. The method of claim **27**, wherein the feedback is generated in real-time.

**32**. A non-transitory computer-readable medium comprising computer-executable instructions for generating feedback during interaction between an agent and a customer, the non-transitory computer-readable medium comprising instructions for:

receiving customer interaction data and video of a target region of exposed skin of the agent;

processing the video to generate a time-series signal and to extract low frequency and high frequency components from the generated time-series signal;

determining stress profile of the agent based on a ratio of the low frequency components and the high frequency components of the integrated power spectrum of the time-series signal over a predefined time interval, wherein the ratio exceeds a predefined stress threshold;

correlating the customer interaction data with the determined stress profile;

identifying agent stress-trigger points based on the correlated customer interaction data; and

generating feedback based on the determined stress profile, wherein the feedback includes suggestive predefined remedial messages based on the identified agent stress-trigger points.

**33**. The non-transitory computer-readable medium of claim **32**, further comprising:

receiving agent identification data; and

correlating the customer interaction data with the determined stress profile based on the received agent identification data.

**34**. The non-transitory computer-readable medium of claim **32**, wherein the predefined stress threshold has one or more values, wherein at least one value of the predefined stress threshold is equal to one.

**35**. The non-transitory computer readable medium of claim **32**, wherein the stress profile of the agent is determined in real-time.

**36**. The non-transitory computer readable medium of claim **32**, wherein the feedback is generated in real-time.

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