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(54) **INTELLIGENT BLOOD PRESSURE MONITORING**

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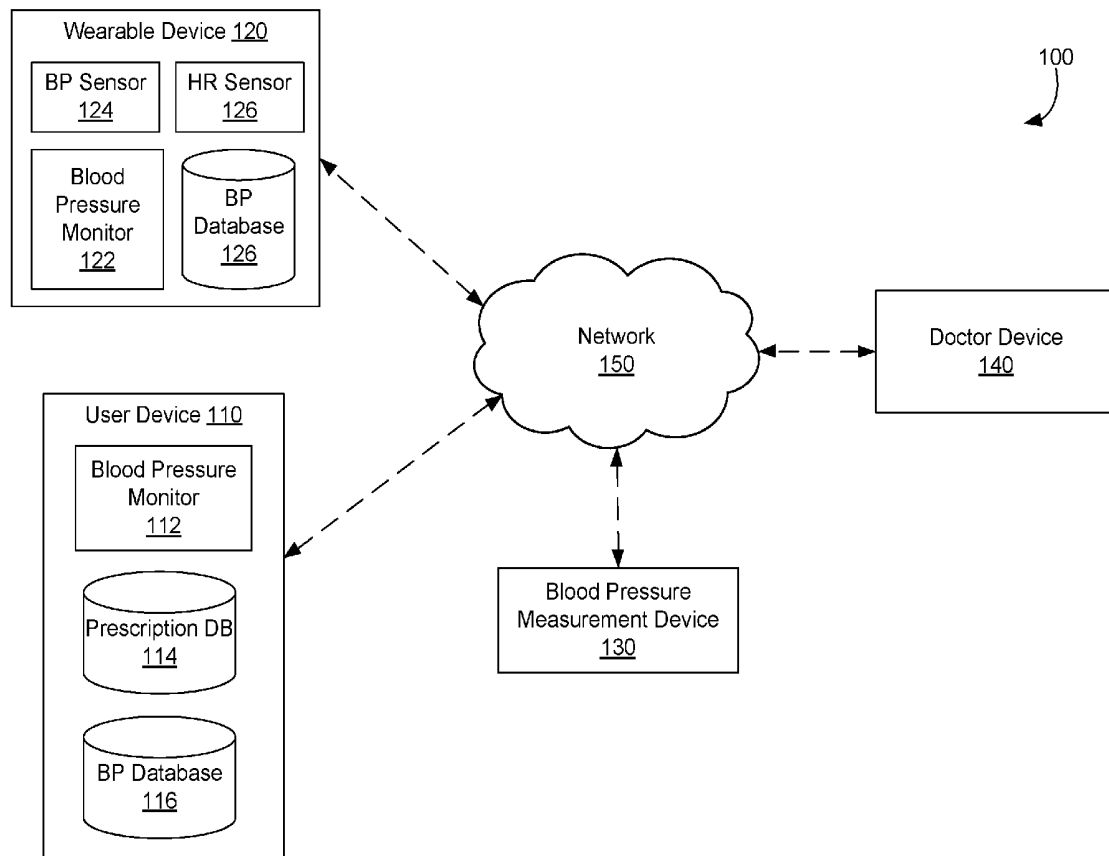
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(57) **ABSTRACT**

In some implementations, a user device can assist a user with intelligent blood pressure monitoring. For example, the user device can present notifications and/or reminders that prompt the user to take blood pressure measurements at a prescribed time or according to a prescribed schedule. The user device can automatically determine that the user should or should not take a blood pressure measurement based on the user's context and suggest an alternative time for taking the blood pressure measurement. For example, the user's context can include the user's physical and/or psychological state inferred based on sensor data, application data, and/or other detectable information. In some implementations, the user device can automatically monitor the user's blood pressure and take blood pressure measurements based on user context triggers.



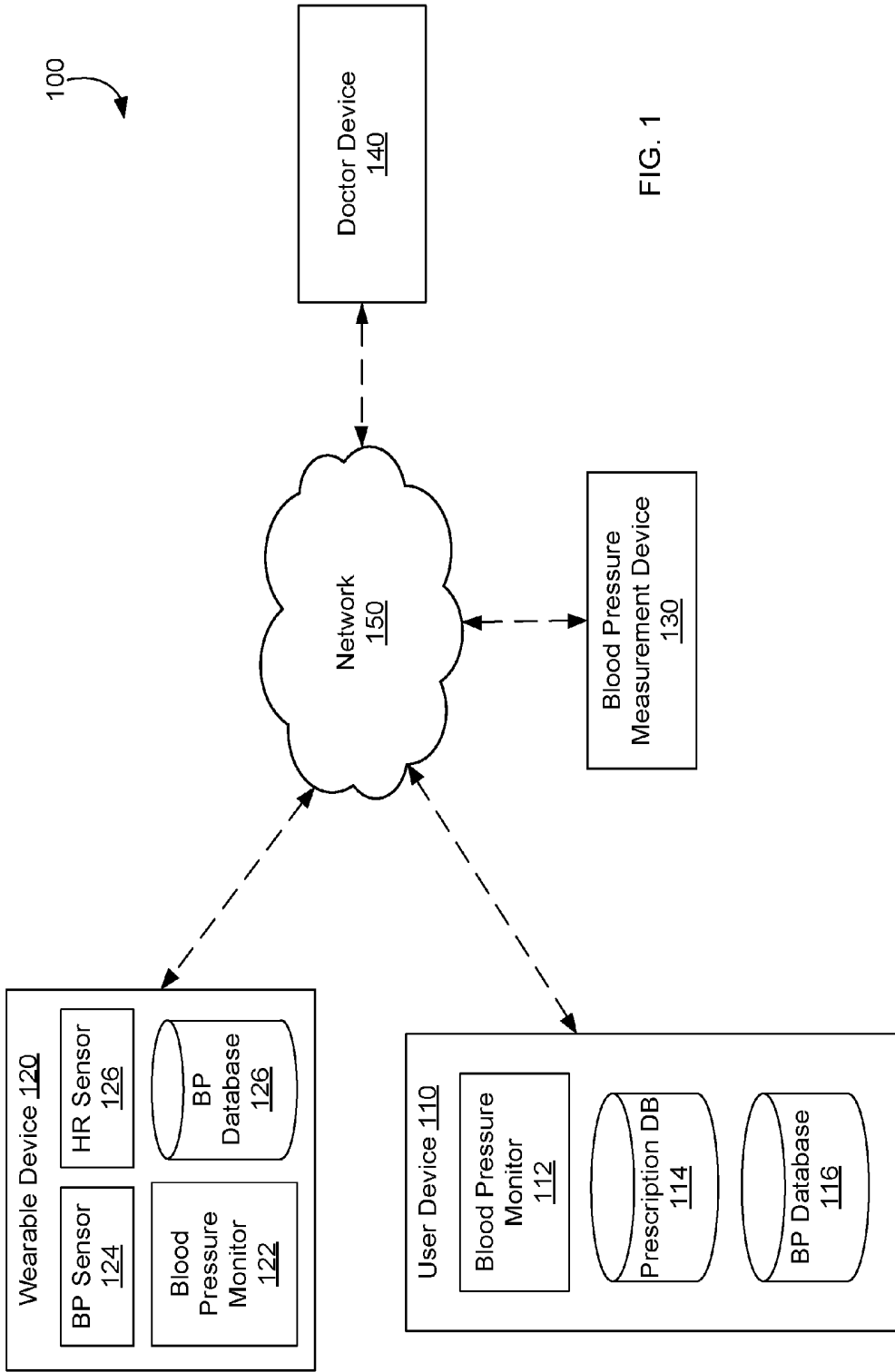


FIG. 1

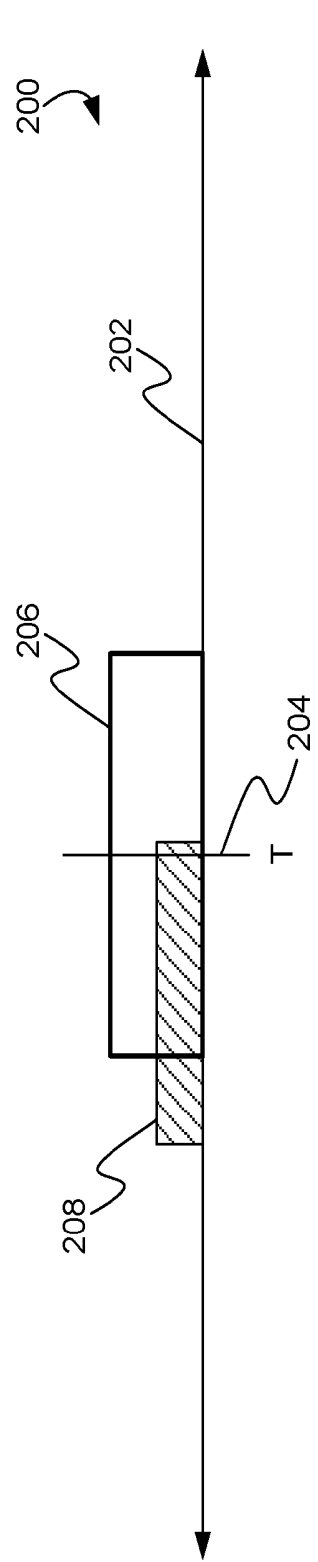


FIG. 2A

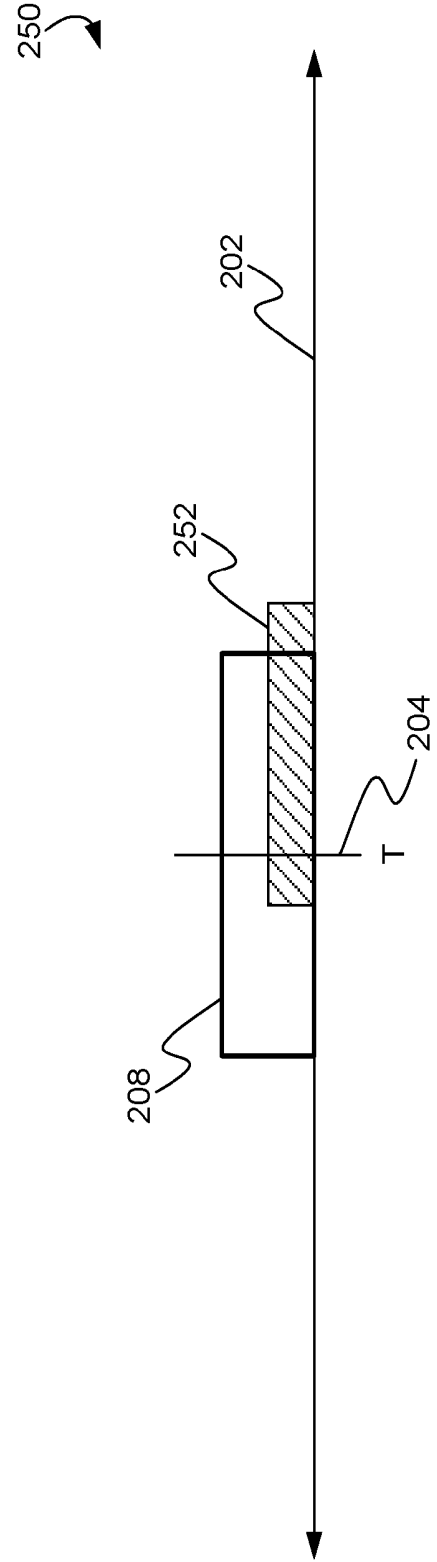


FIG. 2B

300

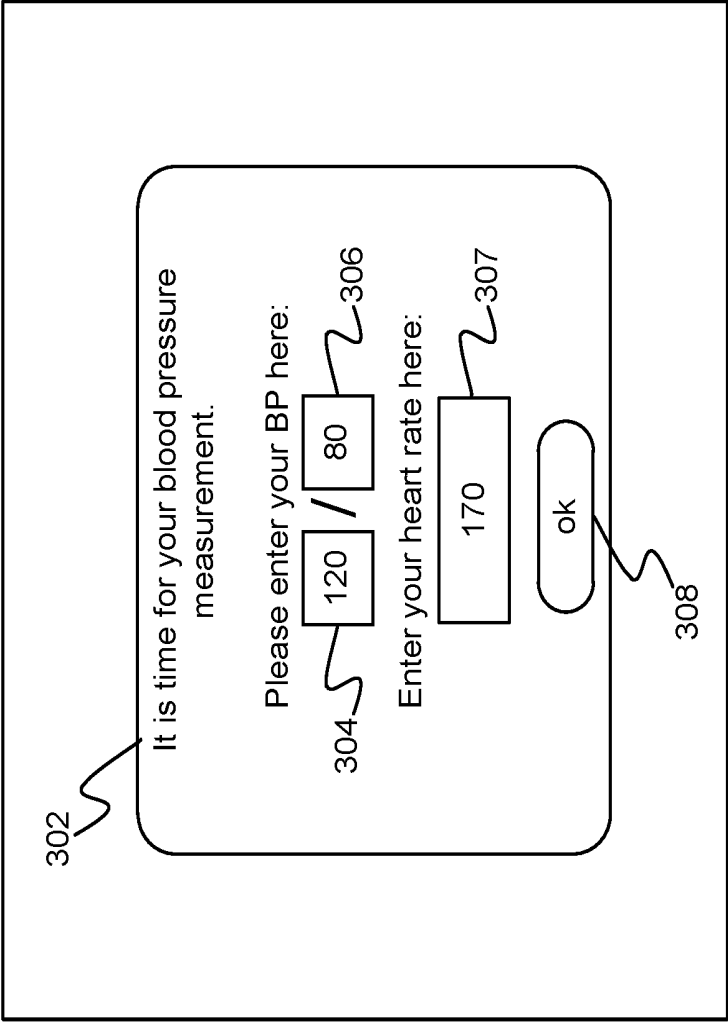


FIG. 3

400

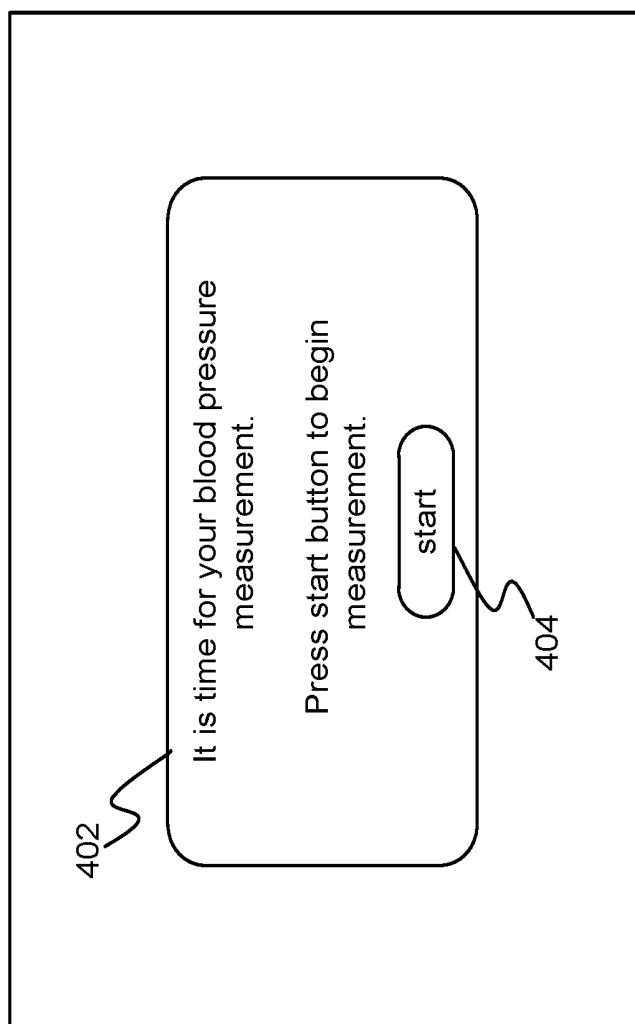


FIG. 4

500

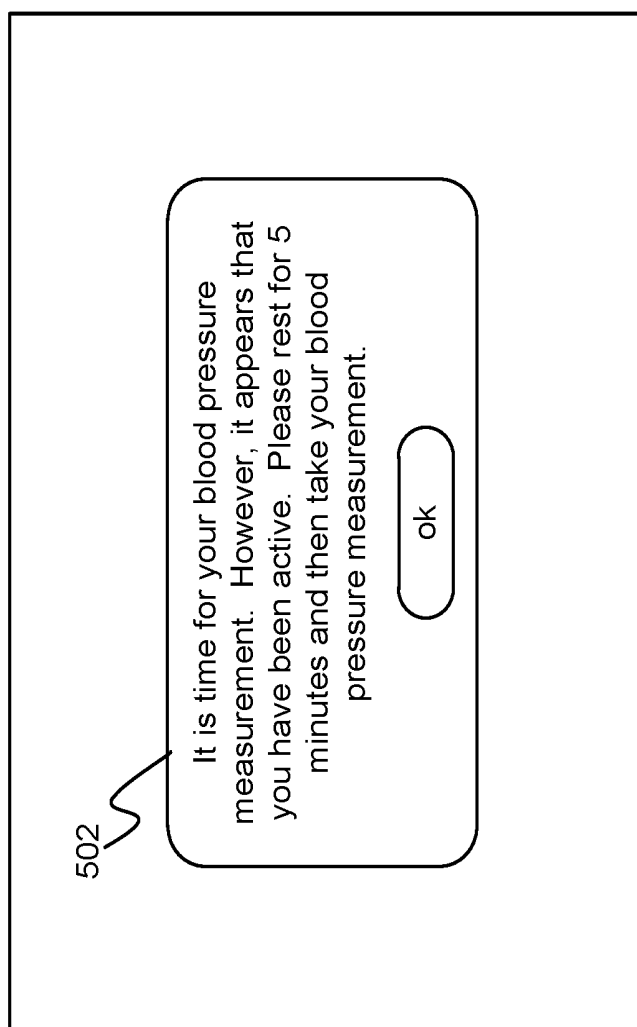



FIG. 5

600

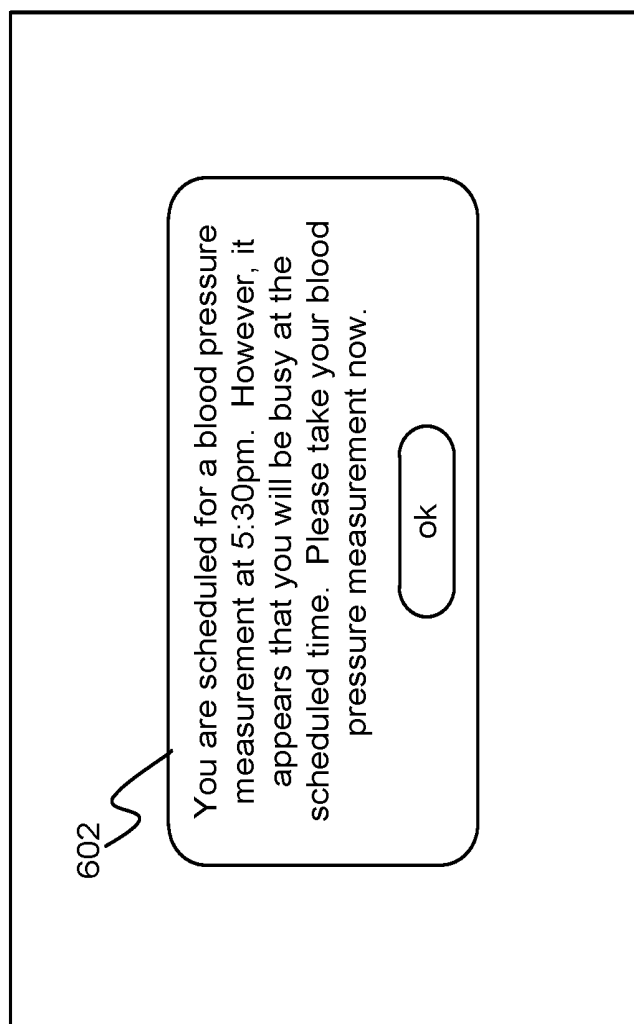
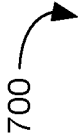


FIG. 6

700 

Time	Systolic	Diastolic	Heart Rate	Context
T-1	183	92	163	Location: Office; Calendar: Meeting; App: Phone
T-2	190	92	171	Motion: Running; App: Music
T-3	114	78	74	Sleep: True; Location: Home; MedAdherence: True
T-4	124	82	82	Sleep: False; Location: Central Park; App: Music

FIG. 7

800

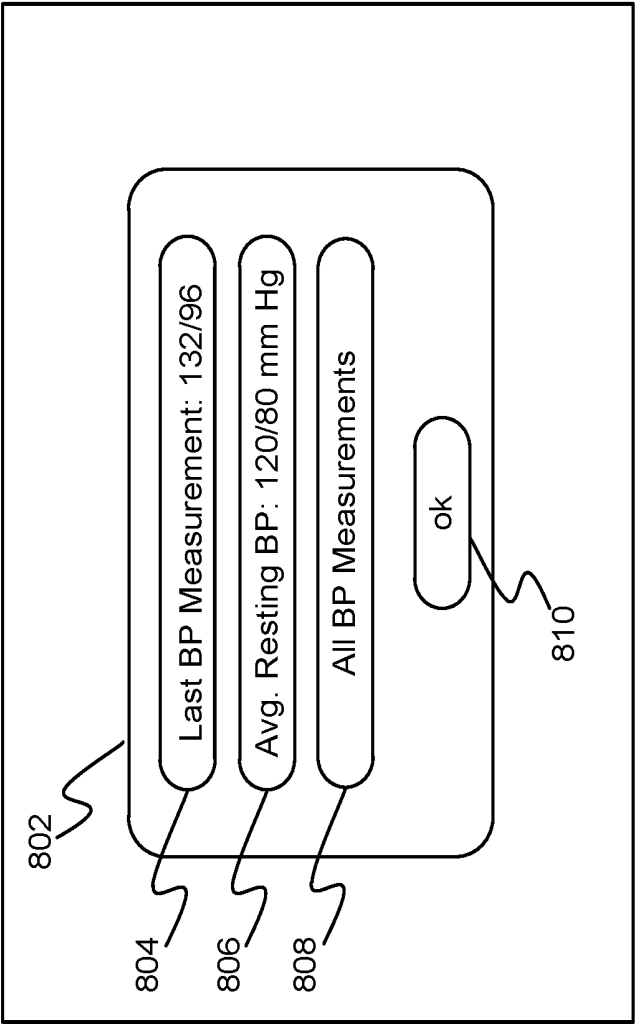


FIG. 8

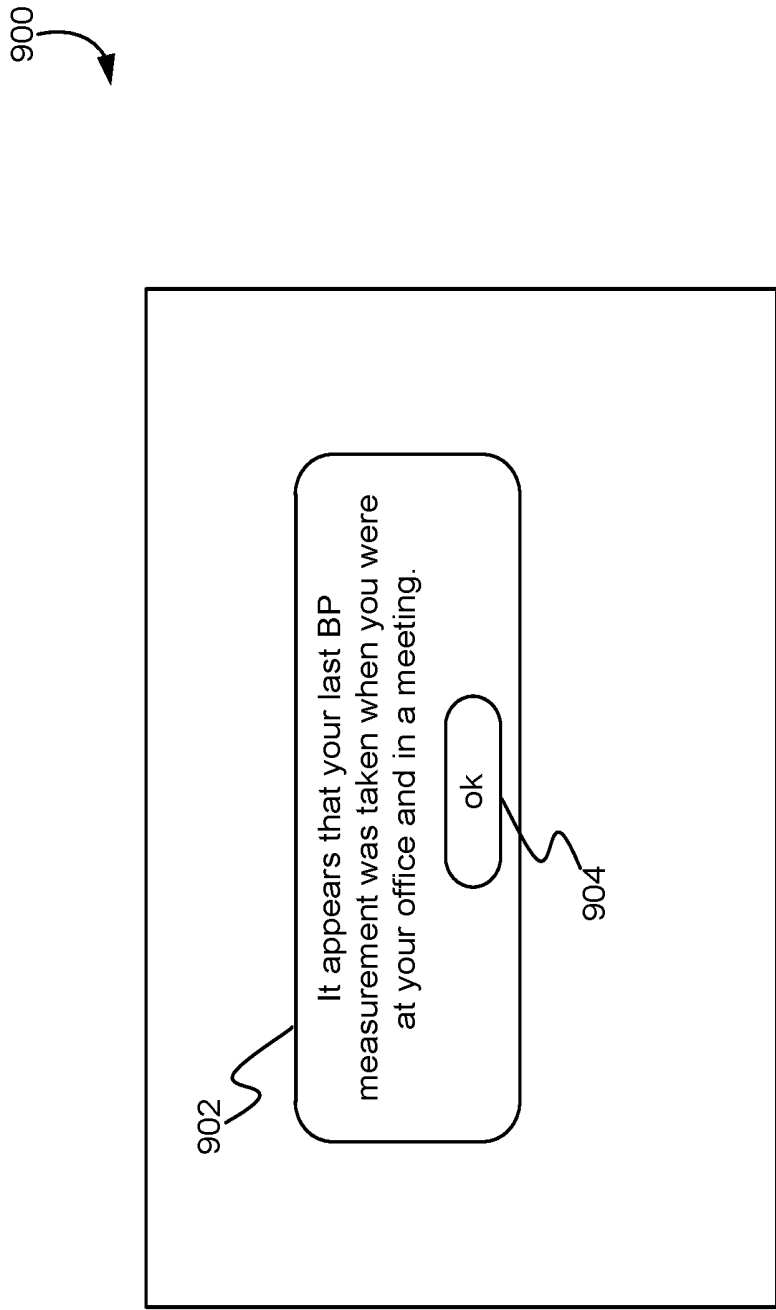


FIG. 9

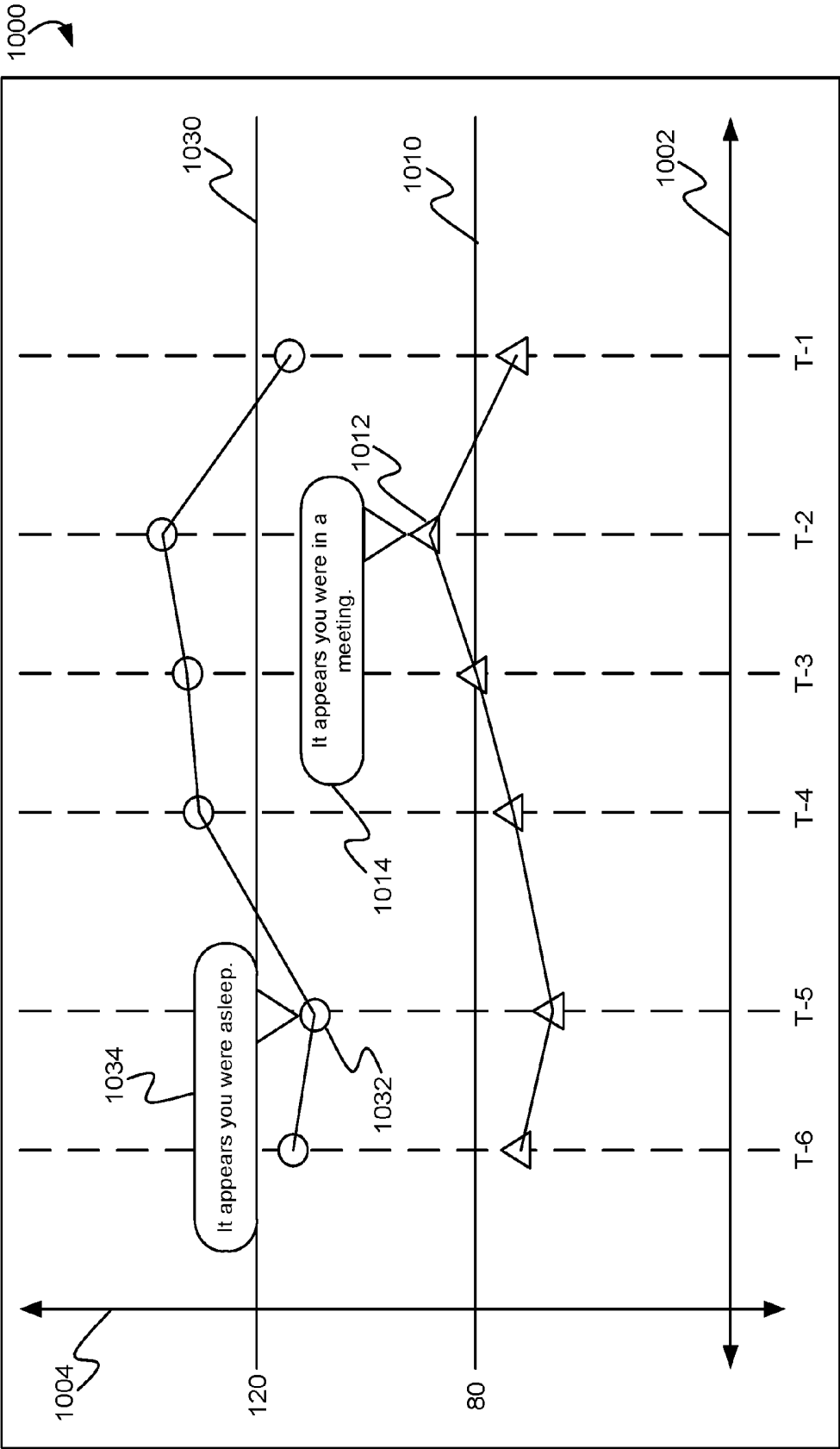


FIG. 10

FIG. 11

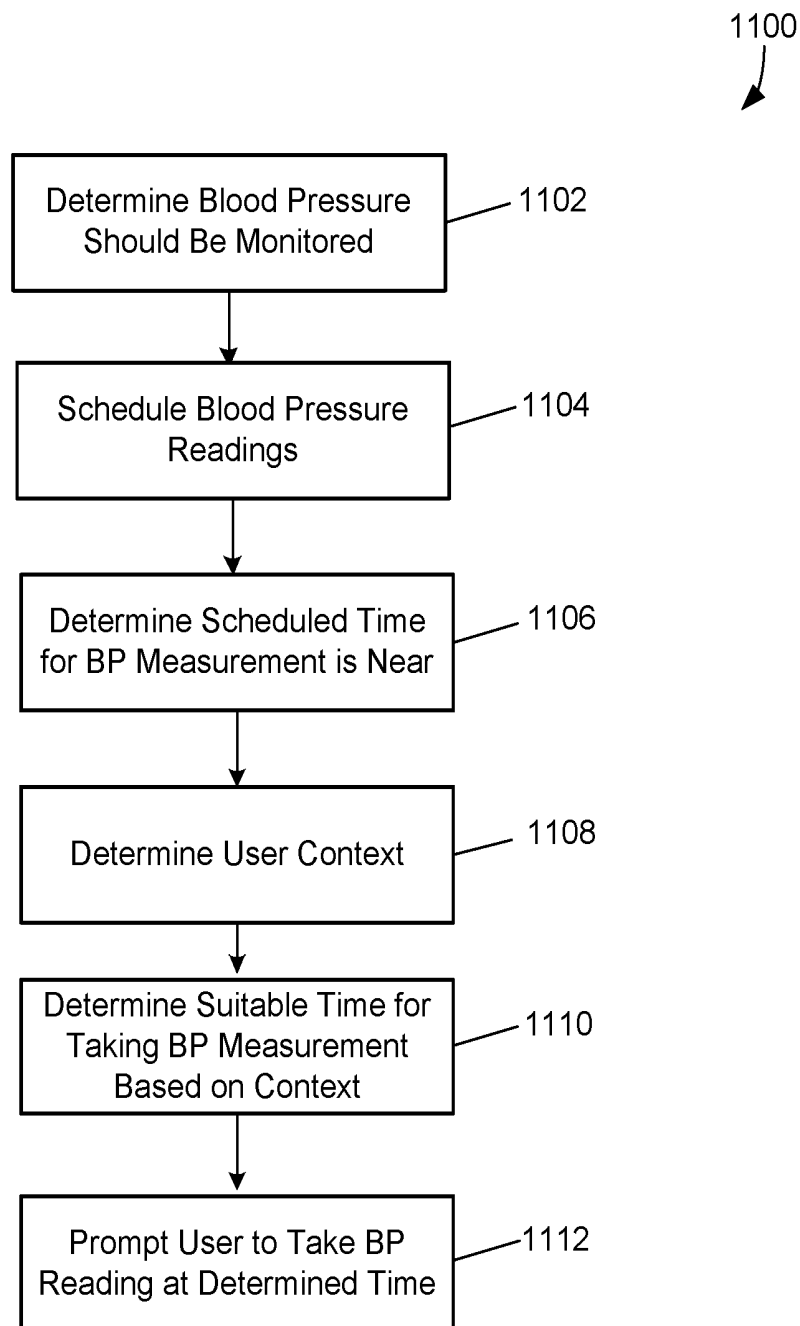
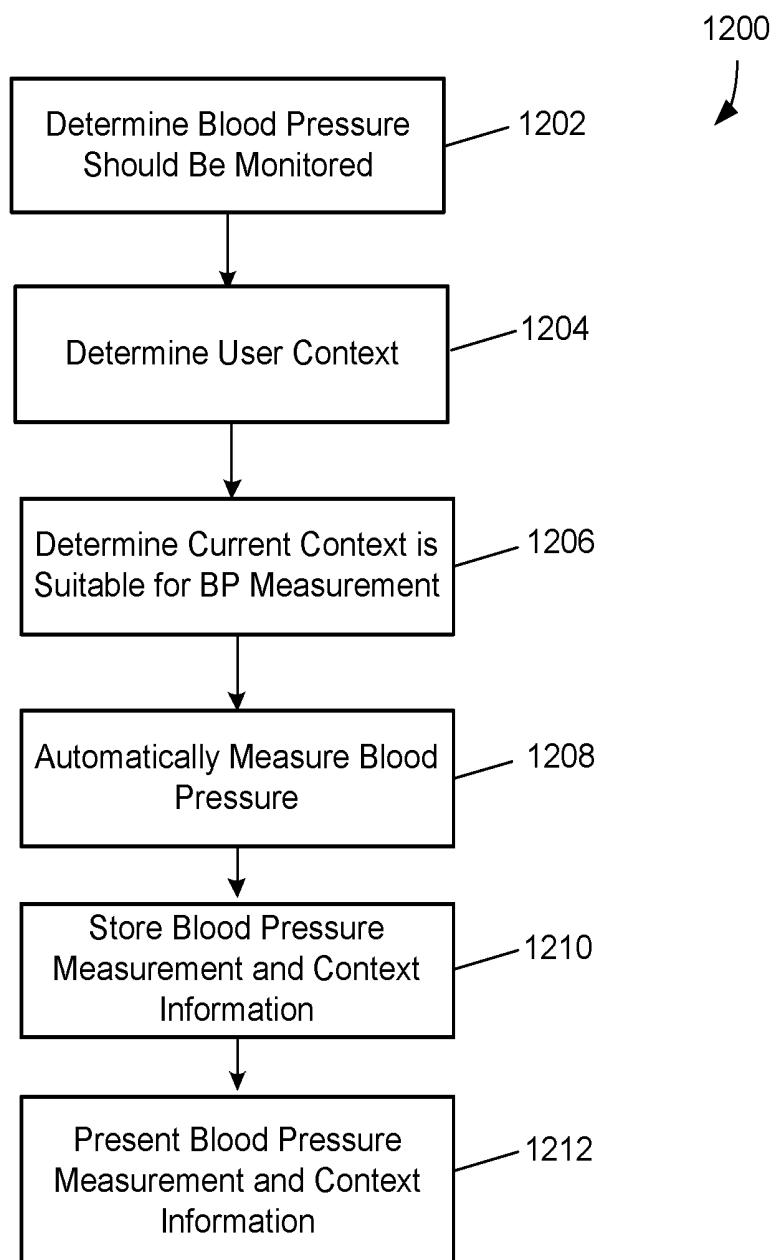


FIG. 12



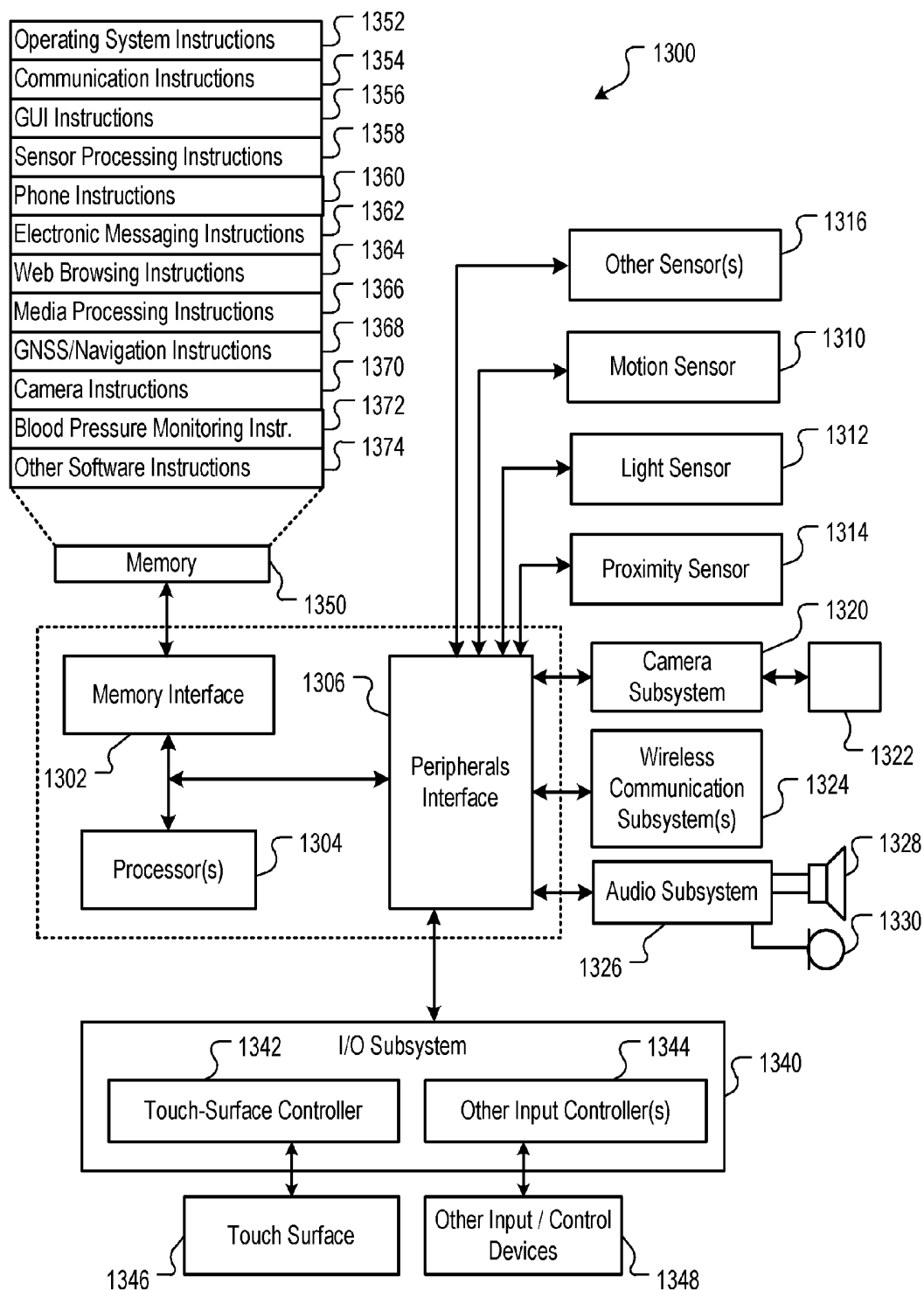


FIG. 13

INTELLIGENT BLOOD PRESSURE MONITORING

TECHNICAL FIELD

[0001] The disclosure generally relates to collecting biometric data.

BACKGROUND

[0002] Patients are often required by their doctor to monitor heart rate, blood pressure, and other biometric data so that the doctor can detect or identify abnormalities or ailments before the patient suffers some irreversible damage. Typically, it is up to the patient to remember to take the patient's blood pressure according to a schedule prescribed by a doctor. Sometimes the patient will take blood pressure measurements according to the prescribed schedule but the patient's recent activity, environment, or other stimuli will result in an erroneous blood pressure measurement.

SUMMARY

[0003] In some implementations, a user device can assist a user with intelligent blood pressure monitoring. For example, the user device can present notifications and/or reminders that prompt the user to take blood pressure measurements at a prescribed time or according to a prescribed schedule. The user device can automatically determine that the user should or should not take a blood pressure measurement based on the user's context and suggest an alternative time for taking the blood pressure measurement. For example, the user's context can include the user's physical and/or psychological state inferred based on sensor data, application data, and/or other detectable information. In some implementations, the user device can automatically monitor the user's blood pressure and take blood pressure measurements based on user context triggers.

[0004] Particular implementations provide at least the following advantages. The user device can help the user take more consistent blood pressure readings. The user device can provide context for the blood pressure readings so that a reviewing doctor can make more informed decisions about the user's health. The user device can identify suitable times for resting, active, and stressed blood pressure measurements so that the measurements are most representative of these physical states of the user.

[0005] Details of one or more implementations are set forth in the accompanying drawings and the description below. Other features, aspects, and potential advantages will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

[0006] FIG. 1 is a block diagram of an example system for intelligent blood pressure monitoring.

[0007] FIG. 2A and FIG. 2B are example graphs illustrating adapting a blood pressure measurement schedule based on user context.

[0008] FIG. 3 illustrates an example graphical user interface for receiving blood pressure measurement input from a user.

[0009] FIG. 4 illustrates an example graphical user interface for initiating a blood pressure measurement.

[0010] FIG. 5 illustrates an example graphical user interface for reminding the user to take a blood pressure mea-

surement and to suggest that the user rest for a period of time before taking the blood pressure measurement.

[0011] FIG. 6 illustrates an example graphical user interface for prompting take a blood pressure measurement in advance of a predicted user stress period.

[0012] FIG. 7 illustrates an example blood pressure measurement database.

[0013] FIG. 8 illustrates an example graphical user interface for presenting a blood pressure measurement summary to the user.

[0014] FIG. 9 illustrates an example graphical user interface for describing the user context associated with a blood pressure measurement.

[0015] FIG. 10 illustrates an example graphical user interface for presenting a detailed view of a user's recorded blood pressure measurements.

[0016] FIG. 11 is flow diagram of an example process for intelligent blood pressure monitoring.

[0017] FIG. 12 is a flow diagram of an example process for automatic blood pressure monitoring.

[0018] FIG. 13 is a block diagram of an exemplary system architecture implementing the features and processes of FIGS. 1-12.

[0019] Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION

[0020] FIG. 1 is a block diagram of an example system 100 for intelligent blood pressure monitoring. For example, system 100 can determine the most suitable times for measuring a user's blood pressure and present notifications reminding the user to take a blood pressure measurement. In some implementations, the user can use a separate blood pressure measuring device and manually input the blood pressure measurements into a user device. In some implementations, the user device (e.g., a wearable device) can automatically take the user's blood pressure measurements.

[0021] In some implementations, system 100 can include user device 110. For example, user device 110 can be a desktop computer, a laptop computer, a handheld device, a smartphone, a tablet device, or any other computing device. User device 110 can be associated with a user (e.g., an owner, operator, etc.) of user device 110. The user of user device 110 can be a patient of a doctor associated with doctor device 140, for example.

[0022] In some implementations, the doctor can use doctor device 140 to write a prescription for the user. For example, the prescription can indicate that the user should take heart rate and/or blood pressure measurements according to a prescribed schedule (e.g., on a periodic time interval, at a specified time and day, etc.). After the doctor has generated the prescription, doctor device 140 can transmit the prescription to user device 110 through network 150. For example, network 150 can be a wired or wireless network. Network 150 can be a local area network (LAN), wide area network (WAN), and/or the Internet. Network 150 can be a peer-to-peer network that uses a near field communication technology, Bluetooth, Bluetooth low energy, Wi-Fi, or some other direct device to device networking technology.

[0023] In some implementations, user device 110 can store a prescription for the user. For example, user device 110 can receive a prescription for medication and/or blood pressure measurements from doctor device 140. Alternatively, the user of user device 110 can manually enter prescription

information (e.g., using an graphical user interface, form, etc.) presented on a display of user device **110**. After user device **110** receives the prescription (e.g., from the user, from doctor device **110**, etc.), user device **110** can store the prescription in prescription database **114**.

[0024] In some implementations, user device **110** can include blood pressure monitor **112**. For example, when user device **110** receives a prescription (e.g., medication and/or blood pressure measurement), blood pressure monitor **112** can schedule notifications to remind the user to measure the user's blood pressure and/or take the prescribed medication according to the prescribed schedule. In some implementations, blood pressure monitor can present a notification reminding the user to measure the user's blood pressure at the prescribed time. For example, blood pressure monitor **112** can present a notification (e.g., notification **302** of FIG. 3, notification **402** of FIG. 4, etc.) every 4 hours reminding the user to take a blood pressure measurement. The notification can be presented graphically on a display of user device **110**, audibly using speakers of user device **110**, using haptic feedback (e.g., vibrations), or a combination thereof.

[0025] In some implementations, blood pressure monitor **112** can present a reminder notification on user device **110** based on a user's context at or near the time when a reminder is scheduled. For example, rather than just presenting a reminder at a specified time, blood pressure monitor **112** can determine whether the user's context at or near a scheduled time is appropriate for the blood pressure measurement and present a notification (e.g., notification **502** of FIG. 5, notification **602** of FIG. 6) suggesting a modification to the prescribed time and/or user context so that the blood pressure measurement does not produce erroneous results.

[0026] FIG. 2A and FIG. 2B are example graphs **200** and **250** illustrating adapting a blood pressure measurement schedule based on user context. For example, graph **200** of FIG. 2A illustrates adapting a blood pressure measurement schedule based on past or current user context that might generate an erroneous blood pressure measurement. Graph **250** of FIG. 2B illustrates adapting a blood pressure measurement schedule based on a current or future user context that might generate an erroneous blood pressure measurement. For example, if the user is attempting to take a resting blood pressure measurement at a time when the user is excited or stressed, the blood pressure measurement may not be an accurate representation of the user's resting blood pressure. Thus, blood pressure monitor **112** can suggest a time best suited for measuring the user's resting blood pressure.

[0027] Graph **200** of FIG. 2A includes a timeline **202** during which a blood pressure measurement is scheduled at time 'T' **204**. In a basic implementation, blood pressure monitor **112** could simply present a notification reminding the user to measure the user's blood pressure at time 'T'. However, in some implementations, blood pressure monitor **112** can adjust the reminder notification and/or suggest an alternate time for measuring blood pressure based on the user's context during a window of time **206** that includes time 'T'. For example, the user may not need to take a blood pressure measurement exactly at time 'T'; it may be sufficient to measure the user's blood pressure within a 10 minute window (e.g., T-5 minutes to T+5 minutes). By adding some flexibility to the blood pressure measurement schedule, blood pressure monitor **112** can adjust the

reminder notifications and/or suggest a different time for measuring the user's blood pressure within window **206** based on the user's context.

[0028] Graph **200** includes user stress period **208**. For example, user stress period **208** can be a period of time during which the user is experiencing some physical stress and/or psychological stress that might influence a blood pressure measurement and produce erroneous results.

[0029] In some implementations, blood pressure monitor **112** can determine user stress period **208** when user device **110** detects a user context that corresponds to physical stress. For example, user device **110** can detect physical stress based on detected motion corresponding to activities such as running, walking, lifting heavy objects, climbing stairs, etc. User device **110** can detect the user's motion using a motion sensor (e.g., accelerometer, gyroscope, etc.). User device **110** can identify the user's activities based on a pattern of motion data generated by the motion sensor. On the other hand, user device **110** can detect or infer the absence of physical stress when user device **110** does not detect motion greater than a threshold amount (e.g., magnitude, frequency, etc.) of motion.

[0030] In some implementations, blood pressure monitor **112** can determine user stress period **208** when user device **110** detects a user context that corresponds to psychological stress. Psychological stressors can include environmental conditions (e.g., loud noises, traffic, etc.), interactions with other people (e.g., telephone calls, meetings, etc.), locations (e.g., office, doctor's office, courtroom, etc.), etc. Psychological stress can be detected by blood pressure monitor **112** based on sensor data, application usage, and/or other user input to user device **110** associated with psychological stress. For example, user device **110** can include a microphone (e.g., sound sensor) that can detect loud noises that might increase the stress level of the user. User device **110** can include motion sensors and/or navigation systems that can detect when user device **110** is moving at a speed that correlates to the user driving (e.g., a stressful activity). User device **110** can include an application or function for making telephone calls that might increase the stress level of the user. User device **110** can include a calendar application that includes information describing scheduled meetings that might influence the user's stress level. User device **110** can include navigation application and/or subsystem that can determine the user's location. Blood pressure monitor **112** can compare the user's location with map data to determine whether the user is at a stressful location (e.g., work, doctor's office, etc.). Blood pressure monitor **112** can determine or infer whether the user is influenced by psychological stressors when user device **110** detects any of the above psychological stressors. An absence of psychological stress can be determined or inferred by blood pressure monitor **112** when user device **110** does not detect any of the psychological stressors described above.

[0031] If user stress period **208** occurs within a period of time before or during the scheduled blood pressure measurement at time 'T', a blood pressure measurement taken at time 'T' may be high and not representative of the user's resting blood pressure. To avoid an erroneous measurement in this situation, blood pressure monitor **112** can delay the blood pressure measurement reminder notification or suggest that the user wait to measure the user's blood pressure until a time after time 'T' but within window **206** to give the user a chance to relax and reach a resting state. For example,

blood pressure monitor **112** can present notification **502** on graphical user interface **500** of FIG. **5** to remind the user that the user should take a blood pressure measurement and to suggest that the user rest for a period of time before taking the blood pressure measurement.

[0032] In some implementations, blood pressure monitor **112** can present a reminder notification at time ‘T’ that indicates a blood pressure measurement is due at time ‘T’ and suggest that the user rest for a period of time before taking the blood pressure measurement at some later time within window **206**. For example, when blood pressure monitor **112** detects user stress period **208** is occurring within a threshold period of time before time ‘T’, blood pressure monitor **112** can present the reminder notification suggesting that the user rest for a period of time before measuring the user’s blood pressure. For example, the rest period can be a period of time determined empirically and configured in blood pressure monitor **112**. If no user stress period **208** is detected at or near time ‘T’, blood pressure monitor **112** can present the reminder notification as scheduled at time ‘T’. For example, when blood pressure monitor **112** does not detect user stress period **208** for at least a threshold period of time (e.g., corresponding to the aforementioned rest period) before time ‘T’, blood pressure monitor **112** can present the blood pressure measurement reminder at time ‘T’ as scheduled.

[0033] Graph **250** of FIG. **2B** is similar to graph **200** of FIG. **2B** except that user stress period **252** is predicted to occur during or after time ‘T’. For example, when window **208** begins (e.g., at time T-5 minutes) blood pressure monitor **112** can predict that user stress period **252** will include time ‘T’. For example, blood pressure monitor **112** can predict user stress period **252** based on historical user data indicating that the user may participate in some stressful activity (e.g., either physical or psychological) during a time period corresponding to user stress period **252**. Blood pressure monitor **112** can predict user stress period **252** based on application data (e.g., scheduled meetings in a calendar application) that indicates the user may be stressed during user stress period **252**. Blood pressure monitor **112** can determine or predict that user stress period **252** is not currently occurring and/or will not occur for a period of time near the beginning of window **208** based on sensor data, application data, user input, etc., as described above. When blood pressure monitor **112** predicts user stress period **252** will occur in during a future period of time that includes time ‘T’ and determines that the user will not be stressed at the beginning of window **208**, blood pressure monitor **112** can adjust the blood pressure measurement reminder scheduled for time ‘T’ so that the reminder notification is presented before the scheduled time ‘T’. For example, blood pressure monitor **112** can present the blood pressure measurement reminder scheduled for time ‘T’ before the predicted start time of user stress period **252** and within window **208** to avoid an erroneous measurement at time ‘T’ during a stressful event. For example, blood pressure monitor **112** can present GUI **600** of FIG. **6**, including a notification **602** for prompting the user to take a blood pressure measurement in advance of time ‘T’, on a display of user device **110** when blood pressure monitor **112** has determined that the user stress period **252** will include the scheduled time ‘T’.

[0034] Referring back to FIG. **1**, in some implementations, blood pressure monitor **112** can receive blood pressure measurements. For example, blood pressure monitor **112** can

present graphical user interface **300** of FIG. **3** for receiving blood pressure measurement input from a user. Blood pressure monitor **112** can present GUI **300** on a display of user device **110**, for example. When blood pressure monitor **112** determines that the user should take a blood pressure measurement, blood pressure monitor **112** can present notification **302** prompting the user to take a blood pressure measurement. The user can measure the user’s blood pressure using blood pressure measurement device **130**, for example. Blood pressure measurement device **130** can be a standard blood pressure measurement device (e.g., an inflatable cuff and/or pressure sensor). Blood pressure measurement device **130** can be used by the user to measure the user’s heart rate as well. After measuring the user’s blood pressure and/or heart rate using blood pressure measurement device **130**, the user can input the blood pressure measurements and/or heart rate measurements into graphical element **304** (e.g., systolic measurement), graphical element **306** (e.g., diastolic measurement), and graphical element **307** (e.g., heart rate) and submit the measurements to blood pressure monitor **112** by selecting graphical element **308**.

[0035] In some implementations, blood pressure measurement device **130** can be a networked device that can transmit blood pressure measurements to blood pressure monitor **112** on user device **110** through network **150**. For example, the user can initiate a blood pressure measurement at blood pressure measurement device **130**. After taking the blood pressure measurement, blood pressure measurement device **130** can transmit the blood pressure measurement (e.g., systolic pressure, diastolic pressure, heart rate, etc.) to blood pressure monitor **112** on user device **110**.

[0036] Alternatively, the user of user device **110** can initiate a blood pressure measurement using graphical user interface **400** of FIG. **4**. In some implementations, blood pressure monitor **112** can present GUI **400** on a display of user device **110** in response to determining that a blood pressure measurement reminder should be presented to the user (e.g., according to the prescribed schedule) and/or when blood pressure monitor **112** is connected to blood pressure measurement device **130**. Blood pressure monitor **112** can present notification **402** when user device **110** is connected or was previously connected (e.g., paired, configured to connect, etc.) to blood pressure monitor **112**. The user can prepare blood pressure measurement device **130** (e.g., an inflatable cuff) for taking the measurement by putting blood pressure measurement device **130** on the user’s arm. After blood pressure measurement device **130** is in place, the user can select graphical element **404** (e.g., a start button) to cause blood pressure measurement device **130** to take the blood pressure measurement. For example, user device **110** can send a message to blood pressure measurement device **130** to initiate the blood pressure measurement. After blood pressure measurement device **130** measures the user’s blood pressure and/or heart rate, blood pressure measurement device **130** can send the measurements (e.g., systolic pressure, diastolic pressure, heart rate, etc.) to user device **110** through network **150**.

[0037] In some implementations, blood pressure monitor **112** can store received blood pressure measurements in blood pressure database **116**. For example, when blood pressure monitor **112** receives a blood pressure measurement (e.g., by user input, by message transmitted through network **150** from blood pressure measurement device **130**), blood pressure monitor **112** can store the blood pressure measure-

ments and/or heart rate in blood pressure database 116. In some implementations, blood pressure monitor 112 can store user context information in association with blood pressure measurements. For example, blood pressure monitor 112 can store data describing physical and/or psychological stressors detected by user device 110 at or about the time when the user measured or entered the user's blood pressure, as described above.

[0038] In some implementations, system 100 can include multiple user devices that can be configured to cooperate to intelligently monitor blood pressure. For example, system 100 can include wearable device 120. Wearable device 120 can be a smart watch, smart glasses, smart clothing, or other wearable device. Wearable device 120 can include some or all of the features of user device 110 described above and below.

[0039] In some implementations, wearable device 120 can include blood pressure monitor 122. For example, blood pressure monitor 122 can be configured with the same or similar functionality as blood pressure monitor 112 of user device 110, described above. For example, blood pressure monitor 122 can schedule blood pressure measurement reminders and/or notifications according to a prescribed schedule and/or user context, as described above.

[0040] In some implementations, blood pressure monitor 122 can be configured to share device data with user device 110. For example, wearable device 120 and user device 110 can be owned or used by the same user and configured to share device data between the devices. Wearable device 120 and user device 110 can share or synchronize device data through network 150, for example. The device data can include sensor data (e.g., movement, light, noise sensor data), application usage information (e.g., describing the applications currently used by the user on each device), and/or blood pressure measurement data (e.g., measurements taken, adjustments to measurement schedules, etc.). Thus, blood pressure monitor 122 of wearable device 120 and blood pressure monitor 112 of user device 110 can synchronize data and operations so that actions, measurements, schedules, and/or schedule adjustments made on one device will be reflected in the measurement data, schedule, and operations of the other device.

[0041] In some implementations, blood pressure monitor 122 on wearable device 120 can automatically take blood pressure measurements. For example, wearable device 120 can be configured with blood pressure sensor 124 and/or heart rate sensor 126. Thus, in some implementations, instead of reminding the user to take a blood pressure measurement at a scheduled time or adjusted time, blood pressure monitor 122 can automatically take the blood pressure measurement at the scheduled or adjusted time (as described above) using blood pressure sensor 124 on wearable device 120. In some implementations, blood pressure monitor 122 can take a heart rate measurement at or near the time of a blood pressure measurement using heart rate sensor 126 of wearable device 120.

[0042] In some implementations, blood pressure monitor 122 can automatically measure the user's blood pressure in response to detecting different user contexts. For example, instead of, or in addition to, determining a suitable user context for measuring a resting blood pressure, as described above, blood pressure monitor 122 can determine the appropriate user contexts for measuring a resting blood pressure, an active blood pressure, and a high stress blood pressure.

Resting blood pressure can, for example, be measured when blood pressure monitor 122 detects that the user is resting (e.g., not experiencing physical and/or psychological stress), as described above. High stress blood pressure (e.g., stress test) can be measured when blood pressure monitor 122 detects that the user is experiencing or participating in a high stress activity, such as running, a business meeting, etc. Active blood pressure can be measured when blood pressure monitor 122 detects that the user is neither resting nor participating in a high stress activity. In some implementations, blood pressure monitor 122 can be configured to automatically measure the user's blood pressure on a periodic basis corresponding to a configured time interval. After blood pressure monitor 122 measures the user's blood pressure, blood pressure monitor 122 can store the blood pressure measurement and/or user context information in blood pressure database 126.

[0043] In some implementations, blood pressure monitor 122 can determine whether the user is experiencing psychological stress based on physiological measurements. For example, wearable device 120 can include a heart rate monitor 120 that can measure the user's heart rate while the user is wearing device 120. For example, a high heart rate in the absence of physical activity can be an indicator of psychological stress. Blood pressure monitor 122 can monitor the user's heart rate and prompt the user to take a blood pressure measurement when the user's heart rate is high (e.g., above a high threshold value) or low (e.g., below a low threshold value). When wearable device 120 is configured with blood pressure sensor 124, blood pressure monitor 122 can automatically measure the user's blood pressure in response to detecting a high or low heart rate condition.

[0044] In some implementations, blood pressure monitor 122 can initiate a blood pressure measurement in response to user input. For example, the user of wearable device 120 may feel faint and initiate a blood pressure measurement by providing input to wearable device 120. In response to the user input, blood pressure monitor 122 can measure the user's blood pressure using blood pressure sensor 124 and/or the user's heart rate using heart rate sensor 126. In some implementations, blood pressure monitor 122 can collect contextual data in response to the user initiating a blood pressure measurement. For example, blood pressure monitor 124 can use a sound sensor (e.g., microphone) to detect the ambient noise level, location sensor to detect the user's current location, and/or other sensors to detect other user context information, as described above. For example, blood pressure monitor 124 can use a motion sensor (e.g., accelerometer) to detect the user's movements and/or posture at the time the blood pressure measurement was taken. The user's posture can be useful, for example, for a doctor to diagnose a postural hypotension or other postural blood pressure anomaly. This contextual data can be stored in correlation with the blood pressure measurements (e.g., in blood pressure database 116 and/or 126) to aid a physician or user in diagnosing blood pressure issues.

[0045] FIG. 7 illustrates an example blood pressure measurement database 700. For example, blood pressure database 700 can correspond to blood pressure database 116 and/or blood pressure database 126 of FIG. 1. In some implementations, blood pressure database 700 can include records (e.g., rows) corresponding to each blood pressure measurement received by blood pressure monitor 112. For example, each blood pressure record can include the time at

which the user's blood pressure was measured, the blood pressure measurements (e.g., systolic and/or diastolic pressure), the user's heart rate, and/or the user context at the time when the user's blood pressure was measured. For example, the user context can include the user's location, calendar events, application usage, motion data, sleep state, medication adherence information (e.g., if a medication adherence application is being used to track medication adherence), ambient noise level, or a combination thereof. By storing blood pressure measurements and user context information, user device 110 and/or wearable device 120 can provide to the user both blood pressure measurements and context information that may explain why a blood pressure reading is particularly high or low. The user can use the context information and blood pressure readings to get a better sense of what a normal blood pressure measurement is for the user.

[0046] FIG. 8 illustrates an example graphical user interface 800 for presenting a blood pressure measurement summary to the user. For example, GUI 800 can be presented on a display of user device 110 and/or wearable device 120 in response to receiving user input indicating that the user would like to view a blood pressure summary. Alternatively, GUI 800 can be presented automatically at some user-configured time or periodically according to some user-configured time interval.

[0047] In some implementations, GUI 800 can include blood pressure summary notification 802. For example, notification 802 can include graphical element 804 describing the last blood pressure measurement. The user can select graphical element 804, for example, to view context information that may explain the blood pressure measurement. Notification 802 can include graphical element 806 describing the user's average resting blood pressure. The user can select graphical element 806 to view details about the average resting blood pressure calculation. For example, user device 110 and/or wearable device 120 can present a chart that describes individual resting blood pressure measurements that were used to calculate the average resting blood pressure. Notification 802 can include graphical element 808 for viewing a chart that describes all blood pressure measurements (e.g., taken over a preceding period of time). The user can dismiss notification 802 by selecting graphical element 810.

[0048] FIG. 9 illustrates an example graphical user interface 900 for describing the user context associated with a blood pressure measurement. For example, GUI 900 can be presented on a display of user device 110 by blood pressure monitor 112 in response to a user selection of graphical element 802 describing the last blood pressure measurement recorded by blood pressure monitor 112. For example, GUI 900 can include notification 902 that includes text describing the user context (e.g., sensor readings, application usage, location, user activity, etc.) at the time the blood pressure measurement was taken or recorded. Thus, if the last blood pressure measurement appears to the user to be a high measurement, the user can determine based on the information presented on notification 902 whether the high blood pressure measurement was appropriate for the user context at the time of the reading or whether the user should consult a physician to determine if the user has any health issues that might be causing an abnormally high blood pressure measurement. The user can select graphical element 904 to dismiss notification 902.

[0049] FIG. 10 illustrates an example graphical user interface 1000 for presenting a detailed view of a user's recorded blood pressure measurements. For example, GUI 1000 can be presented by blood pressure monitor 112 in response to the user selecting graphical element 806 or graphical element 808. GUI 1000 can present a graph that shows blood pressure measurements that have been recorded in blood pressure database 116, for example. When GUI 1000 is presented in response to a user selection of graphical element 806, GUI 1000 can present resting blood pressure measurements. For example, blood pressure monitor 112 can filter the blood pressure measurements recorded in blood pressure database 116 based on user context so that only resting blood pressure measurements are presented on GUI 1000.

[0050] When GUI 1000 is presented in response to a user selection of graphical element 808, blood pressure monitor 112 can present unfiltered blood pressure measurements recorded in blood pressure database 116. For example, blood pressure monitor 112 can present a previous number (e.g., 10, 15, 23, etc.) of measurements. The blood pressure measurements can include resting, active, and/or stressed blood pressure measurements, for example. Blood pressure monitor 112 can present blood pressure measurements taken during a previous time period (e.g., the last 1 day, 2 days, 1 week, etc.). The number of blood pressure measurements and/or the time period can be user-configurable values, for example.

[0051] In some implementations, GUI 1000 can present a graph of blood pressure measurements. For example, GUI 1000 can include timeline axis 1002 corresponding to a period of time for which blood pressure measurements will be presented. GUI 1000 can include measurement axis 1004 corresponding to a range of blood pressure measurements (e.g., in mmHg) stored in blood pressure database 116. In some implementations, GUI 1000 can include blood pressure reference lines 1010 (e.g., diastolic) and 1030 (e.g., systolic) corresponding to normal diastolic and systolic blood pressure measurements. GUI 1000 can include systolic (circles) and diastolic (triangle) measurements at corresponding times (e.g., T-6, T-5, etc.) along timeline 1002. By comparing the blood pressure measurements to the reference lines 1010 and/or 1030, the user can quickly determine how the user's blood pressure measurements compare to normal blood pressure measurements.

[0052] In some implementations, GUI 1000 can present user context information for blood pressure measurements presented on GUI 1000. For example, a user can select a blood pressure measurement (e.g., systolic measurement 1032) to cause GUI 1000 to present graphical element 1034 that includes text, graphics, or other features describing the recorded user context at the time (e.g., T-5) of the selected measurement. Similarly, a user can select diastolic blood pressure measurement 1012 to cause GUI 1000 to present graphical element 1014 describing the recorded user context at the time (e.g., T-2) when blood pressure measurement 1012 was recorded or measured.

[0053] Referring back to FIG. 1, in some implementations, user device 110 can transmit blood pressure measurements to doctor device 140. For example, when the doctor associated with doctor device 140 writes a prescription for blood pressure measurements, the prescription can be transmitted to user device 110 through network 150, as described above. When user device 110 receives the prescription, user device

110 can present a prompt (e.g., a notification, graphical element, etc.) on a display of user device **110** asking the user to provide input to accept the prescription. In some implementations, the prompt can also ask the user if the user wishes to automatically send blood pressure measurements to the doctor (e.g., doctor device **140**). When the user provides input indicating that the user wishes to automatically send blood pressure measurements to doctor device **140**, user device **110** can automatically send blood pressure measurements to doctor device **140**. For example, user device **110** can automatically send blood pressure measurements recorded in blood pressure database **116** to doctor device **140** on a periodic basis (e.g., every 24 hours, once a week, etc.) or in response to recording a blood pressure measurement in blood pressure database **116**.

Example Processes

[0054] FIG. **11** is flow diagram of an example process **1100** for intelligent blood pressure monitoring. For example, process **1100** can intelligently present blood pressure measurement reminders on a display of a user device based on a prescribed schedule and/or user context. For example, process **1100** can be implemented on the user device so that the user device can determine a suitable time to remind the user to take a resting blood pressure measurement.

[0055] At step **1102**, a user device can determine that a user's blood pressure should be monitored. For example, the user device can correspond to user device **110** and/or wearable device **120** of FIG. **1**. The user device can determine that the user's blood pressure should be monitored when a blood pressure measurement prescription is received by the user device. For example, the prescription can be input manually (e.g., transcribed into a graphical user interface) by a user of the user device. The prescription can be transmitted to the user device over a network connection (e.g., from a doctor's device, pharmacist's device, microchip embedded in a prescription label, etc.). The user device can determine that the user's blood pressure should be monitored when the user turns on a blood pressure monitoring feature of the user device.

[0056] At step **1104**, the user device can schedule blood pressure readings according to the prescription. For example, the blood pressure monitoring prescription can describe (prescribe) a schedule for measuring and/or recording the user's blood pressure. The user device can schedule blood pressure measurement reminder notifications according to the prescribed schedule.

[0057] At step **1106**, the user device can determine that the scheduled time for a blood pressure measurement is near. For example, the user device can schedule a window of time during which the user device should remind the user to take a blood pressure measurement, as described above with reference to FIG. **3**. For example, the window of time can be the scheduled time 'T' plus and minus 5 minutes (e.g., a 10 minute window). The user device can schedule (e.g., using an internal timer or alarm) a user context check for T-5 minutes in advance of the scheduled blood pressure measurement at time 'T'.

[0058] At step **1108**, the user device can determine the user context for the scheduled blood pressure measurement. For example, at T-5 minutes the user device can determine the current user context, the predicted user context at time 'T', or a predicted future user context after time 'T' and within the time window. For example, the user device can

determine the current user context based on sensor data, application usage, location information, etc., as described above. The user device can determine the future user context based on historical data (e.g., user behavior patterns), calendar application data indicating future meetings or events, and/or other application data that may indicate what activities in which the user may be involved in the future.

[0059] At step **1110**, the user device can determine a suitable time for taking the blood pressure measurement based on the user context. For example, the user device can determine based on the user context a time during the scheduled time window when the user is most likely to be resting so that the user can take a resting blood pressure measurement.

[0060] At step **1112**, the user device can prompt the user to take the blood pressure measurement at the determined time. For example, the user device can present a prompt on a display of the user device suggesting that the user take a blood pressure measurement before time 'T', at time 'T', or after time 'T', as described above with reference to FIGS. **3-6**. After the user measures the user's blood pressure (e.g., using a sensor of the user device or an external device), the user device can store the blood pressure measurement and/or context information.

[0061] Although the process **1100** describes presenting reminders to prompt the user to take blood pressure measurements according to a prescribed schedule, the user device (e.g., wearable device **120**) can be configured to automatically measure the user's blood pressure in lieu of presenting reminders at the determined times, as described above.

[0062] FIG. **12** is a flow diagram of an example process **1200** for automatic blood pressure monitoring. For example, process **1200** can automatically measure a user's blood pressure based on a prescribed schedule and/or user context. For example, process **1100** can be implemented on the user device so that the user device can determine a suitable time to automatically measure the user's resting, active, and stressed blood pressure.

[0063] At step **1202**, a user device can determine that a user's blood pressure should be monitored. For example, the user device can correspond to user device **110** and/or wearable device **120** of FIG. **1**. The user device can determine that the user's blood pressure should be monitored when a blood pressure measurement prescription is received by the user device. For example, the prescription can be input manually (e.g., transcribed into a graphical user interface) by a user of the user device. The prescription can be transmitted to the user device over a network connection (e.g., from a doctor's device, pharmacist's device, microchip embedded in a prescription label, etc.). The prescription can specify a schedule for taking blood pressure measurements. The prescription can specify the types of blood pressure measurements (e.g., resting, active, stressed, etc.) to be collected by the user device. The user device can determine that the user's blood pressure should be monitored when the user turns on a blood pressure monitoring feature of the user device.

[0064] At step **1204**, the user device can determine the current user context. For example, the user device can determine the current user context based on sensor data, application usage information, location information, etc., collected by the user device and/or other user devices. For example, the user device **110** can receive user context

information from wearable device **120** describing the user's movements (e.g., motion sensor data), location, heart rate, application usage, etc.

[0065] At step **1206**, the user device can determine that the current user context is suitable for a blood pressure measurement. For example, when the user device is configured to measure the user's resting blood pressure, the user device can determine that the current user context is suitable for measuring the user's resting blood pressure when the current user context does not include any physical and/or psychological stressors. When the user device is configured to measure the user's stressed blood pressure, the user device can determine that the current user context is suitable for measuring the user's stressed blood pressure (e.g., for performing a stress test) when the current user context includes physical and/or psychological stressors, such as running or a business meeting. When the user device is configured to measure the user's active blood pressure, the user device can determine that the current user context is suitable for measuring the user's active blood pressure when the current user context is not a resting context and also is not a stressed context, as described above.

[0066] At step **1208**, the user device can automatically measure the user's blood pressure. For example, when the user device includes a blood pressure sensor (e.g., wearable device **120**), the user device can automatically measure the user's blood pressure when the user context is suitable for taking the desired type of blood pressure measurement. For example, in response to determining that the current user context indicates the user is resting, the user device can measure the user's resting blood pressure. In response to determining that the current user context indicates the user is stressed, the user device can measure the user's stressed blood pressure. In response to determining that the current user context indicates the user is participating in normal, everyday activities (e.g., not resting, not stressed), the user device can measure the user's active blood pressure. In some implementations, the blood pressure measurement can be performed as a background task on the user device without notification or prompt to the user.

[0067] At step **1210**, the user device can store the blood pressure measurement and/or context information. For example, the user device can store the automatically measured blood pressure measurement and/or context information describing the user's context at the time when the user's blood pressure was measured in a database on the user device, as described with reference to FIG. **7** above.

[0068] At step **1212**, the user device can present the blood pressure measurement and context information stored in the blood pressure database to the user. For example, the user can provide input to the user device invoking a graphical user interface for presenting blood pressure measurements and/or context information, as described above with reference to FIGS. **8-10**.

[0069] In some implementations, the user device can automatically transmit or send blood pressure measurements and/or user context information to a doctor's device for analysis by the doctor. For example, after blood pressure measurements are stored in the blood pressure database, the user device can periodically send the stored blood pressure measurements to the doctor's device through network **150**.

[0070] While FIG. **11** and FIG. **12** describe specific a specific sequence of steps for processes **1100** and **1200**, respectfully, individual steps of processes **1100** and/or **1200**

can be rearranged, reordered, omitted, etc., while remaining within the scope of the present disclosure. Moreover, a person of ordinary skill will understand that the steps of process **1100** can be combined with steps of process **1200** and, similarly, the steps of process **1200** can be combined with the steps of process **1100**. For example, step **1210** of FIG. **12** can be included in process **1100** so that process **1100** will store the blood pressure measurements taken or received in process **1100**.

Graphical User Interfaces

[0071] This disclosure above describes various Graphical User Interfaces (GUIs) for implementing various features, processes or workflows. These GUIs can be presented on a variety of electronic devices (e.g., user device **110** and/or wearable device **120**) including but not limited to laptop computers, desktop computers, computer terminals, television systems, tablet computers, e-book readers and smart phones. One or more of these electronic devices can include a touch-sensitive surface. The touch-sensitive surface can process multiple simultaneous points of input, including processing data related to the pressure, degree or position of each point of input. Such processing can facilitate gestures with multiple fingers, including pinching and swiping.

[0072] When the disclosure refers to "select" or "selecting" user interface elements in a GUI, these terms are understood to include clicking or "hovering" with a mouse or other input device over a user interface element, or touching, tapping or gesturing with one or more fingers or stylus on a user interface element. User interface elements can be virtual buttons, menus, selectors, switches, sliders, scrubbers, knobs, thumbnails, links, icons, radio buttons, checkboxes and any other mechanism for receiving input from, or providing feedback to a user.

Privacy

[0073] The present disclosure recognizes that the use of personal information data, in the present technology, can be used to the benefit of users. For example, the personal information data can be used to deliver targeted content (e.g., reminders, notifications, etc.) that is of greater interest to the user or more closely tailored to the user's needs. Accordingly, use of such personal information data enables calculated control of the delivered content. Further, other uses for personal information data that benefit the user are also contemplated by the present disclosure.

[0074] The present disclosure further contemplates that the entities responsible for the collection, analysis, disclosure, transfer, storage, or other use of such personal information data will comply with well-established privacy policies and/or privacy practices. In particular, such entities should implement and consistently use privacy policies and practices that are generally recognized as meeting or exceeding industry or governmental requirements for maintaining personal information data private and secure. For example, personal information from users should be collected for legitimate and reasonable uses of the entity and not shared or sold outside of those legitimate uses. Further, such collection should occur only after receiving the informed consent of the users. Additionally, such entities would take any needed steps for safeguarding and securing access to such personal information data and ensuring that others with access to the personal information data adhere to their

privacy policies and procedures. Further, such entities can subject themselves to evaluation by third parties to certify their adherence to widely accepted privacy policies and practices.

[0075] Despite the foregoing, the present disclosure also contemplates embodiments in which users selectively block the use of, or access to, personal information data. That is, the present disclosure contemplates that hardware and/or software elements can be provided to prevent or block access to such personal information data. For example, in the case of advertisement delivery services, the present technology can be configured to allow users to select to “opt in” or “opt out” of participation in the collection of personal information data during registration for services. In another example, users can select not to provide location information for targeted content delivery services. In yet another example, users can select to not provide precise location information, but permit the transfer of location zone information.

Example System Architecture

[0076] FIG. 13 is a block diagram of an example computing device 1300 that can implement the features and processes of FIGS. 1-12. The computing device 1300 can include a memory interface 1302, one or more data processors, image processors and/or central processing units 1304, and a peripherals interface 1306. The memory interface 1302, the one or more processors 1304 and/or the peripherals interface 1306 can be separate components or can be integrated in one or more integrated circuits. The various components in the computing device 1300 can be coupled by one or more communication buses or signal lines.

[0077] Sensors, devices, and subsystems can be coupled to the peripherals interface 1306 to facilitate multiple functionalities. For example, a motion sensor 1310, a light sensor 1312, and a proximity sensor 1314 can be coupled to the peripherals interface 1306 to facilitate orientation, lighting, and proximity functions. Other sensors 1316 can also be connected to the peripherals interface 1306, such as a global navigation satellite system (GNSS) (e.g., GPS receiver), a temperature sensor, a biometric sensor, magnetometer or other sensing device, to facilitate related functionalities.

[0078] A camera subsystem 1320 and an optical sensor 1322, e.g., a charged coupled device (CCD) or a complementary metal-oxide semiconductor (CMOS) optical sensor, can be utilized to facilitate camera functions, such as recording photographs and video clips. The camera subsystem 1320 and the optical sensor 1322 can be used to collect images of a user to be used during authentication of a user, e.g., by performing facial recognition analysis.

[0079] Communication functions can be facilitated through one or more wireless communication subsystems 1324, which can include radio frequency receivers and transmitters and/or optical (e.g., infrared) receivers and transmitters. The specific design and implementation of the communication subsystem 1324 can depend on the communication network(s) over which the computing device 1300 is intended to operate. For example, the computing device 1300 can include communication subsystems 1324 designed to operate over a GSM network, a GPRS network, an EDGE network, a Wi-Fi or WiMax network, and a Bluetooth™ network. In particular, the wireless communication subsystems

1324 can include hosting protocols such that the device 1300 can be configured as a base station for other wireless devices.

[0080] An audio subsystem 1326 can be coupled to a speaker 1328 and a microphone 1330 to facilitate voice-enabled functions, such as speaker recognition, voice replication, digital recording, and telephony functions. The audio subsystem 1326 can be configured to facilitate processing voice commands, voiceprinting and voice authentication, for example.

[0081] The I/O subsystem 1340 can include a touch-surface controller 1342 and/or other input controller(s) 1344. The touch-surface controller 1342 can be coupled to a touch surface 1346. The touch surface 1346 and touch-surface controller 1342 can, for example, detect contact and movement or break thereof using any of a plurality of touch sensitivity technologies, including but not limited to capacitive, resistive, infrared, and surface acoustic wave technologies, as well as other proximity sensor arrays or other elements for determining one or more points of contact with the touch surface 1346.

[0082] The other input controller(s) 1344 can be coupled to other input/control devices 1348, such as one or more buttons, rocker switches, thumb-wheel, infrared port, USB port, and/or a pointer device such as a stylus. The one or more buttons (not shown) can include an up/down button for volume control of the speaker 1328 and/or the microphone 1330.

[0083] In one implementation, a pressing of the button for a first duration can disengage a lock of the touch surface 1346; and a pressing of the button for a second duration that is longer than the first duration can turn power to the computing device 1300 on or off. Pressing the button for a third duration can activate a voice control, or voice command, module that enables the user to speak commands into the microphone 1330 to cause the device to execute the spoken command. The user can customize a functionality of one or more of the buttons. The touch surface 1346 can, for example, also be used to implement virtual or soft buttons and/or a keyboard.

[0084] In some implementations, the computing device 1300 can present recorded audio and/or video files, such as MP3, AAC, and MPEG files. In some implementations, the computing device 1300 can include the functionality of an MP3 player, such as an iPod™. The computing device 1300 can, therefore, include a 36-pin connector that is compatible with the iPod. Other input/output and control devices can also be used.

[0085] The memory interface 1302 can be coupled to memory 1350. The memory 1350 can include high-speed random access memory and/or non-volatile memory, such as one or more magnetic disk storage devices, one or more optical storage devices, and/or flash memory (e.g., NAND, NOR). The memory 1350 can store an operating system 1352, such as Darwin, RTXC, LINUX, UNIX, OS X, WINDOWS, or an embedded operating system such as VxWorks.

[0086] The operating system 1352 can include instructions for handling basic system services and for performing hardware dependent tasks. In some implementations, the operating system 1352 can be a kernel (e.g., UNIX kernel). In some implementations, the operating system 1352 can include instructions for performing voice authentication. For

example, operating system **1352** can implement the intelligent blood pressure monitoring features as described with reference to FIGS. 1-12.

[0087] The memory **1350** can also store communication instructions **1354** to facilitate communicating with one or more additional devices, one or more computers and/or one or more servers. The memory **1350** can include graphical user interface instructions **1356** to facilitate graphic user interface processing; sensor processing instructions **1358** to facilitate sensor-related processing and functions; phone instructions **1360** to facilitate phone-related processes and functions; electronic messaging instructions **1362** to facilitate electronic-messaging related processes and functions; web browsing instructions **1364** to facilitate web browsing-related processes and functions; media processing instructions **1366** to facilitate media processing-related processes and functions; GNSS/Navigation instructions **1368** to facilitate GNSS and navigation-related processes and functions; and/or camera instructions **1370** to facilitate camera-related processes and functions.

[0088] The memory **1350** can store other software instructions **1372** to facilitate other processes and functions, such as the intelligent blood pressure monitoring processes and functions as described with reference to FIGS. 1-12.

[0089] The memory **1350** can also store other software instructions **1374**, such as web video instructions to facilitate web video-related processes and functions; and/or web shopping instructions to facilitate web shopping-related processes and functions. In some implementations, the media processing instructions **1366** are divided into audio processing instructions and video processing instructions to facilitate audio processing-related processes and functions and video processing-related processes and functions, respectively.

[0090] Each of the above identified instructions and applications can correspond to a set of instructions for performing one or more functions described above. These instructions need not be implemented as separate software programs, procedures, or modules. The memory **1350** can include additional instructions or fewer instructions. Furthermore, various functions of the computing device **1300** can be implemented in hardware and/or in software, including in one or more signal processing and/or application specific integrated circuits.

What is claimed is:

1. A method comprising:

determining, by a computing device, that a user of the computing device should measure the user's blood pressure;

scheduling, by the computing device, a time for presenting a notification for reminding the user to measure the user's blood pressure according to a prescribed schedule;

obtaining, by the computing device, user context information describing a context of the user near the scheduled time;

adjusting, by the computing device, the scheduled time for the blood pressure measurement notification based on the user context information; and

presenting, by the computing device, a prompt reminding the user to measure the user's blood pressure at the adjusted time.

2. The method of claim 1, wherein the computing device determines that the user should measure the user's blood pressure in response to receiving a prescription from a second computing device.

3. The method of claim 1, wherein the user context information includes information describing the user's physical activity.

4. The method of claim 1, wherein the user context information includes geographical location information indicating a current or future geographical location of the user.

5. The method of claim 1, wherein the user context information includes application usage information describing a current use of an application on the computing device.

6. The method of claim 1, wherein the user context information includes device data from a third computing device associated with the user.

7. The method of claim 1, wherein the prompt suggests that the user measure the user's blood pressure prior to the scheduled time.

8. The method of claim 1, wherein the prompt suggests that the user measure the user's blood pressure after the scheduled time.

9. The method of claim 1, wherein the prompt suggests that the user rests for a period of time based on a current user context.

10. A non-transitory computer-readable medium including one or more sequences of instructions that, when executed by one or more processors, causes:

determining, by a computing device, that a user of the computing device should measure the user's blood pressure;

scheduling, by the computing device, a time for measuring the user's blood pressure according to a prescribed schedule;

obtaining, by the computing device, user context information describing a context of the user near the scheduled time;

adjusting, by the computing device, the scheduled time for measuring the user's blood pressure based on the user context information; and

automatically measuring, by the computing device, the user's blood pressure at the adjusted time.

11. The method of claim 10, wherein the computing device determines that the user should measure the user's blood pressure in response to receiving a prescription from a second computing device.

12. The method of claim 10, wherein the user context information includes information describing the user's physical activity.

13. The method of claim 10, wherein the user context information includes geographical location information indicating a current or future geographical location of the user.

14. The method of claim 10, wherein the user context information includes application usage information describing a current use of an application on the computing device.

15. The method of claim 10, wherein the user context information includes device data from a third computing device associated with the user.

16. The method of claim 10, wherein the adjusted time is prior to the scheduled time.

17. The method of claim 10, wherein the adjusted time is after the scheduled time.

18. A system comprising:

one or more processors; and

a non-transitory computer-readable medium including one or more sequences of instructions that, when executed by the one or more processors, causes:

determining, by a computing device, that a user of the computing device should measure the user's blood pressure;

obtaining, by the computing device, user context information describing a context of the user;

determining, by the computing device, a time for measuring the user's blood pressure based on the user context information; and

automatically measuring, by the computing device, the user's blood pressure at the determined time.

19. The method of claim **18**, wherein the user context information includes information describing the user's physical activity.

20. The method of claim **18**, wherein the user context information includes geographical location information indicating a geographical location of the user.

21. The method of claim **18**, wherein the user context information includes application usage information describing a current use of an application on the computing device.

22. The method of claim **18**, wherein the user context information includes device data from a third computing device associated with the user.

* * * * *

专利名称(译)	智能血压监测		
公开(公告)号	US20170293727A1	公开(公告)日	2017-10-12
申请号	US15/094978	申请日	2016-04-08
[标]申请(专利权)人(译)	苹果公司		
申请(专利权)人(译)	苹果公司.		
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IPC分类号	G06F19/00 A61B5/024 A61B5/022 A61B5/16 A61B5/11 A61B5/00		
CPC分类号	G06F19/3406 A61B5/1118 A61B5/742 A61B5/1112 A61B5/022 A61B5/6801 A61B2562/0219 A61B5/7475 A61B5/165 A61B5/0022 A61B5/024 A61B5/486 A61B5/6898 A61B5/021 A61B5/681 G06Q10/06 G06Q10/063116 G06Q50/22 G16H40/20 G16H40/63		
外部链接	Espacenet USPTO		

摘要(译)

在一些实施方式中，用户设备可以帮助用户进行智能血压监测。例如，用户设备可以呈现通知和/或提醒，其提示用户在规定的时间或根据规定的时间表进行血压测量。用户设备可以基于用户的背景自动确定用户应该或不应该进行血压测量，并建议用于进行血压测量的替代时间。例如，用户的上下文可以包括基于传感器数据，应用数据和/或其他可检测信息推断的用户的身体和/或心理状态。在一些实施方式中，用户设备可以基于用户上下文触发自动监视用户的血压并进行血压测量。

