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(54) **Title:** MEDICATION SCHEDULING

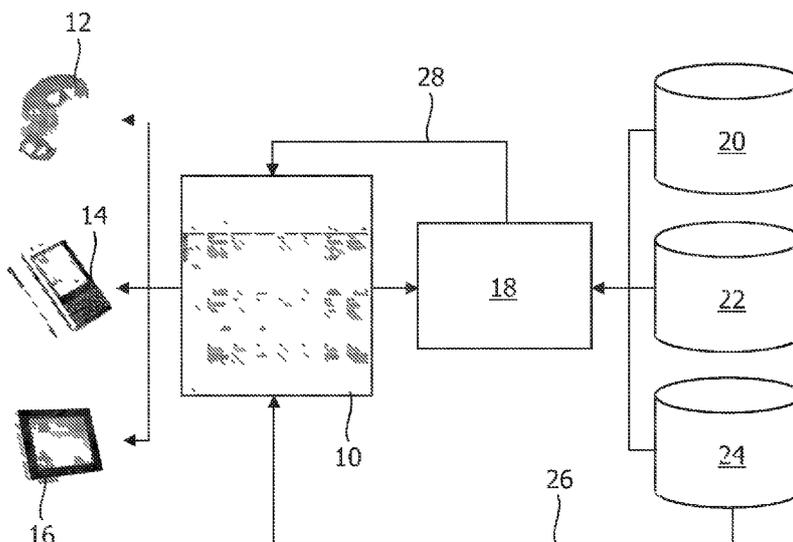


FIG. 1

(57) **Abstract:** A method and apparatus for assisting a person to adhere to a medication schedule is presented. The method comprises storing a medication schedule and reminder system in an electronic calendar, the electronic calendar comprising activity information regarding scheduled activities of the person; and modifying the medication schedule and reminder system based on the medication schedule and at least one of: the activity information, and environmental condition information.

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Medication scheduling

FIELD OF THE INVENTION

This invention relates to medication scheduling, and more particularly to assisting a person to adhere to a medication schedule.

5 BACKGROUND OF THE INVENTION

A person not adhering to a medication schedule, for example by not timely and/or correctly taking medication as prescribed by a medical professional, can potentially have serious consequences.

10 Studies have shown that such consequences may include: increased morbidity (sickness); treatment failure; exacerbation of disease; more frequent physician visits; an increased hospitalization rate; and death.

With people leaving increasingly busy lifestyles, it is common for a person to forget their medication. This is particularly likely when a person deviates from a typical daily routine.

15 Furthermore, beyond dosage, prescribed medication schedules tend not to be tailored to the particular needs of a person.

SUMMARY OF THE INVENTION

20 According to the invention, there is provided a method and apparatus for helping a person adhere to a predetermined medication schedule. By taking account of the activities of a person and/or the environmental conditions to which that person is exposed, embodiments of the invention help to ensure the person is reminded to comply with their medication schedule by generating appropriate reminders and/or modifying the medication schedule.

25 Thus, embodiments take into account the interaction between a person's planned activities and medication schedule to increase the likelihood that the person takes their medication as required. Such improved compliance with a medication schedule may not only be realized for daily/weekly routines, but may also be achieved for deviations from a regular routine.

According to an aspect of the invention, there is provided a method for assisting a person to adhere to a medication schedule comprising; storing a medication schedule and reminder system in an electronic calendar, the electronic calendar comprising activity information regarding scheduled activities of the person; and modifying the medication schedule and reminder system based on the medication schedule and at least one of: the activity information, and environmental condition information.

According to yet another aspect of the invention, there is provided an apparatus for assisting a person to adhere to a medication schedule and comprising:

an electronic calendar adapted to implement a medication schedule and reminder system and to store activity information regarding scheduled activities of the person; and

a processing unit adapted modify the medication schedule and reminder system based on the medication schedule and at least one of: the activity information, and environmental condition information.

Embodiments may be implemented in a portable electronic device, such as a mobile phone or personal electronic organizer. Other embodiments may be implemented in everyday electronic objects, such as a digital photo frame, TV, pill dispenser, kettle, toaster, etc. In this way, a system may be provided which provides a medication reminder to a person on the most appropriate one of a plurality of different devices to improve the likelihood that a person is adequately reminded to take medication according to a medication schedule. Such devices may be linked and/or networked using suitable communication means so as receive updated medication schedule information and/or medication reminders.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described, purely by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a schematic illustration of apparatus according to an embodiment of the invention; and

Fig. 2 is a schematic illustration of an alternative embodiment of the invention.

The dimensions of the diagrams are not to scale and like reference numerals refer to like elements throughout.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Embodiments provide a calendar-based approach for support in medication compliance. Based on scheduled activities in the calendar, medication reminders are sent to the patient / consumer. These reminders can be visual or audible and in different forms such as pop-up windows, email, SMS, flashing medication dispensers, messages on a digital photo-frames and audio sounds. The type of the reminder can be adjusted based on the scheduled appointment in the calendar. For example, a message on a digital photo-frame may be provided when the person is scheduled to be at home, whereas a SMS text message can be sent to the person's mobile phone when the calendar indicates the person is scheduled to be at work. Further, the time in advance at which the reminder is provided may be adjusted. For example, a reminder can be provided ahead of a scheduled holiday which reminds a person to take their medication on holiday.

The medication schedule can be automatically adjusted based on scheduled activities or appointments in the calendar. The calendar provides an indication as to what activities a person will be undertaking, in addition to the time and the location at which such activities are to be executed. In addition, using the time and location information, environmental conditions (such as temperature, air humidity, wind speed, air pollution, pollen count, UV index, and daylight intensity for example) can be retrieved. The combination of the scheduled activities and the environmental conditions in which these activities are executed can lead to adjustments of the medication schedule and/or the generation of medication reminders. Purely by way of example, a dosage for allergy medicine may be introduced or increased when activities are in an area having a high pollen count (recorded or predicted), or diabetes related medicine can be scheduled for before a scheduled dinner.

Referring to Figure 1, an embodiment of the invention comprises an electronic calendar unit 10 adapted to implement an electronic calendar comprising activity information regarding scheduled activities of a person (who is also the user of the electronic calendar). Here, the electronic calendar unit 10 is software program running on a personal computer (PC) or a personal assistant device (PDA).

The electronic calendar unit 10 is in communication with first 12 to third 16 devices and a processing unit 18 which, in turn, has access to first 20 to third 24 information databases.

Specifically, the first device 12 is a medication dispenser, the second device 14 is a mobile communication device such as a mobile phone or Personal Digital Assistant (PDA), and the third device 16 is a digital picture frame.

The first information database 20 comprises environmental condition information such as data relating to temperature, humidity, wind speed, UV index, pollen count, daylight intensity, and air pollution. Such data may be either predicted or recorded, or both. The second information database 22 comprises patient health information such as data relating to the medical health of the person whose activities are scheduled in the electronic calendar. The third information database 24 comprises medication schedule information containing data relating to prescribed medication schedule for the person, for example medication name/type, dosage(s) and dose regularity.

Medication schedule information from the third database 24 is provided to the electronic calendar unit 10 for incorporation with the scheduled activities in the calendar (as depicted by the arrow 26). Based on the medication schedule information and the scheduled activity information the processing unit 18 can either modify the medication schedule or generate a medication reminder, or do both. The modified medication schedule and/or generated medication reminder is then provided to the electronic calendar unit 10 for incorporation into the calendar (as depicted by the arrow 28).

According to updated schedule and reminder information of the calendar, the electronic calendar unit 10 communicates medication reminders to at least one of the first 12 to third 16 devices at appropriate times. The device to which a reminder is communicated will be defined by schedule and reminder information of the calendar, which may have been generated and/or modified by the processing unit 18.

Although the above description only details the processing unit 18 modifying the medication schedule and/or generating a medication reminder based on the medication schedule and the scheduled activity information, the processing unit 18 may also take into account data stored in the first 20, second 22 and/or third 24 databases. In other words, the processing unit 18 may modify the medication schedule further based on at least one of: environmental condition information and patient health information, and the processing unit 18 may also generate a medication reminder further based on at least one of: environmental condition information and patient health information.

Looking now at the processing unit in more detail, the processing unit 18 performs its function according to an algorithm that defines how a medication schedule should be modified and/or how a medication reminder should be generated so as to appropriately take account of factors such as scheduled activities and environmental conditions. One such exemplary algorithm for the modification of a medication schedule may be described in pseudo code as follows:

```
//Step 1: Initialize based on medication prescription
```

```
While (true) do {
```

```
    For each(Rule) do {
```

```
5 //Step2: Get Schedule Information (Activity, Time, Date Location, etc.)
```

```
    Appointments = Schedule.Activities()
```

```
//Step3: Get Environment Information (Temperature, Humidity, Wind, Pressure, etc.)
```

```
    Environment = Environment.Conditions()
```

```
10
```

```
//Step4: Get Medication Information (Medication, Dose, Regularity, etc.)
```

```
    Medication = Medication.Prescription();
```

```
//Step5: Get Health Information (Allergies, blood-pressure, cholesterol, etc.)
```

```
15 Health = Health.Status();
```

```
If(Evaluate(Rule.Appointments,Environment,Medication, Health)) then
```

```
    //Step 6: Adapt medication Schedule
```

```
20 Schedule.Update(Adaptation Rule);
```

```
    }
```

```
}
```

25 In the first step, the program code is initialized. In the second to fifth steps, appointments/schedule information, environmental information, medication information and patient health information is obtained, respectively. Finally, the obtained information is evaluated according to a rule so as to meet a condition, such as "true" for example, the medication schedule is modified according to an adaptation rule.

The above algorithm demonstrates that the rules used consist of two types:

1. Condition: This is a Boolean expression evaluated upon Appointment, Health, 30 Environment and Medication information, such as that stored in the calendar and first to third databases.
2. Adaptation: This is a specification as to how a medication schedule should be modified with respect to dose and time of intake, for example.

It is to be understood that adaptation of the medication schedule can be made to be applicable to different types of medication reminders (MRs) such as: reminders for medications that have to be taken on a regular basis (e.g., to improve/stabilize chronic illnesses such as diabetes, hypertension, arthritis, etc.); reminders for medications that have to be taken on an irregular basis depending on environmental conditions (e.g., allergy medications required for high pollen counts, or sun block cream required for a high UV index, etc.); and reminders for medications that have to be taken on an irregular basis depending on the planned activities of a person (e.g., reducing insulin dose due to planned physical activity such as bicycling or muscle pain relief medication for use before running a marathon, etc.).

It will be appreciated that the algorithm described in pseudo code above is generic. To further aid understanding, exemplary pseudo code will now be detailed for modifying a medication schedule and generating a medication reminder which reduces an insulin dose due to a planned physical activity such as bicycling. Specific examples of rule conditions and rule adaptations are also provided.

//Step 2

Appointments = [bicycling, London, 12:30-14:30];

//Step 3

20 Environment^[24C, 60% humidity, 4.5 wind]

//Step 4

Medication = [3 units, 20 min before a meal, LANTUS®];

25 //Step 5:

Health = Diabetesstable

Rule.condition1 = (Appointmentactivity==moderatebicycling) & (EnvironmentTemp<25 C) & (Medicationbrand = LANTUS insulin)

30 Rule.condition2 = (Appointmentactivity==vigorousbicycling) & (LOvironmentTemp<25 Q & (Medicationbrand = LANTUS insulin)

Rule.condition3 = (Appointmentactivity==moderatebicycling) & (EnvironmentTemp>=25 Q & (Medicationbrand = LANTUS insulin)

Rule.condition4 = (AppointmentActivity == vigorous bicycling) & (EnvironmentTemp >= 25 Q & (MedicationBand = LANTUS insulin)

If (Evaluate(Rule.condition, Appointments, Health, Environment, Medication)) then

5

//Step 6: RuleAdaptation_M corresponds to Rule.CondMon_M, M=I, 2,3,4

RuleAdaptation1 = 30% less insulin, Le. 2 IU

RuleAdaptation2 = 50% less insulin, Le. 1.5 IU

RuleAdaptation3 = 30% less insulin, Le. 2 IU, 250 ml water every hour, apply sun block

10

RuleAdaptation4 = 50% less insulin, Le. 1.5 IU, 250 ml water every hour, apply sun block

Schedule.Update(RuleAdaptation);

15 It will be understood that a medication schedule may be modified and/or a medication reminder generated which takes account of many different scheduled events or activities. For example, during some holidays (summer holiday, winter sport, Christmas) a person may have substantial changes in his/her typical physical activity and nutrition patterns, thereby requiring an adaptation of his/her medical schedule to be made. Such periods can be foreseen by embodiments of the invention based on the integrated electronic calendar.

20 Furthermore, based on past entries in the electronic calendar, embodiments can learn a person's preference(s) in daily activities and may extract patterns, for example, physical training twice per week which has a positive influence on blood pressure. These patterns can be integrated into a medication schedule resulting in modified dosage levels, for example.

25 Embodiments such as those described above can be implemented in combination with existing technologies and infrastructures. By way of example, electronic calendars, with multiple types of reminders already exist. Digital photo-frames with messaging capabilities are also known. Such existing devices can be adapted to implement embodiments of the invention so as to modify a medication schedule and/or generate
30 medication reminder.

For example, as depicted in Figure 2, a portable PDA 100 comprises apparatus for assisting a person to adhere to a medication schedule according to an embodiment of the invention. Specifically, the PDA 100 is adapted to implement an electronic calendar or schedule organizer containing information regarding scheduled activities of a user (the

patient). The PDA comprises a wireless communication unit (not shown) which enables the PDA 100 to establish a wireless connection 102 to the Internet 104. Via the Internet 104, the PDA 100 can communicate with a medical database 106 and a weather database 108.

The medical database 106 comprises medication schedule information
5 containing data relating to a prescribed medication schedule for the patient, for example medication name/type, dosage(s) and dose regularity. The medical database 22 also comprises patient health information such as data relating to the medical health of the patient.

The weather database 108 comprises data regarding current and future weather
10 and environmental conditions such as temperature, humidity, wind speed, UV index, pollen count, daylight intensity, and air pollution.

Also accessible to the PDA 100 via the Internet 104 is an internet-enabled
medication dispenser 110. The medication dispenser 110 is adapted not only to dispense
medication to the patient, but to also provide medication reminders to the patient via
appropriate means such as a graphical display, an audio speaker, a vibrating unit and/or a
15 light emitting device.

The wireless communication unit of the PDA 100 also enables the PDA to
connect to a digital photo frame 112 using a communication link 114 based on a wireless
communication protocol 114, such as Bluetooth for example. The digital photo frame 112 is
similar to a conventional digital photo frame, but is further adapted to provide medication
20 reminders to the patient, for example by displaying a message on its graphical display means.

Medication schedule information from the medical database 106 is provided to
the PDA 100 for incorporation with the scheduled activities in its calendar. Based on the
medication schedule information and the scheduled activity information in the calendar of the
PDA 100, the PDA 100 can either modify the medication schedule or generate a medication
25 reminder, or do both. The modified medication schedule and/or generated medication
reminder is then incorporated into the calendar of the PDA 100.

According to updated schedule and reminder information of the calendar, the
PDA 100 communicates medication reminders to the medication dispenser 110 and/or the
digital photo frame 112. The device to which a reminder is communicated will be defined by
30 the schedule and reminder information of the calendar.

Communication of the reminders may be undertaken in advance so that the
reminders are stored in the reminder devices for future use, or it may be done at appropriate
times according to when the reminders are required. In the latter arrangement, failure to

confirm that the reminder device has received a reminder can indicate that alternative or additional reminders may be required to be communicated and/or scheduled by the PDA 100.

It will be understood that embodiment of Figure 2 employs established technologies in the context of medication compliance. In addition to the existing devices,
5 new devices can be introduced or used for interaction with the patient consumer (smart pill dispensers, integration with lifeline buttons, etc).

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be capable of designing many alternative embodiments without departing from the scope of the invention as defined by the
10 appended claims.

For example, in the embodiment of Figure 2, the PDA processes the medication schedule information and the scheduled activity information, whereas, in an alternative embodiment, scheduled activity information from the calendar of the PDA may be transmitted to a remote processing unit which is also provided with the medication schedule
15 information. This remote processing unit can then undertake the necessary processing to either modify the medication schedule or generate a medication reminder, or do both, therefore relinquishing the PDA 100 of the processing requirements. Such a remote processing unit can be provided in combination with the medical database, therefore enabling a medical professional to review medication schedule/reminder information and modify
20 medication schedules, reminders and/or processing algorithm as necessary.

The electronic calendar may be implemented using any suitable electronic device adapted to manage activity information in a structured manner so that a user of the electronic calendar is able to schedule, organize and/or arrange activities. It will therefore be understood that such an electronic calendar may simply comprise a data processing unit with
25 data storage capabilities. Thus, the electronic calendar may be implemented on a conventional electronic device such as a mobile phone, a digital watch, a portable computer, portable music player or personal organizer, for example.

Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings,
30 the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. A single processor or other unit may fulfill the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. A

computer program may be stored/distributed on a suitable medium, such as an optical storage medium or a solid-state medium supplied together with or as part of other hardware, but may also be distributed in other forms, such as via the Internet or other wired or wireless telecommunication systems. Any reference signs in the claims should not be construed as

5 limiting the scope.

CLAIMS:

1. A method for assisting a person to adhere to a medication schedule comprising;
storing a medication schedule and reminder system in an electronic calendar (10), the electronic calendar comprising activity information regarding scheduled activities of
5 the person; and
modifying the medication schedule and reminder system based on the medication schedule and at least one of: the activity information, and environmental condition information.
- 10 2. A method according to claim 1, wherein the step of modifying comprises the modifying the medication schedule.
3. A method according to claim 1 or 2, wherein the step of modifying comprises modifying a reminder of the medication schedule and reminder system.
- 15 4. A method according to any preceding claim, wherein the activity information comprises data relating to at least one of: activity location; activity date; and activity time;
and wherein the environmental condition information comprises data relating to at least one of: temperature; humidity; wind speed; UV index; pollen count; daylight
20 intensity; and air pollution;
and wherein the medication schedule comprises data relating to at least one of: medication name; medication type; dosage; and dose regularity.
5. A method according to any preceding claim wherein the reminder comprises at
25 least one of: an email message, an SMS message, a flashing indicator, a message on a graphical display, and an audio message.
6. A method according to any preceding claim further comprising communicating the generated reminder to the person, wherein the communication method

depends on at least one of: the activity information and the environmental condition information.

7. Apparatus for assisting a person to adhere to a medication schedule and
5 comprising:

an electronic calendar (10) adapted to implement a medication schedule and reminder system and to store activity information regarding scheduled activities of the person; and

10 a processing unit (18) adapted modify the medication schedule and reminder system based on the medication schedule and at least one of: the activity information, and environmental condition information.

8. Apparatus according to claim 7, wherein the processing unit is adapted to modify the medication schedule.

15

9. Apparatus according to claim 7 or 8, wherein the processing unit is adapted to modify a medication reminder of the medication schedule and reminder system.

10. Apparatus according to any of claims 7 to 9, further comprising a
20 communication unit adapted to communicate a medication reminder, wherein the communication method depends on at least one of: the activity information and the environmental condition information.

11. Apparatus according to claim 10, wherein the communication unit is adapted
25 to communicate the medication reminder to the person in a plurality of different formats.

12. Apparatus according to any of claims 7 to 11, wherein the activity information comprises data relating to at least one of: activity location; activity date; and activity time.

30 or wherein the environmental condition information comprises data relating to at least one of: temperature; humidity; wind speed; UV index; pollen count; daylight intensity; and air pollution

or wherein the medication schedule comprises data relating to at least one of: medication name; medication type; dosage; and dose regularity.

13. A medication dispenser comprising apparatus according to any of claims 8 to
12.

14. A computer program comprising computer program code means adapted to
5 perform all of the steps of any of claims 1 to 7, when said program is run on computer.

15. A computer program as claimed in claim 14 embodied on a computer readable
medium.

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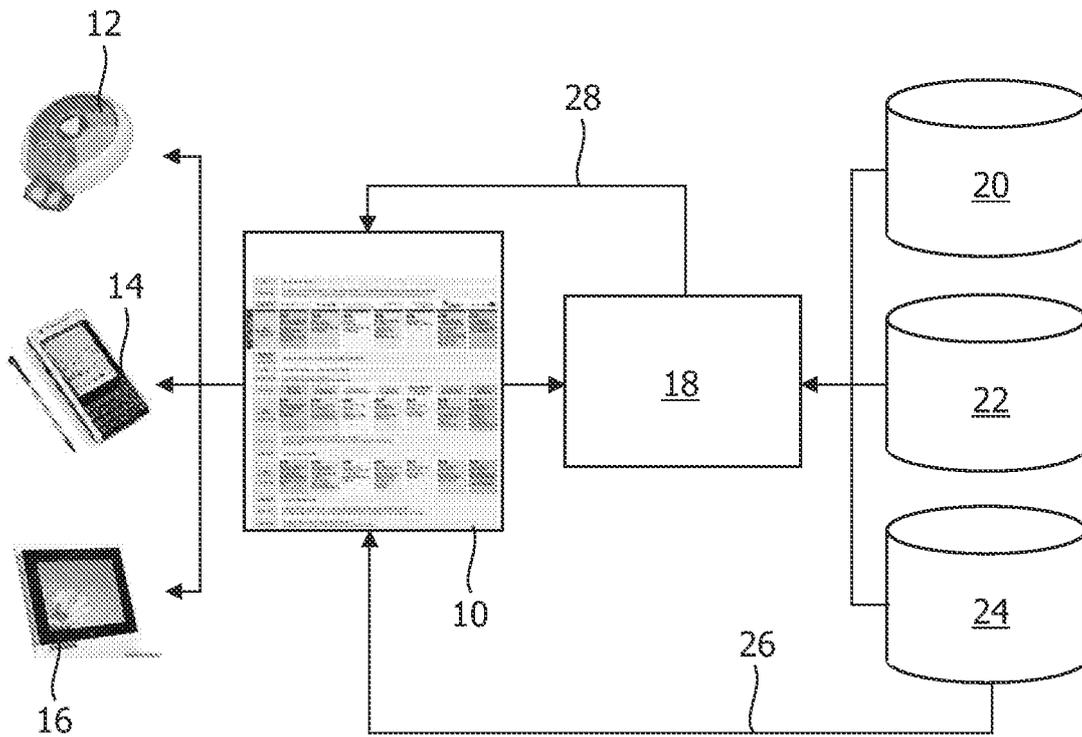


FIG. 1

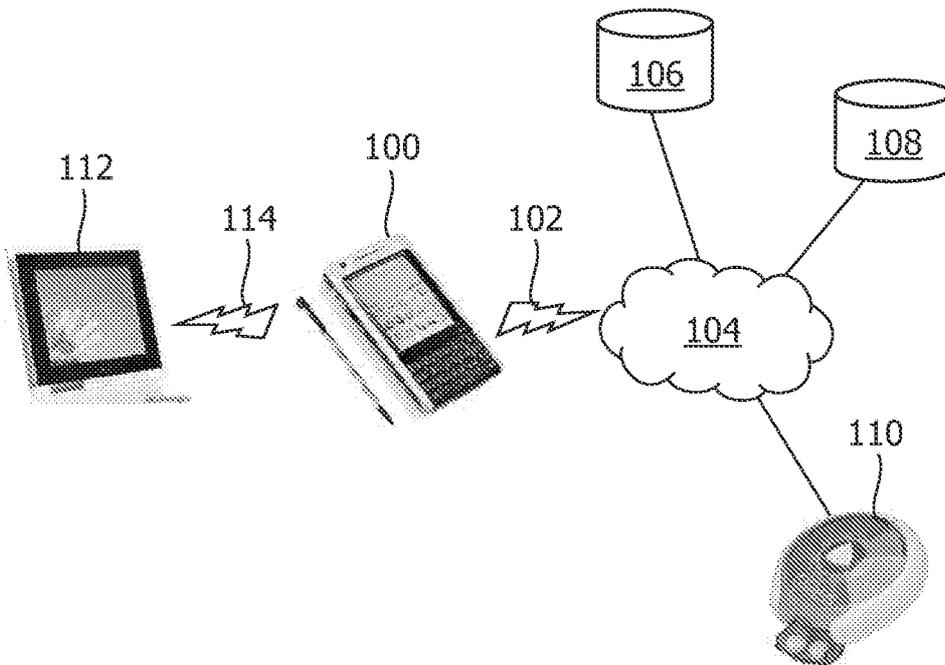


FIG. 2