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(54) **WIRELESS COMMUNICATION AUTHENTICATION FOR MEDICAL MONITORING DEVICE**

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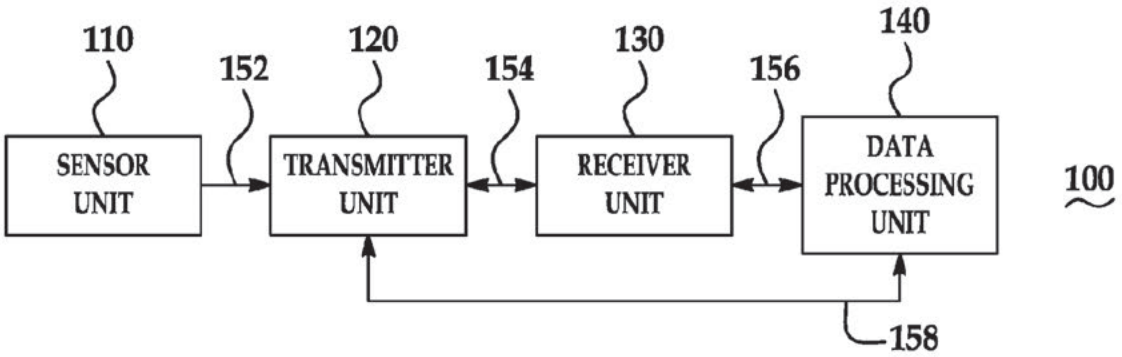
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(57) **ABSTRACT**

Methods, systems, and devices for short-range low-power wireless communication of analyte information are provided. In some implementations, short-range low-power wireless communication of analyte information may include receiving an electromagnetic wireless communication signal and harvesting energy from the electromagnetic wireless communication signal. In some implementations, short-range low-power wireless communication of analyte information may include enabling capabilities associated with an external sensor in response to detecting the external sensor. In some implementations, short-range low-power wireless communication of analyte information may include detecting an analyte sample; determining an analyte concentration associated with the detected analyte sample; and transmitting an indication of the analyte concentration to an external device.



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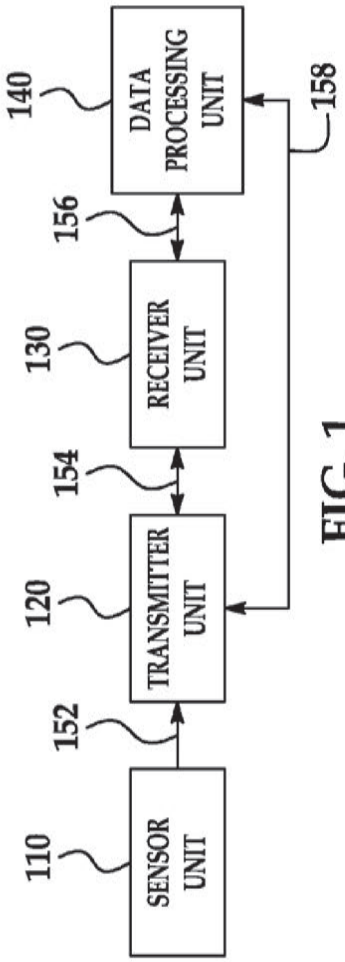

100
140
DATA PROCESSING UNIT
158
156
130
RECEIVER UNIT
154
120
TRANSMITTER UNIT
152
110
SENSOR UNIT

FIG. 1

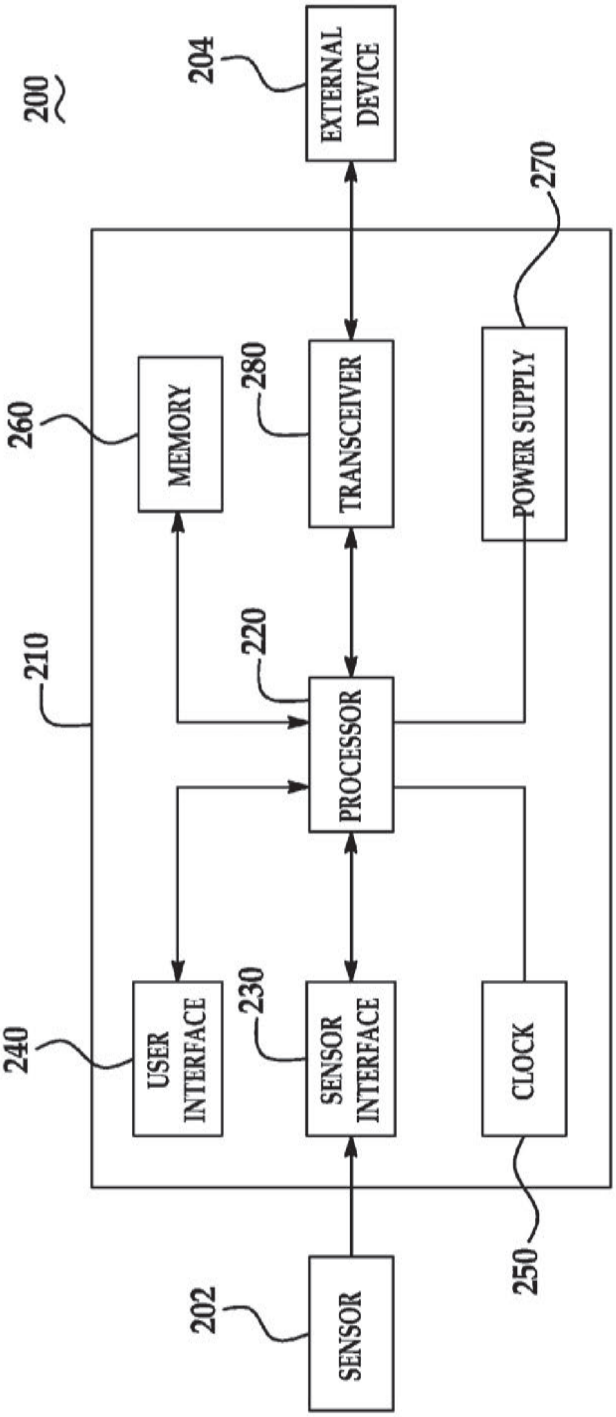

200
204
EXTERNAL DEVICE
270
260
MEMORY
280
TRANSCEIVER
POWER SUPPLY
210
220
PROCESSOR
240
USER INTERFACE
230
SENSOR INTERFACE
CLOCK
202
SENSOR
250

FIG. 2

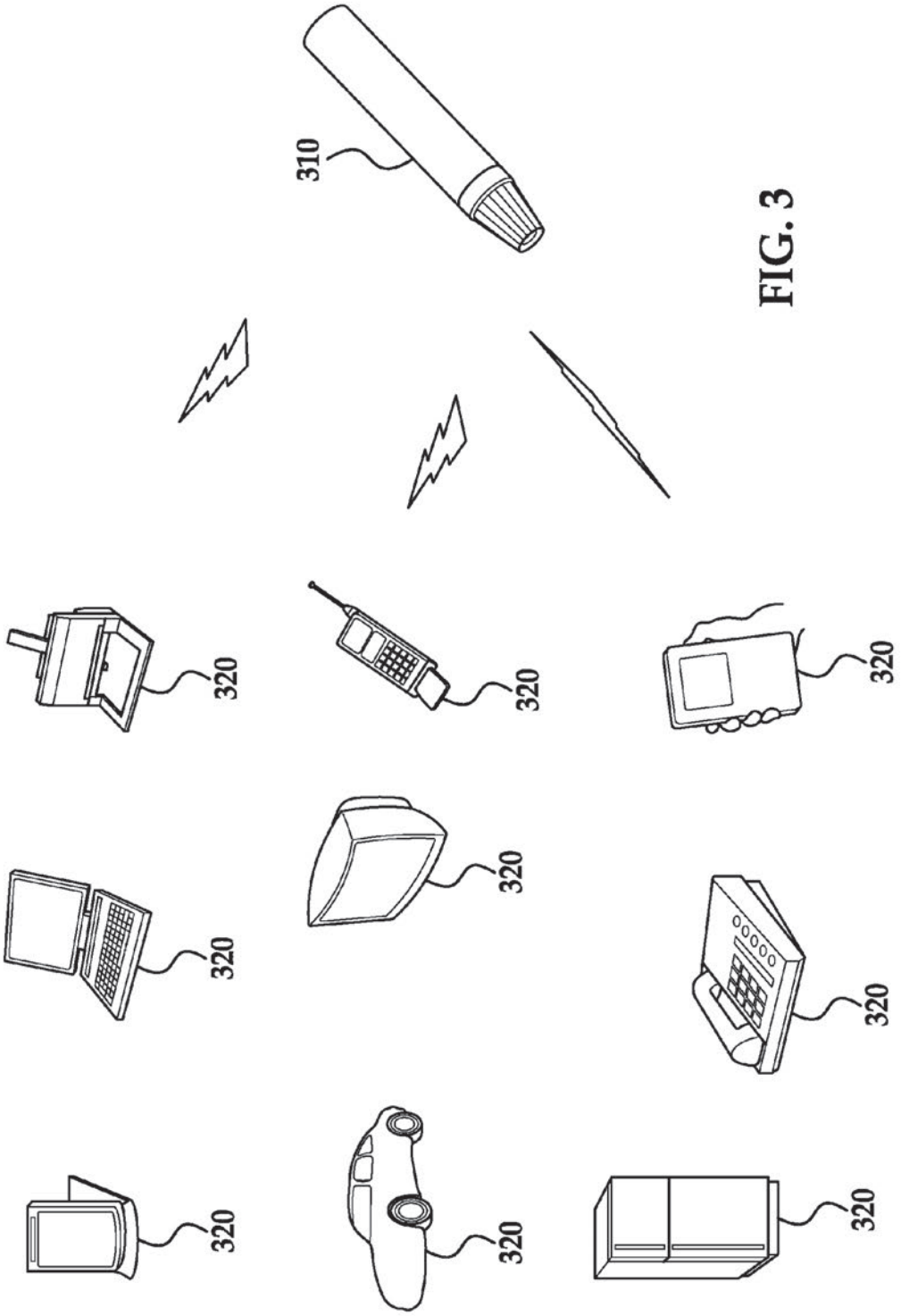


FIG. 3

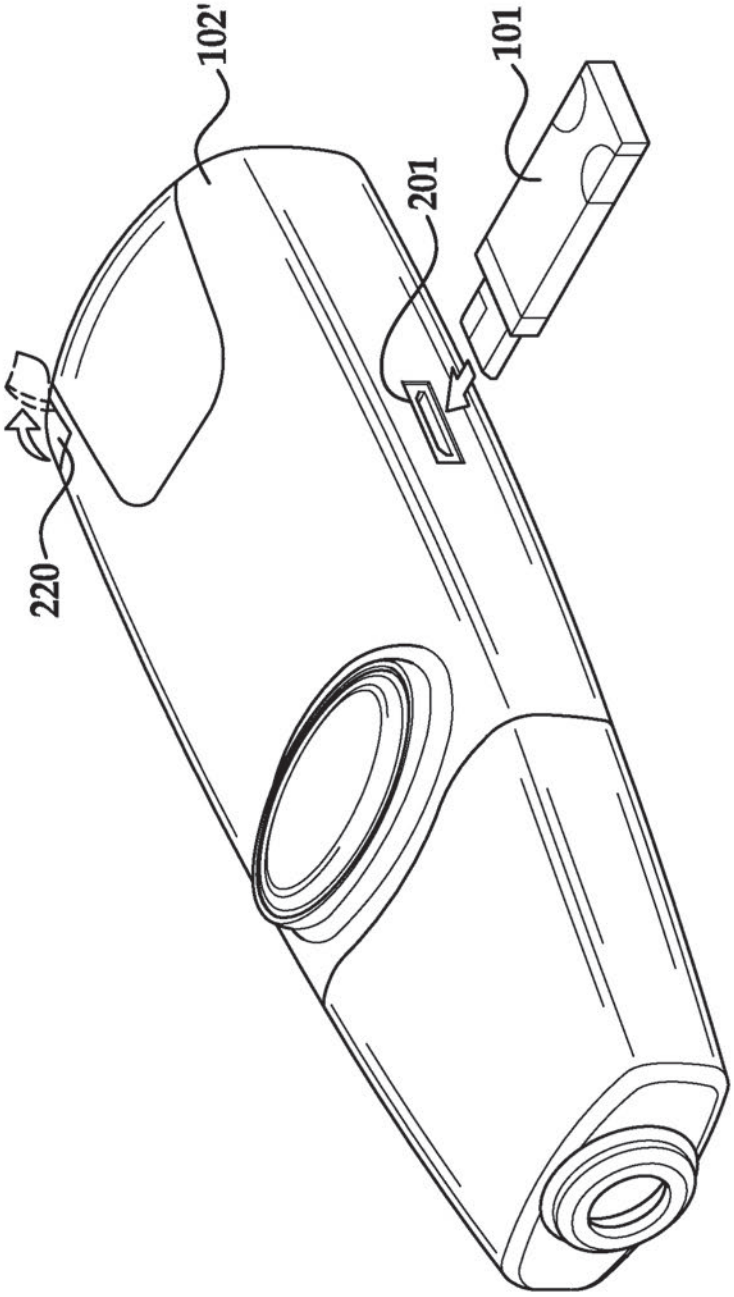


FIG. 4

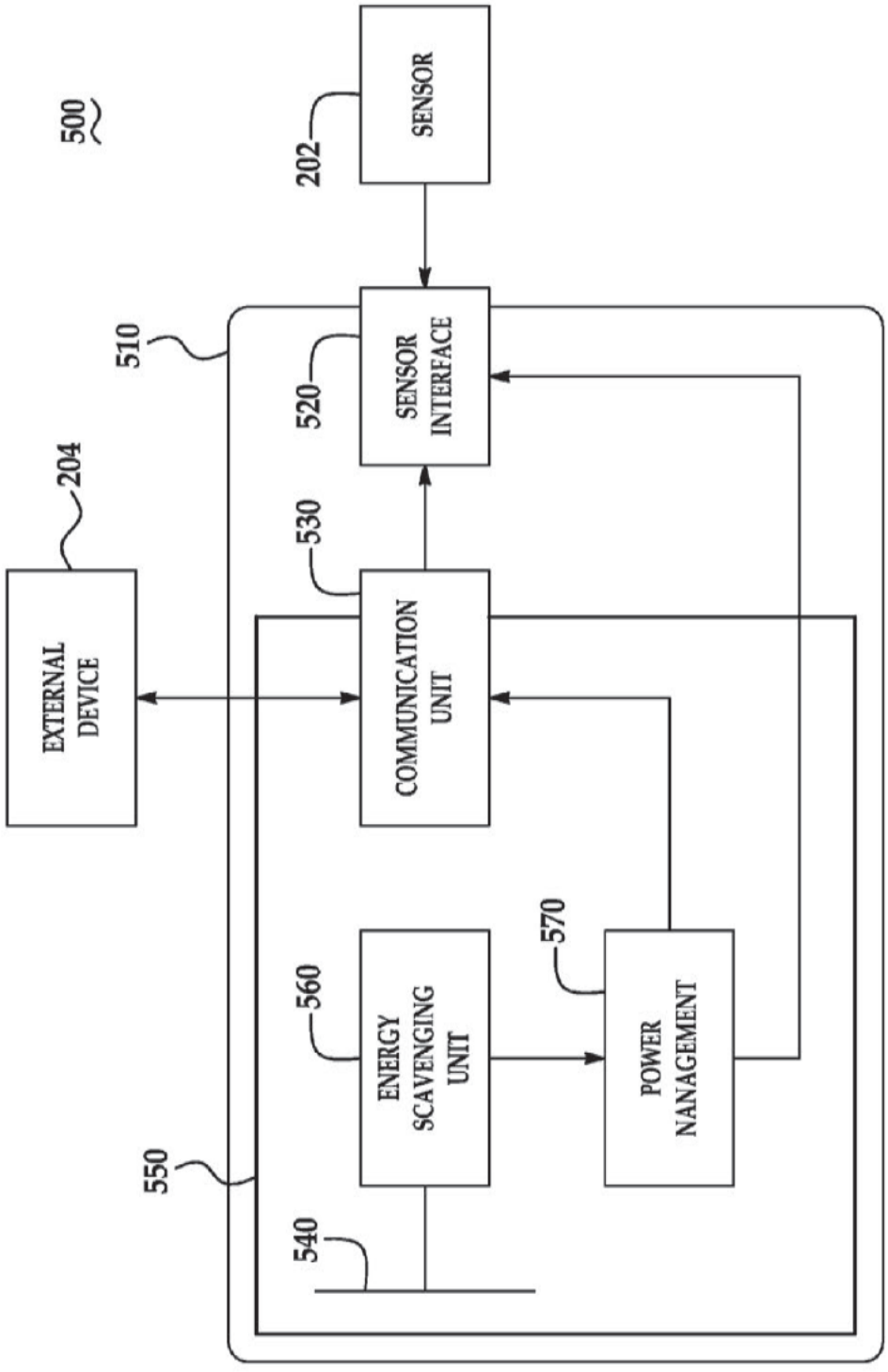

500
202
SENSOR
510
520
SENSOR INTERFACE
204
530
EXTERNAL DEVICE
COMMUNICATION UNIT
570
560
ENERGY SCAVENGING UNIT
POWER NANAGEMENT
550
540

FIG. 5

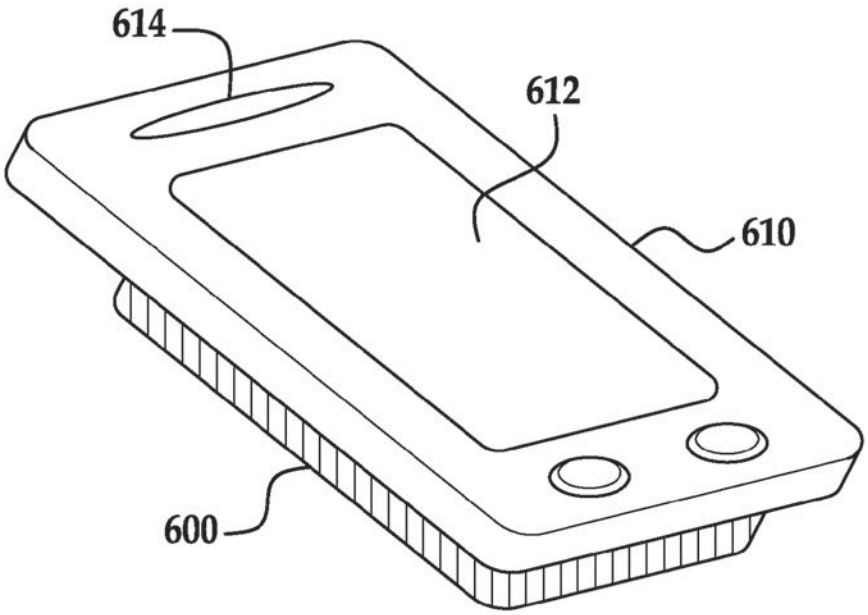

614
612
610
600

FIG. 6

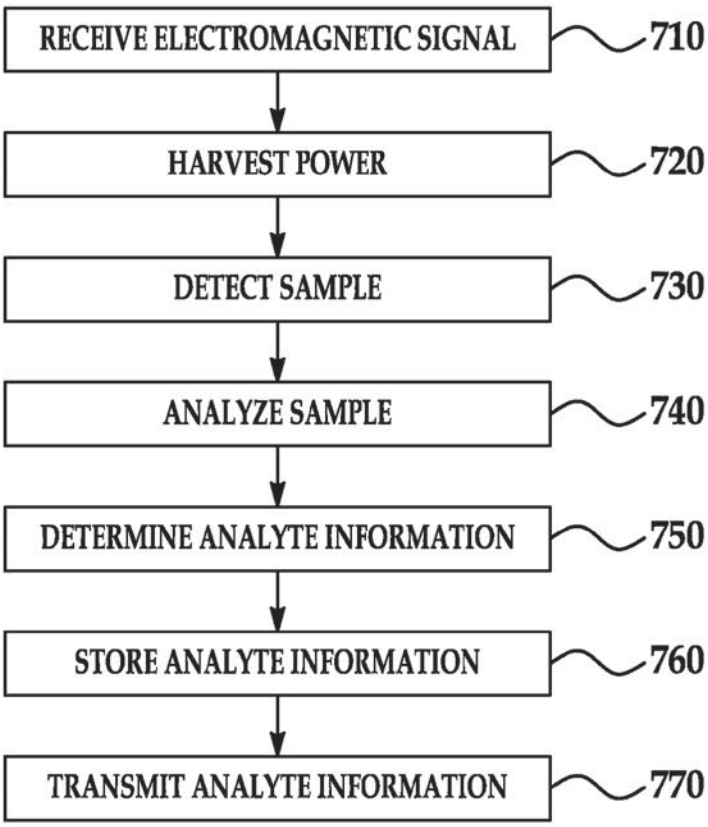

RECEIVE ELECTROMAGNETIC SIGNAL
710
HARVEST POWER
720
DETECT SAMPLE
730
ANALYZE SAMPLE
740
DETERMINE ANALYTE INFORMATION
750
STORE ANALYTE INFORMATION
760
TRANSMIT ANALYTE INFORMATION
770

FIG. 7

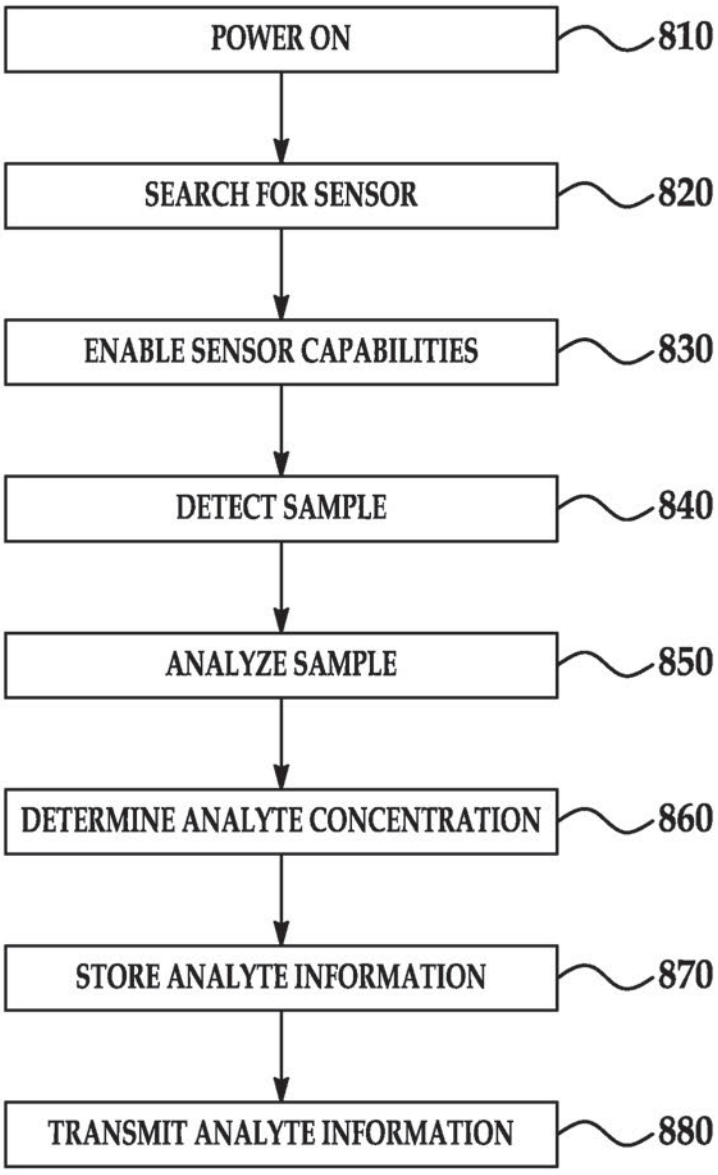

POWER ON
810
SEARCH FOR SENSOR
820
ENABLE SENSOR CAPABILITIES
830
DETECT SAMPLE
840
ANALYZE SAMPLE
850
DETERMINE ANALYTE CONCENTRATION
860
STORE ANALYTE INFORMATION
870
TRANSMIT ANALYTE INFORMATION
880

FIG. 8

WIRELESS COMMUNICATION AUTHENTICATION FOR MEDICAL MONITORING DEVICE

TECHNICAL FIELD

[0001] The embodiments herein relate in general to a device and method for determining and reporting glucose readings using wireless communication.

BACKGROUND

[0002] Analyte monitoring systems, such as glucose monitoring systems, including continuous and discrete monitoring systems, may include a battery powered and microprocessor controlled system which is configured to detect signals proportional to the corresponding measured glucose levels using an electrometer, and transmit the collected data, such as via radio frequency (RF) transmission. In some implementations, glucose monitoring systems may include a transcutaneous or subcutaneous analyte sensor configuration which may be, for example, partially mounted on the skin of a subject whose glucose level is to be monitored. The sensor may use a two or three electrode (work, reference, and counter electrodes) configuration driven by a controlled potential (potentiostat) analog circuit connected through a contact system.

[0003] In view of the foregoing, it would be desirable to provide a short-range low-energy communication unit in a data monitoring and management system.

BRIEF SUMMARY

[0004] In accordance with the various embodiments of the present disclosure, there are provided methods, devices, and systems for providing a short-range low-energy communication unit in a data monitoring and management system.

[0005] In a first aspect, the present disclosure provides a device, including a housing, a processor coupled to the housing, a memory unit configured to store computer executable instructions, an antenna, an energy scavenging unit, and a processor configured to execute the computer executable instructions stored in the memory to control the energy scavenging unit to harvest energy from an electromagnetic signal received by the antenna, detect an analyte sample, determine an analyte concentration associated with the detected analyte sample, and transmit an indication of the analyte concentration to an external device using the harvested energy.

[0006] In a second aspect, the present disclosure provides a method including receiving an electromagnetic wireless communication signal, harvesting energy from the electromagnetic wireless communication signal, detecting an analyte sample, determining an analyte concentration associated with the detected analyte sample, and transmitting an indication of the analyte concentration to an external device using the harvested energy.

[0007] In a third aspect, the present disclosure provides a device, including a housing, a memory unit configured to store computer executable instructions, a transceiver, a plurality of capabilities associated with an external sensor, wherein each capability in the plurality of capabilities associated with the external sensor is disabled, and a processor configured to execute the computer executable instructions stored in the memory to enable an external sensor interface, search for the external sensor, in response to detecting the external sensor, enable each capability in the plurality of capabilities associated with the external sensor, detect an analyte sample using the external sensor interface, determine an analyte concentration associated with the detected analyte sample, and transmit an indication of the analyte concentration to an external device.

[0008] In a fourth aspect, the present disclosure provides a method including enabling an external sensor interface, wherein the external sensor interface is one of a plurality of capabilities associated with an external sensor, wherein each capability in the plurality of capabilities associated with the external sensor is disabled, searching for the external sensor, in response to detecting the external sensor, enabling each capability in the plurality of capabilities associated with the external sensor, detecting an analyte sample using the external sensor interface, determining an analyte concentration associated with the detected analyte sample, and transmitting an indication of the analyte concentration to an external device.

[0009] It should be noted that two or more of the embodiments described herein, including those described above, may be combined to produce one or more additional embodiments which include the combined features of the individual embodiments.

[0010] These and other objects, features, and advantages of the present disclosure will become more fully apparent from the following detailed description of the embodiments, the appended claims and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. **1** shows a block diagram of an analyte data monitoring and management system in accordance with embodiments of the present disclosure;

[0012] FIG. **2** shows a diagram of a health monitor device in accordance with embodiments of this disclosure;

[0013] FIG. **3** shows examples of a health monitor device in communication with external devices in accordance with embodiments of this disclosure;

[0014] FIG. **4** shows a perspective view diagram of a health monitor device in accordance with embodiments of this disclosure.

[0015] FIG. **5** shows a block diagram of a wirelessly powered health monitor device in accordance with embodiments of this disclosure;

[0016] FIG. **6** shows a perspective view diagram of a wirelessly powered health monitor device and external device in accordance with embodiments of this disclosure;

[0017] FIG. **7** shows an example of wirelessly powered wireless communication of analyte data in accordance with embodiments of this disclosure; and

[0018] FIG. **8** is an example of enabling suppressed capabilities in accordance with embodiments of this disclosure.

DETAILED DESCRIPTION

[0019] As described in accordance with the various embodiments of the present disclosure below, there are provided methods and systems for utilizing short-range low-energy wireless communications in an electronic device used in analyte monitoring and management systems, such as in a glucose monitoring and management systems.

[0020] Although FIGS. **1-8** are described with reference to glucose monitoring, any data monitoring and management system may be used. For example, an analyte monitoring system may monitor a variety of analytes, such as, lactate, ketones, acetyl choline, amylase, bilirubin, cholesterol,

chorionic gonadotropin, creatine kinase (e.g., CK-MB), creatine, DNA, fructosamine, glucose, glutamine, growth hormones, hormones, ketones, lactate, peroxide, prostate-specific antigen, prothrombin, RNA, thyroid stimulating hormone, and troponin. In some implementations, the concentration of drugs, such as, for example, antibiotics (e.g., gentamicin, vancomycin, and the like), digitoxin, digoxin, drugs of abuse, theophylline, and warfarin, may be monitored.

[0021] FIG. **1** shows a block diagram of an analyte data monitoring and management system **100**, such as a glucose monitoring system, in accordance with embodiments of the present disclosure. The analyte data monitoring and management system **100** may include a sensor unit **110**, a transmitter unit **120**, a receiver unit **130**, a data processing unit **140**, or any combination thereof.

[0022] In some implementations, one or more of the sensor unit **110**, the transmitter unit **120**, the receiver unit **130**, or the data processing unit **140** may be configured to communicate via a wired or wireless communication link **152/154/156/158**. For example, communicating via a wireless communication link may include using one or more of an radio frequency (RF) communication protocol, a near field communication (NFC) protocol, a radio frequency identification (RFID) protocol, an infrared communication protocol, a Bluetooth® communication protocol, an 802.11x wireless communication protocol, or an equivalent wireless communication protocol which may provide secure, wireless communication with one or more units while avoiding data collision and interference.

[0023] The sensor unit **110** may communicate with the transmitter unit **120** to provide monitored or detected analyte information. The sensor unit **110** may communicate the analyte information in response to manual interaction, based on a transmission schedule, or in response to a request from the transmitter unit **120**.

[0024] In some implementations, the sensor unit **110** may be a test strip, which may be an electrochemical analyte test strip, such as a blood glucose test strip or other fluid sample reception unit. The test strip may be mechanically received in a test strip port of the transmitter unit **120**, which may be a hand-held blood glucose meter.

[0025] In some implementations, the sensor unit **110** may be an external monitoring device, such as a continuous analyte monitoring device. For example, the sensor unit **110** may be physically positioned in or on the body of a user whose glucose level is being monitored, and the sensor unit **110** may continually or substantially continually measure an analyte concentration of a bodily fluid. In some embodiments, the sensor unit **120** may be configured as a compact, low profile on-body patch device assembled in a single integrated housing and positioned on a skin surface of the user or the patient with a portion of the analyte sensor maintained in fluid contact with a bodily fluid such as an interstitial fluid. The sensor unit **110** may be configured to continuously sample the glucose level of the user and convert the sampled glucose level into a corresponding data signal for transmission by the transmitter unit **120**.

[0026] The transmitter unit **120** may be configured to receive analyte information from the sensor unit **110**. For example, the transmitter unit **120** may be configured to receive a fluid sample transported by a test strip. In another example, the transmitter unit **120** may be configured to receive analyte data from an external monitoring device, such as a continuous analyte monitoring device. In another example, the transmitter unit **120** may be configured to receive a fluid sample transported by a test strip and to receive analyte data from an external monitoring device. In some embodiments, the transmitter unit **120** may be configured to control the sensor unit **110**.

[0027] The transmitter unit **120** may be configured to communicate with the receiver unit **130** via a communication link **154**. In some embodiments, the transmitter device **120** may be configured without a user interface or display to minimize the size and cost of the transmitter device **120**. In some embodiments, the transmitter unit **120** may be mounted on the sensor unit **110**, or the sensor unit **110** and the transmitter unit **120** may be configured as a combined unit, and both units may be positioned on a user's body. The transmitter unit **120** may perform data processing such as filtering and encoding of data signals, each of which may correspond to a sampled glucose level of the user, for transmission to the receiver unit **130** via the communication link **154**.

[0028] In some embodiments, the communication link **154** may be unidirectional from the transmitter unit **120** to the receiver unit **130**. The transmitter unit **120** may transmit sampled data signals received from the sensor unit **110** without acknowledgement from the receiver unit **130**. For example, the transmitter unit **120** may be configured to transmit encoded sampled data signals at a fixed rate (e.g., at one minute intervals) after the completion of an initial power on procedure. The receiver unit **130** may be configured to detect transmitted encoded sampled data signals at predetermined time intervals.

[0029] The receiver unit **130** may be configured to receive data from the transmitter unit **120** via communication link **154** and to transmit data to the data processing unit **140** for evaluation via communication link **156**. In some implementations, the receiver unit **130** may include an analog interface unit, which may be configured to communicate with the transmitter unit **120** via the communication link **154**, and a data processing unit, which may be configured to process data signals received from the transmitter unit **120**, by performing, for example, data decoding, error detection and correction, data clock generation, or data bit recovery. In some embodiments, the analog interface section may include or wireless communication receiver and an antenna for receiving and amplifying the data signals from the transmitter unit **120**. The signals may be processed at the receiver unit **130**. For example, the signals may be demodulated with a local oscillator and filtered through a band-pass filter.

[0030] In some implementations, the receiver unit **130** may be configured to detect the presence of the transmitter unit **120** within a range based on, for example, the strength of the detected data signals received from the transmitter unit **120** or based on predetermined transmitter identification information. The receiver unit **130** and the transmitter unit **120** may synchronize and the receiver unit **130** may receive data signals corresponding to the user's detected glucose level from the transmitter unit **120**. For example, the receiver unit **130** may be configured to perform synchronized time hopping with the corresponding synchronized transmitter unit **120** via the communication link **154** to obtain the user's detected glucose level.

[0031] In some embodiments, the receiver unit **130** may include a PDA or smartphone, which may synchronize data with the data processing unit **140**, which may be a personal computer (PC). In another embodiment, the receiver unit **130**

may include a mobile phone, which may communicate via a cellular network with the data processing unit **140**, which may be a computer system at, for example, a physician's office.

[0032] The data processing unit **140** may be configured to evaluate data received from the receiver unit **130**. In some implementations, the data processing unit **140** may be configured to communicate directly with the transmitter unit **120** via communication link **158**. In some implementations, the receiver unit **130** may be configured to include the functions of the data processing unit **140** such that the receiver unit **130** may be configured to receive and evaluate data from the transmitter unit **120**.

[0033] In some implementations, the data processing unit **140** may include a personal computer, a portable computer such as a laptop or a handheld device (e.g., a personal digital assistant (PDA) or smartphone), and the like, and may be configured for data communication with the receiver unit **130** via a wired or a wireless communication link. In some embodiments, the data processing unit **140** may be connected to a data network (not shown) for storing, retrieving and updating data corresponding to the detected glucose level of the user.

[0034] In some implementations, the data processing unit **140** may include an infusion device such as an insulin infusion pump or the like, which may be configured to administer insulin to patients, and which may be configured to communicate with the receiver unit **130** for receiving, for example, glucose level measurements. In some embodiments, the receiver unit **130** may be integrated with an infusion device and the receiver unit **130** may be configured to administer insulin therapy to patients, for example, for administering and modifying basal profiles, as well as for determining appropriate boluses for administration based on, for example, the detected glucose levels received from the transmitter unit **120**.

[0035] In some implementations, the data processing unit **140** may be configured to receive signals including glucose information from the transmitter unit **120**, and may incorporate functions of the receiver unit **130**, which may include data processing for managing the patient's insulin therapy and glucose monitoring.

[0036] Although FIG. **1** shows a sensor unit **110**, a transmitter unit **120**, a receiver unit **130**, and a data processing unit **140**, the glucose monitoring communication system **100** may include multiple sensors, multiple transmitters, multiple communication links, multiple receivers, or multiple data processing units. In some implementations, the glucose monitoring communication system **100** may be a continuous monitoring system, a semi-continuous monitoring system, or a discrete monitoring system. For example, the sensor unit **110** may be configured as a test strip, the transmitter unit **120** may be configured as a hand-held blood glucose monitor, and the receiver unit **130** and the data processing unit **140** may be omitted. In another example, the sensor unit **110** may be configured as an external monitoring device, the transmitter unit **120** may be configured as small device without a user interface to receive information from and control the sensor unit **110**, and the receiver unit **130** may be configured to receive information from and control the transmitter unit **120** and to provide a user interface for the system.

[0037] FIG. **2** shows a diagram of a health monitor device **200** in accordance with embodiments of this disclosure. The health monitor device **200** may include a client device, such as the transmitter unit **120** shown in FIG. **1**, a server device, such as the receiver unit **130** shown in FIG. **1**, or both. The health monitor device **200** may be used for determining a concentration of an analyte in blood or interstitial fluid. For example, the health monitor device **200** may be an analyte test meter, such as a glucose test meter that may be used for determining an analyte concentration, such as a blood glucose concentration, of a sample for determination of a blood glucose level of a patient, such as a patient with Type-1 or Type-2 diabetes. In some embodiments, the health monitor device **200** may be a blood glucose meter, a continuous monitor, an insulin pump, a blood pressure meter, a heart rate monitor, a thermometer, or any other health monitor device capable of measuring, monitoring, or storing raw or analyzed medical data electronically.

[0038] The health monitor device **200** may communicate in a wireless communication system, such as the system shown in FIG. **1**. For example, the health monitor device **200** may receive fluid samples, or sample data, from a sensor device **202**, such as the sensor unit **110** shown in FIG. **1**, and may wirelessly transmit data to an external device **204**, such as the receiver unit **130** or the data processing unit **140** shown in FIG. **1**. The health monitor device **200** may include a housing **210**, a processor **220**, a sensor interface **230**, a user interface **240**, a clock **250**, a data storage unit **260**, a power supply **270**, a communication interface **280**, or a combination thereof.

[0039] The housing **210** may physically enclose one or more of the processor **220**, the sensor interface **230**, the user interface **240**, the clock **250**, the data storage unit **260**, the power supply **270**, or the communication interface **280**, and may be configured to fit into a small profile. Although the housing **210** is shown a single physical unit, the housing **210** may be implemented as one or more physical units that may be physically or electronically connected. Although not shown in FIG. **2**, the housing **210** may include one or more ports, such as a test strip port, a power port, an audio connection port, or a data connection port. For example, the housing **210** may include a test strip port configured to receive a test strip, which may include a fluid sample, and may be connected to the sensor interface **230**.

[0040] The processor **220** may include any device capable of manipulating or processing a signal or other information, including an optical processor, a quantum processor, a molecular processor, or a combination thereof. For example, the processor **220** may include a general purpose processor, a central processing unit (CPU), a special purpose processor, a plurality of microprocessors, a controller, a microcontroller, an Application Specific Integrated Circuit (ASIC), a Field Programmable Gate Array (FPGA), a programmable logic array, programmable logic controller, microcode, firmware, any type of integrated circuit (IC), a state machine, or any combination thereof. As used herein, the term "processor" includes a single processor or multiple processors. The processor **220** may be operatively coupled to the sensor interface **230**, the user interface **240**, the clock **250**, the data storage unit **260**, the power supply **270**, or the communication interface **280**.

[0041] In some embodiments, the sensor interface **230** may receive a fluid sample. For example, the sensor **202** may be a test strip and the sensor interface **230** may receive a fluid sample transported via a test strip. The processor **220** may control the sensor interface **230** to analyze the fluid sample to determine an associated analyte level.

[0042] In some embodiments, the sensor interface **230** may receive raw or analyzed data indicating an analyte level associated with a fluid sample analyzed at an external measurement device, such as a continuous analyte monitoring device, via a wireless communication medium, such as radio frequency identification (RFID). For example, the continuous analyte monitoring device may include a transcutaneously implanted sensor, such as an implantable glucose sensor, that may continually or substantially continually measure an analyte concentration of a bodily fluid. In some embodiments, the sensor interface **230** may receive analyte related data from the external measurement device periodically, based on a transmission schedule, or may request the data from the external measurement device.

[0043] The user interface **240** may include a display unit and one or more input elements, which may include physical input elements, such as buttons, jogs, or dials, virtual input elements, such as butts on a touch screen, or both. The user interface **240**, or a portion thereof, may be integrated with the housing **210**. For example, the user interface **240** may form a part of an external surface of the housing **210**. The user interface **240**, or a portion thereof, may be configured to allow a user of the health monitor device **200** to receive information, input information, or otherwise interact, with the health monitor device **200**. For example, the user of the health monitor device **200** may operate the one or more input buttons to enter a calibration code associated with a test strip or other fluid sample reception device. In another example, the user interface **240** may present visual, tactile, or auditory information indicating, for example, a blood glucose measurement to the user. In some embodiments, the display unit may include a graphical display unit, such as a LCD or an LED display, an auditory display unit, such as speaker, or both a graphical display and an audio display. In some embodiments, the user interface **240** may include a touch screen display. In some embodiments, the display unit, the input elements, or both may be omitted from the user interface **240**.

[0044] The clock **250** may be operatively coupled to the processor **220** and may provide a clock signal at discreet clock frequencies to the processor **220**. For example, the clock may include an oscillator, such as a quartz crystal oscillator, or any other device capable of producing a clock signal for indicating a real time clock.

[0045] The data storage unit **260** may store raw data, analyzed data, or both. In some embodiments, the data storage unit **260** may store instructions that may be executed by the processor to, for example, perform analysis, such as analyte concentration analysis and medication dosage calculation. The data storage unit **260** may include any non-transitory computer-usable or computer-readable medium, such as any tangible device that can, for example, contain, store, communicate, or transport instructions, or any information associated therewith, for use by or in connection with the processor **220**. The non-transitory computer-usable or computer-readable medium may be, for example, a solid state drive, a memory card, removable media, a read only memory (ROM), a random access memory (RAM), any type of disk including a hard disk, a floppy disk, an optical disk, a magnetic or optical card, an application specific integrated circuits (ASICs), or any type of non-transitory media suitable for storing electronic information, or any combination thereof. The data storage unit **260** may be operatively connected to, for example, the processor **220** through, for example, a memory bus.

[0046] The power supply **270** may be any suitable device for powering the health monitor device **200**, or any portion thereof. For example, the power supply **270** may include a wired power source; one or more dry cell batteries, such as nickel-cadmium (NiCd), nickel-zinc (NiZn), nickel metal hydride (NiMH), lithium-ion (Li-ion); solar cells; fuel cells; or any other device capable of powering the health monitor device **200**. The processor **220**, the sensor interface **230**, the user interface **240**, the clock **250**, the data storage unit **260**, or the communication interface **280**, may be operatively coupled to the power supply **270**.

[0047] The communication interface **280** may communicate with an external device **204**, such as the receiver unit **130** shown in FIG. **1**. For example, the communication interface **280** may be an RF transmitter and may communicate using a wireless communication protocol, such as an 802.11 protocol, a Bluetooth® protocol, a cellular protocol, or any other wireless protocol. In some embodiments, the communication interface **280** may include a receiver, a transmitter, or a transceiver. For example, the communication interface **280** may include a wireless transmission unit, such as a Bluetooth® low-energy wireless transmission unit. Although not expressly shown in FIG. **2**, the communication interface **280** may include a wireless antenna, a wired communication port, such as an Ethernet port, an infrared port, a serial port, or any other wired or wireless unit capable of interfacing with a wired or wireless electronic communication medium. In some embodiments, the health monitor device **200** may communicate with the external device **204** indirectly via another device, or series of devices. For example, the health monitor device **200** may communicate with the external device **204** via a network, wherein the health monitor device **200** may transmit signals to, for example, an access point (not shown), and the access point may transmit the signals to the external device **204**, in the same or a different format, via one or more other devices in a network.

[0048] In some embodiments, the health monitor device **200** may audibly present information, such as information indicating an analyte concentration, information indicating a rate of change of an analyte concentration, or information indicating the exceeding of a threshold of an analyte concentration, which may indicate, for example, hypo- or hyperglycemia. For example, the user interface **240** may include a speaker, and the health monitor device **200** may present the audio signal via the speaker. In some embodiments, the health monitor device **200** may transmit raw or analyzed analyte information to the external device **204** and the external device **204** may generate an audio signal for presentation. In some embodiments, the health monitor device **200** may generate an audio signal indicating the information and may transmit the audio indication to the external device **204** for audio presentation.

[0049] Although shown as separate elements, the processor **220**, the sensor interface **230**, the user interface **240**, the clock **250**, the data storage unit **260**, the power supply **270**, the communication interface **280**, or any combination thereof, may be integrated in one or more electronic units, circuits, or chips.

[0050] FIG. **3** shows examples of a health monitor device **310**, such as the health monitor device **200** shown in FIG. **2**, in communication with external devices **320**, such as the receiver device **130** or the data processing unit **140** shown in FIG. **1** in accordance with embodiments of this disclosure. The health monitor device **310** and one or more of the external

devices **320** may be part of a communication network, such as an individual's personal area network, and may be capable of wireless communication.

[0051] In some embodiments, the external device **320** may be a desktop computer, laptop computer, a handheld computer, or a printer, and may be configured to provide displays and printouts of detected or monitored information. In some embodiments, the external device **320** may be a telephone that may be configured to display glucose data as and to transmit the data over a larger network.

[0052] In some embodiments, the external device **320** may be a configured to assist an individual by responding to glucose levels by providing alarms, suggesting that action be taken to correct a hypo or hyperglycemic condition, or to call necessary medical assistance. For example, individuals may be aware of the risks involved in driving when glucose levels are out of range and particularly when they are too low. Thus, a navigation computer, or other electronic device, in an individual's car may become part of the local area network and may download glucose data from the meter. For safety, the car computer system may be programmed to require that the individual to perform a glucose test before driving, and the car may be disabled unless the diabetic takes the test and the result is in an appropriate range.

[0053] FIG. **4** shows a schematic of a health monitor device in accordance with embodiments of this disclosure. In some implementations, a blood glucose meter **102** may not include a display or push buttons and may be combined with a lancing device to form an integrated unit **102'**. Test strip port **201** can be located in the side of integrated device **102'** or in any other appropriate position. A test strip storage compartment can be located within integrated device **102'** and accessed through a flip-lid **220** or other suitable closure means. A second test strip storage compartment (not shown) can be included so that fresh strips and used strips can be separately stored. A desiccant may be provided in one of the storage compartments to preserve the fresh strips. By integrating these features together in a single device without a user interface, the typical test kit that is carried around by people with diabetes can be made much smaller, easier to handle, and less costly.

[0054] A user may use a larger display unit within his or her personal area network, which can be synchronized as they interact and communicate with the wireless enabled meter. The sequences through which the user must "step" to complete tests (e.g. entering the calibration code, prompting application of the sample) may be readily viewed on the larger display units. The meter unit may be simplified, and may be smaller and less expensive to manufacture. Control buttons may be eliminated, saving additional size and cost, since the user can use interface features of the external device. Simplified, wireless enabled meters may be disposable, for example, after a specified number of uses, permitting the producer to routinely upgrade as appropriate.

[0055] The system may permit the user to include security coding at any time the meter unit accesses a display device, so that the user's data is secure. For example, when the health monitor device is used, that the system may request the user enter an identity code in order to verify that the person handling the meter is an authorized user. The system to permit more than one user. The user data may be encrypted prior to wireless transmission and thereafter respectively decrypted upon wireless reception.

[0056] In some implementations, the health monitor device may be configured to advise the user of a glucose level which is determined when the module is used as a "stand-alone" unit. For example, the module may include a very low cost, small three digit LCD display. In another example, the module may include LED indicator lights, a column of LEDs, or an electroluminescent strip to indicate approximate or relative glucose levels. For example, the health monitor device may include a red LED for below range, a green LED for within range, and a yellow LED for above range.

[0057] FIG. **5** shows a block diagram of a wirelessly powered health monitor device **500** in accordance with embodiments of this disclosure. The wirelessly powered health monitor device **500** may be used for determining a concentration of an analyte in blood or interstitial fluid and may communicate in a wireless communication system, such as the wireless system shown in FIG. **1**, using power harvested from wireless communication signals. For example, the wirelessly powered health monitor device **500** may receive fluid samples, or sample data, from a sensor unit **502**, such as the sensor unit **110** shown in FIG. **1**, and may wirelessly transmit data to an external device **504**, such as the data processing unit **140** shown in FIG. **1**. The wirelessly powered health monitor device **500** may be an electronic device, such as transmitter unit **120** shown in FIG. **1**, and may be similar to the health monitor device **200** shown in FIG. **2**, except as described herein.

[0058] The wirelessly powered health monitor device **500** may include a housing **510**, a sensor interface unit **520**, a communication unit **530**, a wideband wireless communication antenna **540**, a magnetic loop wireless communication antenna **550**, a power scavenging unit **560**, a power management unit **570**, or a combination thereof. Although not shown in FIG. **5**, the a wirelessly powered health monitor device **500** may include other elements of a health monitor device, which may include a processor, such as the processor **220** shown in FIG. **2**, a user interface, such as the user interface **240** shown in FIG. **2**, a clock, such as the clock **250** shown in FIG. **2**, a data storage unit, such as the data storage unit **260** shown in FIG. **2**, or any combination thereof. In some implementations, the wirelessly powered health monitor device **500** may be batteryless.

[0059] The wirelessly powered health monitor device **500** may determine a concentration of an analyte in blood or interstitial fluid. For example, the wirelessly powered health monitor device **500** may be an analyte test meter, such as a glucose test meter that may be used for determining an analyte concentration, such as a blood glucose concentration, of a sample for determination of a blood glucose level of a patient, such as a patient with Type-1 or Type-2 diabetes. In some embodiments, the wirelessly powered health monitor device **500** may be a blood glucose meter, a continuous monitor, an insulin pump, a blood pressure meter, a heart rate monitor, a thermometer, or any other health monitor device capable of measuring, monitoring, or storing raw or analyzed medical data electronically.

[0060] The housing **510** may physically enclose one or more of the sensor interface unit **520**, the communication unit **530**, the wideband wireless communication antenna **540**, the magnetic loop wireless communication antenna **550**, the power scavenging unit **560**, or the power management unit **570**, and may be configured to fit into a small profile. Although the housing **510** is shown a single physical unit, the housing **510** may be implemented as one or more physical units that may be physically or electronically connected. Although not shown in FIG. **5**, the housing **510** may include

one or more ports, such as a test strip port, a power port, an audio connection port, or a data connection port. For example, the housing **510** may include a test strip port configured to receive a test strip, which may include a fluid sample, and may be connected to the sensor interface unit **520**.

[0061] The sensor interface unit **520** may be configured to receive analyte information from the sensor unit **502**. For example, the sensor interface unit **520** may be configured to receive a glucose current signal, convert the glucose current signal to a voltage signal, and amplify the voltage signal for use in analog to digital signal conversion. In some embodiments, the sensor interface unit **520** may receive a fluid sample. For example, the sensor unit **502** may be a test strip, and the test strip may transport a fluid sample to the sensor interface unit **520**. The sensor interface unit **520** may be configured to analyze the fluid sample to determine an associated analyte level. In some embodiments, the sensor interface unit **520** may receive raw or analyzed data indicating an analyte level associated with a fluid sample analyzed at an external measurement device, such as a continuous analyte monitoring device, via a wireless communication medium, such as radio frequency identification (RFID). For example, the continuous analyte monitoring device may include a transcutaneously implanted sensor, such as an implantable glucose sensor, that may continually or substantially continually measure an analyte concentration of a bodily fluid. In some embodiments, the sensor interface unit **520** may receive analyte related data from the external measurement device periodically, based on a transmission schedule, or may request the data from the external measurement device.

[0062] Although not shown separately, the health monitor device may include a processor, such as the processor **220** shown in FIG. **2**. The processor may be operatively coupled to sensor interface unit **520**, the communication unit **530**, the power management unit **570**, the power scavenging unit **560**, the wideband wireless communication antenna **540**, or the magnetic loop wireless communication antenna **550**. The processor may be configured to receive signals, such as amplified analog voltage signals, from the sensor interface **520**, and to convert the analog signals into digital signals, using, for example, analog to digital signal conversion circuitry. The processor may be configured to send the digital signals to the communication unit **530** for transmission to the external device **504**.

[0063] The communication unit **530** may communicate with an external device **504**, such as the receiver unit **130** shown in FIG. **1**. For example, the communication unit **530** may be configured to communicate with a smartphone via a wireless communication link. In some embodiments, the communication unit **530** may be configured to transmit analyte information to the external device. In some implementations, the communication unit **530** may be an RF transmitter, such as the RF transmitter **206** shown in FIG. **2**, and may communicate using a wireless communication protocol, such as an 802.11 protocol, a Bluetooth® RF protocol, a cellular protocol, or any other wireless protocol. In some embodiments, the communication unit **530** may include a receiver, a transmitter, or a transceiver.

[0064] In some embodiments, the communication unit **530** may communicate using a short-range low-energy wireless communication protocol, such as NFC or RFID. Communicating using a low-energy wireless communication protocol may allow the communication unit **530** to use substantially less power than communicating using other wireless communication protocols. For example, using a low-energy wireless communication protocol, the communication unit **530** may have a lower duty cycle and may actively operate less frequently, for shorter periods of time, or both.

[0065] In some embodiments, the health monitor device **500** may communicate with the external device **504** indirectly via another device, or series of devices. For example, the health monitor device **500** may communicate with the external device **504** via a network, wherein the health monitor device **500** may transmit signals to, for example, an access point (not shown), and the access point may transmit the signals to the external device **504**, in the same or a different format, via one or more other devices in a network.

[0066] The wideband wireless communication antenna **540** may be configured to receive energy from a wireless signal, such as high frequency electromagnetic field energy emitted by the external device **504**. For example, the external device **504** may be cellular telephone and the wideband wireless communication antenna **540** may receive electromagnetic field energy from cellular telephone communication performed by the external device **504**. The wideband wireless communication antenna **540** may receive energy inductively, capacitively, or radiatively.

[0067] The magnetic loop wireless communication antenna **550**, may be configured to receive energy from a near field wireless signal, such as magnetic field energy generated by a short-range low-energy communication unit in the external device **504**, such as an NFC communication unit or an RFID communication unit. The magnetic loop wireless communication antenna **550** may receive energy inductively, capacitively, or radiatively.

[0068] The power scavenging unit **560** may include circuitry, such as a rectifier circuit, and may harvest electromagnetic field energy from the wideband wireless communication antenna **540**, the magnetic loop wireless communication antenna **550**, or both. In some implementations, the power scavenging unit **560** may be operatively coupled with other elements of the health monitor device **500** to provide power to those elements.

[0069] The power management unit **570** may be operatively coupled to elements of the health monitor device **500**, such as the sensor interface **520**, and may manage the distribution of power from the power scavenging unit **560** to the elements of the health monitor device **500**. Managing the distribution of power may include filtering and regulating the power.

[0070] In some embodiments, the power management unit **570** may include a power reservoir, which may receive and store power from the power scavenging unit **560**. For example, when the health monitor device **500** is not in an active mode, received power may be stored in the power reservoir, and when the health monitor device **500** is in an active mode, power stored in the the power reservoir may distributed to the health monitor device **500**.

[0071] Although shown as separate elements, the sensor interface unit **520**, the communication unit **530**, the wideband wireless communication antenna **540**, the magnetic loop wireless communication antenna **550**, the power scavenging unit **560**, or the power management unit **570**, or any combination thereof, may be integrated in one or more electronic units, circuits, or chips.

[0072] Although not explicitly shown in FIG. **5**, the wirelessly powered health monitor device **500** may be imple-

mented as a solid flat molded unit without mechanical elements. Mass production of the wirelessly powered health monitor device **500** may be relatively inexpensive.

[0073] FIG. **6** shows a perspective view diagram of a health monitor device **600**, such as the wirelessly powered health monitor device **500** shown in FIG. **5**, positioned in close proximity, or attached, to an external device **610**, such as the receiver **130** shown in FIG. **1**, for short-range, low-energy wireless communication of analyte data in accordance with embodiments of this disclosure.

[0074] In some implementations, the health monitor device **600** may be configured with a small physical footprint, such as in a solid, flat shape as shown. For example, the health monitor device **600** may be configured as a case for a glucose meter or a cell phone.

[0075] In some implementations, the external device **610** may include a user interface for presenting the analyte data. The external device **610** may control the wirelessly powered health monitor device **600**. For example, the external device **610** may receive user input and may control the wirelessly powered health monitor device **600** to perform tests or communicate analyte information. The external device **610** may include a graphical display unit **612**, which may be configured to display a visual representation of the analyte data, and an audio presentation unit **614**, which may be configured to present an audible representation of the analyte data.

[0076] FIG. **7** shows an example of wirelessly powered wireless communication of analyte data in accordance with embodiments of this disclosure. In some embodiments, a wirelessly powered health monitor device, such as the wirelessly powered health monitor device **500** shown in FIG. **5**, may perform wirelessly powered wireless communication of analyte data with an external device which may include transmitting health monitoring information, such as analyte information, to the external device. Wirelessly powered wireless communication of analyte data of may include receiving an electromagnetic signal at **710**, scavenging power at **720**, detecting a sample at **730**, analyzing the sample at **740**, determining an analyte concentration at **750**, storing analyte information at **760**, transmitting an indication of the analyte concentration at **770**, or a combination thereof.

[0077] An electromagnetic signal may be received at **710**. For example, the wirelessly powered health monitor device may receive a short-range low-energy electromagnetic signal, such as an RFID signal or a NFC signal, or the wirelessly powered health monitor device may receive a wideband electromagnetic signal, such as a cellular telephone signal (EDGE, UMTS, HSPA, LTE, or the like) or a wireless networking signal (802.11, or the like). In some embodiments, the wirelessly powered health monitor device may receive a wideband electromagnetic signal and a short-range low-energy electromagnetic signal.

[0078] Power may be harvested (scavenged) from the received electromagnetic signal at **720**. The receive power may be distributed to elements of the wirelessly powered health monitor device to power the respective elements. In some embodiments, power may be harvested while the wirelessly powered health monitor device is in an inactive mode, may be stored in a power reservoir, and stored power may be used to power, or partially power, the wirelessly powered health monitor device in an active mode.

[0079] A sample, such as a blood sample, may be identified at **730**. For example, the health monitor device may include a sensor interface, such as the sensor interface unit **560** shown in FIG. **5**, which may be configured to receive a fluid sample, such as a fluid sample transported via a test strip. In some embodiments, the sample may be identified by an external measurement device, such as a continuous analyte monitoring device, configured to communicate with the health monitor device using, for example, a short range wireless communication method, such as RFID or NFC. For example, the continuous analyte monitoring device may include a transcutaneously implanted sensor that may continually or substantially continually measure an analyte concentration of a bodily fluid.

[0080] The sample may be analyzed to determine a corresponding analyte level, such as a glucose level, at **740**. For example, the health monitor device may include a processor, such as the processor **220** shown in FIG. **2**, configured to analyze the sample. In some embodiments, the sample may be analyzed by an external analysis device, such as a continuous analyte monitoring device, configured to communicate with the health monitor device.

[0081] An analyte concentration may be identified at **750**. For example, the analyte concentration may be identified based on the sample analysis at **740**. In some embodiments, the analyte concentration may be received from an external analysis device, such as a continuous analyte monitoring device, configured to communicate with the health monitor device. In some embodiments, the analyte concentration may be identified based on stored information, such as previously stored raw or analyzed sample data.

[0082] In some embodiments, raw or analyzed analyte information, such the analyte concentration identified at **750**, may be stored at **760**. For example, health monitor device may include a data storage unit, such as the memory **260** shown in FIG. **2**, a processor, such as the processor **220** shown in FIG. **2**, a sensor interface, such as the sensor interface unit **520** shown in FIG. **5**, or a combination thereof, and the processor, the sensor interface, or a combination thereof, may identify the analyte concentration based on raw or analyzed analyte data stored on the data storage unit.

[0083] An indication of the analyte concentration may be transmitted to the external device at **770**. For example, the indication of the analyte concentration may be transmitted from the health monitor device to the external device using, for example, a short-range low-energy wireless communication link, such as an NFC communication link. In some embodiments, transmitting the indication of the analyte concentration may include transmitting raw or analyzed analyte information. In some embodiments, transmitting the indication of the analyte concentration may include transmitting health care instructions. In some embodiments, transmitting the indication of the analyte concentration may include synchronizing information between the health monitor device and the external device.

[0084] FIG. **8** an example of enabling suppressed capabilities in accordance with embodiments of this disclosure. In some implementations, a health monitor device may include a first set of capabilities (monitor capabilities) associated with monitoring and analysis of analyte data receive via a fluid at the health monitor device, such as a fluid receive via a test strip, and a second set of capabilities (sensor capabilities) configured for monitoring and analysis of analyte data receive from an external sensor, such as a continuous analyte monitoring device.

[0085] Prior to activation, the monitor capabilities may be active or enabled, such that the monitor capabilities may be

functional and available via the health monitor device, and the sensor capabilities may be inactive, suppressed, hidden, or disabled, such that the sensor capabilities may be non-functional and may be unavailable via the health monitor device.

[0086] Suppressing the sensor capabilities may include disabling, or not enabling, capabilities of the health monitor device. For example, a sensor interface for communicating with a sensor device may be disabled. Similarly, user interface features of the health monitor device associated with the sensor interface may be disabled or hidden. In some embodiments, the user interface capabilities associated with the sensor may be provided by an external device and may be hidden on the external device.

[0087] In some implementations, a health monitor device, such as the health monitor device **200** shown in FIG. **2** or the health monitor device **500** shown in FIG. **5**, may include suppressed capabilities that may be enabled in response to detecting an enabling device, such as a sensor. Enabling suppressed capabilities may include powering on at **810**, searching for a sensor at **820**, enabling suppressed capabilities at **830**, detecting a sample at **840**, analyzing the sample at **850**, determining an analyte concentration at **860**, storing analyte information at **870**, transmitting analyte information at **880**, or a combination thereof.

[0088] The health monitor device may be powered on at **810**. Powering on may include enabling a sensor interface for a defined period of time. For example, the sensor interface may include circuitry for communicating with an external sensor, such as a continuous analyte monitoring device, and the communication circuitry may be enabled. In some embodiments, the sensor interface may be temporarily enabled in response to user input, such as a manual activation feature.

[0089] The health monitor device may search for a sensor at **820**. Searching for the sensor may include transmitting a signal, such as a beacon signal, for a determined period of time, such as 15 seconds. If a sensor is not detected, the health monitor device may terminate transmitting the signal and may disable the temporarily enabled sensor interface. In some embodiments, the health monitor device may search for a sensor in response to user input.

[0090] If a sensor is detected, the health monitor device may enable the sensor capabilities at **830**. In some embodiments, enabling the sensor capabilities may include enabling a sensor interface configured to receive raw or analyzed analyte information from an external device, such as a continuous analyte monitoring device, configured to communicate with the health monitor device using, for example, a short range wireless communication method, such as RFID or NFC. In some embodiments, enabling the sensor capabilities may include enabling user interface capabilities of the health monitor device. In some implementations, enabling the sensor capabilities may include enabling sensor capabilities on an external device. For example, enabling the sensor capabilities may include activating a sensor, enabling user interface capabilities on an external device, or both. In some embodiments, enabling the sensor capabilities may include enabling product labeling, such as product labeling stored on the health monitor device.

[0091] In some implementations, an unlocking device, such as a non-functional sensor or a ROM calibrator, may be detected at **820** and the sensor capabilities may be enabled. In some implementations, the sensor capabilities may be enabled in response to user input. For example, the health monitor device may receive user input indicating an enabling instruction, such as an unlock code, and the sensor capabilities may be enabled.

[0092] A sample, such as a blood sample, may be identified at **840**. For example, a sensor may not be detected at **820** and the monitor capabilities may include a sensor interface configured to receive a fluid sample, such as a fluid sample transported via a test strip. In another example, a sensor may be detected at **820** and the sensor capabilities may include a sensor interface configured to receive sample information identified by an external measurement device, such as a continuous analyte monitoring device, configured to communicate with the health monitor device using, for example, a short range wireless communication method, such as RFID or NFC.

[0093] The sample may be analyzed to determine a corresponding analyte level, such as a glucose level, at **850**. For example, the health monitor device may include a processor, such as the processor **220** shown in FIG. **2**, configured to analyze the sample. In some embodiments, a sensor may be detected at **820** and the health monitor device may be configured to receive sample information analyzed by an external analysis device, such as a continuous analyte monitoring device.

[0094] An analyte concentration may be identified at **860**. For example, the analyte concentration may be identified based on the sample analysis at **850**. In some embodiments, a sensor may be detected at **820** and the health monitor device may be configured to receive the analyte concentration from an external analysis device, such as a continuous analyte monitoring device. In some embodiments, the analyte concentration may be identified based on stored information, such as previously stored raw or analyzed sample data.

[0095] In some embodiments, raw or analyzed analyte information, such the analyte concentration identified at **860**, may be stored at **870**. For example, health monitor device may include a data storage unit, such as the memory **260** shown in FIG. **2**, a processor, such as the processor **220** shown in FIG. **2**, a sensor interface, such as the sensor interface unit **520** shown in FIG. **5**, or a combination thereof, and the processor, the sensor interface, or a combination thereof, may identify the analyte concentration based on raw or analyzed analyte data stored on the data storage unit.

[0096] An indication of the analyte concentration may be transmitted to the external device at **880**. For example, the indication of the analyte concentration may be transmitted from the health monitor device to the external device using, for example, a wireless communication link, such as an NFC communication link, a Bluetooth® communication link, or a wireless LAN communication link. In some embodiments, transmitting the indication of the analyte concentration may include transmitting raw or analyzed analyte information. In some embodiments, transmitting the indication of the analyte concentration may include transmitting health care instructions. In some embodiments, transmitting the indication of the analyte concentration may include synchronizing information between the health monitor device and the external device.

[0097] Various other modifications and alterations in the structure and method of operation of this invention will be apparent to those skilled in the art without departing from the scope and spirit of the invention. Although the invention has been described in connection with specific preferred embodiments, it should be understood that the invention as claimed

should not be unduly limited to such specific embodiments. It is intended that the following claims define the scope of the present invention and that structures and methods within the scope of these claims and their equivalents be covered thereby.

What is claimed is:

1. An apparatus, comprising:
a housing;
a memory unit configured to store computer executable instructions;
an antenna;
an energy scavenging unit; and
a processor configured to execute the computer executable instructions stored in the memory to:
control the energy scavenging unit to harvest energy from an electromagnetic signal received by the antenna,
detect an analyte sample,
determine an analyte concentration associated with the detected analyte sample, and
transmit an indication of the analyte concentration to an external device using the harvested energy.

2. The apparatus of claim **1**, wherein the antenna includes a magnetic loop antenna configured to receive a short-range low-power wireless communication signal.

3. The apparatus of claim **2**, further comprising a wideband antenna configured to receive a wideband wireless communication signal, wherein the processor is configured to control the energy scavenging unit to harvest energy from an electromagnetic signal received by the wideband antenna.

4. The apparatus of claim **1**, wherein the antenna includes a wideband antenna configured to receive a wideband wireless communication signal.

5. The apparatus of claim **4**, further comprising a magnetic loop antenna configured to receive a short-range low-power wireless communication signal, wherein the processor is configured to control the energy scavenging unit to harvest energy from an electromagnetic signal received by the magnetic loop antenna.

6. The apparatus of claim **1**, further comprising a power reservoir configured to:
store harvested power on a condition that the apparatus is in an inactive mode; and
distribute stored power on a condition that the apparatus is in an active mode.

7. The apparatus of claim **1**, wherein the electromagnetic signal is a near field communication signal or a radio frequency identification signal.

8. A method comprising:
receiving an electromagnetic wireless communication signal;
harvesting energy from the electromagnetic wireless communication signal;
detecting an analyte sample;
determining an analyte concentration associated with the detected analyte sample; and
transmitting an indication of the analyte concentration to an external device using the harvested energy.

9. The method of claim **8**, wherein receiving the electromagnetic wireless communication signal include receiving a short-range low-power wireless communication signal.

10. The method of claim **9**, further comprising:
receiving a wideband wireless communication signal; and
harvesting energy from the wideband wireless communication signal.

11. The method of claim **8**, wherein receiving the electromagnetic wireless communication signal include receiving a wideband wireless communication signal.

12. The method of claim **11**, further comprising:
receiving a short-range low-power wireless communication signal; and
harvesting energy from the short-range low-power wireless communication signal.

13. The method of claim **8**, further comprising:
in an inactive mode, storing harvested power in a power reservoir; and
in an active mode, distributing stored power from the power reservoir.

14. The method of claim **8**, wherein receiving the electromagnetic wireless communication signal includes receiving a near field communication signal or a radio frequency identification signal.

15. An apparatus, comprising:
a housing;
a memory unit configured to store computer executable instructions;
a transceiver;
a plurality of capabilities associated with an external sensor, wherein each capability in the plurality of capabilities associated with the external sensor is disabled; and
a processor configured to execute the computer executable instructions stored in the memory to:
enable an external sensor interface,
search for the external sensor,
in response to detecting the external sensor, enable each capability in the plurality of capabilities associated with the external sensor,
detect an analyte sample using the external sensor interface,
determine an analyte concentration associated with the detected analyte sample, and
transmit an indication of the analyte concentration to an external device.

16. The apparatus of claim **15**, wherein the transceiver is configured to perform short-range low-power wireless communication, and the processor is configured to search for the external sensor using short-range low-power wireless communication.

17. The apparatus of claim **16**, wherein using short-range low-power wireless communication includes using a near field communication protocol or a radio frequency identification protocol.

18. A method comprising:
enabling an external sensor interface, wherein the external sensor interface is one of a plurality of capabilities associated with an external sensor, wherein each capability in the plurality of capabilities associated with the external sensor is disabled;
searching for the external sensor;
in response to detecting the external sensor, enabling each capability in the plurality of capabilities associated with the external sensor;
detecting an analyte sample using the external sensor interface;
determining an analyte concentration associated with the detected analyte sample; and

transmitting an indication of the analyte concentration to an external device.

19. The method of claim **18**, wherein searching for the external sensor includes using short-range low-power wireless communication.

20. The method of claim **19**, wherein using short-range low-power wireless communication includes using a near field communication protocol or a radio frequency identification protocol.

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