US Patent & Trademark Office
Patent Public Search | Text View

United States Patent Application Publication 20250267580
Kind Code A1
Publication Date August 21, 2025
Inventor(s) KRUSE; Geoffrey A.

Methods For Reduction of Battery Usage In Ambulatory Infusion Pumps

Abstract

A battery-powered infusion pump for medicament delivery (e.g., insulin) may collect and store data related to the pump. The infusion pump can communicate some or all of the stored data to another device and control the timing and amount of data communicated in order to conserve battery life.

Inventors: **KRUSE; Geoffrey A. (San Diego, CA)**

Applicant: **Tandem Diabetes Care, Inc.** (San Diego, CA)

Family ID: **1000008578203**

Appl. No.: **19/198932**

Filed: **May 05, 2025**

Related U.S. Application Data

parent US continuation 18528117 20231204 parent-grant-document US 12294946 child US 19198932
parent US continuation 17549419 20211213 parent-grant-document US 11838867 child US 18528117
parent US continuation 16676118 20191106 parent-grant-document US 11218968 child US 17549419
parent US continuation 15354495 20161117 parent-grant-document US 10492141 child US 16676118
us-provisional-application US 62256398 20151117

Publication Classification

Int. Cl.: **H04W52/02** (20090101); **A61M5/142** (20060101); **H04W4/80** (20180101)

U.S. Cl.:

CPC **H04W52/0232** (20130101); **A61M5/142** (20130101); **H04W4/80** (20180201); **H04W52/0251** (20130101); A61M5/14244 (20130101); A61M2205/18 (20130101); A61M2205/3569 (20130101); A61M2205/3584 (20130101); A61M2205/50 (20130101); A61M2205/52 (20130101); A61M2205/8206 (20130101); A61M2205/8212 (20130101); Y02D30/70 (20200801)

Background/Summary

RELATED APPLICATIONS [0001] This application is a continuation of U.S. patent application Ser. No. 18/528,117 (filed Dec. 4, 2023), which is a continuation of U.S. patent application Ser. No. 17/549,419 (filed Dec. 13, 2021), which is a continuation of U.S. patent application Ser. No. 16/676,118 (filed Nov. 6, 2019), which is a continuation of U.S. patent application Ser. No. 15/354,495 (filed Nov. 17, 2016), which claims priority from U.S. Provisional App. No. 62/256,398 (filed Nov. 17, 2015), each of which is hereby incorporated by reference in its entirety.

TECHNICAL FIELD
[0002] The present disclosure relates to infusion pumps and, more particularly, to reducing power usage in battery-powered ambulatory infusion pumps.
BACKGROUND
[0003] There are many applications in academic, industrial, and medical fields that benefit from devices and methods that are capable of accurately and controllably delivering fluids, such as liquids and gases that have a beneficial effect when administered in known and controlled quantities. Such devices and methods can be particularly useful in the medical field where treatments for many patients include the administration of a known amount of a substance at predetermined intervals.
[0004] One category of devices for delivering such fluids is that of pumps that have been developed for the administration of insulin and other medicaments for those suffering from both type I and type II diabetes. Some pumps configured as portable infusion devices can provide continuous subcutaneous medicament injection and/or infusion therapy for the treatment of diabetes. Such therapy may include, e.g., the regular and/or continuous injection or infusion of insulin into the skin of a person suffering from diabetes and offer an alternative to multiple daily injections of insulin by an insulin syringe or an insulin pen. Such pumps can be ambulatory/portable infusion pumps that are worn by the user and may use replaceable cartridges. Examples of such pumps and various features that can be associated with such pumps include those disclosed in U.S. patents application Ser. Nos. 13/557,163, Ser. No. 12/714,299, Ser. No. 12/538,018, Ser. No. 13/838,617, and Ser. No. 13/827,707, as well as U.S. Pat. No. 8,287,495—each of which is hereby incorporated by reference in its entirety.
[0005] Ambulatory infusion pumps as described above typically rely on one or more batteries to power the drive mechanism of the pump to deliver medicament. Many such ambulatory infusion pumps are programmable and include data storage and review features accessed through user interfaces of the devices. Many such pumps also enable wireless communications with other devices, such as continuous glucose monitors and data storage devices, through communications protocols such as Bluetooth or the like. Each of these and other features that can be a part of ambulatory infusion pumps further require power from the pump battery. However, in order for such pumps to be of a size to be conveniently carried by a user, there is limited space for the one or more batteries and therefore limited battery capacity. As such, there is a need in the art for ways in which to preserve battery power while still enabling full functional use of such ambulatory infusion

pumps.

SUMMARY

[0006] Systems and methods for conserving battery life of a medical device and/or a smartphone are provided herein. Mobile phones such as smartphones, may aid in determining, programming and data tracking therapy provided by a medical device such as an insulin pump. A smartphone can be in wireless communication with an insulin pump and can also be capable of connecting to one or more additional devices, such as a blood glucose meter, a therapy management system or a cloud storage service means. The smartphone can facilitate the transfer of data and measurements between and among these devices. Data may comprise one or more parameters related to the infusion pump such as operating status or warning status, therapy related events such as delivery of a bolus, and/or patient related parameters such as blood glucose.

[0007] Embodiments disclosed herein may conserve battery life of the medical device and/or smartphone by limiting exchanges of information, or data transfers, between the medical device and smartphone and/or between the smartphone and one or more additional devices such as a cloud storage means. For example, such data transfers may be event-based, time-based, proximity-based.

[0008] In one embodiment, the present invention comprises an infusion pump including a battery, a data storage means, a wireless communication means configured to communicate data related to the infusion pump to another device, and a processor. The processor may be configured to collect and store the data in the data storage means, and control communication of the data to another device so as to reduce energy consumption of the battery based on information contained in the data storage means.

[0009] In one embodiment, the present invention comprises a method for reducing energy consumption of a battery of an infusion pump, the method comprising collecting data related to the infusion pump, storing the data in a data storage means in the infusion pump, wirelessly communicating the data to another device, and controlling communication of the data so as to reduce energy consumption of the battery based on information contained in the data storage means.

[0010] In one embodiment, the present invention comprises a user-wearable infusion pump including a battery, a memory, a transceiver configured to wirelessly communicate data related to the infusion pump to another device, a connector configured for interfacing with an external power source, and a processor. The processor may be configured to collect and store the data in the memory, and control communication of the data to another device so as to reduce energy consumption of the battery by communicating only part of the stored data while the infusion pump is powered by the battery, and by communicating additional stored data upon connection of the infusion pump to an external power source via the connector.

[0011] Certain embodiments are described further in the following description, examples, claims, and drawings. These embodiments will become more apparent from the following detailed description when taken in conjunction with the accompanying exemplary drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Subject matter hereof may be more completely understood in consideration of the following detailed description of various embodiments in connection with the accompanying figures, in which:

[0013] FIG. **1** is a medical device that can be utilized with embodiments of the present invention.

[0014] FIG. **2** is a block diagram representing a medical device that can be used with embodiments of the present invention.

[0015] FIG. **2**A is another block diagram representing a medical device that can be used with

embodiments of the present invention.
[0016] FIG. **3** depicts an exemplary screen shot of a home screen page of a user interface of a medical device such as an infusion pump that can be used with embodiments of the present invention.
[0017] FIG. **4** is a schematic representation of a system according to embodiments of the present invention.
[0018] While the invention is amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail. It should be understood, however, that the intention is not to limit the invention to the embodiments described. On the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention.
DETAILED DESCRIPTION
[0019] The following detailed description should be read with reference to the drawings in which similar elements in different drawings are numbered the same. The drawings, which are not necessarily to scale, depict illustrative embodiments and are not intended to limit the scope of the invention.
[0020] FIG. **1** depicts an embodiment of a medical device that can be used with embodiments of the present invention. In this embodiment, the medical device is configured as a pump **12**, such as an infusion pump, that can include an internal pumping or delivery mechanism and reservoir for delivering medicament such as insulin to a patient and an output/display **44**. The type of output/display **44** may vary as may be useful for a particular application. The type of visual output/display may include LCD displays, LED displays, plasma displays, graphene-based displays, OLED displays and the like. The output/display **44** may include an interactive and/or touch sensitive screen **46** having an input device such as, for example, a touch screen comprising a capacitive screen or a resistive screen. The pump **12** may additionally include a keyboard or other input device known in the art for data entry, which may be separate from the display. The pump **12** may additionally include one or more of a keyboard, microphone, or other input device known in the art for data entry, which such input device or devices may be separate from the display. The pump **12** may also include a capability to operatively couple to a secondary display device such as a remote display, a remote control device, a laptop computer, personal computer, tablet computer, mobile communication device such as a smartphone or personal digital assistant (PDA) or the like.
[0021] In one embodiment, the medical device can be a portable insulin pump configured to deliver insulin to a user or patient. Further details regarding such pump devices can be found in U.S. Patent Application No. 2011/0144586, which is incorporated herein by reference. In other embodiments, the medical device can be an infusion pump configured to deliver one or more additional or other medicaments to a patient. In a further embodiment, the medical device can include a glucose meter such as continuous glucose monitor. In other embodiments, the medical device can additionally or separately monitor one or more other physiological parameters of a patient.
[0022] FIG. **2** illustrates a block diagram of some of the features that can be used with embodiments of the present invention, including features that may be incorporated within the housing **26** of a medical such as the pump **12**. The pump **12** includes a processor **42** that functions to control the overall functions of the device. The infusion pump **12** may also include, e.g., a data storage means such as a memory device **30**, a communications means such as a transmitter/receiver (transceiver) **32**, an alarm **34**, a speaker **36**, a clock/timer **38**, an input device **40**, a user interface suitable for accepting input and commands from a user such as a caregiver or patient, a drive mechanism **48**, an estimator device **52** and a microphone (not pictured). One embodiment of a user interface as shown in FIG. **2** is a graphical user interface (GUI) **60** having a touch sensitive screen **46** with input capability. The memory device **30** may be coupled to the processor **42** to receive and store input data and to communicate that data to the processor **42**. The input data may include user input data and non-user/sensor input data. The input data from the memory device **30** may be used

to generate therapeutic parameters for the infusion pump **12**. The GUI **60** may be configured for displaying a request for the user to input data and for receiving user input data in response to the request, and communicating that data to the memory.

[0023] The processor **42** may communicate with and/or otherwise control the drive mechanism, output/display, memory, a transmitter/receiver and other components. In some embodiments, the processor **42** may communicate with another processor within the pump **12** and/or one or more processors of other devices, for example, a continuous glucose monitor (CGM), display device, smartphone, etc. through the transmitter/receiver. The processor **42** may include programming that can be run to control the infusion of insulin or other medicament from the cartridge, the data to be displayed by the display, the data to be transmitted via the transmitter, etc. The processor **42** may also include programming that may allow the processor to receive signals and/or other data from an input device, such as a sensor that may sense pressure, temperature or other parameters.

[0024] The processor **42** may also include additional programming to allow the processor **42** to learn user preferences and/or user characteristics and/or user history data. This information can be utilized to implement changes in use, suggestions based on detected trends, such as, weight gain or loss. The processor can also include programming that allows the device to generate reports, such as reports based upon user history, compliance, trending, and/or other such data. Additionally, infusion pump device embodiments of the disclosure may include a “power off” or “suspend” function for suspending one or more functions of the device, such as, suspending a delivery protocol, and/or for powering off the device or the delivery mechanism thereof. For some embodiments, two or more processors may be used for controller functions of the infusion pumps, including a high power controller and a low power controller used to maintain programming and pumping functions in low power mode, in order to save battery life. In another embodiment, a first processor may be utilized for pump functions and a second processor may be utilized for communication functions.

[0025] The memory device **30** may be any type of memory capable of storing data and communicating that data to one or more other components of the device, such as the processor. The memory may be one or more of a Flash memory, SRAM, ROM, DRAM, RAM, EPROM and dynamic storage, for example. For instance, the memory may be coupled to the processor and configured to receive and store input data and/or store one or more templates or generated delivery patterns. For example, the memory can be configured to store one or more personalized (e.g., user defined) delivery profiles, such as a profile based on a user's selection and/or grouping of various input factors, past generated delivery profiles, recommended delivery profiles, one or more traditional delivery profiles, e.g., square wave, dual square wave, basal and bolus rate profiles, and/or the like. The memory can also store, for example, user information, history of use, glucose measurements, compliance and an accessible calendar of events. The memory can also store limits on insulin doses that can be delivered based on CGM data, as discussed herein.

[0026] The housing **26** of the pump **12** may be functionally associated with an interchangeable and removable glucose meter **20** and/or one or more infusion cartridges **16**. The infusion cartridge **16** may have an outlet port **54** that may be connected to an infusion set (not shown) via an infusion set connector **18**. Further details regarding some embodiments of various infusion pumps can be found in U.S. Patent App. No. 2011/0144586, which is hereby incorporated by reference in its entirety.

[0027] FIG. **2**A is another block diagram of some of the features that can be used with embodiments of the present invention. Pump **12** includes a power management system that is connected to the connector port **110** that receives a combined data/power cable, such as a USB cable. That is, the cable has the capability of simultaneously providing electrical energy for charging and data transmission for communications. A connector interface **206** supports data exchange and receives electrical power through the connector port **110**, and controls a connector data element **208** and a connector power element **210**. The device may be powered by battery power in place of or in addition to the connector interface. The connector interface **206** passes data

communications from the connector port **110** through the connector data element **208** to a system bus **212**. The connector interface **206** passes electrical power from the connector port **110** through the connector power element **210** to a battery charger **214**, which in turn is coupled to a battery **216** and which recharges the battery. In one embodiment, the connector data element **208** is implemented in the FIG. **2**A device with a USB Isolation Chip ADUM4160 product from Analog Devices, Inc. of Norwood, Massachusetts, USA, and the connector power element **210** is implemented in the FIG. **2**A device with a USB Power Isolation Chip LT3573 product from Linear Technology Corporation of Milpitas, California, USA. Those skilled in the art will be aware of alternative suitable devices.

[0028] A control processor **218** is connected to the system bus **212** and receives the data communications from the connector data element **208** for processing. The control processor controls operation of the various elements of the pump **12** that are connected to the system bus. The control processor operates according to program instructions that may be stored in device memory **220**. Program instructions may be stored in processor memory incorporated in the control processor **218**. The control processor also stores data from its operations in the device memory **220**. The control processor **218** controls a data communications element **222** that may comprise a receiver/transmitter for wireless RF communications, such as “WiFi” communications or “Bluetooth” communications between the portable device **100** and compatible external systems and networks. The pump **12** includes an output/display element **224** such as a touchscreen display, operating buttons or switches, and the like. The pump **12** includes a drive/pump element **226** such as a pumping mechanism for delivery of fluid such as insulin via outlet port **54**. To meet industry standards and governmental regulations, the connector data element **208** and the connector power element **210** are both electrically isolated from the other device components, so as to provide a device that can be safely connected to the power source and the patient at the same time.

[0029] The memory **220** of pump **12** may be any type of memory capable of storing data and retrieving that data for transfer to one or more other components of the device, such as the control processor **218**. Memory **220** may comprise one or more of a Flash memory, SRAM, ROM, DRAM, RAM, EPROM or dynamic storage. Memory **220** may be coupled to the control processor **218** and may be configured to receive and store input data and/or store one or more template or predetermined fluid delivery patterns. For example, the memory can be configured to store one or more personalized (e.g., user defined) delivery profiles, such as a profile based on a user's selection and/or grouping of various input factors; past generated delivery profiles; recommended delivery profiles; one or more traditional delivery profiles, e.g., square wave, dual square wave, basal and bolus rate profiles; and/or the like. The memory can also store user information, history of use, glucose measurements, compliance, an accessible calendar of events, and the like. In some embodiments, the memory **220** of pump **12** may have a data capacity of up to about 10 GB, more specifically, up to about 3 GB, even more specifically, about 1 MB to about 200 MB. In some embodiments, the memory of pump **12** may be up to about 3 GB, more specifically, up to about 500 MB, and even more specifically, about 200 kB to about 200 MB.

[0030] The embodiments depicted in FIG. **2** and FIG. **2**A are not to be considered mutually exclusive, rather, components depicted in either may be interchanged between embodiments.

[0031] Referring to FIG. **3**, a front view of pump **12** is depicted. The pump **12** may include a user interface, such as, for example, a user-friendly GUI **60** on a front surface **58** or other location of pump **12**. The GUI **60** may include a touch-sensitive screen **46** that may be configured for displaying data, facilitating data and/or command entry, providing visual tutorials, as well as other interface features that may be useful to the patient operating the pump **12**. The GUI can also present alarm or alerts to the user.

[0032] Referring now to FIG. **4**, a system **100** according to embodiments of the present invention includes a medical device such as an insulin pump **12** having a wireless connection **104** to a mobile phone **102**, such as a smartphone, via, for example, Bluetooth, Bluetooth low energy, mobile or Wi-

Fi communications. Wireless connection **104** is established via transmitter/receiver **32**. In some embodiments, the phone **102** can also have a wireless or wired connection **106** to one or more other nodes **108**, such as a cloud storage service means, a blood glucose meter **108** or a continuous glucose monitor (CGM). Although the system **100** is described with respect to a mobile phone, alternate types of devices could be used in place of a phone as the device **102**, including, for example, an electronic tablet or a laptop or desktop computer. Similarly, although described with respect to an insulin pump, the medical device **12** can be any other type of programmable medical device capable of wirelessly communication with a mobile phone **102** or other device, including, for example, infusion pumps for infusing medicaments other than insulin.

[0033] In embodiments wherein node **108** comprises a cloud storage service means for receiving data from phone **102** regarding pump **12**, it is especially desired to conserve battery life of both pump **12** and phone **102**. Phone **102** may comprise a master device, and pump **12** may comprise a slave device, such that phone **102** initiates and controls the transmission of data between phone **102** and pump **12**, via, for example, Bluetooth or other wireless means. Phone **102** may include a program or application configured to receive and/or transmit data, instructions and/or other information between pump **12** and phone **102**. Although pump **12** and phone **102** may be in constant or near-constant communication in an attempt to provide real-time feedback, such an arrangement may negatively impact battery life of both pump **12** and phone **102**. Therefore, various embodiments herein provide improved methods of communication between pump **12** and phone **102** to prolong battery life of both devices.

[0034] Pump **12** may, for example, be configured to transmit Bluetooth advertising packets via transmitter/receiver **32**, each packet containing a number of bits of information. Phone **102**, via the Bluetooth connection **104**, is configured to detect and receive the advertising packets transmitted by pump **12**.

[0035] In some embodiments, the frequency of communications between pump **12** and phone **102** to transmit data may be modified to conserve battery power of one or both devices. In one embodiment, the frequency of communications may be event-based. For example, the event may comprise delivery of a bolus, change in basal delivery rate, triggering of an alarm or other predetermined event. Upon occurrence of such a predetermined event, processor **42** of pump **12** is configured to modify the contents of its next Bluetooth advertising packet to include an indication based on the event that phone **102** should initiate communication with pump **12** to transmit data regarding the event. This allows pump **12** to remain in a lower power, advertising state until phone **102** initiates communication resulting in pump **12** and phone **102** being paired. In one embodiment, a list of predetermined events is stored in memory device **30** of pump **12**. In another embodiment, processor **42** includes programming having a list of predetermined events.

[0036] In another embodiment, each Bluetooth advertising packet from pump **12** may be configured to include an indication of pump status. Upon occurrence of a predetermined notable event requiring a data transfer between pump **12** and phone **102**, the indication of pump status included in the Bluetooth advertising packet from pump **12** signals phone **102** to initiate communication with pump **12** to transmit data regarding the event.

[0037] In another embodiment, the frequency of wireless communications may be event-based but the amount of data transmitted varies according to the nature of the event. For example, for any events predetermined to be of a less important nature, pump **12** may transmit an indication to phone **102** that a data transfer is required at a later time when pump **12** is connected to an external power source via connector port **110** for recharging. For any events predetermined to be of a more important nature, pump **12** may transmit an indication that a data transfer is required immediately to transmit data regarding the event. The relationship between the nature of an event and the amount of data to be transmitted may be stored in memory device **30** or included as part of programming operable by processor **42**.

[0038] In another embodiment, the frequency of wireless communications may be periodic, or

time-based. For example, pump **12** may transmit an indication to phone **102** at predetermined intervals that a data transfer is required. Such intervals may comprise every 15 minutes, every 30 minutes, every 60 minutes, or any other desired interval. Contained in the periodic indication will be information regarding the pump, including for example basal rate, delivery of last bolus, any events that have occurred since the last data transmission, or other information stored by the pump. The frequency of wireless communications may be stored in memory device **30** or included as part of programming operable by processor **42**.

[0039] In another embodiment, wireless communications between pump **12** and phone **102** may comprise only a partial subset of all available information. Pump **12** may transmit an indication to phone **102** that a data transfer is required, and upon initiation of the data transfer only transmit a partial subset of all available information stored by the pump. When pump **12** is connected to an external power source via connector port **110** for recharging, pump **12** transmits an indication to phone **102** to transfer all available saved data regarding pump **12**. The data selected to be contained in the partial subset may be based on information stored in memory device **30** or included as part of programming operable by processor **42**.

[0040] In another embodiment, wireless communications between pump **12** and phone **102** may be proximity-based. For example, phone **102** may rely on GPS information to initiate data transfer from pump **12** such that if a patient having phone **102** arrives at a specific location such as a hospital, clinic or other care facility, phone **102** may determine through GPS information that a complete data transfer is required from pump **12** in order to have the most current data available on phone **102** when the patient visits their care provider. A list of locations for full data transfers, and/or relationships between locations and the amount of data to be transferred, may be stored in memory device **30** or included as part of programming operable by processor **42**.

[0041] In another embodiment, it is also desired to prolong battery life of phone **102**. For example, when transferring information from phone **102** to node **108** such as a cloud storage service means for receiving data from phone **102** regarding pump **12**. In one embodiment, transfers from phone **102** to node **108** are delayed until the cellular connection of phone **102** meets a predetermined minimum signal strength, or until phone **102** is connected to a wi-fi network, at which time data saved on phone **102** is transmitted to node **108**.

[0042] In another embodiment, data transfers from phone **102** to node **108** only occur when the user of phone **102** first launches the application which controls data transfers, and/or only when the user is actively using the application. In another embodiment, data transfers from phone **102** to node **108** only occur when phone **102** is connected to a power source and is being recharged.

[0043] In another embodiment, data transfers from phone **102** to node **108** are event-based, such data transfers are delayed until a predetermined event has occurred. Alternatively, data transfers may be delayed until a predetermined number of events have occurred. Alternatively, data transfers may be event-based but the amount of data transferred varies according to the nature of the event. For example, for events predetermined to be of a less important nature, the data transfer from phone **102** to node **108** may be delayed. Whereas events predetermined to be of a more important nature cause phone **102** to transfer data to node **108** upon occurrence of the event.

[0044] In another embodiment, data transfers from phone **102** to node **108** may be periodic, or time-based. For example, data transfers may occur at predetermined intervals such as every 15 minutes, every 30 minutes, every 60 minutes, or any other desired interval.

[0045] In another embodiment, data transfers from phone **102** to node **108** may be proximity-based. For example, phone **102** may rely on GPS information to initiate the data transfer such that if a patient having phone **102** enters a hospital, clinic or other care facility, phone **102** may determine through GPS information that a complete data transfer is required to node **108** in order to have the most current data available on phone **102** when the patient visits their care provider.

[0046] The above described embodiments regarding conserving battery life of both pump **12** and phone **102** may be combined if desired. For example, the frequency of communications between

pump **12** and phone **102** to transmit data may be event-based and time-based. Or, for example, one or more embodiments for conserving battery life of pump **12** may be combined with one or more embodiments for conserving battery life of phone **102**. Other such combinations of energy-saving methods described herein are within the spirit and scope of the invention.

[0047] Although embodiments described herein may be discussed in the context of the controlled delivery of insulin, delivery of other medicaments, singly or in combination with one another or with insulin, including, for example, glucagon, pramlintide, etc., as well as other applications are also contemplated. Device and method embodiments discussed herein may be used for pain medication, chemotherapy, iron chelation, immunoglobulin treatment, dextrose or saline IV delivery, treatment of various conditions including, e.g., pulmonary hypertension, or any other suitable indication or application. Non-medical applications are also contemplated.

[0048] With regard to the above detailed description, like reference numerals used therein may refer to like elements that may have the same or similar dimensions, materials, and configurations. While particular forms of embodiments have been illustrated and described, it will be apparent that various modifications can be made without departing from the spirit and scope of the embodiments herein. Accordingly, it is not intended that the invention be limited by the forgoing detailed description.

[0049] The entirety of each patent, patent application, publication, and document referenced herein is hereby incorporated by reference. Citation of the above patents, patent applications, publications and documents is not an admission that any of the foregoing is pertinent prior art, nor does it constitute any admission as to the contents or date of these documents.

[0050] Also incorporated herein by reference in their entirety are commonly owned U.S. Pat. Nos. 8,287,495; 8,408,421 8,448,824; 8,573,027; 8,650,937; 8,986,523; 9,173,998; 9,180,242; 9,180,243; 9,238,100; 9,242,043; and 9,335,910 commonly owned U.S. Patent App. Pub. Nos. 2009/0287180; 2012/0123230; 2013/0053816; 2013/0159456; 2013/0324928; 2013/0331790; 2013/0332874; 2014/0273042; 2014/0276419; 2014/0276420; 2014/0276423; 2014/0276531; 2014/0276537; 2014/0276553; 2014/0276556 2014/0276569; 2014/0276570; 2014/0276574; 2014/0378898; 2015/0073337; 2015/0072613; 2015/0182693; 2015/0182694; 2015/0182695; 2016/0030669; and 2016/0082188 and commonly owned U.S. patents application Ser. Nos. 14/707,851 and 15/158,125 and commonly owned U.S. Provisional App. Nos. 61/911,576; 61/920,902; 61/920,914; 61/920,940; 62/139,275; 62/207,748; 62/256,398; 62/272,255; 62/300,410; and 62/352,164.

[0051] Further incorporated by reference herein in their entirety are U.S. Pat. Nos. 8,601,465; 8,502,662; 8,452,953; 8,451,230; 8,449,523; 8,444,595; 8,343,092; 8,285,328; 8,126,728; 8,117,481; 8,095,123; 7,999,674; 7,819,843; 7,782,192; 7,109,878; 6,997,920; 6,979,326; 6,936,029; 6,872,200; 6,813,519; 6,641,533; 6,554,798; 6,551,276; 6,295,506; and 5,665,065.

[0052] Various embodiments of systems, devices, and methods have been described herein. These embodiments are given only by way of example and are not intended to limit the scope of the claimed inventions. It should be appreciated, moreover, that the various features of the embodiments that have been described may be combined in various ways to produce numerous additional embodiments. Moreover, while various materials, dimensions, shapes, configurations and locations, etc. have been described for use with disclosed embodiments, others besides those disclosed may be utilized without exceeding the scope of the claimed inventions.

[0053] Persons of ordinary skill in the relevant arts will recognize that the subject matter hereof may comprise fewer features than illustrated in any individual embodiment described above. The embodiments described herein are not meant to be an exhaustive presentation of the ways in which the various features of the subject matter hereof may be combined. Accordingly, the embodiments are not mutually exclusive combinations of features; rather, the various embodiments can comprise a combination of different individual features selected from different individual embodiments, as understood by persons of ordinary skill in the art. Moreover, elements described with respect to one

embodiment can be implemented in other embodiments even when not described in such embodiments unless otherwise noted.

[0054] Although a dependent claim may refer in the claims to a specific combination with one or more other claims, other embodiments can also include a combination of the dependent claim with the subject matter of each other dependent claim or a combination of one or more features with other dependent or independent claims. Such combinations are proposed herein unless it is stated that a specific combination is not intended.

[0055] Any incorporation by reference of documents above is limited such that no subject matter is incorporated that is contrary to the explicit disclosure herein. Any incorporation by reference of documents above is further limited such that no claims included in the documents are incorporated by reference herein. Any incorporation by reference of documents above is yet further limited such that any definitions provided in the documents are not incorporated by reference herein unless expressly included herein.

[0056] For purposes of interpreting the claims, it is expressly intended that the provisions of 35 U.S.C. § 112(f) are not to be invoked unless the specific terms “means for” or “step for” are recited in a claim.

Claims

1. A infusion pump, comprising: a battery; a data storage means; a wireless communication means configured to communicate data related to the infusion pump to another device; and a processor configured to: collect and store the data in the data storage means; and control communication of the data to another device so as to reduce energy consumption of the battery based on information contained in the data storage means.