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(54) **Title:** CONTEXTUAL DATA FOR INFUSION PUMPS

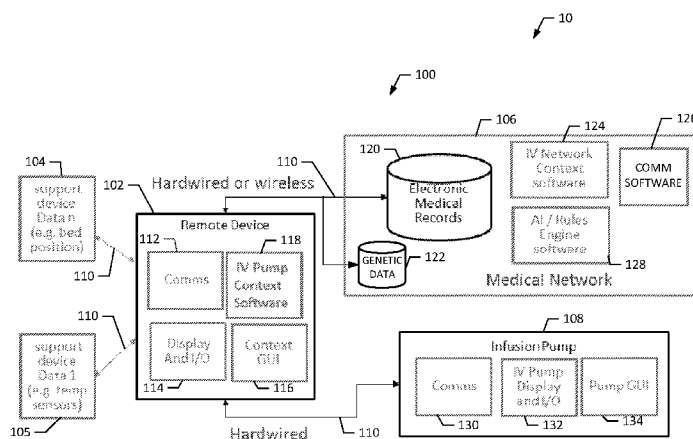


FIG. 1

(57) **Abstract:** Systems and methods for controlling infusion pump operation based on contextual medical data are provided. Such systems may include a database in memory of a network server. Such a database may store medical information regarding one or more patients. Systems may further include a communication interface that receives infusion pump data from an infusion pump, as well as a processor that executes instructions to identify that the medical information regarding the patient and the received infusion pump data correspond to one or more rules. The processor may also generate control instructions for the infusion pump based on an action associated with the corresponding rules. The communication interface may then send the control instructions to the infusion pump for execution, and the infusion pump may execute the instructions to perform the action associated with the corresponding rules.

CONTEXTUAL DATA FOR INFUSION PUMPS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the priority benefit of U.S. provisional application number 62/273,955 filed December 31, 2015 and entitled “Contextual Data for Infusion Pumps,” the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention generally relates to infusion pumps. More specifically, the present invention relates to remote device that provides contextual data infusion pumps.

Description of the Related Art

[0003] Infusion pumps are devices that deliver fluids, nutrients, and/or medication directly into a patient’s body in controlled amounts and at controlled rates. Infusion pumps may deliver intravenous, subcutaneous, arterial, or epidural infusions. Presently available infusion systems and pumps currently do not have the ability to intelligently use electronic medical records to adjust treatment in real-time.

[0004] Magnetic resonance imaging (MRI) is a procedure generally used to create images of internal organs and structures in the human body by using magnetic fields. Patients undergoing an MRI may need to continue infusion treatments that are administered by one or more MRI-compatible infusion pumps.

[0005] There is, therefore, a need in the art for improved systems and methods for a remote device that provides contextual medical data to infusion pumps, including MRI-compatible infusion pumps.

SUMMARY OF THE CLAIMED INVENTION

[0006] Embodiments of the present invention include systems and methods for controlling infusion pump operation based on contextual medical data. Such systems may include a database in memory of a network server. Such a database may store medical information regarding one or more patients. Systems may further include a communication interface that receives infusion pump data from an infusion pump, as well as a processor that executes instructions to identify that the medical information regarding the patient and the received infusion pump data corresponding to one or more rules. The processor may also generate control instructions for the infusion pump based on an action associated with the corresponding rules. The communication interface may then send the control instructions to the infusion pump for execution, and the infusion pump may execute the instructions to perform the action associated with the corresponding rules.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 illustrates an exemplary network environment in which a system for providing contextual data for infusion pump operations may be implemented.

[0008] FIG. 2 illustrates an exemplary context GUI that includes fields for contextual data to be displayed at the remote device.

[0009] FIG. 3 illustrates an exemplary pump GUI that includes fields for pump data to be displayed at the infusion pump.

[0010] FIG. 4 is a flowchart illustrating an exemplary method for adjusting infusion pump operations based on contextual data.

[0011] FIG. 5 illustrates an exemplary computing system that may be used to implement an embodiment of the present invention.

DETAILED DESCRIPTION

[0012] Embodiments of the present invention include systems and methods for controlling infusion pump operation based on contextual medical data. A database in memory of a network server may store medical information regarding one or more patients. A remote device may receive infusion pump data from an infusion pump, identify that the medical information regarding the patient and the received infusion pump data correspond to one or more rules, and generate control instructions for the infusion pump based on an action associated with the corresponding rules. The remote device may then send the control instructions to the infusion pump, which then executes the instructions to perform the action associated with the corresponding rules.

[0013] FIG. 1 illustrates an exemplary network environment 10 in which a system 100 for providing contextual data for infusion pump operations may be implemented. As illustrated, the network environment may include a remote device 102 for MRI-compatible infusion pump (e.g., IV pump), one or more support devices 104, one or more medical network servers 105, and an infusion pump 108. Such devices may communicate with each other via hard-wired or wireless communications systems and networks known in the art.

[0014] Such communication networks 110 may include a local, proprietary network (e.g., an intranet) and/or may be a part of a larger wide-area network. The communications network may be a local area network (LAN), which may be communicatively coupled to a wide area network (WAN) such as the Internet. The Internet is a broad network of interconnected computers and servers allowing for the transmission and exchange of Internet Protocol (IP) data between users connected through a network service provider. Examples of network service providers are the public switched telephone network, a cable service provider, a provider of digital subscriber line (DSL) services, or a satellite service provider. Communications networks 110 allow for communication between the various components of network environment.

[0015] The remote device 102 may include a communication module 112, display screen (and/or another input/output mechanism) 114, context graphic user interface (GUI)

116, and IV pump context software 118 executable to make decisions on infusion/IV pump operations. The remote device 102 may be in communication with a medical network server 106 and able to access electronic medical records stored at the medical network server 106. Such a remote device 102 can allow a user (*e.g.*, patient, medical care provider, or other authorized personnel) to input and access contextual data regarding a patient directly from the medical records. Such medical data can also be downloaded to the remote device 102, which may use such data to adjust operation parameters of an infusion pump 108 used by the patient.

[0016] The remote device 102 can be a small computer or a computing device, such as that shown in FIG. 5, able to complete a handshake with a communication network 110 having access to the medical record-keeping servers 106. The remote device 102 may be any number of different electronic user devices, such as general purpose computers, mobile phones, smartphones, personal digital assistants (PDAs), portable computing devices (*e.g.*, laptop, netbook, tablets), desktop computing devices, handheld computing device, or any other type of computing device capable of communicating over communication network (wired or wireless). The remote device 102 may also be configured to access data from other storage media, such as memory cards or disk drives as may be appropriate in the case of downloaded services. The remote device 102 may include standard hardware computing components such as network and media interfaces, non-transitory computer-readable storage (memory), and processors for executing instructions that may be stored in memory.

[0017] The remote device 102 may receive data from the IV pump 108 and displays it on the display screen 114. In addition, the remote device 102 may also access contextual data (*e.g.*, electronic medical records for the patient being treated by the infusion pump 108) from the medical network server 106 and displays via the context GUI 116. Context data can also be collected at the remote device 102 and sent to medical network server 106 for storage (*e.g.*, in the electronic medical record files of the patient). Context data can be collected from hardware in various support devices 104 associated with the patient, including hospital bed data or other medical sensors 105 (*e.g.*, temperature, heart rate).

[0018] The remote device 102 may use local context software 118 to evaluate context data to determine patient status and if applicable, provide a response. For example, the remote device 102 may identify whether there should be any changes to the operation of the infusion pump 108, as well as provide insights or alerts regarding possible medical conditions. Such alerts may be sent to designated medical personnel or to other remote alert devices (*e.g.*, used to monitor different medical conditions). For example, possible medical conditions that may affect the patient are identified in stored genetic data. Such stored genetic data may include family histories, results of one or more genetic tests, and full or partial gene sequences. In one embodiment, the patient genetic data may be stored in the same database 120 containing the electronic medical records for the patient.

[0019] The medical network server 106 may include any type of server or other computing device as is known in the art, including standard hardware computing components such as network and media interfaces, non-transitory computer-readable storage (memory), and processors for executing instructions or accessing information that may be stored in memory. The functionalities of multiple servers may be integrated into a single server. Any of the aforementioned servers (or an integrated server) may take on certain client-side, cache, or proxy server characteristics. These characteristics may depend on the particular network placement of the server or certain configurations of the server.

[0020] Medical network server 106 may include or have access to one or more databases 120-122 storing digital patient medical records. In some embodiments, the medical network server 106 may also have access to third party databases and information sources, including various forums, chat rooms, medical personnel, and other medical experts. In any case, the medical network server 106 may be able to aggregate information relevant to the patient in real-time from multiple sources (*e.g.*, current support devices 104, sensors 105, various databases), as well as update the patient's electronic medical records regarding the same. For example, a separate database 122 storing genetic data for the patients may be a part of the medical network along with the electronic records database as shown in FIG. 1.

[0021] In addition, the medical network server 106 may further include IV network context software 124, communication software 126, and an artificial intelligence (AI) engine or rules engine 128. The AI/rules engine 128 may be used to evaluate context data (*e.g.*, from the remote device 102 and IV pump), as well as suggest changes or provide calculated context insights (*e.g.*, notifications that “patient may be in danger”). Such evaluations may be based on rules associating certain combinations of contextual data (*e.g.*, whether certain measurements or biometric data fall within ranges or meet thresholds) with one or more conclusions or actions.

[0022] The infusion pump 108 may also include communications systems 130, an associated IV display 132 (and/or other input-output mechanisms), and a pump GUI 134.

[0023] FIG. 2 illustrates an exemplary context GUI 116 that includes fields 136 for contextual data to be displayed at the remote device 102. Such contextual data may have been provided to the remote device 102 by various sources, including electronic medical records databases 120, other sources accessible to medical network server 106, support devices 104, infusion pumps 108, and other sensors 105, as well as data that may be entered directly by a user (*e.g.*, the patient themselves or other medical personnel). Some of the data may be updated in real-time as the measurements (*e.g.*, temperature) are taken by the various device sensors 105 associated with the patient.

[0024] FIG. 3 illustrates an exemplary pump GUI 134 that includes fields 138 for pump data to be displayed at the infusion pump 108. As illustrated, a pump GUI 134 may include pump data fields 138 for type of medication, rate of infusion, and volume of infusion. Such pump GUI 134 may be displayed on a screen 132 associated with the infusion pump 108, as well as be sent to other devices for storage and/or analysis.

[0025] FIG. 4 is a flowchart illustrating an exemplary method 200 for adjusting infusion pump operations, for example at the infusion pump 108, based on contextual data. The method 200 of FIG. 4 may be embodied as executable instructions in a non-transitory computer readable storage medium including but not limited to a CD, DVD, or non-volatile memory such as a hard drive. The instructions of the storage medium may be executed by a processor (or processors) to cause various hardware components of a computing device

hosting or otherwise accessing the storage medium to effectuate the method. The steps 202-214 identified in FIG. 4 (and the order thereof) are exemplary and may include various alternatives, equivalents, or derivations thereof including but not limited to the order of execution of the same.

[0026] In the method of FIG. 4, an infusion pump 108 may send its current infusion pump data to remote device 102 at step 202. The remote device 102 receives data not only from the infusion pump 108, but from various support devices 104/ sensors 105 as well at step 204. Such received data may be stored in a database, as well as displayed at step 206 in a context GUI 116. The remote device 102 also allows a user to enter data into the context GUI 116 via one or more input-output devices known in the art (*e.g.*, touchscreen, keyboard, keypad, other buttons, microphone, camera, and other peripheral devices).

[0027] At step 208, the infusion pump data, context data, and patient identifier may be sent to medical network server 106, which stores such data in an electronic medical records database 120. Specifically, such data may be stored in a record associated with the patient (as identified by the patient identifier). The medical network server 106 may also execute IV network context software 124 to process and evaluate such data at step 210 to determine which next steps are to be taken. For example, at step 212, the AI/rules engine 128 may be executed to evaluate the contextual data against rules stored in memory to derive certain conclusions about the patient. Such conclusions and associated data may be sent by the medical network server 106 to the remote device 102 at step 214. In turn, the remote device 102 may perform further analyses, use such data to control operation of the infusion pump 108 (or other support devices 104 or sensors 105), and/or provide to the infusion pump (which may also perform local analyses for use in adjusting operations).

[0028] FIG. 5 illustrates an exemplary computing system 300 that may be used to implement an embodiment of the present invention. The computing system of FIG. 5 includes one or more processors 302 and memory 304. Main memory 304 stores, in part, instructions and data for execution by the processor 302. Main memory 304 can store the executable code when in operation. The system of FIG. 5 may further include a mass storage

device 306, portable storage medium drive(s) 308, output devices 310, user input devices 312, a graphics display 314, and peripheral devices 316.

[0029] The components shown in FIG. 5 are depicted as being connected via a single bus 318. However, the components may be connected through one or more data transport means. For example, the processor unit 302 and main memory 304 may be connected via a local microprocessor bus, and the mass storage device 306, peripheral device(s) 316, portable storage device 308, and display system 314 may be connected via one or more input/output (I/O) buses.

[0030] The mass storage device 306, which may be implemented with a magnetic disk drive or an optical disk drive, is a non-volatile storage device for storing data and instructions for use by processor unit. The mass storage device 306 can store the system software for implementing embodiments of the present invention and for purposes of loading that software into main memory 304.

[0031] The portable storage device 308 operates in conjunction with a portable non-volatile storage medium, such as a floppy disk, compact disk, or Digital video disc, to input and output data and code to and from the computer system of FIG. 5. The system software for implementing embodiments of the present invention may be stored on such a portable medium and input to the computer system via the portable storage device 308.

[0032] Input devices 312 provide a portion of a user interface. Input devices 312 may include an alpha-numeric keypad, such as a keyboard, for inputting alpha-numeric and other information, or a pointing device, such as a mouse, a trackball, stylus, or cursor direction keys. Additionally, the system 300 as shown in FIG. 5 includes output devices 310. Examples of suitable output devices 310 include speakers, printers, network interfaces, and monitors.

[0033] The display system 314 may include a liquid crystal display (LCD) or other suitable display device. The display system 314 receives textual and graphical information, and processes the information for output to the display device.

[0034] Peripherals 316 may include any type of computer support device to add additional functionality to the computer system. For example, peripheral device(s) may include a modem or a router.

[0035] The components contained in the computer system 300 of FIG. 5 are those typically found in computer systems that may be suitable for use with embodiments of the present invention and are intended to represent a broad category of such computer components that are well known in the art. Thus, the computer system 300 of FIG. 5 can be a personal computer, hand held computing device, telephone, mobile computing device, workstation, server, minicomputer, mainframe computer, or any other computing device. The computer can also include different bus configurations, networked platforms, multi-processor platforms, etc. Various operating systems can be used including Unix, Linux, Windows, Macintosh OS, Palm OS, and other suitable operating systems.

[0036] The present invention may be implemented in an application that may be operable using a variety of devices. Non-transitory computer-readable storage media refer to any medium or media that participate in providing instructions to a central processing unit (CPU) for execution. Such media can take many forms, including, but not limited to, non-volatile and volatile media such as optical or magnetic disks and dynamic memory, respectively. Common forms of non-transitory computer-readable media include, for example, a floppy disk, a flexible disk, a hard disk, magnetic tape, any other magnetic medium, a CD-ROM disk, digital video disk (DVD), any other optical medium, RAM, PROM, EPROM, a FLASH EPROM, and any other memory chip or cartridge.

[0037] Various forms of transmission media may be involved in carrying one or more sequences of one or more instructions to a CPU for execution. A bus carries the data to system RAM, from which a CPU retrieves and executes the instructions. The instructions received by system RAM can optionally be stored on a fixed disk either before or after execution by a CPU. Various forms of storage may likewise be implemented as well as the necessary network interfaces and network topologies to implement the same.

[0038] The foregoing detailed description of the technology has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the

technology to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. The described embodiments were chosen in order to best explain the principles of the technology, its practical application, and to enable others skilled in the art to utilize the technology in various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the technology be defined by the claim.

CLAIMS

WHAT IS CLAIMED IS:

1. A system for controlling infusion pump operation based on contextual medical data, the system comprising:

a database in memory of a network server, the database storing medical information regarding a patient;

a communication interface that receives infusion pump data from an infusion pump;
and

a processor that executes instructions stored in memory, wherein execution of the instructions by the processor:

identifies that the medical information regarding the patient and the received infusion pump data correspond to one or more rules stored in memory, and

generates control instructions for the infusion pump based on an action associated with the corresponding rules;

wherein the communication interface sends the control instructions to the infusion pump for execution, and wherein the infusion pump executes the instructions to perform the action associated with the corresponding rules

2. A system for controlling infusion pump operation based on contextual medical data, the system comprising:

a memory;

a communication interface that:

receives a first communication from an infusion pump, the first communication comprising infusion pump data;

transmits a second communication to a medical network server; the medical network server comprising a database storing patient data, and the second communication comprising the infusion pump data, contextual data, and identification data of a patient; and

receives a third communication from the medical network server; the third communication comprising patient data associated with the identification data and rule data associated with the patient;

a user interface that displays the infusion pump data; and

a processor that executes instructions stored in memory, wherein execution of the instructions by the processor determines one or more operation parameters for the infusion pump based on the patient data and the rule data,

wherein the communication interface transmits a fourth communication to the infusion pump, wherein the fourth communication comprises control instructions for operation of the infusion pump.

3. The system of claim 2, wherein the communication interface further receives external data from a support device or a sensor and the contextual data comprises the external data.

4. The system of claim 3, wherein the processor determines other control instructions for operation of one or more support devices.

5. The system of claim 2, wherein the processor is disposed within a remote device in communication with the network server and the infusion pump.

6. The system of claim 5, wherein the remote device further comprises:
 - a communication interface device;
 - a display device;
 - a data input device; and
 - a remote device memory to store IV pump context software executable by the processor.
7. The system of claim 6, wherein the contextual data comprises at least one of:
 - data input to the remote device via the data input device and a context graphical user interface displayed at the display device; and
 - external data.
8. The system of claim 6, wherein the remote device further comprises a data storage device for storing at least one of the infusion pump data, the context data, and rule data.
9. The system of claim 2, wherein the rule data is determined by a rules engine executing at the medical network server based on the patient data and the contextual data.

10. A method for controlling infusion pump operation based on contextual medical data, the method comprising:

receiving, by at least one processor, a first communication from an infusion pump, the first communication comprising infusion pump data;

displaying, by the at least one processor, the infusion pump data on a user interface;

transmitting, by the at least one processor, a second communication to a medical network server; the medical network server comprising a database storing patient data, and the second communication comprising the infusion pump data, contextual data, and identification data of a patient;

receiving, by the at least one processor, a third communication from the medical network server; the third communication comprising patient data associated with the identification data and rule data associated with the patient ;

determining, by the at least one processor, one or more operation parameters for the infusion pump based on the patient data and the rule data; and

transmitting, by the at least one processor, a fourth communication to the infusion pump; wherein the fourth communication comprises control instructions for operation of the infusion pump.

11. The method of claim 10, further comprising receiving external data from a support device or a sensor and the contextual data comprises the external data.

12. The method of claim 11, further comprising determining other control instructions for operation of one or more support devices.

13. The method of claim 10, wherein the processor is disposed within a remote device in communication with the medical network server and the infusion pump.

14. The method of claim 13, wherein the remote device further comprises a communication interface device, a display device, a data input device, and remote device memory; and wherein the processor executes an IV pump context software stored in the remote device memory.

15. The method of claim 14, further comprising:

receiving, by the at least one processor, patient contextual data input at the remote device via the data input device and a context graphical user interface displayed at the display device; and

wherein the contextual data comprises at least one of the user input data and external data.

16. The method of claim 14, wherein the remote device further comprises a data storage device; and further comprising storing, by the at least one processor at least one of the infusion pump data, the context data, and rule data in the data storage device.

17. The method of claim 10, further comprising determining, by other processor, rule data based on the patient data and the contextual data by a rules engine executing at least one other processor of the medical network server.

18. A non-transitory computer-readable medium having instructions stored thereon that, when executed by at least one processor, cause the at least one processor to perform operations comprising:

- receiving a first communication from an infusion pump, the first communication comprising infusion pump data;

- displaying the infusion pump data on a user interface;

- transmitting a second communication to a medical network server; the medical network server comprising a database storing patient data, and the second communication comprising the infusion pump data, contextual data, and identification data of a patient;

- receiving a third communication from the medical network server; the third communication comprising patient data associated with the identification data and rule data associated with the patient ;

- determining one or more operation parameters for the infusion pump based on the patient data and the rule data; and

- transmitting a fourth communication to the infusion pump; wherein the fourth communication comprises control instructions for operation of the infusion pump.

19. The non-transitory computer-readable medium of claim 18, wherein the processor is disposed within a remote device in communication with the medical network server and the infusion pump.

20. The non-transitory computer-readable medium of claim 18 where the instructions cause the at least one processor to perform operations further comprising

- receiving patient contextual data input at the remote device via the data input device and a context graphical user interface displayed at the display device; and

- wherein the contextual data comprises at least one of the user input data and external data.

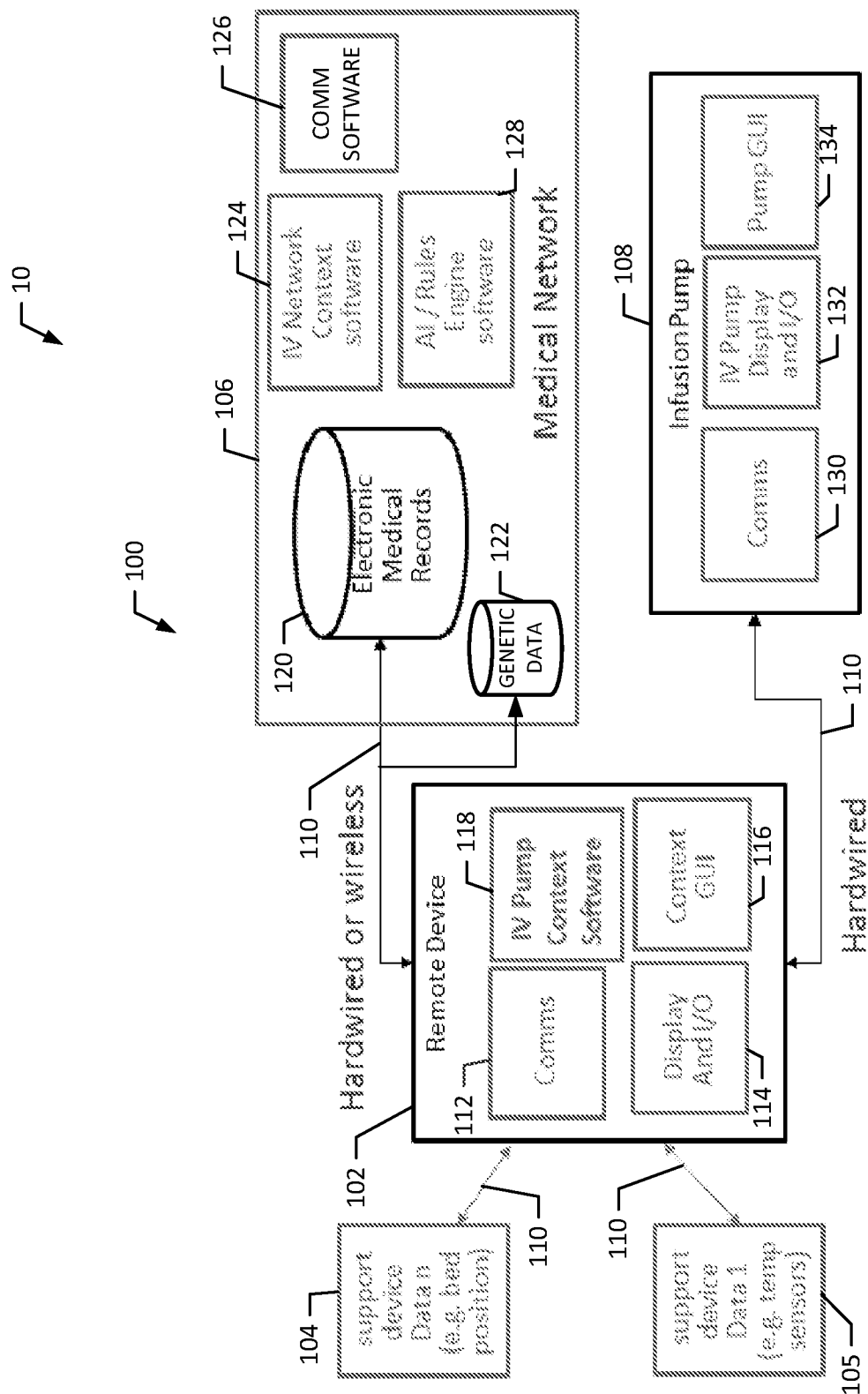


FIG. 1

Context GUI

New Medication Administered:

2mg Ativan

New Symptom:

N/A

Body Position:

Arms above head

Temperature :

98 degrees

Patient complaint:

Feeling minor pain in left arm

Observation:

Patient's breathing is shallow, due to claustrophobia

Pain Level:

2

Medical Network AI/Rule Context:

Alert :Patient's is prone to heart attack, pain in left arm could be important"

Save

Patient ID:

A0802835

116

136

136

136

Patient Data

Name: John Doe

Age: 35

Height: 5'10"

Weight: 180lbs

Allergies: N/A

FIG. 2

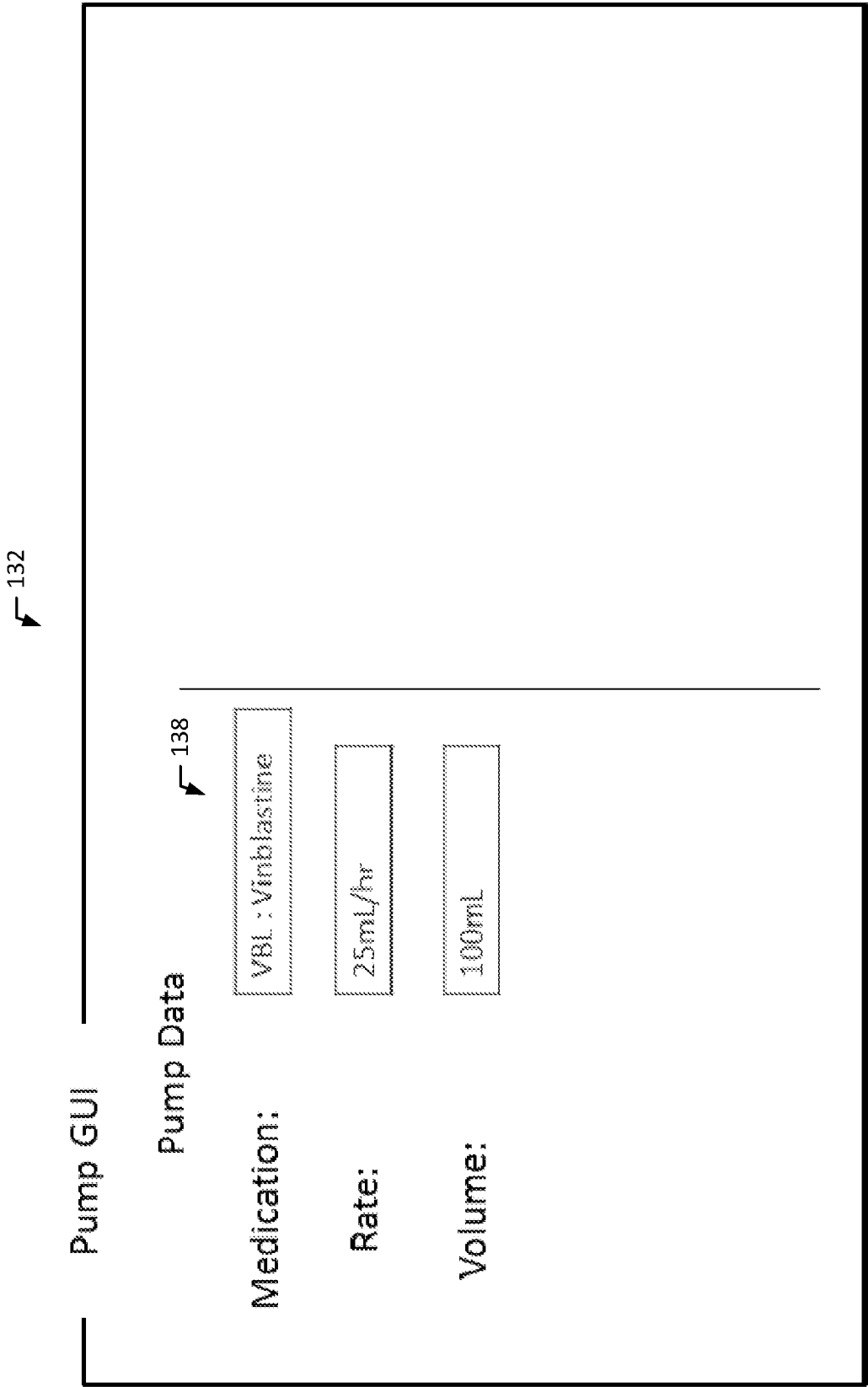


FIG. 3

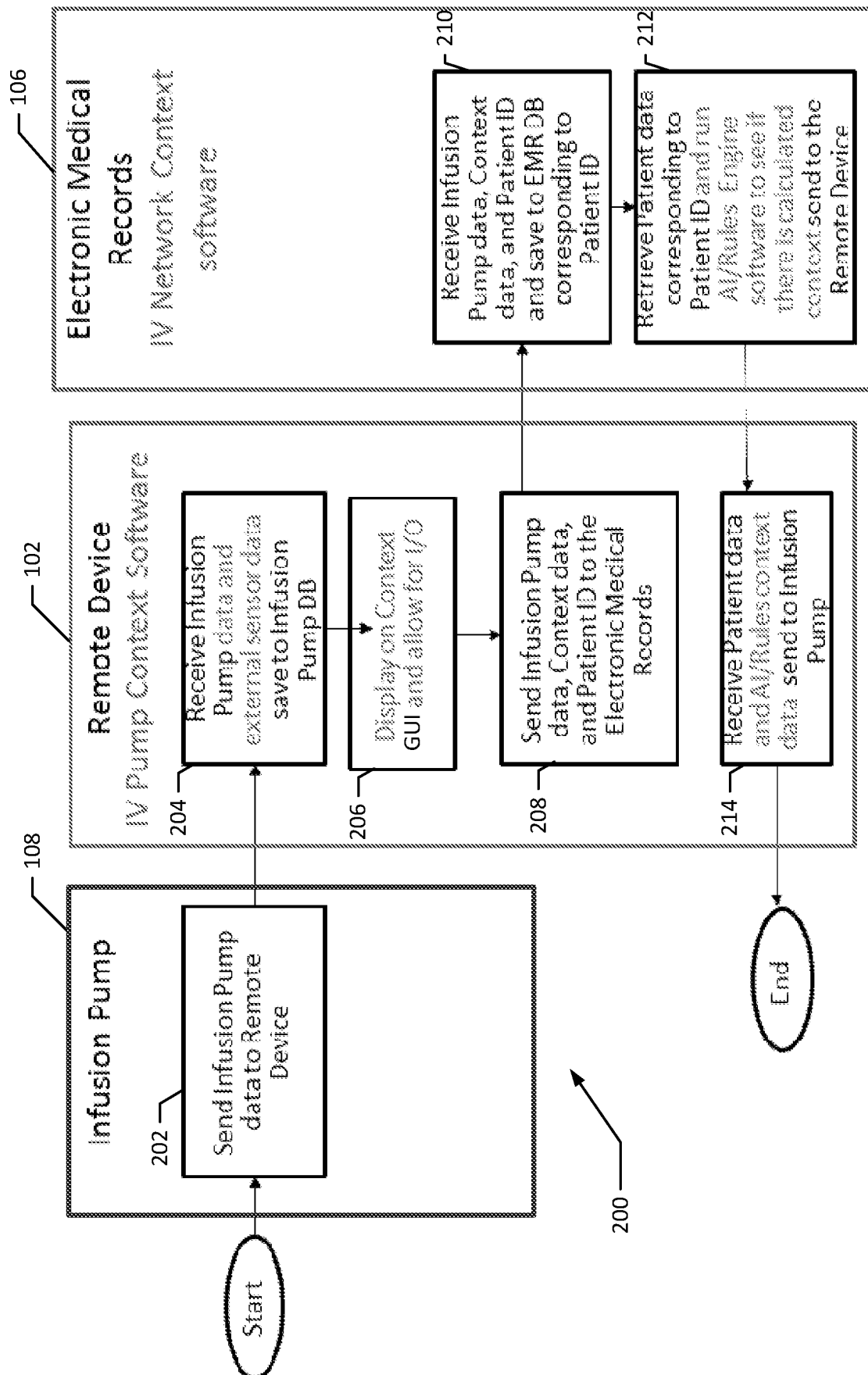


FIG. 4

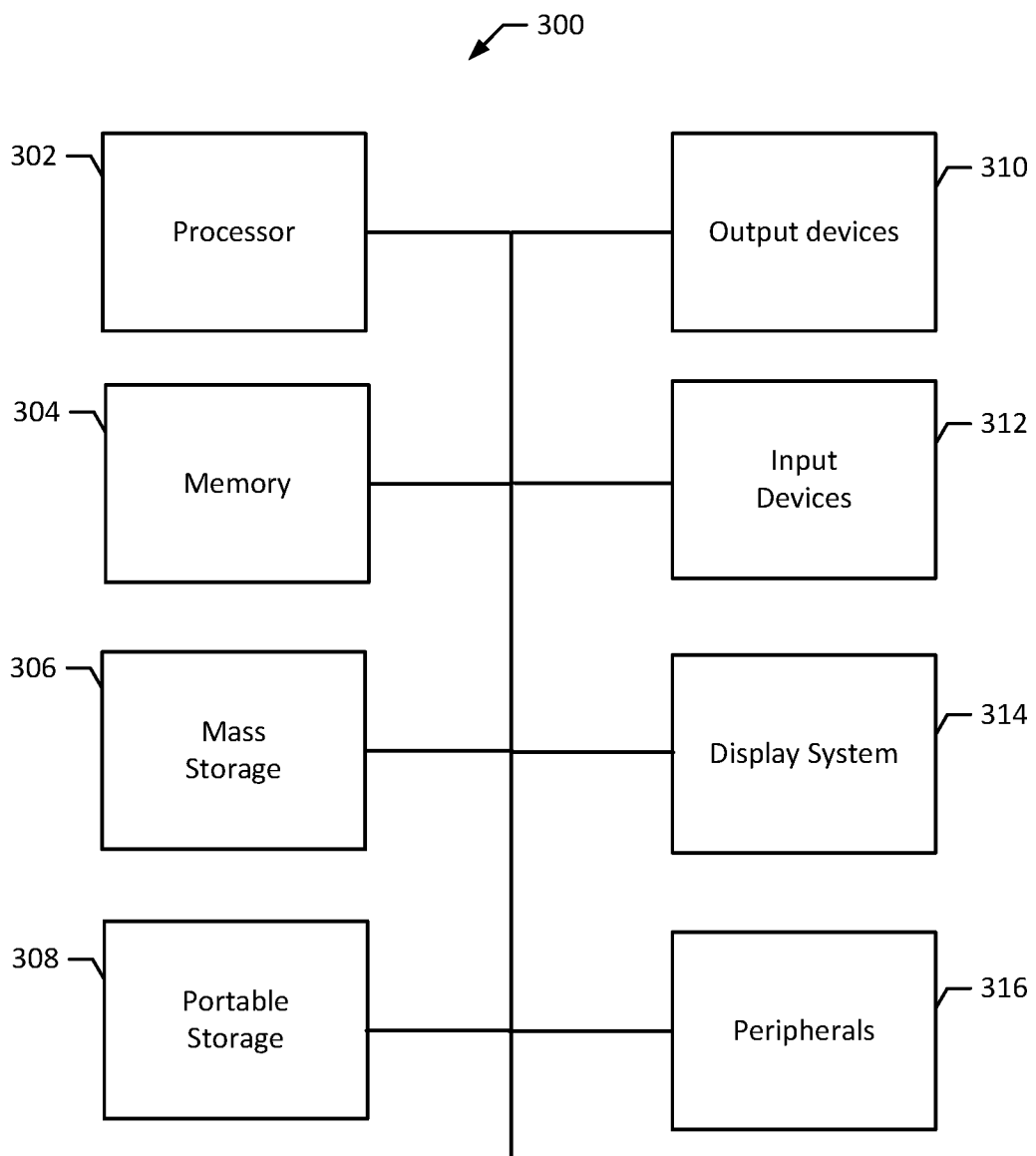


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2016/057913

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F19/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/313789 A1 (KAMEN DEAN [US] ET AL) 22 December 2011 (2011-12-22) paragraph [0006] - paragraph [0008] paragraph [0016] - paragraph [0027] paragraph [0033] figures 1-7	1-20
X	US 2011/178462 A1 (MOBERG SHELDON B [US] ET AL) 21 July 2011 (2011-07-21) paragraph [0006] - paragraph [0013] paragraph [0032] - paragraph [0045] paragraph [0104] - paragraph [0118]	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

13 March 2017

Date of mailing of the international search report

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NL - 2280 HV Rijswijk
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Authorized officer

Menschner, Philipp

INTERNATIONAL SEARCH REPORT

Information on patent family members

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PCT/IB2016/057913

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011313789 A1	22-12-2011	US 2011313789 A1	22-12-2011
		US 2013339049 A1	19-12-2013

US 2011178462 A1	21-07-2011	NONE	
