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AIR MATTRESS CONTROLLER

Abstract

A method may comprise receiving, at a central controller, a command, from a remote control, to adjust a feature of a first component of an air mattress framework; relaying, from the central controller, the command to the first component; receiving from the first component at the central controller, an indication of the success of the command; and relaying the indication from the central controller to the remote control.

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Background/Summary

CROSS-REFERENCES [0001] This Application is a continuation of U.S. application Ser. No. 18/416,387, filed on Jan. 18, 2024, which is a continuation of U.S. application Ser. No. 17/986,351, filed on Nov. 14, 2022, which is a continuation of U.S. application Ser. No. 17/136,741, filed on Dec. 29, 2020, now U.S. Pat. No. 11,497,321, which is a continuation of U.S. application Ser. No. 16/230,086, filed on Dec. 21, 2018, now U.S. Pat. No. 10,881,219, which is a continuation of U.S. application Ser. No. 14/211,367, filed on Mar. 14, 2014, now U.S. Pat. No. 10,201,234, which claims the benefit of priority to U.S. Provisional Application No. 61/781,503, filed on Mar. 14, 2013, the disclosures of which are incorporated herein in their entirety by reference. [0002] The subject matter described in this application is related to subject matter disclosed in the following applications: U.S. Application Ser. No. 61/781,266 (Attorney Docket No. 3500.049PRV), filed on Mar. 14, 2013, entitled “INFLATABLE AIR MATTRESS ALARM AND MONITORING SYSTEM”; U.S. Application Ser. No. 61/781,541 (Attorney Docket No. 3500.051PRV), filed on Mar. 14, 2013, entitled “INFLATABLE AIR MATTRESS AUTOFILL AND OFF BED PRESSURE ADJUSTMENT”; U.S. Application Ser. No. 61/781,571 (Attorney Docket No. 3500.052PRV), filed on Mar. 14, 2013, entitled “INFLATABLE AIR MATTRESS SLEEP ENVIRONMENT ADJUSTMENT AND SUGGESTIONS”; U.S. Application Ser. No. 61/782,394 (Attorney Docket No. 3500.053PRV), filed on Mar. 14, 2013, entitled “INFLATABLE AIR MATTRESS SNORING DETECTION AND RESPONSE”; U.S. Application Ser. No. 61/781,296 (Attorney Docket No. 3500.054PRV), filed on Mar. 14, 2013, entitled “INFLATABLE AIR MATTRESS WITH LIGHT AND VOICE CONTROLS”; U.S. Application Ser. No. 61/781,311 (Attorney Docket No. 3500.055PRV), filed on Mar. 14, 2013, entitled “INFLATABLE AIR MATTRESS SYSTEM WITH DETECTION TECHNIQUES.” The contents of each of the above-references U.S. patent applications are herein incorporated by reference in their entirety.

TECHNICAL FIELD
[0003] This patent document pertains generally to network systems and more particularly, but not by way of limitation, to an inflatable air mattress system architecture.
BACKGROUND
[0004] In various examples, an air mattress control system allows a user to adjust the firmness or position of an air mattress bed. The mattress may have more than one zone thereby allowing a left and right side of the mattress to be adjusted to different firmness levels. Additionally, the bed may be adjustable to different positions. For example, the head section of the bed may be raised up while the foot section of the bed stays in place. In various examples, two separate remote controls are used to adjust the position and firmness, respectively.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0005] Some embodiments are illustrated by way of example and not limitation in the figures of the accompanying drawings in which:

[0006] FIG. **1** is a diagrammatic representation of an air bed system, according to an example.

[0007] FIG. **2** is a block diagram of various components of the air bed system of FIG. **1**, according to an example.

[0008] FIG. **3** is a block diagram of an air bed system architecture, according to an example.

[0009] FIG. **4** is a block diagram of machine in the example form of a computer system within which a set instructions, for causing the machine to perform any one or more of the methodologies discussed herein, may be executed.

DETAILED DESCRIPTION

[0010] FIG. **1** is a diagrammatic representation of air bed system **10** in an example embodiment. System **10** may include bed **12**, which may comprise at least one air chamber **14** surrounded by a resilient border **16** and encapsulated by bed ticking **18**. The resilient border **16** may comprise any suitable material, such as foam.

[0011] As illustrated in FIG. **1**, bed **12** may be a two chamber design having a first air chamber **14**A and a second air chamber **14**B. First and second air chambers **14**A and **14**B may be in fluid communication with pump **20**. Pump **20** may be in electrical communication with a remote control **22** via control box **24**. Remote control **22** may communicate via wired or wireless means with control box **24**. Control box **24** may be configured to operate pump **20** to cause increases and decreases in the fluid pressure of first and second air chambers **14**A and **14**B based upon commands input by a user through remote control **22**. Remote control **22** may include display **26**, output selecting means **28**, pressure increase button **29**, and pressure decrease button **30**. Output selecting means **28** may allow the user to switch the pump output between the first and second air chambers **14**A and **14**B, thus enabling control of multiple air chambers with a single remote control **22**. For example, output selecting means may by a physical control (e.g., switch or button) or an input control displayed on display **26**. Alternatively, separate remote control units may be provided for each air chamber and may each include the ability to control multiple air chambers. Pressure increase and decrease buttons **29** and **30** may allow a user to increase or decrease the pressure, respectively, in the air chamber selected with the output selecting means **28**. Adjusting the pressure within the selected air chamber may cause a corresponding adjustment to the firmness of the air chamber.

[0012] FIG. **2** is a block diagram detailing data communication between certain components of air bed system **10** according to various examples. As shown in FIG. **2**, control box **24** may include power supply **34**, processor **36**, memory **37**, switching means **38**, and analog to digital (A/D) converter **40**. Switching means **38** may be, for example, a relay or a solid state switch. Switching means **38** may be located in the pump **20** rather than the control box **24**.

[0013] Pump **20** and remote control **22** may be in two-way communication with the control box **24**. Pump **20** may include a motor **42**, a pump manifold **43**, a relief valve **44**, a first control valve **45**A, a second control valve **45**B, and a pressure transducer **46**, and may be fluidly connected with the first air chamber **14**A and the second air chamber **14**B via a first tube **48**A and a second tube **48**B, respectively. First and second control valves **45**A and **45**B may be controlled by switching means **38**, and may be operable to regulate the flow of fluid between pump **20** and first and second air chambers **14**A and **14**B, respectively.

[0014] In an example, pump **20** and control box **24** may be provided and packaged as a single unit. Alternatively, pump **20** and control box **24** may be provided as physically separate units.

[0015] In operation, power supply **34** may receive power, such as 110 VAC power, from an external source and may convert the power to various forms required by certain components of the air bed system **10**. Processor **36** may be used to control various logic sequences associated with operation of the air bed system **10**, as will be discussed in further detail below.

[0016] The example of the air bed system **10** shown in FIG. **2** contemplates two air chambers **14**A and **14**B and a single pump **20**. However, other examples may include an air bed system having two or more air chambers and one or more pumps incorporated into the air bed system to control the air chambers. In an example, a separate pump may be associated with each air chamber of the air bed system or a pump may be associated with multiple chambers of the air bed system. Separate pumps may allow each air chamber to be inflated or deflated independently and simultaneously. Furthermore, additional pressure transducers may also be incorporated into the air bed system such that, for example, a separate pressure transducer may be associated with each air chamber.

[0017] In the event that the processor **36** sends a decrease pressure command to one of air chambers **14**A or **14**B, switching means **38** may be used to convert the low voltage command signals sent by processor **36** to higher operating voltages sufficient to operate relief valve **44** of pump **20** and open control valves **45**A or **45**B. Opening relief valve **44** may allow air to escape from air chamber **14**A or **14**B through the respective air tube **48**A or **48**B. During deflation, pressure transducer **46** may send pressure readings to processor **36** via the A/D converter **40**. The A/D converter **40** may receive analog information from pressure transducer **46** and may convert the analog information to digital information useable by processor **36**. Processor **36** may send the digital signal to remote control **22** to update display **26** on the remote control in order to convey the pressure information to the user.

[0018] In the event that processor **36** sends an increase pressure command, pump motor **42** may be energized, sending air to the designated air chamber through air tube **48**A or **48**B via electronically operating corresponding valve **45**A or **45**B. While air is being delivered to the designated air chamber in order to increase the firmness of the chamber, pressure transducer **46** may sense pressure within pump manifold **43**. Again, pressure transducer **46** may send pressure readings to processor **36** via A/D converter **40**. Processor **36** may use the information received from A/D converter **40** to determine the difference between the actual pressure in air chamber **14**A or **14**B and the desired pressure. Processor **36** may send the digital signal to remote control **22** to update display **26** on the remote control in order to convey the pressure information to the user.

[0019] Generally speaking, during an inflation or deflation process, the pressure sensed within pump manifold **43** provides an approximation of the pressure within the air chamber. An example method of obtaining a pump manifold pressure reading that is substantially equivalent to the actual pressure within an air chamber is to turn off pump **20**, allow the pressure within the air chamber **14**A or **14**B and pump manifold **43** to equalize, and then sense the pressure within pump manifold **43** with pressure transducer **46**. Thus, providing a sufficient amount of time to allow the pressures within pump manifold **43** and chamber **14**A or **14**B to equalize may result in pressure readings that are accurate approximations of the actual pressure within air chamber **14**A or **14**B. In various examples, the pressure of **48**A/B is continuously monitored using multiple pressure sensors.

[0020] In an example, another method of obtaining a pump manifold pressure reading that is substantially equivalent to the actual pressure within an air chamber is through the use of a pressure adjustment algorithm. In general, the method may function by approximating the air chamber pressure based upon a mathematical relationship between the air chamber pressure and the pressure measured within pump manifold **43** (during both an inflation cycle and a deflation cycle), thereby eliminating the need to turn off pump **20** in order to obtain a substantially accurate approximation of the air chamber pressure. As a result, a desired pressure setpoint within air chamber **14**A or **14**B may be achieved without the need for turning pump **20** off to allow the pressures to equalize. The latter method of approximating an air chamber pressure using mathematical relationships between the air chamber pressure and the pump manifold pressure is described in detail in U.S. application Ser. No. 12/936,084, the entirety of which is incorporated herein by reference.

[0021] FIG. **3** is illustrates an example air bed system architecture **300**. Architecture **300** includes bed **301**, central controller **302**, firmness controller **304**, articulation controller **306**, temperature controller **308**, external network device **310**, remote controllers **312**, **314**, and voice controller **316**. While described as using an air bed, the system architecture may also be used with other types of beds.

[0022] As illustrated in FIG. **3**, network bed architecture **300** is configured as a star topology with central controller **302** and firmness controller **304** functioning as the hub and articulation controller **306**, temperature controller **308**, external network device **310**, remote controls **312**, **314**, and voice controller **316** functioning as possible spokes, also referred to herein as components. Thus, in various examples, central controller **302** acts a relay between the various components.

[0023] In other examples, different topologies may be used. For example, the components and central controller **302** may be configured as a mesh network in which each component may communicate with one or all of the other components directly, bypassing central controller **302**. In various examples, a combination of topologies may be used. For example, remote controller **312** may communicate directly to temperature controller **308** but also relay the communication to central controller **302**.

[0024] In yet another example, central controller **302** listens to communications (e.g., control signals) between components even if the communication is not being relayed through central controller **302**. For example, consider a user sending a command using remote **312** to temperature controller **308**. Central controller **302** may listen for the command and check to determine if instructions are stored at central controller **302** to override the command (e.g., it conflicts with a previous setting). Central controller **302** may also log the command for future use (e.g., determining a pattern of user preferences for the components).

[0025] In various examples, the controllers and devices illustrated in FIG. **3** may each include a processor, a storage device, and a network interface. The processor may be a general purpose central processing unit (CPU) or application-specific integrated circuit (ASIC). The storage device may include volatile or non-volatile static storage (e.g., Flash memory, RAM, EPROM, etc.). The storage device may store instructions which, when executed by the processor, configure the processor to perform the functionality described herein. For example, a processor of firmness control **304** may be configured to send a command to a relief valve to decrease the pressure in a bed.

[0026] In various examples, the network interface of the components may be configured to transmit and receive communications in a variety of wired and wireless protocols. For example, the network interface may be configured to use the 802.11 standards (e.g., 802.11a/b/c/g/n/ac), PAN network standards such as 802.15.4 or Bluetooth, infrared, cellular standards (e.g., 3G/4G etc.), Ethernet, and USB for receiving and transmitting data. The previous list is not intended to exhaustive and other protocols may be used. Not all components of FIG. **3** need to be configured to use the same protocols. For example, remote control **312** may communicate with central controller **302** via Bluetooth while temperature controller **308** and articulation controller **306** are connected to central controller using 802.15.4. Within FIG. **3**, the lightning connectors represent wireless connections and the solid lines represent wired connections, however, the connections between the components is not limited to such connections and each connection may be wired or wireless.

[0027] Moreover, in various examples, the processor, storage device, and network interface of a component may be located in different locations than various elements used to effect a command. For example, as in FIG. **1**, firmness controller **302** may have a pump that is housed in a separate enclosure than the processor used to control the pump. Similar separation of elements may be employed for the other controllers and devices in FIG. **3**.

[0028] In various examples, firmness controller **304** is configured to regulate pressure in an air mattress. For example, firmness controller **304** may include a pump such as described with reference to FIG. **2** (see e.g., pump **20**). Thus, in an example, firmness controller **304** may respond to commands to increase or decrease pressure in the air mattress. The commands may be received from another component or based on stored application instruction that are part of firmness controller **304**.

[0029] As illustrated in FIG. **3** central controller **302** includes firmness controller **304**. Thus, in an example, the processor of central controller **302** and firmness control **304** may be the same processor. Furthermore, the pump may also be part of central controller **302**. Accordingly, central controller **302** may be responsible for pressure regulation as well as other functionality as described in further portions of this disclosure.

[0030] In various examples, articulation controller **306** is configured to adjust the position of a bed (e.g., bed **301**) by adjusting the foundation that supports the bed. In an example, separate positions may be set for two different beds (e.g., two twin beds placed next to each other). The foundation may include more than one zone that may be independently adjusted. Articulation control **306** may also be configured to provide different levels of massage to a person on the bed.

[0031] In various examples, temperature controller **308** is configured to increase, decrease, or maintain the temperature of a user. For example, a pad may be placed on top of or be part of the air mattress. Air may be pushed through the pad and vented to cool off a user of the bed. Conversely, the pad may include a heating element that may be used to keep the user warm. In various examples, temperature controller **308** receives temperature readings from the pad.

[0032] In various examples, additional controllers may communicate with central controller **302**. These controllers may include, but are not limited to, illumination controllers for turning on and off light elements placed on and around the bed and outlet controllers for controlling power to one or more power outlets.

[0033] In various examples, external network device **310**, remote controllers **312**, **314** and voice controller **316** may be used to input commands (e.g., from a user or remote system) to control one or more components of architecture **300**. The commands may be transmitted from one of the controllers **312**, **314**, or **316** and received in central controller **302**. Central controller **302** may process the command to determine the appropriate component to route the received command. For example, each command sent via one of controllers **312**, **314**, or **316** may include a header or other metadata that indicates which component the command is for. Central controller **302** may then transmit the command via central controller **302**'s network interface to the appropriate component.

[0034] For example, a user may input a desired temperature for the user's bed into remote control **312**. The desired temperature may be encapsulated in a command data structure that includes the temperature as well as identifies temperature controller **308** as the desired component to be controlled. The command data structure may then be transmitted via Bluetooth to central controller **302**. In various examples, the command data structure is encrypted before being transmitted. Central controller **302** may parse the command data structure and relay the command to temperature controller **308** using a PAN. Temperature controller **308** may be then configure its elements to increase or decrease the temperature of the pad depending on the temperature originally input into remote control **312**.

[0035] In various examples, data may be transmitted from a component back to one or more of the remote controls. For example, the current temperature as determined by a sensor element of temperature controller **308**, the pressure of the bed, the current position of the foundation or other information may be transmitted to central controller **302**. Central controller **302** may then transmit the received information and transmit it to remote control **312** where it may be displayed to the user.

[0036] In various examples, multiple types of devices may be used to input commands to control the components of architecture **300**. For example, remote control **312** may be a mobile device such as a smart phone or tablet computer running an application. Other examples of remote control **312** may include a dedicated device for interacting with the components described herein. In various examples, remote controls **312**/**314** include a display device for displaying an interface to a user. Remote control **312**/**314** may also include one or more input devices. Input devices may include, but are not limited to, keypads, touchscreen, gesture, motion and voice controls.

[0037] Remote control **314** may be a single component remote configured to interact with one component of the mattress architecture. For example, remote control **314** may be configured to accept inputs to increase or decrease the air mattress pressure. Voice controller **316** may be configured to accept voice commands to control one or more components. In various examples, more than one of the remote controls **312**/**314** and voice controller **316** may be used.
[0038] With respect to remote control **312**, the application may be configured to pair with one or more central controllers. For each central controller, data may be transmitted to the mobile device that includes a list of components linked with the central controller. For example, consider that remote control **312** is a mobile phone and that the application has been authenticated and paired with central controller **302**. Remote control **312** may transmit a discovery request to central controller **302** to inquiry about other components and available services. In response, central controller **302** may transmit a list of services that includes available functions for adjusting the firmness of the bed, position of the bed, and temperature of the bed. In various embodiments, the application may then display functions for increasing/decreasing pressure of the air mattress, adjusting positions of the bed, and adjusting temperature. If components are added/removed to the architecture under control of central controller **302**, an updated list may be transmitted to remote control **312** and the interface of the application may be adjusted accordingly.
[0039] In various examples, central controller **302** is configured to analyze data collected by a pressure transducer (e.g., transducer **46** with respect to FIG. **2**) to determine various states of a person lying on the bed. For example, central controller **302** may determine the heart rate or respiration rate of a person lying in the bed. Additional processing may be done using the collected data to determine a possible sleep state of the person. For example, central controller **302** may determine when a person falls asleep and, while asleep, the various sleep states of the person.
[0040] In various examples, external network device **310** includes a network interface to interact with an external server for processing and storage of data related to components in architecture **300**. For example, the determined sleep data as described above may be transmitted via a network (e.g., the Internet) from central controller **302** to external network device **310** for storage. In an example, the pressure transducer data may be transmitted to the external server for additional analysis. The external network device **310** may also analyze and filter the data before transmitting it to the external server.
[0041] In an example, diagnostic data of the components may also be routed to external network device **310** for storage and diagnosis on the external server. For example, if temperature controller **308** detects an abnormal temperature reading (e.g., a drop in temperature over one minute that exceeds a set threshold) diagnostic data (sensor readings, current settings, etc.) may be wireless transmitted from temperature controller **308** to central controller **302**. Central controller **302** may then transmit this data via USB to external network device **310**. External device **310** may wirelessly transmit the information to an WLAN access point where it is routed to the external server for analysis.
Example Machine Architecture and Machine-Readable Medium
[0042] FIG. **4** is a block diagram of machine in the example form of a computer system **400** within which instructions, for causing the machine to perform any one or more of the methodologies discussed herein, may be executed. In alternative embodiments, the machine operates as a standalone device or may be connected (e.g., networked) to other machines. In a networked deployment, the machine may operate in the capacity of a server or a client machine in server-client network environment, or as a peer machine in a peer-to-peer (or distributed) network environment. The machine may be a personal computer (PC), a tablet PC, a set-top box (STB), a Personal Digital Assistant (PDA), a cellular telephone, a web appliance, a network router, switch or bridge, or any machine capable of executing instructions (sequential or otherwise) that specify actions to be taken by that machine. Further, while only a single machine is illustrated, the term “machine” shall also be taken to include any collection of machines that individually or jointly execute a set (or multiple

sets) of instructions to perform any one or more of the methodologies discussed herein.

[0043] The example computer system **400** includes a processor **402** (e.g., a central processing unit (CPU), a graphics processing unit (GPU), ASIC or a combination), a main memory **404** and a static memory **406**, which communicate with each other via a bus **408**. The computer system **400** may further include a video display unit **410** (e.g., a liquid crystal display (LCD) or a cathode ray tube (CRT)). The computer system **400** also includes an alphanumeric input device **412** (e.g., a keyboard, touchscreen), a user interface (UI) navigation device **414** (e.g., a mouse), a disk drive unit **416**, a signal generation device **418** (e.g., a speaker) and a network interface device **420**.

Machine-Readable Medium

[0044] The disk drive unit **416** includes a machine-readable medium **422** on which is stored one or more sets of instructions and data structures (e.g., software) **424** embodying or utilized by any one or more of the methodologies or functions described herein. The instructions **424** may also reside, completely or at least partially, within the main memory **404** and/or within the processor **402** during execution thereof by the computer system **400**, the main memory **404** and the processor **402** also constituting machine-readable media.

[0045] While the machine-readable medium **422** is shown in an example embodiment to be a single medium, the term “machine-readable medium” may include a single medium or multiple media (e.g., a centralized or distributed database, and/or associated caches and servers) that store the one or more instructions or data structures. The term “machine-readable medium” shall also be taken to include any tangible medium that is capable of storing, encoding or carrying instructions for execution by the machine and that cause the machine to perform any one or more of the methodologies of the present invention, or that is capable of storing, encoding or carrying data structures utilized by or associated with such instructions. The term “machine-readable medium” shall accordingly be taken to include, but not be limited to, solid-state memories, and optical and magnetic media. Specific examples of machine-readable media include non-volatile memory, including by way of example semiconductor memory devices, e.g., Erasable Programmable Read-Only Memory (EPROM), Electrically Erasable Programmable Read-Only Memory (EEPROM), and flash memory devices; magnetic disks such as internal hard disks and removable disks; magneto-optical disks; and CD-ROM and DVD-ROM disks.

Transmission Medium

[0046] The instructions **424** may further be transmitted or received over a communications network **426** using a transmission medium. The instructions **424** may be transmitted using the network interface device **420** and any one of a number of well-known transfer protocols (e.g., HTTP). Examples of communication networks include a local area network (“LAN”), a wide area network (“WAN”), the Internet, mobile telephone networks, Plain Old Telephone (POTS) networks, and wireless data networks (e.g., WiFi and WiMax networks). The term “transmission medium” shall be taken to include any intangible medium that is capable of storing, encoding or carrying instructions for execution by the machine, and includes digital or analog communications signals or other intangible media to facilitate communication of such software.

[0047] Although an embodiment has been described with reference to specific example embodiments, it will be evident that various modifications and changes may be made to these embodiments without departing from the broader spirit and scope of the invention. Accordingly, the specification and drawings are to be regarded in an illustrative rather than a restrictive sense. The accompanying drawings that form a part hereof, show by way of illustration, and not of limitation, specific embodiments in which the subject matter may be practiced. The embodiments illustrated are described in sufficient detail to enable those skilled in the art to practice the teachings disclosed herein. Other embodiments may be utilized and derived therefrom, such that structural and logical substitutions and changes may be made without departing from the scope of this disclosure. This Detailed Description, therefore, is not to be taken in a limiting sense, and the scope of various embodiments is defined only by the appended claims, along with the full range of equivalents to which such claims are entitled. As it common, the terms “a” and “an” may refer to one or more unless otherwise indicated.

Claims

1. A method comprising: receiving, at a central controller, a command, from a remote control, to adjust a feature of a first component of an air mattress framework; relaying, from the central controller, the command to the first component; receiving from the first component at the central controller, an indication of the success of the command; and relaying the indication from the central controller to the remote control.
2. The method of claim 1, wherein the remote control cannot communicate directly with the first component.
3. The method of claim 2, further comprising: receiving, at the central controller, a command, from a remote control, to adjust a feature of a second component of the air mattress framework; relaying from the central controller the command to adjust the feature of the second component to the second component, wherein the first component and second component are not directly communicatively coupled.
4. The method of claim 1, further comprising: receiving, at the central controller, an indication of a failure of the first component; requesting, from the central controller, diagnostic data from the first component; receiving, from the first component, the diagnostic data in response to the request; and relaying the diagnostic data from the central controller to an external network device.