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Recreational vehicles with on-board intelligence

Abstract

A recreational vehicle includes a power source, a first electrical junction box, a second electrical junction box, a chassis power subsystem, and a recreational vehicle (RV) power subsystem. The first electrical junction box is electrically coupled between the power source and the second electrical junction box, the first electrical junction box is electrically coupled between the power source and the chassis power subsystem, and the second electrical junction box is electrically coupled between the first electrical junction box and the RV power subsystem.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION (1) This application claims priority to Provisional Application No. 63/139,166, filed Jan. 19, 2021, which is herein incorporated by reference in its entirety.

SUMMARY

(1) Certain embodiments of the present disclosure describe various systems, subsystems, components, and methods for use with vehicles such as recreational vehicles.

(2) While multiple embodiments are disclosed, still other embodiments of the present invention will become apparent to those skilled in the art from the following detailed description, which shows and describes illustrative embodiments of the invention. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not restrictive.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIGS. 1A-1D show various examples of recreational vehicles, in accordance with certain embodiments of the present disclosure.

(2) FIG. 2 shows a schematic of a power system of a recreational vehicle, in accordance with certain embodiments of the present disclosure.

(3) FIG. 3 shows a block diagram of a system of devices, networks, and subsystems for use in connection with recreational vehicles, in accordance with certain embodiments of the present disclosure.

(4) FIG. 4 shows a block diagram of components of the system of FIG. 3 for carrying out functions described herein, in accordance with certain embodiments of the present disclosure.

(5) FIGS. 5A and 5B show various arrangements of battery capacity indicators, in accordance with certain embodiments of the present disclosure.

(6) FIGS. 6A and 6B show schematics of screens of a display in different modes, in accordance with certain embodiments of the present disclosure.

(7) FIG. 7 shows a block diagram of a parts of system of FIG. 3 and a window of one of recreational vehicles, in accordance with certain embodiments of the present disclosure.

(8) FIG. 8 shows a communication system, in accordance with certain embodiments of the present disclosure.

(9) FIG. 9 shows a graphical user interface, in accordance with certain embodiments of the present disclosure.

(10) FIGS. 10A-10C show schematics of electrical connectors, in accordance with certain embodiments of the present disclosure.

(11) While the disclosure is amenable to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and are described in detail below. The intention, however, is not to limit the disclosure to the particular embodiments described but instead is intended to cover all modifications, equivalents, and alternatives falling within the scope the appended claims.

DETAILED DESCRIPTION

- (12) FIG. 1A shows a recreational vehicle **100** having a body **102** that houses a cab area **104** at a front end **106** of the recreational vehicle **100** and a living space area **108** positioned between the cab area **104** and a rear end **110** of the recreational vehicle **100**. The recreational vehicle **100** can include one or more power sources (represented by block **112** for simplicity of illustration) that are operably coupled to (e.g., via a transmission, shafts) front and/or rear axles and that provide the energy to rotate the axle(s) and/or wheels **114** and therefore propel the recreational vehicle **100**. The power source **112** can include an engine (e.g., gas engine or diesel engine), rechargeable batteries, fuel cell, or a combination (e.g., hybrid) of an engine and rechargeable batteries, etc.
- (13) In embodiments where the recreational vehicle **100** is at least partially powered and propelled by electricity created by batteries **112**, the batteries **112** can be distributed throughout the chassis of the recreational vehicle **100**. For example, the batteries **112** may be positioned below a floor of the living space area **108** of the recreational vehicle **100**. In certain embodiments, the batteries **112** power electric motors that rotate one or more of the wheels **114** (e.g., by rotating the axles or by directly rotating the wheels).
- (14) FIG. 1B shows a different example of a recreational vehicle **120**, which is coupled to a vehicle **122** such as a car, truck, or sport utility vehicle. The vehicle **122** can be mechanically coupled to the recreational vehicle **120** (e.g., via a hitch) such that the vehicle **122** can be towed or pulled by the recreational vehicle **100**. As will be described in more detail below, the recreational vehicle **100** can also be commutatively and electrically coupled to the vehicle **122** (or other types of vehicles) such that the vehicles can exchange data and power signals.
- (15) Although FIG. 1B shows the towed vehicle as being a vehicle, in certain embodiments, the recreational vehicle **120** can tow a trailer. The trailer could support the vehicle **122** or could support smaller motorized or electric-powered vehicles such as motorcycles and all-terrain vehicles or could support marine equipment such as boats. As such, the recreational vehicle **120** can tow a variety of smaller vehicles and equipment. The recreational vehicles **100/120** can be what is referred to a Class A, Class B, or Class C recreational vehicle or another type of motorized recreational vehicle.
- (16) FIG. 1C shows a towable recreational vehicle **140** that includes a hitch **142** positioned at a front end of the recreational vehicle **140**. The recreational vehicle **140** can be what is referred to a toy hauler, 5th-wheel, travel trailer, or other types of towable recreational vehicles. As shown in FIG. 1C, the recreational vehicle **140** is coupled to a vehicle **144** such as a car, truck, or sport utility vehicle. The vehicle **144** can be mechanically coupled to the recreational vehicle **144** (e.g., via the hitch **142**) such that the vehicle **144** can tow or pull the recreational vehicle **140**. As will be described in more detail below, the recreational vehicle **140** can also be commutatively and electrically coupled to the vehicle **144** (or other types of vehicles such as all-terrain vehicles or motorcycles) such that the vehicles can exchange data and power signals.
- (17) As shown in FIG. 1D, the recreational vehicles **100/120/140** can include a garage **150** at the rear end of the recreational vehicle **100/120/140**. The garage **150** can hold and support vehicles such as an all-terrain vehicle **152** and/or motorcycle.
- (18) Power System
- (19) FIG. 2 shows a block diagram of a power system **200** for use with recreational vehicles. For simplicity, the description below refers to the recreational vehicle **100** of FIG. 1 in connection with the power system **200**, however the other recreational vehicles shown in the figures and described above could incorporate the power system **200**.
- (20) The power system **200** includes a power source **202**. The power source **202** can include an assembly or pack of battery cells **204** and various components for managing temperature (e.g., fans, cooling subsystem) of the assembly/pack.
- (21) The power system **200** also includes a chassis power subsystem **206**. The chassis power subsystem **206** includes powertrain components used to propel the recreational vehicle **100** such as motors that, directly or indirectly, rotate the wheels **114** (as shown in FIG. 1). The chassis power

subsystem **206** also includes components used to operate, at least, basic functions of the recreational vehicle **100** such as brake lights, headlights, dash lights, dash air-conditioning, windshield wiper motors, steering, etc. In short, the chassis power subsystem **206** includes components that are assembled to the vehicle by its manufacturer before the vehicle is delivered to a recreational vehicle manufacturer and outfitted with additional subsystems and components for using the vehicle as a recreational vehicle.

(22) The power system **200** includes an RV power subsystem **208**, which is described in greater detail below. In short, the RV power subsystem **208** includes additional subsystems and components installed by a recreational vehicle manufacturer such as subsystems and components for temperature control, storing and preparing food, operating appliances, supplying and disposing of water and waste, etc.

(23) The power system **200** also includes a first electrical junction box **210** (e.g., a first high-voltage junction box) and a second electrical junction box **212** (e.g., a second high-voltage junction box). The first electrical junction box **210** is electrically coupled between the power source **202** and the chassis power subsystem **206**. The first electrical junction box **210** is also electrically coupled between the power source **202** and the second electrical junction box **212**. In certain embodiments, the first electrical junction box **210** and the second electrical junction box **212** are positioned under a hood of the recreational vehicle **100** where an engine would typically be located.

(24) The first electrical junction box **210** receives a high-voltage input (e.g., 60 volts or higher such as 350-700 volts) from the power source **202**. The first electrical junction box **210** transforms and distributes the high-voltage input to multiple outputs. For example, one set of outputs (e.g., a positive output and a negative output) connects to positive and negative terminals of the second electrical junction box **212** to provide power to the second electrical junction box **212**. As another example, another set of outputs connects to various components of the chassis power subsystem **206** to provide power to the motors that rotate the wheels **114** to propel the recreational vehicle **100**. The first electrical junction box **210** includes various bus bars, fuses, electrical contacts, etc., to distribute the high voltage input to the outputs. In certain embodiments, the first electrical junction box **210** is coupled between the power source **202** and the subsystems and components that are assembled to the vehicle by its manufacturer before the vehicle is delivered to a recreational vehicle manufacturer and outfitted with additional subsystems for using the vehicle as a recreational vehicle.

(25) The second electrical junction box **212** is coupled between the first electrical junction box **210** and the RV power subsystem **208**. As noted above, the second electrical junction box **212** includes positive and negative terminals **214A** and **214B** that are electrically coupled (e.g., via wires) to positive and negative outputs of the first electrical junction box **210**. In certain embodiments, the positive and negative terminals **214A** and **214B** are adapted to receive high voltage inputs (e.g., 60 volts or higher such as 350-700 volts). The second electrical junction box **212** includes multiple outputs that are electrically coupled to various subsystems and components of the recreational vehicle **100** such as those used for temperature control, storing and preparing food, operating appliances, supplying and disposing of water and waste, etc. In certain embodiments, the second electrical junction box **212** includes an output to provide power to a charging station on the recreational vehicle **100**. The charging station can be used to charge the all-terrain vehicle **152** or another electric-powered vehicle or device.

(26) The second electrical junction box **212** includes a switch **216** that can be changed between on and off positions. In certain embodiments, the switch **216** is a handle or bar that can be manually moved (e.g., rotated) between on and off positions. In other embodiments, the switch **216** can be remotely controlled and activated/deactivated (e.g., pressed/depressed) between on and off positions.

(27) Regardless of the specific structure of the switch **216**, the switch **216** can turn power off and on to the various outputs of the second electrical junction box **212**. For example, the switch **216** can

cause power to be removed from an electrical contact **218** that electrically connects the high-voltage input to the various outputs.

(28) By having two electrical junction boxes, the RV power subsystem **208** and its components can be powered off (e.g., via the switch **216** of the second electrical junction box **212**) while power is still delivered to the chassis power subsystem **206** to provide power to the motors that rotate the wheels **114** to propel the recreational vehicle **100**. As such, the recreational vehicle **100** can still be driven although the RV power subsystem **208** and its components are powered off.

(29) For example, as the recreational vehicle **100** is being outfitted with the RV power subsystem **208**, etc., at a manufacturing site, the recreational vehicle **100** can be driven from station to station because the chassis power subsystem **206** is still powered. As such, during manufacture, high-voltage power can be provided to some subsystems and components of the recreational vehicle **100** and turned off for others (e.g., locked out and tagged out) for safety purposes. Turning off power to the RV power subsystem **208** can also save power consumption while the recreational vehicle **100** is not being actively used (e.g., on a dealer's lot, on an owner's driveway).

(30) As another example, if the recreational vehicle **100** experiences an electrical problem (e.g., electrical shorts) with the RV power subsystem **208**, the second electrical junction box **212** can be used to turn off power to the RV power subsystem **208**, but the recreational vehicle **100** can still be driven because power would still be delivered to the chassis power subsystem **206**. As such, an electrical problem with the RV power subsystem **208** does not inhibit the recreational vehicle **100** from being able perform basic and safety functions.

(31) In certain embodiments, if the first electrical junction box **210** is used to disconnect high-voltage power between its inputs and outputs (e.g., via the switch **216** and the electrical contact **218**), this prevents high-voltage power from reaching the second electrical junction box **212** because the first electrical junction box **210** is electrically coupled between the power source **202** and the second electrical junction box **212**.

(32) Having two electrical junction boxes can also assist recreational vehicle manufacturers to use base vehicles from multiple, different manufacturers. For example, the second electrical junction box **212** could be used in connection with batteries and/or chassis made by two different suppliers such that the RV power subsystem **208** does not have to be customized or modified to work with different suppliers.

(33) The second electrical junction box **212** can include a housing **220** that houses the various electrical components (e.g., bus bars, fuses, electrical contacts) of the second electrical junction box **212**. The switch **216** can extend, at least partially, out of and into the housing **220** such that the switch **216** can be moved between on and off positions by a user without needing to access the interior of the housing **220**.

(34) The second electrical junction box **212** can include a lid or cover or access panel that, when opened, allows access to the interior of the housing **220**. In certain embodiments, the second electrical junction box **212** includes another switch **222** (e.g., magnetic switch, proximity switch) that detects when the cover/lid/access panel is opened. In response to the switch **222** detecting such, high-voltage power connections in the second electrical junction box **212** can be automatically turned off (e.g., via the electrical contact **218**) as a safety precaution. In certain embodiments, the switch **222** is a reed switch.

(35) Central Controller

(36) FIG. 3 shows a system **300** of devices, networks, and subsystems for use in connection with one or more vehicles such as those described above. For simplicity, the description below refers to the recreational vehicle **100** of FIG. 1 in connection with the system **300**, however the other recreational vehicles shown in the figures and described above also incorporate the system **300**.

(37) The system **300** includes a central controller **302** (hereinafter the “controller **302**” for brevity), which is communicatively coupled to the various devices, networks, and subsystems of the one or more vehicles. For example, the controller **302** can be communicatively coupled to subsystems and

components of both the chassis power subsystem **206** and the RV power subsystem **208** (as shown in FIG. 2). For simplicity, only some of the recreational vehicle's subsystems and components are shown in FIG. 3. The controller **302** can be programmed to communicate with a variety of subsystems and components, including those utilizing low-side drivers, high-side drivers, half-H-bridge drivers, and full-H-bridge drivers. The controller **302** can include various components used in computing devices and that are detailed below in connection with the description of FIG. 4. (38) The system **300** can also include protocol translators **304** (hereinafter “translators **304**” for brevity) that are communicatively positioned in between the various devices, networks, and subsystems. The translators **304** can include hardware and software that enable the devices, networks, and subsystems—which, together, may utilize several separate communication protocols—to communicate with the controller **302** and vice versa. For example, the translators **304** can include or be coupled to a processor (e.g., microprocessor) and memory and be programmed to convert or translate data and commands from one or more protocol languages to one or more other protocol languages and vice versa. The translators **304** can be characterized as being bi-directional translators **304**.

(39) In certain embodiments, the controller **302** is coupled to a separate translator **304** for each type of communication protocol used with the system **300**. For example, the controller **302** may use one translator **304** to communicate with devices, networks, and subsystems that utilize the Controller Area Network (CAN) protocol, another translator **304** for the SAE J1939 protocol, another translator **304** for the Local Interconnect Network (LIN) protocol, another for the RV-C protocol, and so on. In other embodiments, one or more of the translators **304** are able to translate between multiple protocols. In certain embodiments, one or more translators **304** can be considered to be a component of the controller **302** itself. FIG. 3 shows two translators **304** in such a configuration. In certain embodiments, the controller **302** may not need to utilize one of the translators **304** for communicating with subsystems that also utilize the same protocol. For example, if the controller **302** is programmed to communicate using the RV-C protocol, the controller **302** would not necessarily need to use one of the translators **304** to communicate with subsystems using the RV-C protocol.

(40) The hardware portion of the translators **304** can include electrical connectors that are compatible with a given protocol. For example, the translators **304** may include different electrical receptacles because some protocols may use a single wire at a comparatively low voltage level while other protocols use a comparatively higher voltage level while other protocols use multiple wires. Further, the translators **304** may include one or more transceivers that convert signals to one that is usable by the controller **302**. The translators **304** can further include or be coupled to one or more processors (e.g., microprocessors) and memory that includes instructions or software that, when executed by the processor(s), carry out functions such as error correction and signal translation. In certain embodiments, the translators **304** include analog-to-digital converters. For example, the system **300** may include various sensors (e.g., temperature sensors, position sensors, relays) that produce analog signals, which can be converted to digital signals by the analog-to-digital converters for use by the controller **302**.

(41) The controller **302** can therefore enable the various devices, networks, and subsystems of a recreational vehicle and vehicle to communicate with each other even though the devices, etc., may be programmed to communicate via different protocols. For example, data or signals from a drivetrain subsystem (using the CAN protocol) can cause the controller **302** to issue commands that ultimately control subsystems and devices that use the RV-C protocol or the LIN protocol and vice versa. As such, the controller **302** can use information (e.g., data, signals) formatted, for example, using the RV-C protocol as inputs to control non-RV-C subsystems and devices and vice versa. More specific examples are provided further below. Further, in certain embodiments, the controller **302** itself outputs commands directly in a given protocol, so a translator **304** may not be necessary for each subsystem, etc., that the controller **302** communicates with.

(42) Drivetrain Subsystem

(43) The system **300** can include a drivetrain subsystem **306**. The drivetrain subsystem **306** can include the mechanical and electrical components required to propel the recreational vehicle **100**. For example, the drivetrain subsystem **306** can include an engine and/or batteries as well as the sensors (e.g., temperature sensors, position sensors, current sensors) used to ensure that the engine and/or batteries and other drivetrain components are operating properly.

(44) The drivetrain subsystem **306** may include its own controllers (e.g., microcontrollers) that are programmed to observe, measure, control, and communicate with components of the drivetrain subsystem **306**. The controllers can include Electronic Control Units (ECUs) of the recreational vehicle **100**. The drivetrain subsystem **306** may be designed to use communication protocols such as the CAN protocol or the SAE J1939 protocol.

(45) The controllers of the drivetrain subsystem **306** can be arranged to communicate with the controller **302**. For example, the controller **302** may periodically receive certain information from the drivetrain subsystem **306** or the controller **302** may query the drivetrain subsystem **306** for certain information such as gas tank level, battery charge level, and other operational information about the drivetrain subsystem **306**. One or more of the translators **304** can enable communication between the controller **302** and the drivetrain subsystem **306**. Further, as will be described in more detail below, the controller **302** can be programmed to control operations of the drivetrain subsystem **306**.

(46) HVAC Subsystem

(47) The system **300** can also include a heating, ventilation, and air conditioning (HVAC) subsystem **308**. The HVAC subsystem **308** can include the mechanical and electrical components required to maintain a desired internal environment in recreational vehicles. For example, the HVAC system **308** can include a heating system **310** (e.g., a furnace), vents **312** that allow exchange between internal living spaces and the external environment, and a cooling system **314** (e.g., air conditioning unit) along with sensors **316** (e.g., temperature sensors, position sensors) used to ensure that the HVAC system **308** is operating properly.

(48) The HVAC subsystem **308** may include its own controllers (e.g., microcontrollers) that are programmed to observe, measure, control, and communicate with components of the HVAC subsystem **308**. The controllers of the HVAC subsystem **308** can be arranged to communicate with the controller **302**. For example, the controller **302** may periodically receive certain information from the HVAC subsystem **308** or the controller **302** may query the HVAC subsystem **308** for certain information such as interior temperature, exterior temperature, vent position, and other operational information about the HVAC subsystem **308**. One or more of the translators **304** can enable communication between the controller **302** and the HVAC subsystem **308**. The HVAC subsystem **308** may be designed to use communication protocols such as the RV-C protocol. Further, as will be described in more detail below, the controller **302** can be programmed to control operations of the HVAC subsystem **308**.

(49) Electrical Power Subsystem

(50) The system **300** can also include an electrical power subsystem **318** (hereinafter “power subsystem **318**” for brevity). The power subsystem **318** can include the mechanical and electrical components required to provide electrical power to components of recreational vehicles. For example, the power subsystem **318** can include electrical storage such as batteries **320** and solar panels along with sensors **322** (e.g., temperature sensors, current sensors) used to ensure that the power subsystem **318** is operating properly. In certain embodiments, as noted above, batteries can also be considered part of the drivetrain.

(51) The power subsystem **318** may include its own controllers (e.g., microcontrollers) that are programmed to observe, measure, control, and communicate with components of the power subsystem **318**. The controllers of the power subsystem **318** can be arranged to communicate with the controller **302**. For example, the controller **302** may periodically receive certain information

from the power subsystem **318** or the controller **302** may query the power subsystem **318** for certain information such as the amount of stored power and other operational information about the power subsystem **318**. One or more of the translators **304** can enable communication between the controller **302** and the power subsystem **318**. Further, as will be described in more detail below, the controller **302** can be programmed to control operations of the power subsystem **318**. In certain embodiments, the batteries **320** are also shared with the drivetrain subsystem **304** to help propel the recreational vehicles and vehicles.

(52) Water Subsystem

(53) The system **300** can also include a water subsystem **322**. The water subsystem **322** can include the mechanical and electrical components required to provide adequate water supply and waste and water drainage/storage. For example, the water system **322** can include one or more pumps, piping, faucets, drains, tanks (e.g., clean water tank, grey water tank, black water tank), and sensors (e.g., water level sensors).

(54) The water subsystem **322** may include its own controllers (e.g., microcontrollers) that are programmed to observe, measure, control, and communicate with components of the water subsystem **322**. The controllers of the water subsystem **322** can be arranged to communicate with the controller **302**. For example, the controller **302** may periodically receive certain information from the water subsystem **322** or the controller **302** may query the water subsystem **322** for certain information such as the water levels of each of the tanks and other operational information about the water subsystem **322**. One or more of the translators **304** can enable communication between the controller **302** and the water subsystem **322**. Additionally or alternatively, the controller **302** can be programmed to directly control one or more operations of the water subsystem **322** without the use of an intervening controller. For example, the controller **302** may directly query or request readings from sensors of the water subsystem **322** and display the results of the readings such that a user can see the water levels of the various tanks.

(55) Appliance Subsystem

(56) The system **300** can also include an appliance subsystem **323**. The appliance subsystem **323** can include the mechanical and electrical components required to operate appliances within a recreational vehicle. For example, the appliance subsystem **323** can include one or more refrigerators, ovens, microwaves, and sensors (e.g., temperature sensors).

(57) The appliance subsystem **323** may include its own controllers (e.g., microcontrollers) that are programmed to observe, measure, control, and communicate with components of the appliance subsystem **323**. The controllers of the appliance subsystem **323** can be arranged to communicate with the controller **302**. For example, the controller **302** may periodically receive certain information from the appliance subsystem **323** or the controller **302** may query the appliance subsystem **323** for certain information such as whether a given appliance is operating, temperatures, and other operational information about the appliance subsystem **323**. One or more of the translators **304** can enable communication between the controller **302** and the appliance subsystem **323**. Additionally or alternatively, the controller **302** can be programmed to directly control one or more operations of the appliance subsystem **323** without the use of an intervening controller. For example, the controller **302** may directly query or request readings from sensors of the appliance subsystem **323** and display the results of the readings such that a user can see the internal temperature of the refrigerator or oven.

(58) Computing System and Network Access

(59) In certain embodiments, the controller **302** can be considered to be a computer or computing system or a component of a larger computer or computing system. FIG. 4 shows a block diagram of illustrative components of the controller **302** for carrying out aspects of the various functions and processes described here. This diagram is merely an example and the controller **302** may have additional or fewer components.

(60) The controller **302** includes a bus **324** or other communication mechanism for communicating

information between or among one or more processors **326** (e.g., microprocessors), memory **328** (e.g., random access memory (RAM), flash memory, and/or other dynamic storage devices), read only memory (ROM) **330**, a data storage device **332** (e.g., a hard disk drive, optical disk drive, or solid state drive), and/or a network interface **334**.

(61) In certain examples, the network interface **334** is communicatively coupled to a network **336** via one or more communication links. Example network interfaces **334** include wired and wireless signal transmitters and receivers. Example communication links include a wired communication link (e.g., a serial communication), a wireless communication link such as, for example, a short-range radio link, such as Bluetooth, IEEE 802.11, a proprietary wireless protocol, and/or the like. The term “communication link” may refer to an ability to communicate some type of information in at least one direction between at least two devices. The communication links may be a persistent communication link, an intermittent communication link, an ad-hoc communication link, and/or the like. As such, the network interface **334** allows the controller **302** to communicate with a variety of networks, including local networks and cloud computing networks.

(62) The processor(s) **326** can execute software and/or firmware stored in the memory **328** of the controller **302**. The software/firmware code contains instructions (e.g., computer code, machine-useable instructions, and the like) that, when executed by the processor **326**, cause the controller **302** to perform the functions of the control algorithm described herein. The controller **302** may alternatively or additionally include one or more application-specific integrated circuits (ASICs), field-programmable gate arrays (FPGAs), digital signal processors (DSPs), hardwired logic, or combinations thereof.

(63) The controller **302** can also be communicatively coupled to a display **338** and an input device **340**. For example, the controller **302** may be coupled to or physically positioned within a control panel that is positioned within an interior of a recreational vehicle (e.g., attached to a wall or partition of a recreational vehicle). The control panel may include the display **338** and the input device **340**. In some embodiments, the display **338** (e.g., an LCD display or a touch screen) is configured to display information to a user of the system **300**. In some examples, the input device **340** (e.g., alphanumeric and other keys) is configured to communicate information and commands to the controller **302**. In some embodiments, the display **338** is a touchscreen and therefore includes input devices **340**.

(64) The controller **302** can also be communicatively coupled to a user device **342** such as a mobile phone or detachable control panel. For example, the user device **342** may include an application (e.g., an app downloaded from an app store) that enables the user device **342** to communicate with the controller **302** directly or indirectly (e.g., via the network interface **334** and network **336**). The user device **342** can have its own display and/or user inputs for sending information and commands to the controller **302**.

(65) In certain embodiments, the various subsystems and devices of the recreational vehicle **100** periodically or by request send status updates to the controller **302**, which can store the status updates in the memory **328**. For example, the drivetrain subsystem **306** can send information about the recreational vehicle's current fuel level or remaining stored battery power. As such, the controller **302** can store or otherwise have access to snapshots of the system's status at various points in time. This information can be used by the controller **302** in various routines described below.

(66) Battery Capacity Indicators

(67) As noted above, the controller **302** can receive and store information about the remaining stored battery power of the recreational vehicle's power source **202**. For simplicity, this information is referred to below as the “state of charge” of the power source **202**. The state of charge can be denoted as a percentage at or between 0% to 100%, where “0” indicates that there is no available power left and “100” indicates that the power source **202** is fully charged. The controller **302** can cause such information to be displayed throughout the recreational vehicle **100** using various

approaches described below.

(68) FIG. 4 shows a block **344** that represents one or more lighting subsystems. The lighting subsystem **344** is communicatively coupled to the controller **302** and can include one or more sets or strips of light sources such as light-emitting diodes (LEDs).

(69) FIG. 5A shows an example set of light sources **346** (for simplicity, only two light sources shown in FIG. 5A are denoted with reference number **346**). In certain embodiments, each light source **346** can be individually addressable by the controller **302** such that the controller **302** can individually and separately control each light source **346**. For example, the controller **302** can turn on, turn off, dim, brighten, change colors each light source **346** separately. Each light source **346** may have its own address or identification number that the controller **302** can use to distinguish among the light sources **346**.

(70) In certain embodiments, the set of light sources **346** are positioned on an external surface of the recreational vehicle **100**. For example, the light sources **346** may be positioned together on a strip or in a tube that is coupled to a bottom surface **116** (in FIG. 1) of the recreational vehicle **100** and protected by a clear cover or the like. These exterior-positioned light sources **346** can be controlled by the controller **302** to indicate the state of charge of the recreational vehicle's power source.

(71) In some embodiments, all the light sources **346** are controlled to emit one color of light (e.g., green light) when the state of charge is at or between 50% and 100%, emit a different color of light (e.g., yellow light) when the state of charge is at or between 20% and 50%, and emit a different color of light (e.g., red light) when the state of charge is below 20%. The specific color being emitted can change over time as the state of charge changes over time.

(72) In some embodiments, the light sources **346** are controlled to emit different colors depending on the location within the array of light sources. For example, the controller **302** can cause a certain percentage of light sources **346** to emit one color of light (e.g., green light) and another percentage of light sources **346** to emit another color or light (e.g., red light). The percentage of light sources **346** that emit green light can indicate what the current state of charge is. For example, if the state of charge is 75% and there are 100 light sources **346**, then 75 of the light sources **346** can emit a green light while the other 25 can emit a red light. In some embodiments, the light sources **346** are controlled to emit different brightness depending on the state of charge.

(73) FIG. 5B shows a button assembly **350**, which includes five buttons **352** that each include or are coupled to individually-addressable light sources **354**. The button assembly **350** can be positioned on an exterior surface of the recreational vehicle **100**. For example, the button assembly **350** could be positioned on the frame between the front passenger-side door and the rear passenger-side sliding door or positioned on one of the doors itself.

(74) The button assembly **350** can be programmed to enable functions (e.g., through the controller **302**) such as locking/unlocking doors, closing/opening an awning, closing/opening windows, etc. For example, the buttons may be programmed to cause different actions depending on whether the buttons are held, tapped, tapped twice, or simultaneously depressed in different combinations. The light sources **354** of the button assembly **350** can be controlled using the same or similar approaches described immediately above to emit light to indicate the state of charge.

(75) Additionally or alternatively, the light sources **354** and/or button assembly **350** can be positioned within the interior of the recreational vehicle **100** and used to indicate the current state of charge. In addition to indicating the state of charge, the various light sources can indicate other status information about the recreational vehicle **100**. As one example, the light sources can indicate when the recreational vehicle **100** has recently been plugged into a charging station (e.g., by emitting a green light for a set period of time) or is currently charging.

(76) Light sources can also be used to indicate things like the water temperature. For example, if a user turns on hot water for a shower, one or more light sources in the recreational vehicle **100** could emit light to indicate when the water has reached a desired temperature (e.g., initially emit a blue

light that turns to red or green when the water has reached temperature).

(77) Reversible Display

(78) As noted above with respect to FIG. 4, the system 300 may include a control panel with the display 338. For example, the control panel may be attached (e.g., removably attached and detached) to a wall or other structure in the recreational vehicle 100. The display 338 can utilize different screen modes depending on the status of the recreational vehicles. FIGS. 6A and 6B show the display 338 in two different screen modes.

(79) FIG. 6A shows the display 338 in a parked screen mode. As just one example of the types of information the display 338 can show, the display 338 in FIG. 6A includes a visual indicator 356 (e.g., graphics, icons) that visually represents the current state of charge. The display 338 can also include a numerical indicator 358 that shows the current state of charge. The display 338 can include many other screens as part of a graphical user interface, such as screens with icons, buttons, or indicators for controlling and viewing aspects of the various subsystems and devices of the vehicles.

(80) FIG. 6B shows the display 338 in a driving screen mode. As can be seen by comparing FIG. 6A and FIG. 6B, the driving screen mode displays the indicators 356 and 358 in a mirror or reverse image. When the display 338 is reversed, the person driving the recreational vehicle 100 can view the display 338 using the recreational vehicle's rearview mirror, and the driver would see the display 338 in a non-reversed orientation. For example, the display 338 may be positioned within the recreational vehicle 100 such that the display 338 is in the driver's field of view via the rearview mirror.

(81) In certain embodiments, the driving screen mode is initiated when the transmission or power source of the recreational vehicle 100 is transferred to drive or reverse or when an operator manually changes screen modes. When the transmission or power source of the recreational vehicle 100 is transferred to park, the display 338 can revert back to the parked screen mode. In certain embodiments, when the driving screen mode is initiated, the display 338 automatically displays information relevant to operation of the recreational vehicle 100 when being driven.

(82) HVAC Subsystem Control

(83) Automatic Environment Control

(84) Traditional recreational vehicles require occupants to manually and individually control the different components of HVAC systems to establish a desired internal environment. For example, traditional recreational vehicles do not allow occupants to simply set a desired temperature and instead require occupants to manually turn on and off (or adjust) heating systems, cooling systems, and vents to control the interior temperature and environment.

(85) In certain embodiments, the controller 302 can be programmed to efficiently utilize the energy use of the HVAC subsystem 308 while also creating a user-friendly experience. As noted above, the recreational vehicles' HVAC subsystem 308 and its components can be communicatively coupled to the controller 302.

(86) In certain embodiments, the controller 302 can be programmed such that the user needs to only set a desired interior temperature (e.g., via a thermostat or a mobile application on a mobile device) and optionally select "heat" or "cool," and the controller 302 can determine how to operate the components of the HVAC subsystem 308 to reach the selected temperature. How the controller 302 accomplishes reaching the selected temperature may depend on the status of the various subsystems of the recreational vehicle. For example, if the recreational vehicle 100 is plugged into shore power, the recreational vehicle 100 may not consider inputs such as available battery power. However, if the power source is the recreational vehicle's batteries, the controller 302 can take into account the current state of charge. As another example, the power source may be a generator, which may cause the controller 302 to utilize a higher-efficiency mode that is similar or the same as when the batteries are the power source for the HVAC subsystem 308. The following are a few examples of higher-efficiency approaches for reaching a desired internal temperature.

(87) In certain embodiments, in response to a requested interior temperature, the controller **302** may first determine the current interior temperature from a sensor positioned in the recreational vehicle **100**. The controller **302** may also determine an exterior temperature from a sensor coupled to the recreational vehicle **100** or from a weather mobile application that tracks or predicts local temperatures. The controller **302** may also receive sensor signals or information about current or predicted weather conditions such as precipitation, etc.

(88) If the requested temperature and exterior temperature is lower than the measured interior temperature, the controller **302** may be programmed to open the vents **312** and turn on a fan to pull in the cooler air from the exterior to reach the desired temperature to save energy consumption by the cooling system **314**. In certain embodiments, this approach is used to initially pre-cool the interior for a period of time or until reaching a certain interior temperature-after which the cooling system **314** is turned on and used to reach and/or maintain the final desired temperature. In certain embodiments, if precipitation is detected (e.g., via a rain sensor or weather mobile application), the controller **302** can bypass opening the vents **312** to avoid precipitation entering the interior of the recreational vehicle or the controller **302** can close the vents **312** in the event the vents **312** are already open. In some embodiments, the controller **302** can reduce the speed of the vents **312** if the detected rain is light (e.g., a drizzle).

(89) In certain embodiments, if the humidity of the exterior air is greater than a threshold (e.g., 70-80%), then the controller **302** can be programmed to use the cooling system **314** instead of opening the vents **312**.

(90) Window Sensor

(91) FIG. 7 shows a block diagram of the controller **302**, the HVAC subsystem **308**, and the sensor **316** (which are also shown in FIG. 3). FIG. 7 also shows a window **360**. The window **360** in FIG. 7 represents one or more of the windows of the recreational vehicles **100/120/140** shown in FIGS. 1A-1C. Each of the figures show multiple windows positioned at various locations along the recreational vehicles **100/120/140**. The window **360** can be opened and closed to allow or prevent air exchanging between the interior and exterior of the recreational vehicles **100/120/140**.

(92) The sensor **316** is arranged and configured to detect when the window **360** is open or closed. For example, the sensor **316** can be a position sensor or a proximity sensor that, respectively, detects the position or proximity of the window **360** with respect to the sensor **316**. In certain embodiments, the sensor **316** is a magnetic sensor such as a magnetic reed sensor. Regardless of the specific type of sensor, the sensor **316** can send a signal to the controller **302** to indicate when the window **360** is open or closed. The controller **302** can then use the status of the window **360** for various operations described below.

(93) As one example, if the controller **302** determines (via a signal from the sensor **316**) that the window **360** is open and that it is currently raining or will rain, the controller **302** can send a warning or alert to a user's mobile application. As another example, if the controller **302** determines that (1) the window **360** is open, (2) cooling is required to reach a desired interior temperature, and (3) the exterior temperature is greater than the interior temperature, the controller **302** can send a warning or alert to the user's mobile application. Additionally or alternatively, regardless of the exterior temperature, the controller **302** can open the vents **312** (as shown in FIG. 3) instead of turning on the air conditioner to avoid spending energy on cooling air that may exit through the open window **360**. Similar approaches can be used in the event that heating is required to reach a desired temperature and the window **360** is open.

(94) In certain embodiments, if the controller **302** determines that there will be an upcoming large (e.g., 10+ degree) increase or decrease in temperature of the exterior air (e.g., via a mobile weather application) and the window **360** is open, then the controller **302** can be programmed to send a warning or alert to the user's mobile application or can cause the window **360** to be shut automatically.

(95) In addition to the sensor **316** for the window **360**, the recreational vehicle **100** may include a

sensor that is arranged and configured to detect when an awning is extended/open. In certain embodiments, if the controller **302** determines that the awning is open and that there is currently or soon to be windy conditions (e.g., winds at 20+ miles per hour), then the controller **302** can be programmed to send a warning or alert to the user's mobile application or can cause the awning to be retracted automatically. As another example, if the controller **302** determines that the awning is open, the controller **302** can be programmed to send a signal (e.g., command or message) to the drivetrain subsystem **306** to prevent the drivetrain subsystem **306** from being driven (e.g., preventing the transmission from shifting from park to drive).

(96) Communication System and Graphical User Interface

(97) FIG. **8** shows a communication system **400**, which includes one or more cell phone towers **402** and one or more servers **404**.

(98) FIG. **8** also shows the recreational vehicle **100** of FIG. **1** which includes equipment to wirelessly communicate with the cell tower **402** and/or the server **404**. As noted above, the recreational vehicle **100** includes the controller **302**, which was discussed at length herein. The controller **302** receives data (e.g., via various signals) about the recreational vehicle **100** from the various subsystems (including those that communicate using different communication protocols), components, and sensors. In certain embodiments, the controller **302** translates the various signals from the subsystems, etc., to the CAN protocol. The translated signals are sent to a wireless transmitter of the recreational vehicle **100** that is programmed to communicate the translated signals to the cell tower **402**. The cell tower **402** can then relay the translated signals to the server **404**, which can store certain data and process/analyze/parse/structure the data. The server **404** can then communicate with the cell tower **402** (which may be the same or different cell tower **402** that communicated the translated to the server **404**) such that the data is transmitted to a user's mobile device **406** (e.g., via a mobile application).

(99) FIG. **9** shows a graphical user interface (GUI) **410** of a mobile application for use with the recreational vehicle **100** and the communication system **400**. The GUI **410** can include a home screen such as that shown in FIG. **9** which displays information about the recreational vehicle **100** and its various systems, subsystems, and components and also enables a user to control various aspects of the recreational vehicle **100** and its systems, etc.

(100) As one example, the home screen of the GUI **410** can include information relating to the power system **200** such as the state of charge of batteries, the remaining travel range, the time required to reach a full charge, and the like. As another example, the home screen can include information about the climate (e.g., temperature) internal to the recreational vehicle **100** and external. The home screen can also include buttons that allow a user to control the HVAC subsystem **308** such as cooling, heating, or automatic climate control settings. As another example, the home screen can include information about the water subsystem **322** such as the current levels of the fresh water, gray water, and black water tanks of the recreational vehicle **100**. The home screen can also include buttons/links to other screens for viewing information about or controlling the power subsystem, drivetrain subsystem, HVAC subsystem, lighting subsystem, etc., of the recreational vehicle **100**.

(101) In certain embodiments, in addition to displaying the GUI **410** on a user's cell phone, the recreational vehicle **100** can display the GUI **410** on an in-dash infotainment system. The in-dash system can include a screen (e.g., touchscreen) in the recreational vehicle's front dash that can reproduce or mirror the GUI **410** such that the driver and/or passenger can view and interact with the GUI **410** from the front dash. For example, the screen in the vehicle's front dash can be communicatively coupled to a processor operating an Apple or Android operating system, which can download and operate the mobile application. As such, a user can view information about and control aspects of the recreational vehicle **100** from the screen in the front dash.

(102) Data Transmission Speeds

(103) As noted above, the system **300** can include hardware and software that enable the devices

and subsystems to communicate with the controller **302** and vice versa even though the devices, etc., utilize different communication protocols. In addition to removing protocol-based limitations, the system **300** can remove limitations on data transmission speeds, such as the 1 megabyte-per-second limit using the traditional CAN protocol.

(104) In certain embodiments of the present disclosure, the system **300** can include hardware (e.g., busses, wires, wireless transmitters) and software that permit data transfer speeds greater than 1 MB/sec (e.g., >5 MB/sec, 1-10 MB/sec). For example, in addition to wiring required by the various protocols of the recreational vehicle **100**, the system **300** may include one or more data transmission wires or wireless transmitters, which can be used for applications requiring faster data transmission speeds. The additional data speeds can assist with incorporating more complex and data-heavy subsystems and devices into vehicles. For example, data transmission speeds greater than 1 MB/sec can allow the controller **302** to process and communicate video signals (e.g., from cameras on the vehicles) to the various subsystems and devices and, perhaps, bypass traditional protocols used by recreational vehicles.

(105) Controller Operation Modes

(106) In certain embodiments, the controller **302** is programmed with different operation modes. For example, the memory **328** of the controller **302** may store instructions such as routines that are unique to different modes. The modes can be initialized in response to different events.

(107) As a first example, one of the modes can be characterized as a manufacturer mode. This mode may be the initial default mode for the controller **302**. For example, when a recreational vehicle is first powered on, the controller **302** can be powered and programmed to run the manufacturer mode. In this mode, the controller **302** can run various diagnostic routines as the recreational vehicles are being assembled and completed before shipment to customers or dealers. The controller **302** can communicate with a central server for a manufacturing site and provide periodic updates or alerts about the status of the recreational vehicles and their various devices and subsystems. In some embodiments, the controller **302** can be communicatively coupled to a global positioning sensor (GPS) or other types of locational sensors such that the controller **302** can communicate its position. Using position data could help determine where respective recreational vehicles are located on a manufacturer's production site.

(108) As a second example, another one of the modes can be characterized as a dealer mode. Once the recreational vehicles have been assembled, tested, and approved for shipping to a dealer, the controller **302** can be switched from the manufacturer mode to the dealer mode (e.g., by the manufacturer). In this mode, the controller **302** can run routines that are useful while the recreational vehicles are parked on a dealer's lot, for example, for maintenance and/or marketing purposes. In the dealer mode, the controller **302** could control recreational vehicles' infotainment systems to cause a television or other display to automatically play a pre-recorded marketing video when a door of the vehicles is opened or when the infotainment systems are turned on. As another example, the controller **302** can count the number of times doors have been opened to keep track of how often the recreational vehicles are being shown to potential customers. As another example, the controller **302** can send reminders to a dealer's central server about the status of the recreational vehicles (e.g., whether the vehicles are connected to shore power) or diagnostic related information. In some embodiments, the controller **302** can be communicatively coupled to a GPS or other types of locational sensors such that the controller **302** can communicate its position. Using position data could help determine where respective recreational vehicles are located on a dealer's site.

(109) As a third example, another one of the modes can be characterized as a customer mode or standard operating mode. Once the recreational vehicles have been sold to a customer, the controller **302** can be switched from the dealer mode to the customer mode. In this mode, the controller **302** can run routines that are useful for end users such as the various functions described above and below in more detail (e.g., querying various subsystems of the recreational vehicle) and

diagnostic and maintenance information (e.g., maintenance reminders).

(110) Electrical Connectors

(111) FIGS. **10A-10C** show schematics of different electrical connectors that can be used to facilitate communication between vehicles and/or equipment. FIG. **10A** shows a 7-pin connector **500**, FIG. **10B** shows a 9-pin connector **510**, and FIG. **10C** shows a 7-pin connector **520** and a 2-pin connector **530**. Each connector can be part of a pair. For example, one vehicle can have a receptacle connector (e.g., a female connector) and the other vehicle can have a corresponding plug connector (e.g., a male connector). An extension cord can be communicatively coupled between the pair of connectors and may also have its own corresponding electrical connectors at each end of the extension cord. Although each of the connectors are shown as being round, the connectors can be other shapes (e.g., oval, rectangle, square).

(112) The connectors involve adding two pins or two electrical and/or communication paths to traditional electrical connectors typically used with recreational vehicles. For example, the 7-pin connector **500** includes 5 pins traditionally used in a 5-pin connector, which includes pins that are used for taillights, brakes, left turn signal and brake lights, right turn signal and brake lights, and ground. The 9-pin connector **510** includes 7 pins traditionally used in a 7-pin connector, which includes pins used for tail/running lights, auxiliary power, right turn and brake lights, backup lights, brakes, left turn and brake lights, and ground. Both the 7-pin connector **500** and the 9-pin connector **510** include one additional pin for power and another additional pin for communications. As will be described in more detail below, the power pin can be used to transfer power between the vehicles which can facilitate the ability to charge batteries, for example. The communication pin can be used to transfer command signals and data between the vehicles (e.g., between the vehicles' respective controllers) to facilitate various functions described below.

(113) The 7-pin connector **520** of FIG. **10C** can be a traditional 7-pin connector (as described above) that is used along with the 2-pin connector **530**, which can include one pin for power and another for communications. As such, the power pin and communication pin can be part of a connector that is separate from a traditional 5- or 7-pin connector. Alternatively, the 7-pin connector **520** and the 2-pin connector **530** can be physically connected to each other.

(114) In certain embodiments, the power pin has a larger diameter than all or some of the other pins of the electrical connector. For example, the power pin may communicate power signals with a voltage that is higher than some or all of the other pins. In certain embodiments, the communication pin can have a smaller diameter than all or some of the other pins of the electrical connector. The communication pin may use a lower voltage than some or all of the other pins.

(115) In certain embodiments, instead of having a separate pin for communications, signals such as command signals or those containing data can be wirelessly transmitted between vehicles. For example, the vehicles can transmit wireless signals to each other using one or more wireless communication protocols (e.g., WiFi, Bluetooth, 3G, 4G, 5G, among others). In such embodiments, the connectors described above may only include one additional pin (e.g., the power pin) than that traditionally used in connectors for recreational vehicles.

(116) Although the description above only refers to adding pins/communication paths for traditional 5- and 7-pin connectors, it is appreciated that such pins/communication paths can be incorporated with or added to electrical connectors with a different number of pins (e.g., 4-9 pins, 4-7 pins).

(117) In addition to electrical connectors, the vehicles can have one or more pneumatic lines (e.g., tubes, hoses) communicatively coupled between the vehicles. The pneumatic lines can allow the ability to utilize brakes of both vehicles. For example, the action of pressing the brake pedal of the towing vehicle can cause the brakes of the towing vehicle to be pressed as well as (via the pneumatic lines) the brakes of the towed vehicle. This can provide additional braking abilities of the towing vehicle and towed vehicle.

(118) Vehicle-to-Vehicle Communications and Power Sharing

(119) As noted above, the recreational vehicles **100/120/140** can be communicatively coupled to the vehicles such as cars, trucks, and sport utility vehicles. Communications between the vehicles can be facilitated by the electrical connectors **500/510/520** or other types of electrical connectors and managed by the controller **302**.

(120) In some embodiments, both the recreational vehicle and the vehicle include one or more batteries that are used to power devices and subsystems, while in other embodiments, the recreational vehicle and the vehicle also include an engine. Regardless of the vehicles' arrangement, the controller **302** can manage power sharing or charging between the vehicles, and the power sharing can be bi-directional.

(121) As one example, the vehicle that is towing can transfer power to the vehicle being towed. In embodiments where the towing vehicle is powered by an engine, that vehicle may be generating more power than is needed for its own electrical needs. The controller **302** can be programmed to determine if the towing vehicle is generating excess power and if the towed vehicle's batteries should be charged. This approach may be facilitated by the controller **302** receiving information from sensors about current power generation and power storage and comparing that information to pre-determined thresholds. The controller **302** can send a message or command to the towing vehicle's drivetrain subsystem (e.g., via the communication pin on the electrical connectors **500/510/520**) to cause the towing vehicle to transfer power to the towed vehicle (e.g., via the power pin on the electrical connectors **500/510/520**).

(122) As another example, the vehicle that is being towed can transfer power to the vehicle that is towing. In embodiments where the towing vehicle is powered by batteries, that vehicle will be using its stored power to propel the two vehicles. The controller **302** can be programmed to determine (1) if the towing vehicle is running low on power (e.g., less than 25% remaining power) and (2) if the towed vehicle has power stored in its batteries that can be transferred to the towing vehicle (e.g., greater than 25% remaining power). In some embodiments, an operator can manually initiate power transfer between the two vehicle and set desired thresholds for initiating and stopping the transfer of power. The controller **302** can send a message or command to the towed vehicle's power subsystem to cause the towed vehicle to transfer power to the towing vehicle (e.g., via the power pin on the electrical connectors **500/510/520**). Power can be continued to be transferred until the towed vehicle's power source drops below a given power threshold or until the operator manually stops the power transfer between the vehicles. In this example, the towed vehicle can act as auxiliary power storage for the towing vehicle and therefore extend the range of the towing vehicle.

(123) As another example, the vehicle that is towing can communicate with the towed vehicle to control or request assistance from the towed vehicle in various scenarios. One scenario involves the towing vehicle pulling the towed vehicle up a steep grade (e.g., up a mountain road). In that scenario, the towing vehicle can send a command to the controller **302** to cause power to be sent to the wheels of the towed vehicle such that the towed vehicle helps or otherwise assists with propelling the two vehicles using its power subsystem. This can reduce the load on the power subsystem of the towing vehicle. Another scenario involves the towing vehicle pulling the towed vehicle down a steep grade. In that scenario, the towing vehicle can send a command to the controller **302** to initiate or control braking of the towed vehicle. In certain embodiments, these assisted-power or -braking approaches can be initiated when the power required to propel the towing vehicle reaches or approaches a threshold, when GPS data indicates a steep grade, when a steep grade is detected by one or more sensors of the vehicles, and/or by an operator manually requesting assisted power or braking.

(124) As another example, the vehicles can share power when the vehicles are parked. In embodiments where one vehicle includes an engine and the other vehicle includes batteries, the engine-powered vehicle can essentially act as a generator for the battery-powered vehicle. For example, if the recreational vehicle is battery powered, the controller **302** can determine when the

recreational vehicle's power subsystem **318** has depleted its stored power below a threshold level. In response, the controller **302** can send a command to the engine-powered vehicle (e.g., to the vehicle's drivetrain subsystem via the communication pin on the electrical connectors **500/510/520**) that requests or otherwise causes that vehicle to start its drivetrain (e.g., engine and alternator) and send excess power (e.g., via the power pin on the electrical connectors **500/510/520**) to the batteries of the recreational vehicle. As noted above, the controller **302** can have access to snapshots of the operating status of the vehicles' subsystems, etc. As such, the controller **302** could refer to the last received fuel level status update of the engine-powered vehicle and may only initiate a command to start the engine if the fuel level is above a threshold (e.g., the tank is 25% full), which can be set to avoid the engine-powered vehicle from dropping below a certain fuel level. Further, the controller **302** can send a command to the engine-powered vehicle to shut-off once the controller **302** determines that the fuel level has dropped below a certain fuel level. In embodiments, an operator can set desired thresholds and can initiate and stop power transfer between the two parked vehicles.

(125) Storage Modes

(126) In addition to the different operation modes described above, the controller **302** can be programmed with different storage modes. For example, the memory **328** of the controller **302** may store routines that are unique to the different modes. These different modes can be initiated manually by an operator the recreational vehicles **100/200**.

(127) As a first example, one of the modes can be characterized as a plugged-in storage mode. This mode can be set when the recreational vehicle is in short-term or long-term storage (e.g., winter storage) and is plugged into shore power or the like. In this mode, the recreational vehicle can periodically "wake up" and run routines to check the status of the subsystems, networks, and devices of the recreational vehicle. If one of the subsystems, etc., is not operating properly as determined by the controller **302** or in response to an error message, the controller **302** can send an alert in a format and as desired by the owner of the recreational vehicle. Also in this mode, if the recreational vehicle is battery powered, the controller **302** can periodically measure the power level of the batteries and maintain the batteries in a desired power level range. For example, batteries such as lithium-based batteries should not be kept at 100% full charged capacity and instead should be kept at a lower range (e.g., up to 65% of full charged capacity). As such, the controller **302** can schedule periodic checks and initiate small power boosts to the batteries to maintain a desired power level range.

(128) As another example, one of the modes can be characterized as an off-the-grid mode. This mode can be set when the recreational vehicle is being stored but is not plugged into shore power. In this mode, the recreational vehicle can periodically check the status of the subsystems, etc., although less often than the plugged-in storage mode. Instead of communicating the status updates to an external party, the recreational vehicle can store the status updates until the recreational vehicle is connected to power.

(129) In any of the above-described storage modes, the controller **302** can also be programmed with various security routines. For example, using signals from sensors (e.g., proximity sensors), the controller **302** can determine whether a door opens or whether exterior steps have extended down. In such events, the controller **302** can create and send an alert to a mobile application or via a text message, telephone call, e-mail and the like. Further, the controller **302** can initiate a local alarm or warning. Further yet, the controller **302** can cause a camera (e.g., backup camera, side mirror camera, interior camera) to take pictures, which can be stored to the memory **328** and/or communicated to a mobile application or sent via text message, etc.

CONCLUSION

(130) Although the features above were described in the context of recreational vehicle applications, the features could be implemented in marine applications. For example, boats can include controllers, sensors, etc., which can be used to control aspects of various subsystems such as power subsystems. As another example, marine applications can use electrical connectors that

enable communication and/or power sharing between power sources.

(131) Various modifications and additions can be made to the embodiments disclosed without departing from the scope of this disclosure. For example, while the embodiments described above refer to particular features, the scope of this disclosure also includes embodiments having different combinations of features and embodiments that do not include all of the described features. Accordingly, the scope of the present disclosure is intended to include all such alternatives, modifications, and variations as falling within the scope of the claims, together with all equivalents thereof.

Claims

1. A recreational vehicle comprising: a power source, a first electrical junction box, a second electrical junction box, a chassis power subsystem, and a recreational vehicle (RV) power subsystem, wherein: the first electrical junction box is electrically coupled between the power source and the second electrical junction box, the first electrical junction box is electrically coupled between the power source and the chassis power subsystem, the second electrical junction box is electrically coupled between the first electrical junction box and the RV power subsystem, and the first electrical junction box and the second electrical junction box are arranged and electrically connected such that the power source can selectively provide power to the chassis power subsystem but not the RV power subsystem.
2. The recreational vehicle of claim 1, wherein the chassis power subsystem facilitates power supply to brake lights, headlights, and dash lights.
3. The recreational vehicle of claim 1, wherein the chassis power subsystem comprises electrical motors arranged to directly or indirectly rotate wheels.
4. The recreational vehicle of claim 1, wherein the RV power subsystem comprises a heating, ventilation, and air-conditioning (HVAC) subsystem.
5. The recreational vehicle of claim 4, wherein the HVAC system comprises a heater and an air-conditioner.
6. The recreational vehicle of claim 1, wherein the power source provides 60-750 volts to the first electrical junction box.
7. The recreational vehicle of claim 1, wherein the second electrical junction box includes a switch, a power input, and a power output.
8. The recreational vehicle of claim 7, wherein the switch is configured to be switched between an off position and an on position.
9. The recreational vehicle of claim 8, wherein, in the off position, the power input and the power output are not electrically coupled to each other.
10. The recreational vehicle of claim 8, wherein, in the off position, the switch has caused electrical contacts to physically separate from each other.
11. The recreational vehicle of claim 7, wherein the switch is configured to disconnect power between the power source and the RV power subsystem.
12. The recreational vehicle of claim 7, wherein the second electrical junction box comprises a housing with an interior space, wherein the switch is accessible from outside the housing.
13. The recreational vehicle of claim 1, wherein the first electrical junction box and the second electrical junction box are positioned under a hood of the recreational vehicle.
14. The recreational vehicle of claim 1, further comprising a body that houses a cab area and a living space.
15. The recreational vehicle of claim 1, wherein the chassis power subsystem facilitates power supply to headlights, wherein the chassis power subsystem includes electrical motors arranged to directly or indirectly rotate wheels, wherein the RV power subsystem comprises a heating, ventilation, and air-conditioning (HVAC) subsystem.

16. The recreational vehicle of claim 1, wherein the first electrical junction box has a first housing, wherein the second electrical junction box has a second housing separate from the first housing, wherein the first housing houses a first set of bus bars, fuses, and electrical contacts: wherein the second housing houses a second set of bus bars, fuses, and electrical contacts.

17. A recreational vehicle comprising: a power source, a first electrical junction box, a second electrical junction box, a chassis power subsystem, and a recreational vehicle (RV) power subsystem, wherein: the first electrical junction box is electrically coupled between the power source and the second electrical junction box, the first electrical junction box is electrically coupled between the power source and the chassis power subsystem, the second electrical junction box is electrically coupled between the first electrical junction box and the RV power subsystem, the second electrical junction box includes a switch, a power input, and a power output, the second electrical junction box includes a housing with an interior space, and the switch is accessible from outside the housing.

18. The recreational vehicle of claim 17, wherein: the chassis power subsystem facilitates power supply to brake lights, headlights, and dash lights; and the RV power subsystem comprises a heating, ventilation, and air-conditioning (HVAC) subsystem.

19. The recreational vehicle of claim 17, wherein the first electrical junction box and the second electrical junction box are positioned under a hood of the recreational vehicle.

20. The recreational vehicle of claim 17, wherein the switch is configured to disconnect power between the power source and the RV power subsystem.
