

ZIGBEE network , and that relays this information to the centralized location via an internet-accessible wide area network (WAN) such as a cellular network.

SUMMARY OF THE INVENTION

[009] A wireless relay is described that can monitor a characteristic of a power source of the module, and transmit an alarm upon detecting a change in the characteristic. In addition, the wireless relay can monitor a characteristic of an associated medical device, and transmit an alarm upon detecting a change in this characteristic.

[009a] According to a first aspect of the present invention, there is provided a wireless relay module comprising:

an electrical connector configured to receive primary power from a power source;

a battery configured to provide secondary power upon a changed characteristic of primary power;

a first receiver capable of wirelessly receiving medical device data over a wireless relay network from at least one medical device, wherein the wireless relay network is a local area network;

a first transmitter capable of wirelessly transmitting medical device data over the wireless relay network;

a second transmitter capable of wirelessly transmitting medical device data over an Internet-accessible wireless communications network;

and a controller coupled to the first and second transmitters, said controller capable of controlling said wireless relay module to select one of said first or second transmitter for transmitting medical device data received by said first receiver;

and said controller further capable of producing a power alarm signal upon the changed characteristic of the primary power and sending the power alarm signal to at least a second wireless relay module communicating on the same wireless relay network for proliferation of the alarm over the network.

[009b] According to a second aspect of the present invention, there is provided a wireless relay module comprising: an electrical connector configured to receive power from a power source;

a first receiver capable of wirelessly receiving medical device data over a wireless relay network from at least one medical device, wherein the wireless relay network is a local area network;

a first transmitter capable of wirelessly transmitting medical device data over the wireless relay network;

a second transmitter capable of wirelessly transmitting data over an internet-accessible wireless communications network;

and a controller coupled to the first and second transmitters, said controller capable of controlling said wireless relay module to select one of said first and second transmitter for transmitting the medical device data received by said first receiver;

and said controller further capable of producing a power alarm signal upon a changed characteristic of the received power and sending the alarm signal to at least a second wireless relay module communicating on the same wireless relay network for proliferation of the alarm over the network.

[009c] According to a third aspect of the present invention, there is provided a process for operating a relay module in a medical device wireless network, the relay module comprising a first transmitter in communication with a wireless relay network, comprising:

receiving medical device data from at least one medical devices over the wireless relay network;

transmitting the medical device data to a second relay module through the medical device network or to a web server through an internet-accessible wireless network, based upon an accessibility condition of the wireless relay module to the internet-accessible wireless network; and

upon disruption of primary power to the relay module, connecting the relay module to a secondary power source and sending a power alarm signal to at least the second wireless relay module on the same wireless relay network for proliferation of the alarm over the network, wherein the wireless relay network is a local area network.

[009d] According to a fourth aspect of the present invention, there is provided a process for operating a wireless relay module comprising:

a first receiver capable of wirelessly receiving medical device data over a wireless relay network from at least one medical device;

a first transmitter capable of wirelessly transmitting the medical device data to at least a second wireless relay module over the wireless relay network;

a second transmitter capable of wirelessly transmitting the medical device data over an internet-accessible wireless communications network;

an alarm indicator and a controller coupled to the first and second transmitters and the alarm indicator, said controller capable of selecting one of said first and second transmitter for transmitting medical device data received by said first receiver;

and said controller further capable of activating the alarm indicator if a characteristic of a signal received over the wireless relay network from a medical device falls below a particular threshold, and sending the alarm signal to at least a second wireless relay module communicating on the same wireless relay network to proliferate the alarm over the network.

[009e] According to a fifth aspect of the present invention, there is provided a process for operating a process for operating a relay module in a medical device wireless network, the relay module comprising a first transmitter in communication with a wireless relay network, comprising:

receiving medical data from at least one medical device over the wireless relay network;

determining the status of an internet-accessible wireless communications network in communication with a said wireless relay module;

transmitting said medical device data from said at least one medical device over said internet-accessible wireless communications network if said determined status satisfies a particular criteria;

transmitting said medical device data from said at least one medical device to a second relay module over the wireless relay network if said determined status fails to satisfy the particular criteria;

monitoring a characteristic of a received signal over the wireless relay network from said at least one medical device;

generating an alarm if said monitored characteristic is outside of predetermined limits;
and

and sending the alarm to at least a second wireless relay module communicating on the same wireless relay network to proliferate the alarm over the network.

[0010] ~~The Embodiments of the~~ present invention ~~is~~are directed to wireless relay modules for enabling alarm recognition and display alerts in networked communications between medical devices and remote monitoring devices via wireless relay networks and/or internet-accessible wireless communications networks. In some embodiments, the wireless relay module comprises a display, a receiver capable of wirelessly receiving medical device data over a wireless relay network from at least one medical device, a first transmitter capable of wirelessly transmitting medical device data to a second wireless relay module over the wireless relay network, and a second transmitter capable of wirelessly transmitting data over an internet-accessible wireless communication network. It is possible for the transmitters and receivers to be implemented as transceivers.

[0011] “Medical device data” as generally used herein means data from or about the medical device including, for example, medical device identification, medical device software, medical device settings or status information (including alarm information and/or alarm priority), medical device location information (including for example global positioning system (GPS) coordinates), patient identification information, patient personal identification number(s) “PIN(s)”, patient prescriptions, and/or patient medical and/or physiological data as is collected, produced and/or generated by at least one of the medical device and patient identification device; as well as wireless relay network information such as location or status information.

[0012] A controller is typically coupled to the first and second transmitters, and controls the wireless relay module to select one of said first or second transmitter for transmitting medical device data received by the receiver over one of the two respective networks. The controller is further capable of producing an alarm signal upon a changed characteristic of a power source for

We claim:

1. A wireless relay module comprising:
 - an electrical connector configured to receive power from a power source;
 - a first receiver capable of wirelessly receiving medical device data over a wireless relay network from at least one medical device;
 - a first transmitter capable of wirelessly transmitting medical device data over the wireless relay network;
 - a second transmitter capable of wirelessly transmitting data over an internet-accessible wireless communications network; and
 - a controller coupled to the first and second transmitters, said controller capable of controlling said wireless relay module to select one of said first and second transmitter for transmitting the medical device data received by said first receiver, and said controller further capable of producing an alarm signal upon a changed characteristic of the received power.
2. The wireless relay module of claim 1, further comprising at least one of a visual display or speaker coupled to the controller and configured to provide a visual and/or audio alert.
3. The wireless relay module of claim 1, wherein the second transmitter is configured to transmit an alert signal to a remote monitoring device over the internet-accessible wireless communications network.
4. The wireless relay module of claim 1, wherein the first transmitter is configured to transmit an alert signal to at least one of at least one other wireless relay module and the medical device.
5. The wireless relay module of claim 1, wherein said power source is a battery and the controller is capable of transmitting an alarm signal when the charge state of the battery falls to or below a particular charge level.

6. The wireless relay module of claim 5, wherein the controller is configured to modulate the alarm signal to be indicative of the state of charge of the power source between a low charge state and a zero charge state.

7. The wireless relay module of claim 1, further comprising:
a memory electrically connected to said controller, said memory capable of storing said received medical device data.

8. The wireless relay module of claim 1, wherein at least one of the first and second transmitters is configured to transmit the stored medical device data based upon the characteristic of received power.

9. The wireless relay module of claim 1, wherein said first transmitter is configured to, upon generation of the alarm signal, send a notice to the medical device or to another wireless relay module.

10. The wireless relay module of claim 1, wherein said controller is capable of transmitting to a remote monitoring device at least one of the medical device data and an acknowledgement signal in response to receipt of a particular signal transmitted by the remote monitoring device.

11. The wireless relay module of claim 1, wherein the electrical connector is configured to receive primary power from the power source, the wireless relay module further comprising a battery configured to provide secondary power upon a changed characteristic of primary power.

12. The wireless relay module of claim 1, further comprising a sensor capable of detecting disconnection of the connector from the power source.

13. The wireless relay module of claim 12 wherein the controller is capable of transmitting an alarm signal when the sensor detects disconnection of the connector from the power source.

14. A process for operating a relay module in a medical device wireless network, the relay module comprising a first transmitter in communication with a wireless relay network, comprising the steps of:

receiving medical device data from at least one medical device over the wireless relay network;

transmitting said medical device data to a second relay module through the wireless relay network or to a web server through an internet-accessible wireless network, based on an accessibility condition of the relay module to the internet-accessible wireless network; and

upon disruption of primary power to the relay module, connecting the relay module to a secondary power source and generating an alarm signal.

15. The process of claim 14, further comprising the steps of:

determining the accessibility condition of the internet-accessible wireless network from the relay module.

16. The process of claim 14, further comprising the steps of:

providing a visual and/or audio alert based upon the generated alarm signal.

17. The process of claim 14, further comprising the step of:

transmitting an alert signal to a remote monitoring device over the internet-accessible wireless network after connecting the wireless relay module to the secondary power source.

18. The process of claim 14, further comprising the step of:

transmitting an alert signal to at least one of another wireless relay module and the medical device based upon the alarm signal.

19. The process of claim 14, further comprising the step of:
transmitting a second alarm signal when the charge state of the secondary power source falls below a particular charge level.

20. The process of claim 19, wherein the particular charge level indicates one of a low battery condition or a near dead battery condition, and the alarm signals for indicating each of the low battery condition or the near dead battery condition are indicative of its depreciated charge level.

21. The process of claim 20, further comprising the steps of:
storing in a memory of the relay module said received medical device data; and
transmitting the stored medical device data upon restoration of the primary power.

22. The process of claim 21, further comprising the step of sending a notice to the at least one medical device or to another wireless relay module indicating that the primary power has been restored.

23. A wireless relay module comprising:
a first receiver capable of wirelessly receiving medical device data over a wireless relay network from at least one medical device;
a first transmitter capable of wirelessly transmitting the medical device data to at least a second wireless relay module over the wireless relay network;
a second transmitter capable of wirelessly transmitting the medical device data over an internet-accessible wireless communications network;
an alarm indicator; and
a controller coupled to the first and second transmitters and the alarm indicator, said controller capable of selecting one of said first and second transmitter for transmitting medical device data received by said first receiver, and said controller further capable of activating the alarm indicator if a characteristic of a signal received over the wireless relay network from a medical device falls below a particular threshold.

24. The wireless relay module of claim 23, wherein said characteristic is at least one of signal strength, data rate, and an indication of distance between said relay module and said medical device.

25. The wireless relay module of claim 23, wherein the second transmitter is capable of transmitting an alert to a remote monitoring device upon interruption of the receipt of the medical device data from the medical device.

26. A process for operating a relay module in a medical device wireless network, the relay module comprising a first transmitter in communication with a wireless relay network, comprising the steps of:

receiving medical data from at least one medical device over the wireless relay network;

determining the status of an internet-accessible wireless communications network in communication with a said wireless relay module;

transmitting said medical device data from said at least one medical device over said internet-accessible wireless communications network if said determined status satisfies a particular criteria;

transmitting said medical device data from said at least one medical device to a second relay module over the wireless relay network if said determined status fails to satisfy the particular criteria;

monitoring a characteristic of a received signal over the wireless relay network from said at least one medical device;

generating an alarm if said monitored characteristic is outside of predetermined limits.

27. The process of claim 26, wherein said characteristic is at least one of signal strength, data rate, and an indication of distance between said relay module and said medical device.

28. The process of claim 26, wherein the step of generating the alarm further comprises transmitting a notice regarding the alarm to a remote monitoring device.

We claim:

1. A wireless relay module comprising:
 - an electrical connector configured to receive primary power from a power source;
 - a battery configured to provide secondary power upon a changed characteristic of primary power;
 - a first receiver capable of wirelessly receiving medical device data over a wireless relay network from at least one medical device, wherein the wireless relay network is a local area network;
 - a first transmitter capable of wirelessly transmitting medical device data over the wireless relay network;
 - a second transmitter capable of wirelessly transmitting medical device data over an Internet-accessible wireless communications network;
 - and a controller coupled to the first and second transmitters, said controller capable of controlling said wireless relay module to select one of said first or second transmitter for transmitting medical device data received by said first receiver;
 - and said controller further capable of producing a power alarm signal upon the changed characteristic of the primary power and sending the power alarm signal to at least a second wireless relay module communicating on the same wireless relay network for proliferation of the alarm over the network.
2. The wireless relay module of claim 1, further comprising at least one of a visual display or speaker coupled to the controller and configured to provide a visual and/or audio alert.
3. The wireless relay module of claim 1, wherein the second transmitter is configured to transmit an alert signal to a remote monitoring device over the internet-accessible wireless communications network.
4. The wireless relay module of claim 1, wherein the controller is capable of transmitting an alarm signal when a charge state of the battery falls below a particular charge level.

5. The wireless relay module of claim 4, wherein the controller is configured to modulate the alarm signal to be indicative of the state of charge of the secondary power source between a low charge state and a zero charge state.

6. The wireless relay module of claim 1 further comprising a sensor capable of detecting disconnection of the connector from the power source.

7. The wireless relay module of claim 6, wherein the controller is capable of transmitting an alarm signal when the sensor detects disconnection of the connector from the power source.

8. The wireless relay module of claim 1 further comprising: a memory electrically connected to said controller, said memory capable of storing said received medical device data.

9. The wireless relay module of claim 8 wherein at least one of the first or second transmitters is configured to transmit the stored medical device data upon restoration of the primary power.

10. The wireless relay module of claim 1 wherein said first transmitter is configured to, upon generation of the alarm signal, send a notice to the medical device or to another wireless relay module indicating that the primary power has been disrupted.

11. The wireless relay module of claim 10 wherein said first transmitter is further configured to, upon restoration of the primary power, send a notice to the medical device or to the other wireless relay module indicating that the primary power has been restored.

12. The wireless relay module of claim 1 wherein said controller is capable of transmitting to the remote monitoring device at least one of the medical data or an

acknowledgement signal in response to receipt of a particular signal transmitted by the remote monitoring device.

13. A wireless relay module comprising: an electrical connector configured to receive power from a power source;

a first receiver capable of wirelessly receiving medical device data over a wireless relay network from at least one medical device, wherein the wireless relay network is a local area network;

a first transmitter capable of wirelessly transmitting medical device data over the wireless relay network;

a second transmitter capable of wirelessly transmitting data over an internet-accessible wireless communications network;

and a controller coupled to the first and second transmitters, said controller capable of controlling said wireless relay module to select one of said first and second transmitter for transmitting the medical device data received by said first receiver;

and said controller further capable of producing a power alarm signal upon a changed characteristic of the received power and sending the alarm signal to at least a second wireless relay module communicating on the same wireless relay network for proliferation of the alarm over the network.

14. The wireless relay module of claim 13, further comprising at least one of a visual display or speaker coupled to the controller and configured to provide a visual and/or audio alert.

15. The wireless relay module of claim 13, wherein the second transmitter is configured to transmit an alert signal to a remote monitoring device over the internet-accessible wireless communications network.

16. The wireless relay module of claim 13, wherein said power source is a battery and the controller is capable of transmitting an alarm signal when the charge state of the battery falls to or below a particular charge level.

17. The wireless relay module of claim 16, wherein the controller is configured to modulate the alarm signal to be indicative of the state of charge of the secondary power source between a low charge state and a zero charge state.

18. The wireless relay module of claim 13 further comprising: a memory electrically connected to said controller, said memory capable of storing said received medical device data.

19. The wireless relay module of claim 18 wherein at least one of the first and second transmitters is configured to transmit the stored medical device data based upon the characteristic of received power.

20. The wireless relay module of claim 13 wherein said first transmitter is configured to, upon generation of the alarm signal, send a notice to the medical device or to another wireless relay module.

21. The wireless relay module of claim 13 wherein said controller is capable of transmitting to a remote monitoring device at least one of the medical device data and an acknowledgement signal in response to receipt of a particular signal transmitted by the remote monitoring device.

22. A process for operating a relay module in a medical device wireless network, the relay module comprising a first transmitter in communication with a wireless relay network, comprising:

receiving medical device data from at least one medical devices over the wireless relay network;

transmitting the medical device data to a second relay module through the medical device network or to a web server through an internet-accessible wireless network, based upon an accessibility condition of the wireless relay module to the internet-accessible wireless network; and

upon disruption of primary power to the relay module, connecting the relay module to a secondary power source and sending a power alarm signal to at least the second wireless relay

module one the same wireless relay network for proliferation of the alarm over the network, wherein the wireless relay network is a local area network.

23. The process of claim 22 further comprising determining the accessibility condition of the internet-accessible wireless communications network from the second transmitter of said relay module.

24. The process of claim 22 further comprising providing a visual and/or audio alert based upon the generated alarm signal.

25. The process of claim 24 further comprising transmitting, via the second transmitter, an alert signal to a remote monitoring device over the internet-accessible wireless communications network after connecting the wireless relay module to the secondary power source.

26. The process of claim 22 further comprising transmitting, via the first transmitter, an alert signal to at least one of another wireless relay module and the medical device based upon the alarm signal.

27. The process of claim 22 further comprising transmitting, via at least one of the first or second transmitters, a second alarm signal when the charge state of the secondary power source falls below a particular charge level.

28. The process of claim 27 wherein the particular charge level indicates one of a low battery condition or a near dead battery condition, and the alarm signals for indicating each of the low battery condition or the near dead battery condition are indicative of its depreciated charge level.

29. The process of claim 22, further comprising storing the received medical device data in a memory of the relay module.

30. The process of claim 28, further comprising transmitting, via at least one of the first or second transmitters, the stored medical device data upon restoration of the primary power.

31. The process of claim 29, further comprising upon restoration of the primary power, sending, via the first transmitter, a notice to the medical device or to another wireless relay module indicating that the primary power has been restored.

32. A wireless relay module comprising:
a first receiver capable of wirelessly receiving medical device data over a wireless relay network from at least one medical device;
a first transmitter capable of wirelessly transmitting the medical device data to at least a second wireless relay module over the wireless relay network;
a second transmitter capable of wirelessly transmitting the medical device data over an internet-accessible wireless communications network;
an alarm indicator and a controller coupled to the first and second transmitters and the alarm indicator, said controller capable of selecting one of said first and second transmitter for transmitting medical device data received by said first receiver;
and said controller further capable of activating the alarm indicator if a characteristic of a signal received over the wireless relay network from a medical device falls below a particular threshold, and sending the alarm signal to at least a second wireless relay module communicating on the same wireless relay network to proliferate the alarm over the network.

33. The wireless relay module of claim 32 wherein said characteristic is signal strength.

34. The wireless relay module of claim 32 wherein said characteristic is data rate.

35. The wireless relay module of claim 32 wherein said characteristic is indicative of distance between said relay module and said medical device.

36. The wireless relay module of claim 32 wherein the second transmitter is capable of transmitting an alert to a remote monitoring device upon interruption of the receipt of the medical device data from the medical device.

37. A process for operating a relay module in a medical device wireless network, the relay module comprising a first transmitter in communication with a wireless relay network, comprising:

- receiving medical data from at least one medical device over the wireless relay network;
- determining the status of an internet-accessible wireless communications network in communication with a said wireless relay module;

- transmitting said medical device data from said at least one medical device over said internet-accessible wireless communications network if said determined status satisfies a particular criteria;

- transmitting said medical device data from said at least one medical device to a second relay module over the wireless relay network if said determined status fails to satisfy the particular criteria;

- monitoring a characteristic of a received signal over the wireless relay network from said at least one medical device;

- generating an alarm if said monitored characteristic is outside of predetermined limits;
- and

- and sending the alarm to at least a second wireless relay module communicating on the same wireless relay network to proliferate the alarm over the network.

38. The process of claim 37 wherein said characteristic is signal strength.

39. The process of claim 37 wherein said characteristic is data rate.

40. The process of claim 37 wherein said characteristic is indicative of distance between said relay module and said medical device.

41. The process of claim 37 wherein generating the alarm further comprises transmitting a notice regarding the alarm to a remote monitoring device.

42. The wireless relay module of claim 1 wherein the wireless relay network is a mesh network and the controller includes a network interface for communicating over the mesh network.

43. The wireless relay module of claim 1 wherein the controller is configured to store the device data in a memory prior to loss of power when a voltage level is below a near-death voltage.

44. The wireless relay module of claim 1 wherein the wireless relay produces one alarm in response to loss of AC power and another alarm in response to a low battery voltage level.