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(54) **WIRELESS NETWORK HAVING PORTABLE
ULTRASOUND DEVICES**

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(57) **ABSTRACT**

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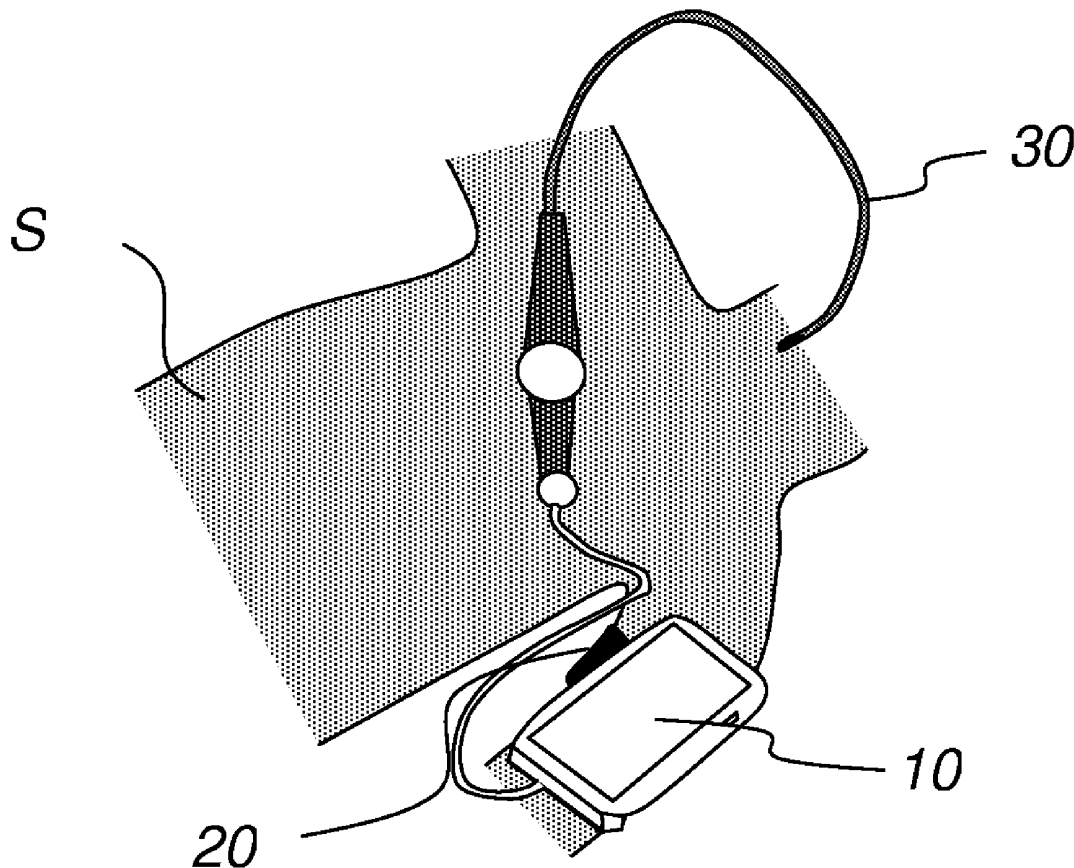
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A patient monitoring system has one or more ultrasound devices that monitor patients. The ultrasound devices can communicate to a central station by way of a wireless data communication network. Ultrasound images acquired by the ultrasound devices may be displayed at the central station. Alarms may be generated based upon conditions detected by the ultrasound devices. An ultrasound device may have a strap that permits it to be held in place with a transducer against the skin of a subject to permit ultrasound observation of the subject either continuously or intermittently over an extended period.

Related U.S. Application Data

(63) Continuation of application No. 12/188,193, filed on Aug. 7, 2008.

(60) Provisional application No. 60/955,331, filed on Aug. 10, 2007.



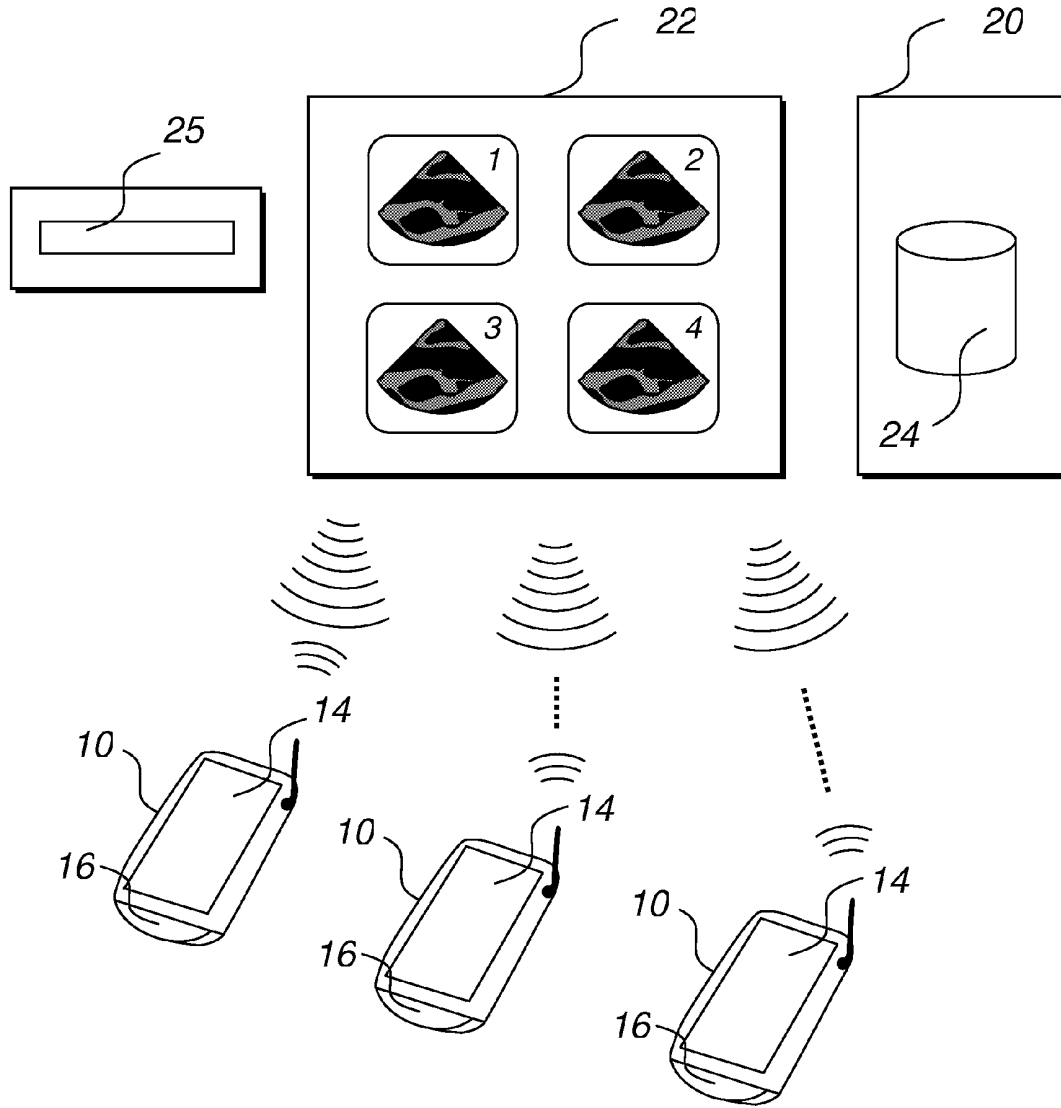


FIG. 1

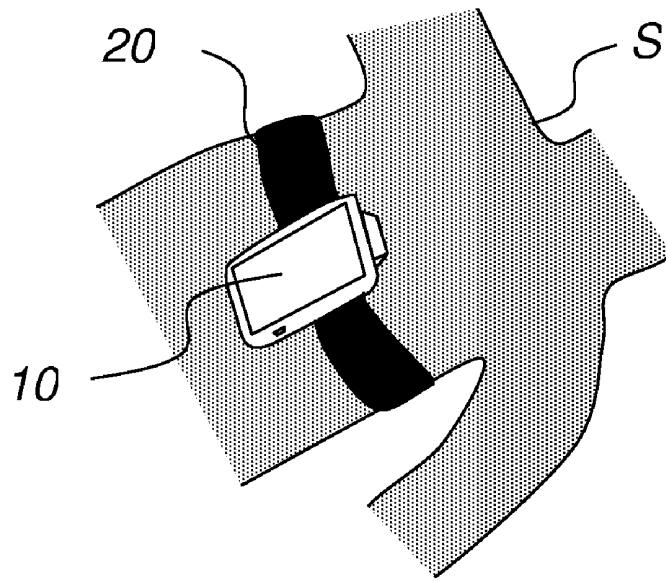


FIG. 2A

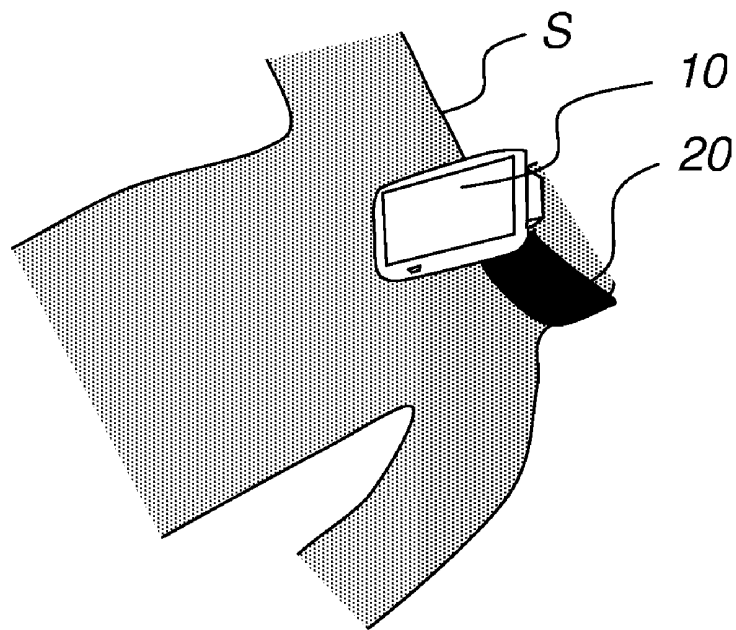


FIG. 2B

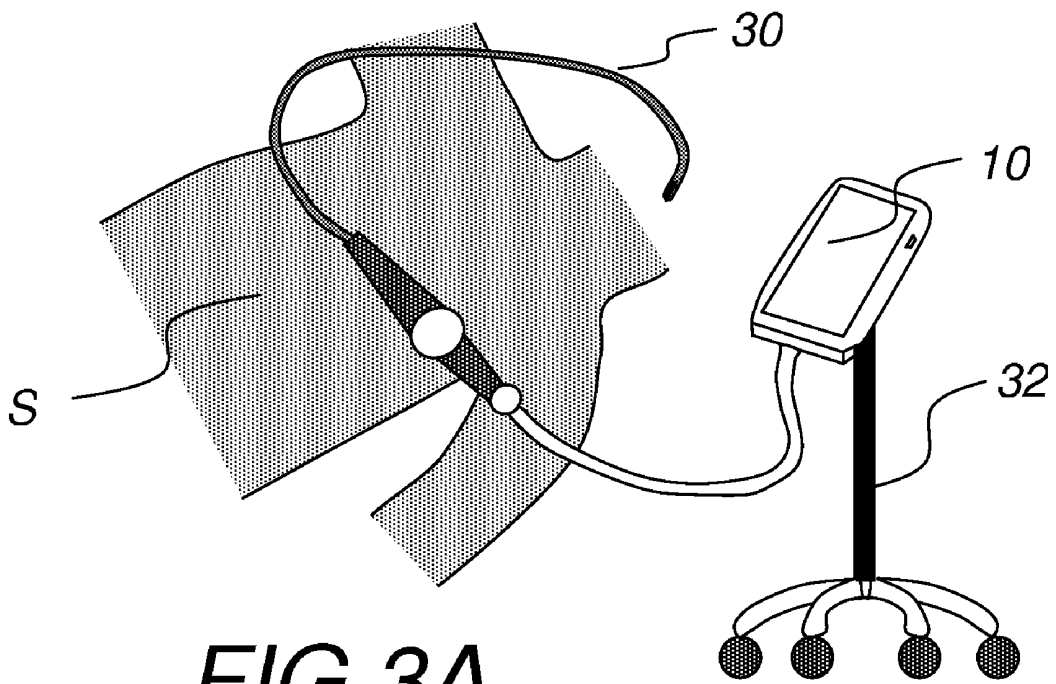


FIG. 3A

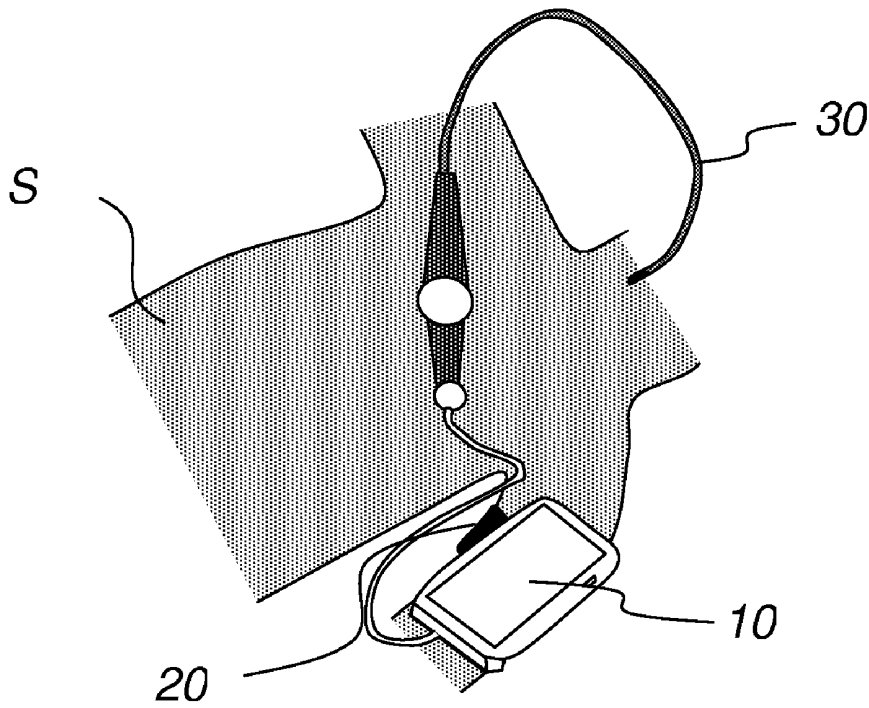


FIG. 3B

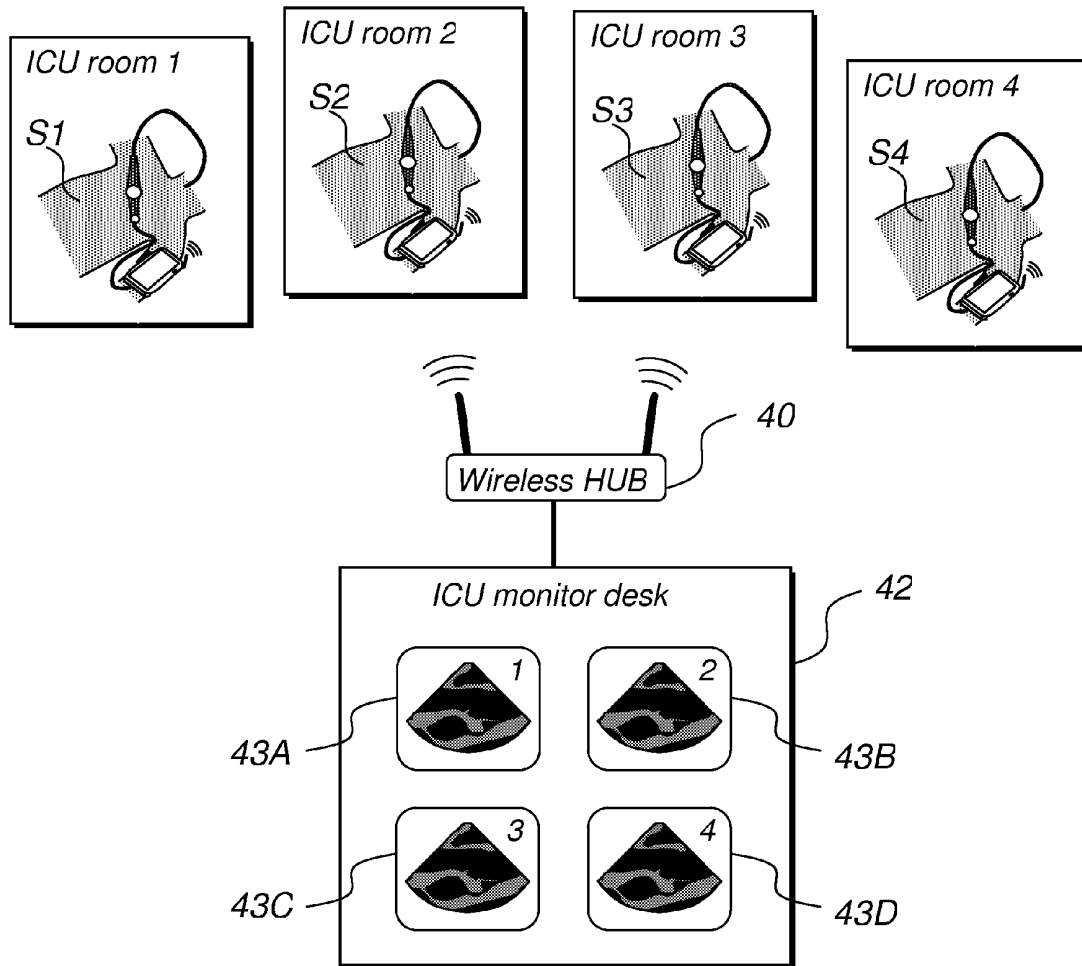


FIG.4

WIRELESS NETWORK HAVING PORTABLE ULTRASOUND DEVICES

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation of U.S. patent application Ser. No. 12/188,193 filed 7 Aug. 2008, which claims the benefit under 35 U.S.C. §119 of U.S. patent application No. 60/955331 filed on 10 Aug. 2007, all of which are entitled WIRELESS NETWORK HAVING PORTABLE ULTRASOUND DEVICES. This application claims the benefit under 35 U.S.C. §120 of U.S. patent application No. 60/955331 filed on 10 Aug. 2007 and entitled WIRELESS NETWORK HAVING PORTABLE ULTRASOUND DEVICES.

TECHNICAL FIELD

[0002] This invention relates to medical monitoring systems. The invention relates particularly to systems which apply ultrasound to detect physiological features or characteristics of a subject.

BRIEF DESCRIPTION OF DRAWINGS

[0003] Exemplary embodiments are illustrated in referenced figures of the drawings. It is intended that the embodiments and figures disclosed herein are to be considered illustrative rather than restrictive.

[0004] FIG. 1 is a schematic view of a system according to an example embodiment of the invention.

[0005] FIGS. 2A and 2B show ultrasound devices having holding means such as straps.

[0006] FIGS. 3A and 3B show ultrasound devices deployed to monitor subjects for extended periods.

[0007] FIG. 4 is a schematic view showing an example embodiment of the invention deployed in a Intensive Care Unit.

DESCRIPTION

[0008] Throughout the following description specific details are set forth in order to provide a more thorough understanding to persons skilled in the art. However, well known elements may not have been shown or described in detail to avoid unnecessarily obscuring the disclosure. Accordingly, the description and drawings are to be regarded in an illustrative, rather than a restrictive, sense.

[0009] The features as described herein may be combined in any suitable combinations with the features described in the commonly-owned U.S. provisional patent applications entitled:

[0010] HAND-HELD ULTRASOUND SYSTEM HAVING STERILE ENCLOSURE (application No. 60/955327);

[0011] HAND-HELD ULTRASOUND IMAGING DEVICE HAVING RECONFIGURABLE USER INTERFACE (application No. 60/955328);

[0012] POWER MANAGEMENT IN PORTABLE ULTRASOUND DEVICES (application No. 60/955329);

[0013] HAND-HELD ULTRASOUND IMAGING DEVICE HAVING REMOVABLE TRANSDUCER ARRAYS (application No. 60/955325); and

[0014] HANDHELD ULTRASOUND IMAGING SYSTEMS (application No. 60/977353) all of which are hereby incorporated herein by reference. The features as described

herein may also be combined in any suitable combinations with the features described in the commonly-owned U.S. non-provisional patent applications which are filed on the same day as the instant application and entitled:

[0015] HAND-HELD ULTRASOUND SYSTEM HAVING STERILE ENCLOSURE (claiming priority from application No. 60/955327);

[0016] HAND-HELD ULTRASOUND IMAGING DEVICE HAVING RECONFIGURABLE USER INTERFACE (claiming priority from application No. 60/955328);

[0017] POWER MANAGEMENT IN PORTABLE ULTRASOUND DEVICES (claiming priority from application No. 60/955329);

[0018] HAND-HELD ULTRASOUND IMAGING DEVICE HAVING REMOVABLE TRANSDUCER ARRAYS (claiming priority from application No. 60/955325); and

[0019] HANDHELD ULTRASOUND IMAGING SYSTEMS (claiming priority from application No. 60/977353) all of which are hereby incorporated herein by reference.

[0020] FIG. 1 is a schematic view of a network comprising a plurality of portable ultrasound devices 10 which are in wireless connection with a central station on the network. Communications between devices 10 and central station 20 may be provided by any wireless networking technology suitable for use in the area in which the network is deployed. The network may be deployed, for example, in a hospital, medical clinic, or the like. In some embodiments, the wireless networking may be provided by way of "WiFi" networking technology (e.g. a technology according to an IEEE 802.11 standard). In some embodiments, an interface to the wireless network is hard-wired into device 10. In other embodiments, device 10 has a slot that can receive a networking card. For example, a device 10 may have a slot for receiving a card such as a microSD card and a wireless interface that connects to the slot.

[0021] The protocol by which data is communicated between device 10 and central station 20 or other devices over the wireless network may optionally provide compression of data. This reduces the amount of data to be transmitted over the wireless network at the expense of some computation (and/ or compression hardware) at the device 10.

[0022] Portable ultrasound devices 10 each have a transducer assembly 16 which can emit ultrasound signals. The ultrasound signals can interact with a subject and are reflected back to transducer assembly 16. Reflected signals are detected by device 10.

[0023] By applying suitable signal processing to reflected signals picked up at device 10, it is possible to generate an ultrasound image which contains information about the physiology of a subject or a physiological status of the subject. Different types of images or other information may be obtained by operating devices 10 in different modes. Signal processing algorithms are performed on reflected signals to generate the images or other desired information.

[0024] Device 10 may comprise a control and data processing system that controls the operation of device 10 and processes ultrasound data acquired at transducer assembly 16. The control and data processing system may comprise one or more programmed data processors, signal processing circuits, configurable logic circuits such as a field-programmable gate arrays, or a suitable combination thereof.

[0025] In a preferred embodiment, signal processing to generate ultrasound images is performed in each portable

device **10** and the resulting images are displayed upon a screen **14** of the device **10**. Image data from devices **10** is also, or in the alternative, conveyed back to central station **20** by way of the wireless network. At central station **20**, the images may be displayed. It is not necessary for devices **10** to display ultrasound images in all embodiments.

[0026] In some embodiments, device **10** may generate alerts in response to detecting certain conditions relating to a subject being monitored. The alerts may be transmitted to central station **20** and may also, or in the alternative, be transmitted to portable devices being carried by medical personnel. For example, a device **10** may generate an alert upon a detected heart beat becoming irregular, exceeding or falling below threshold rates or a failure to detect a pulse signal. The alert may be transmitted to a portable device carried by a responsible physician and/or a portable device carried by a responsible nurse. In some embodiments, central station **20** is configurable to forward alerts to one or more pagers or other portable devices that have been associated with a device **10**.

[0027] In some embodiments, a user may carry a portable viewer which enables the user to view images from a device **10**. The images may be received directly from the device **10** or may be retrieved from central station **20**. Communication between the portable viewer and the device **10** and/or central station **20** may be provided by way of the wireless network. For example, a physician or other user may carry a portable viewer that has a user interface control which permits the physician or other user to select a device **10**. Upon selecting the device **10** the viewer may receive an image originating from the device **10** and display the image for inspection by the physician or other user. In some embodiments, each device **10** has a code (which may be marked on the device **10**) and the viewer may permit a user to enter the code to cause an image originating from the corresponding device **10** to be viewed.

[0028] In some embodiments, the signal processing performed at devices **10** is less intensive, but it is sufficient to allow an operator of the device **10** and to see an image that is clear enough to perform the desired imaging operation. The image data transmitted to central station **20** may be further processed at central station **20** to provide more refined images.

[0029] At central station **20** images may be displayed on a display **22** and/or stored in a database **24**, printed on a hard copy unit **25** or transmitted to another destination by way of a computer network to which central station **20** is attached either wirelessly or by some other networking technology.

[0030] As shown in FIGS. 2A and 2B, a device **10** may be equipped with a strap **20**, or other retaining mechanism, which allows the device **10** to be held in place with transducer assembly **16** pressed against the skin of a subject **S**. Device **10** may be held in place in such a location that an ultrasound image may be acquired of some anatomical feature of subject **S** using the ultrasound device **10**. When attached to a subject **S**, a device **10** may operate continuously or intermittently to generate an image of a structure within the subject **S** that is being monitored (for example, the image may be an image of a site of which the subject has been operated on, or a area within the body where fluids are building up or otherwise needs monitoring), or the operation of an organ within the subject **S**'s body, such as the heart or the like. Device **10** may thus monitor subject **S** over an extended period of time.

[0031] In addition to or instead of generating an image, a ultrasound device **10** may acquire other information regarding the physiological status of subject **S**. For example, the

device **10** may make Doppler blood flow measurements at certain points within the individual without necessarily acquiring an image.

[0032] Signals from devices **10** may be relayed back to central station **20** where images acquired by devices **10** may be viewed on display **22**. Central station **20** may be configured to monitor features of the signals from devices **10** and to generate an alarm if those features deviate from a predicted pattern. For example, alarms may be generated upon one or more of the following events:

[0033] A device **10** ceases transmitting an image that can be recognized as representing some part of the anatomy of the subject **S**—this would occur if the device **10** somehow become dislodged from its desired position.

[0034] A device **10** detects that measured parameter, such as a Doppler blood flow parameter deviates from an acceptable value.

[0035] A device **10** detects the presence of a void within the subject **S** as might occur in the case that the subject was suffering from edema or internal bleeding. Signal processing algorithms applied at central station **20** to images generated by devices **10** can detect the possible presence of such voids in the images.

[0036] FIGS. 3A and 3B illustrate devices **10** equipped with trans-esophageal probes **30** may be inserted into subjects **S** by way of the esophagus (either through an opening or inserted into the subjects' mouths and down the subject's throats (if the subjects are unconscious or otherwise in a condition to receive a probe orally). Probes **30** include ultrasound transducers which transmit ultrasound signals and receive ultrasound signals that have been reflected from within the patient.

[0037] In FIG. 3A, device **10** is shown mounted on a stand **32**. In FIG. 3B, device **10** is shown strapped to the subject's arm with a strap **20**. In both embodiments, device **10** is a portable device which is mounted so that it can be used to monitor subject **S** over an extended period of time without the need that the device **10**, or its probe **30**, be continuously held or manipulated by a physician, nurse, or other operator.

[0038] FIG. 4 shows an example embodiment of the invention deployed in a Intensive Care Unit. Subjects **S1**, **S2**, **S3** and **S4** are respectively located in Intensive Care Unit rooms 1, 2, 3 and 4. A device **10** is provided for monitoring each subject. Each device **10** has a trans-esophageal probe **30** which is inserted into the subject and monitors the functioning of the subject's heart. Each device **10** may operate in a Doppler mode, for example.

[0039] Signals from devices **10** are transmitted wirelessly to a wireless hub **40**. Wireless hub **40** receives the signals and transmits the data from the signals to an ICU monitoring desk **42** which displays images **43A**, **43B**, **43C** and **43D** which correspond respectively to subjects **S1**, **S2**, **S3** and **S4**.

[0040] By using the network shown in FIG. 4, a full ultrasound ICU type environment can be simulated at any desktop to monitor multiple or single patients.

[0041] Where a component (e.g. a software module, processor, assembly, device, circuit, etc.) is referred to above, unless otherwise indicated, reference to that component (including a reference to a "means") should be interpreted as including as equivalents of that component any component which performs the function of the described component (i.e., that is functionally equivalent), including components which are not structurally equivalent to the disclosed structure

which performs the function in the illustrated exemplary embodiments of the invention.

[0042] While a number of exemplary aspects and embodiments have been discussed above, those of skill in the art will recognize certain modifications, permutations, additions and sub-combinations thereof.

What is claimed is:

1. A patient monitoring system comprising:
 at least one ultrasound device comprising an ultrasound transceiver,
 an ultrasound transducer connected to transmit and receive ultrasound signals,
 a control and data processing system configured to cause the ultrasound device to operate intermittently to generate first images of a structure within a subject that is being monitored and by processing ultrasound signals received at the ultrasound transducer by applying first processing to the ultrasound signals to generate the first ultrasound images,
 a local display operable to display the first ultrasound images, a wireless network interface, and
 a retaining mechanism which allows the ultrasound device to be held in place with the ultrasound transducer against a subject for extended monitoring of a structure within the subject; and
 a station connected to a network to receive ultrasound data from the ultrasound device by way of the wireless network interface and network, the station comprising a station display and a processor configured to further process the ultrasound data from the ultrasound device according to second processing different from the first processing to generate second ultrasound images for display on the station display;
 wherein the ultrasound device or the station is configured to process the ultrasound data to detect the presence of voids within the subject and to generate an alarm signal when the result of the processing indicates that a void is present within the subject.

2. A patient monitoring system according to claim 1 wherein the ultrasound device is marked with a code and the system further comprises a portable viewer comprising a display and a wireless interface, wherein upon selection of the code corresponding to the ultrasound device at the portable viewer, the portable viewer is configured to wirelessly receive from the ultrasound device the first ultrasound images and to display the first ultrasound images on the display of the portable viewer.

3. A patient monitoring system according to claim 1 wherein the station is configured to: process the ultrasound data to determine whether an image in the ultrasound data transmitted from the ultrasound device can be recognized as representing a part of the anatomy of the subject and to generate an alarm signal upon the ultrasound image data from the device ceasing to represent the part of the anatomy of the subject.

4. A patient monitoring system according to claim 1 wherein processing the ultrasound signals comprises detecting a heart beat signal and wherein the ultrasound device is configured to generate an alarm signal in response to detecting that the heartbeat signal has: become irregular, has a rate exceeding a high threshold rate; has a rate below a low threshold rate; or is absent.

5. A patient monitoring system according to claim 4 wherein the ultrasound device comprises an elongated flexible esophageal probe wherein the ultrasound transducer is on the esophageal probe.

6. A patient monitoring system according to claim 1 wherein the station is configured to generate an alarm signal upon the station ceasing to receive the ultrasound image data from the device.

7. A patient monitoring system according to claim 1 wherein the retaining mechanism comprises a strap.

8. A patient monitoring system according to claim 3 wherein the ultrasound device has a Doppler ultrasound mode.

9. A patient monitoring system according to claim 1 comprising a plurality of the ultrasound devices wherein the station is connected to the network to receive ultrasound data from all of the plurality of ultrasound devices.

10. A patient monitoring system according to claim 9 wherein the station is configured to forward alerts relating to one of the plurality of ultrasound devices to one or more pagers or other portable devices that have been associated with the one of the plurality of ultrasound devices.

11. A patient monitoring system according to claim 10 wherein the portable devices are configured to generate the alerts in response to detecting conditions relating to subjects being monitored.

12. A patient monitoring system according to claim 11 wherein the ultrasound devices are configured to generate the alerts in response to a detected heart beat becoming irregular, exceeding or falling below upper and lower threshold rates or a failure to detect a pulse signal.

* * * * *

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申请(专利权)人(译)	ULTRASONIX医疗法人		
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摘要(译)

患者监测系统具有一个或多个监测患者的超声装置。超声设备可以通过无线数据通信网络与中心站通信。由超声设备获取的超声图像可以显示在中心站。可以基于超声设备检测到的条件生成警报。超声装置可具有带子，该带子允许其利用换能器抵靠受试者的皮肤保持在适当位置，以允许在延长的时间段内连续或间歇地超声观察受试者。

