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(54) **A SYSTEM FOR REMOTE EVALUATION OF ULTRASOUND INFORMATION OBTAINED BY A PROGRAMMED APPLICATION-SPECIFIC DATA COLLECTION DEVICE**

SYSTEM ZUR FERNAUSWERTUNG VON DURCH EIN PROGRAMMIERTES ANWENDUNGSSPEZIFISCHES DATENGEWINNUNGSGERÄT AUFGENOMMENEN ULTRASCHALLINFORMATIONEN

SYSTEME DE TELEEVALUATION D'INFORMATIONS SOUS FORME D'ULTRASONS OBTENUES PAR UN DISPOSITIF PROGRAMMABLE DE RECUEIL DE DONNEES PROPRES A DES APPLICATIONS

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Description

Technical Field

[0001] This invention relates generally to medical diagnostic systems using ultrasound, and more particularly concerns application-specific medical ultrasound systems.

Background of the Invention

[0002] The majority of medical ultrasound examinations/procedures are carried out using "general purpose" ultrasound machines, which produce images of a selected portion of the human body. These images are in turn interpreted by a trained specialists in ultrasound. Radiologists, sonographers and, in some cases, specially trained physicians, usually in certain specialties, are among those who are trained to read and interpret an ultrasonic image. The cost of a general purpose ultrasound machine, however, is quite high, as is the cost of interpretation. Accordingly, an ultrasound procedure is typically quite expensive. This cost factor inherently limits the use of ultrasound, even though it is potentially a widely applicable, non-invasive diagnostic tool.

[0003] WO 99/66841 describes an ultrasonic imaging system for imaging anatomic structures which have periodic physiologic motion. The collection image frame rate is adjustable.

[0004] An alternative to the general purpose ultrasound machine is an application-specific ultrasound device. With an application-specific device, instead of using a general purpose ultrasound machine, a single type of ultrasound procedure is accomplished. There are many examples of application-specific or single purpose ultrasound machines. Two examples are shown in U.S. Patent No. 4,926,871 and U.S. Patent No. 5,235,985, both of which are directed toward a device for measuring the amount of urine in the bladder.

[0005] Instead of producing a real-time image which must be interpreted by a skilled operator, by measuring the image and then calculating the volume, the application-specific apparatus uses ultrasound signals and follow-on signal processing to automatically locate the bladder within the overall ultrasound volume, determine its boundaries, and then automatically compute the bladder volume, which is then provided to the trained, but not ultrasound skilled (e.g. sonographer), operator.

[0006] While bladder volume, of course, can be determined using a general purpose machine, as indicated above, an application-specific machine itself produces an actual volume number. This approach not only decreases the time to produce a bladder volume determination, it is also typically more accurate, and certainly less expensive. It does not require the services of an ultrasound-skilled operator, because the machine itself automatically produces the desired bladder volume information once the ultrasound probe (transmitter/receiver) has been properly positioned.

[0007] Application-specific ultrasound devices significantly lower the cost of ultrasound examinations and thus can be regularly used for a single patient in order to track bladder volume information over an extended period of time. This has proved to be extremely useful in both diagnosis and treatment of bladder dysfunction.

[0008] There are many other examples of application-specific ultrasound machines. These include machines which determine abdominal aorta size and kidney volume, among others. The significant disadvantage of application-specific ultrasound machines is that they are, in fact, just that -- useful for just a single application. It would be too expensive and too cumbersome for a physician, particularly a general practitioner, to maintain a large number of application-specific ultrasound machines, even though ultrasound is useful in a variety of diagnostic situations.

[0009] Accordingly, it would be desirable to have an ultrasound system which is inexpensive, reliable and which does not require a specially trained operator and which further can be used in a variety of diagnostic situations.

Summary of the invention

[0010] Accordingly, in one aspect of the invention there is provided a system as claimed in claim 1. In another aspect of the invention there is provided a method as claimed in claim 16. In the following any example and embodiment which does not fall under the scope of the independent claims is not part of the invention.

Brief description of the drawings

[0011]

Figure 1 is a diagram showing the complete system of an embodiment of the present invention.

Figure 1A is a diagram illustrating the overall system of an embodiment of the present invention.

Figure 2 is a diagram showing the ultrasound coverage of the transducer portion of the system of Figure 1.

Figure 3 is a diagram showing the block diagram of the data collection device portion of Figure 1.

Figure 4 is a flow chart showing the operation of a portion of the system of an embodiment of the present invention.

Figure 5 is a flow chart showing steps in a business method.

[0012] Figure 1 shows the overall system of an embodiment of the present invention. The patient upon whom the ultrasound procedure is to be performed is shown generally at 10. In Figure 1, the patient is shown in a supine position on a table 11; however, the patient can be in virtually any position, depending upon the par-

ticular section of the body being imaged by the ultrasound device.

[0013] A data collection device (DCD) is shown generally at 12. DCD 12 includes a conventional ultrasound transducer (transmitter/ receiver) 14 (Figure 3). DCD 12 is programmed, as described below, to perform a specific ultrasound examination. In general, the operator places DCD 12 appropriately on the patient in the region which is to be imaged, and the ultrasound procedure is undertaken by the transmission and return of ultrasound signals. As an example, if the bladder is to be imaged, DCD 12 is placed on the skin area adjacent the bladder. The same procedure would be followed for other organs or areas of the body. The ultrasound information obtained by the DCD is then transmitted to a remote location where it is processed to produce a recognizable result of some kind, such as a three-dimensional model of the body part being imaged or specific numerical result.

[0014] More specifically, referring still to Figure 1, DCD 12 is used in combination with an internet-connected "thin server" 17, linked to DCD 12 by a communication link 15. In one example, thin server 17 can be an off-the-shelf personal digital system (PDA). Alternatives to the PDA could include a conventional PC, laptop or other internet-accessible device. PDA 17 includes a conventional web browser and through the internet 16 can log onto a system ultrasound web database and server, generally indicated at 18. Web database and server 18 will, among other data, maintain a list of patients for the physician using the DCD and PDA combination.

[0015] Prior to beginning the ultrasound procedure, the patient is first identified to the PDA. If the patient is not in the web database 18, information about the patient will be created in the form of a record for storage in web database 18. PDA 17 will then display a list of application-specific programs for possible use by the data collection device 12. The selected program will then control the operation of the DCD for a specific ultrasound application.

[0016] The operator will select one from the list of programs available, which will then be downloaded into the data collection device 12. The communication link 15 between DCD 12 and PDA 17 can be either hard wire or wireless, such as infrared. In the event that infrared is used, DCD 12 and PDA 17 will be placed in a rack or stand 19 which will align the two devices appropriately for a line-of-sight Ir infrared transmission. The specific selected program selection is then transmitted through PDA 17 from the system database 18 through the internet.

[0017] DCD 12 may vary in shape, depending upon the surface of the body on which it is used, particularly whether it is to be used internally, such as vaginally, or externally, such as on the chest or abdominal area. DCD 12 in the embodiment shown is battery-powered and quite rugged in construction and will be operated by a simple on-off switch or push-button.

[0018] The DCD includes a spherical coordinate control module for the ultrasound transducer. The control module includes two stepper motors working in combination that will sweep the ultrasound transducer (and the ultrasound signals) through a three-dimensional volume.

[0019] Referring to Figures 2 and 3, DCD 12 includes a microprocessor 22 which controls the movement of the transducer 14 through a two-axis stepper motor control 26, which is used to step the transducer through a three-dimensional volume in precise movements. One motor (not shown) moves the transducer 14 through a specific angle in a given plane, referred to as the phi (φ) dimension (Figure 2). This angle can be varied, but in the embodiment shown is 120°. Approximately 77 ultrasound signals are transmitted in the embodiment shown as the transducer is moved through the 120° angle in one phi plane. This could differ; in another embodiment, the number of ultrasound signals could be up to 120.

[0020] After the ultrasound signal sweep in the one phi plane is made, a second motor (not shown) moves the transducer in the theta (θ) direction, shown in Figure 2. The transducer 14 is then again swept through a 120° angle phi plane. This process continues until the transducer has completed a 360° theta coverage. While in some cases it may not be necessary to complete a 360° coverage, the system of the embodiment of the present invention has the ability to do so. In the embodiment shown, successive scan lines are separated by 1.5°, although this can be readily varied. The resulting three-dimensional ultrasound "cone" coverage is shown in Figure 2. It should be understood, however, that other coverage patterns can be successfully used, depending upon the ultrasound procedure to be accomplished.

[0021] In generating the ultrasound signals, the microprocessor 22 pulses a digital signal processor (DSP) 30 to produce the ultrasound signals, at a typical frequency of 3.7 MHz, although this could be within the range of 1-12 MHz. The ultrasound signals are applied to an amplifier 32 and then to transducer 14, which transmits ultrasound signals to the body area of interest. Return signals are directed through the receiving portion of transducer 14 into a time controlled gain (TCG) amplifier 34. The output from TCG amplifier 34 is applied to an analog-to-digital converter 36, which outputs the resulting digital information on twelve output lines 39 to the digital signal processor 30, which then directs the data into SRAM memory 44 (static random access memory). An address bus 42 connects microprocessor 22, flash memory 40 and SRAM 44. Flash memory 40 stores the program information.

[0022] Figure 1A shows a generalized system of the present invention utilizing the internet (WWW) 21, a plurality of DCD devices 23-23, which could be either single or multiple module DCDs (as explained in more detail hereinafter), a central database and server 25 and a plurality of IEDs (intelligent electronic devices), including, for example, a PC with a browser 27, a laptop with browser 29, or a PDA with browser 31.

[0023] In the overall system, the central database and

server 25 connected to the internet 21 has a capability of communicating with a large plurality of DCD devices positioned at various physical locations, such as at various clinics or doctor's offices, each one of which is separately maintained and accounted for by the physician-user at that location. The DCD devices 23-23 may be either a single module device or one with multiple modules. In the system arrangement of Figure 1A, the cost of an individual DCD is small, particularly compared with a general purpose ultrasound machine, since the DCD can be fairly simple, typically without significant processing power.

[0024] The cost of connection to the internet for the DCD, such as through a PDA as shown in Figure 1 or by some other arrangement, is also quite small. Hence, it is relatively easy for a physician-user to fund his/her part of the system. The processing of the ultrasound image collected by the DCD occurs in the web database server 25. The processed output from database server 25 is then fed back to the practitioner through the internet 21 to the practitioner's IED, which will include conventional browser technology. The ultrasound data collected by the DCDs and transmitted to the web database and server typically will be compressed, as is the information from the web database server 25 back to the individual IEDs.

[0025] A flow chart for downloading the data-collection software into the individual DCD devices is shown in Figure 4. The data collection software runs in the DCD during the collection of the ultrasound data. It is application-specific, i.e. it is specific to the type of ultrasound procedure being conducted. The web database server maintains a list of software available for each DCD in the system and which are authorized for use by that DCD. Authorization of use of specific software may be maintained by appropriate payment by the user of each DCD.

The present system permits every DCD instrument to be upgraded or just selected DCD instruments. Once a DCD communicates with the database server for particular software, if new software for that particular application is available, the new software will be loaded into the DCD, if the DCD listed version does not match the overall database software for that specific application.

[0026] In the flow chart of Figure 4, after the DCD is initially powered, a determination is made as to whether or not the particular requested data collection program exists at the server for that DCD. If the data collection program does exist, a determination is then made at block 62 as to whether or not a replacement data collection program is available from the server. If the answer is "yes", or if the requested data collection program does not currently exist in the list for that DCD, the requested data collection program is downloaded from the server (block 64). If the data collection program, on the other hand, does exist in the DCD list and there is no replacement program, then ultrasound data is collected, along with voice (audio) information, typed information and/or digital picture information, if desired, as shown at block 66. The actual ultrasound information is annotated with the additional information (block 68) and then uploaded to the server (block 70) for analysis, as discussed above.

[0027] Figure 3 shows microprocessor 22 controlling a DCD with a total of four identical modules, each with its own transducer. All the modules are served by the microprocessor 22 and the SRAM/flash memory 44, 40. When the modules are ganged together, the field of view being imaged is significantly increased. For instance, a DCD that includes four modules ganged together in a straight line would be appropriate for imaging a narrow but elongated body structure. Larger anatomies, such as the aorta or a third trimester fetus, require even a larger plurality of DCD modules (perhaps a total of 10 modules in three columns) arranged to cover the desired volume. The multiple module DCD, with its corresponding larger field of view, increases the probability of obtaining an image that includes the portion of the body of interest, where some part or feature of the portion of interest may be hidden from view from a single module by shadow structures, such as bowel gas, stones or bone.

[0028] The plurality of modules in the DCD are typically operated in parallel so that the total scan time for a multiple module DCD is approximately the same as that for a single module. The transducers in each module have a spatial pattern and orientation (start and stop points) of movement so that their ultrasound signals will not interfere with each other. In some cases, it may be desirable to orient the individual transducers such that one transducer is transmitting while others are receiving relative to the same target. As indicated briefly above, the use of multiple modules, each with a 120° scan angle (as compared to the more typical 75º scan angle), produces more accurate overall images, since the target area is being scanned from more than one position. Such an arrangement produces superior ultrasound data, without the need for a highly skilled device operator.

[0029] The ultrasound information gathered by the DCD 12, converted to digital signals and transferred to memory, is then transmitted over a connecting link (Ir link 46 in Figure 3) to the PDA or similar unit 17 (Figure 1). It should be understood, however, as indicated briefly above, that other communication links can be used, including various infrared links/protocols, an RF connection or other compliant interface (the "Bluetooth" interface is one example). As indicated above, the PDA 17 is referred to as generally being a "thin" server, which could be a PDA, as indicated, a PC (with Windows software) or any other conventional internet connectable device; even a cell phone having an internet connectability would produce satisfactory results.

[0030] The data obtained by the DCD is then sent to the web database server 18 which is connected to the internet. The link between PDA 17 and the internet 16 is by any standard internet access. The database server 18, as indicated above, includes a number of application-specific collection programs which can be downloaded into the DCD through the internet and the PDA.

[0031] Once the raw ultrasound data from the DCD 12

is uploaded into database 18, it can be processed in a number of different ways. First, the web database server 18 may include diagnostic software which can itself evaluate the raw data to provide a resulting diagnosis. Further, the database software can create a three-dimensional model of the portion of the body being investigated from the ultrasound information. For instance, in the ultrasound examination of a kidney, a three-dimensional picture of an imaged kidney can be produced, along with any interior stones, which could be shown as interior solid objects. In another example, the abdominal aorta could be shown in three dimensions, along with an indication of the maximum diameter of the aorta.

[0032] The resulting processed information from the database server 18 is available to the physician, who has access to the database server 18 through his own PC or similar terminal unit. After review of the information, the physician can then take appropriate action, including, if necessary, instructing the patient to go to the hospital for emergency treatment. Alternatively, the basic ultrasound data could be interpreted at the database server location by an ultrasound technician, or through a combination of processing and skilled interpretation.

[0033] The system of the present technique also has a number of additional special features. Referring now again to Figure 3, the system includes an accelerometer 50 which can be used to detect instrument motion in three-dimensional space. This allows the system to detect and correct for motion introduced if either the operator or the patient inadvertently moves during the ultrasound procedure. In some applications, the accelerometer 50 can be used in monitoring a maximum threshold displacement which may occur during the ultrasound scanning of the patient. If patient movement exceeds the threshold, as determined by the accelerometer, an indication can then be provided to the operator that the scan needs to be re-done. In other applications, the record of motion provided by the accelerometer can be used to orient each individual scan line (the phi scan) with respect to other scan lines. This assures a locked geometry between the successive scan lines.

[0034] Accelerometer 50 is sensitive enough to resolve the gravity effect produced by the earth. This allows the system to obtain an indication of the patient's position during the examination. If the patient were supine, with the instrument on the patient's abdomen, the gravity vector would be straight down, normal to the direction of the ultrasound signals. However, even if the position of the patient is known, by means of external information, the earth gravity vector can still provide useful information, e.g. if the patient is supine, and the ultrasound examination is of the patient's bladder, the angle of the ultrasound probe is provided by the gravity vector. The probe angle is important information for a system which does not include the use of a trained sonographer.

[0035] In the operational steps of the overall system, which includes the various portions of the system discussed above, an operator first uses the thin server (PDA 17) to access the ultrasound database server 18 through the internet connection. If the patient's record is not in the database, a record is created. The PDA 17 will then provide a list of software available to it from the database for application-specific examinations. The correct one is selected by the operator and the control software for that application then is downloaded into the DCD 12. Once this is completed, the PDA screen will produce a screen image (from the ultrasound web database server 18) with an explanation of how to position the DCD 12 on the patient for the particular selected examination.

[0036] The operator then applies a standard coupling gel or gel pad article to the DCD 12 and orients the DCD on the patient, as shown on the PDA 17, and presses the scan button on the DCD 12. The DCD 12 then transmits and collects all of the required ultrasound raw data in a short amount of time, typically two seconds or less.

[0037] After the ultrasound data collection is completed, the operator returns DCD 12 to the equipment stand or otherwise positions it in such a way that DCD 12 can communicate via infrared with the PDA 17, and from there to the web database server 18. The uploading of data typically takes a relatively small amount of time, typically less than 45 seconds, and during that time, the operator can locate the patient's record on the database and link the new ultrasound information with the patient's existing record. Once the raw information is in database server 18, it is processed such that it can be readily interpreted by the operator or a physician. The physician will then take appropriate action, if any action is indicated.

[0038] In the system of the present technique, a single web database server 18 can respond to many DCDs. The database server 18 will keep a list of software which is available and authorized for each DCD which is connectable to it through the internet. With such an arrangement, the DCD can be a relatively simple, inexpensive, robust device for transmitting and receiving ultrasound data, while the image processing of the data is accomplished by software in the web database server 18, which can serve a large number of similar DCD systems. This minimizes the cost for an individual ultrasound examination carried out with a DCD. The ultrasound data is typically compressed prior to transmission to the web database, which speeds up the transmission and reduces the file storage requirements on the internet server. The processed information can be fed back to the browser with compression as well.

[0039] In another specific additional feature, referring again to Figure 3, a CCD camera subsystem 52 is used with the DCD 12. The CCD camera 52 takes a digital photograph of the patient at the time of the ultrasound procedure. This photograph can be included with the patient's raw ultrasound data in the database. The operator can also take pictures of other important information, such as the patient's insurance card or other insurance information. A video camera can also be utilized as part of the CCD system. The database server 18 can also accept fingerprint or other scan information which aids

in patient identification.

[0040] In still another feature, again referring to Figure 3, a microphone and digitizer 54 could be included to record audio information. All audio information during the ultrasound procedure could be recorded, or just selective information provided by the operator.

[0041] The audio recording, after it is digitized, can then be readily "attached" or linked to the ultrasound data collected by the DCD and uploaded together to the web-based database server 18. The audio recording can be used at the web server, or can be used along with the processed ultrasound data by the physician-user through an internet connected device. The audio information can provide information concerning the procedure or other information concerning the patient.

[0042] Voice-print software can also be included at the web server to analyze the recording and identify the speaker, based on voice print biographical information. This would be another way to both identify the DCD operator and/or the patient.

[0043] In some cases, the operator will perform the ultrasound procedure and upload the raw data without necessarily identifying the patient. It is not mandatory that the operator find or create a patient record at the time of the ultrasound procedure. Further, since the ultrasound data will be stored in memory, there can be a lapse between the time of the ultrasound procedure and when the raw data is uploaded. When the raw data is uploaded, either shortly after the data is obtained or at a later time, an "exam incident" indicator can be created in database 18, which includes the exact time and date the procedure was performed, as well as the serial number of the device used. Database 18 will eventually be able to link the DCD instrument to a specific location and a list of possible users. When convenient, the operator will access the database, where the list of "exam incidents", connected with their facility/user name, is listed. The operator can then connect the appropriate patient to the exam.

[0044] The present technique has a number of applications in addition to the ability to provide ultrasound procedures quickly, efficiently and at a low cost. First, the database has the capability of maintaining and collecting every ultrasound examination on every patient in the database. This provides an ability to track a patient's history over time. For instance, by maintaining a complete history of all abdominal aorta scans, the system can provide an indication on the progression and growth of an aneurysm in the aorta. The data can even be presented in the form of a computer-generated video or movie of the characteristics of the particular organ changing over time. This visual information may also be a significant incentive for the patient to follow guidelines suggested by the physician.

[0045] The system also provides to the clinician an ability to "blind" clinical studies early in an application product design cycle. Raw data for a particular ultrasound examination can be collected in the course of normal patient flow. When a surgeon or other physician is treating a particular condition, they will take an ultrasound scan at the same time that a conventional CT or MRI examination is ordered. The radiologist or other professional interprets the results of the CT or MRI in normal course. An analysis of the ultrasound data is then also performed. The results can then be compared and a report generated concerning the correlation between the ultrasound results and the more conventional CT or MRI results.

[0046] One of the significant advantages of the present technique is the resulting relatively low cost to the physician, and to the patient, of an ultrasound examination. The DCD and PDA hardware are quite inexpensive compared to a traditional ultrasound machine. The charge made by a central system administrator for managing the database would also be relatively inexpensive. The actual cost would depend upon the processing necessary for a particular ultrasound procedure. The present system can also be used to develop appropriate billing for the patient's insurance provider, saving time and expense for the insurer.

[0047] Figure 5 shows a business payment system or method involving use of the remotely based ultrasound system of the present technique. In block 80, the acquiring event is shown, i.e. the ultrasound data is acquired by a user (typically a physician) using a DCD. The particular ID (identification) of the patient is attached to that data. In block 82, the data is transmitted (uploaded) to the internet and then to the database server, where it is processed as discussed above. - After processing is completed, it is then determined at block 84 whether the user's account is "blocked" and thereby prevented from receiving analysis information. If "yes", the user is provided a message to call a particular phone number or similar contact, at block 86.

[0048] The user then has the opportunity to take any action to re-open the account (block 88). The user's account will be blocked typically by an unpaid balance. If the user's account is not blocked, or is reopened by action of the user, the results of the processing are made available to the user, as shown at block 90.

[0049] After the results are made available to the user, both the identification number of the examination and the ID of the particular electronic instrument used are sent to the customer relationship management (CRM) accounting server, as shown at block 92. The CRM server then creates a billing for that user's account in accordance with the contract between the user and the system owner (block 94); the CRM server either bills the user's credit card or provides a statement for payment to the user, as shown in block 96. This is the end of the billing system relative to the user directly.

[0050] There is also a determination made by the accounting server as to whether a third party (insurance company) is to be billed for the service, as shown at block 98, which is a branch of the program. If not, the third party billing branch ends. If there is to be a third party billing, billing information is transmitted to the third party insurer, as shown at block 100. A confirmation of receipt is then

received from the insurer (block 102).

[0051] The overall business billing system includes coordination between the analysis and transmission of the ultrasound data and the determination of the status of the user's account. If the user's account is current, then the billing is automatically tallied and provided both to the user and/or to the insurance company, as appropriate.

[0052] Hence, an ultrasound system has been developed which combines relatively inexpensive data collection hardware at a physician's site with a remote processing and evaluation capability available to the physician by means of a web database server. The processing can be relatively inexpensive, with the result, such as a three-dimensional model, being made available to the physician for evaluation. In such an arrangement, the physician, without specialized ultrasound training, can readily make accurate diagnostic determinations from the results provided. A specialist in ultrasound interpretation is not necessary. Hence, the system is a general purpose, application-specific structure where the system performs in operation like an application-specific device, but has the capability, depending upon the program software, of operating and processing data like a plurality of different application-specific structures, using the same hardware and software base but with different program applications obtained from a central database.

[0053] Although a preferred embodiment of the invention has been disclosed here for purposes of illustration, it should be understood that various changes, modifications and substitutions may be incorporated without departing from the scope of the disclosure.

Claims

1. A system for generating application-specific medical ultrasound information, comprising:

an ultrasound data collection assembly (12) to carry out an ultrasound scan of a selected part of the human body of a patient at a given location and to produce ultrasound information therefrom;

an internet based database server (18) configured to:

provide, to a user device located remotely from the internet based database server (18), a list of application-specific programs associated with operation of the ultrasound data collection assembly (12),

receive a selection, via the user device, of one of the application-specific programs from the list of application-specific programs, and

download the selected one of the application-specific programs to the ultrasound data collection assembly,

wherein the ultrasound data collection assembly (12) is configured to carry out the ultrasound scan based on the selected one of the application-specific programs;

a data transmission system (17) for transmitting ultrasound information obtained by the assembly (12) to a processing location remote from the data collection assembly (12) location;

a processor (25) located at the processing location for processing the transmitted information sufficiently to permit a medical analysis of the selected body part therefrom;

wherein the internet based database server (18) comprises a memory structure which is configured for storing program information for a plurality of ultrasound procedures to be carried out by the data collection assembly (12), and storing information produced from the ultrasound procedure for each patient, and includes a data link between the memory structure and the data collection assembly (12).

2. A system of claim 1, wherein the data collection assembly (12) includes an ultrasound transducer (14) and an associated transducer control assembly for moving the transducer through a specified angle in a plurality of scan lines, with each successive scan line being separated by a selected angle.

3. A system of claim 2, wherein the scan lines cover approximately 360°, and each scan line is separated by approximately 1.5°.

4. A system of claim 2, wherein the selected angle is 120°.

5. A system of claim 1, wherein the ultrasound information is processed to produce a three-dimensional image of the human body part.

6. A system of claim 1, wherein communication between the data collection assembly (12) and the server/database (18, 25) includes an infrared communication link (15).

7. A system of claim 1, wherein the data transmission system includes a thin server (17) with an internet browser located with the data collection assembly (12), wherein the thin server (17) provides a visual image of the selected part of the body, so that an operator can properly position the ultrasound assembly (12) on the human body to carry out the selected ultrasound procedure.

8. A system of claim 1, including at least one accelerometer (50) to indicate movement of the ultrasound

assembly (12) or patient during the ultrasound procedure,
wherein the system is configured to:

correct for the movement, or
provide an indication that the ultrasound scan is to be re-done, in response to determining that the movement exceeds a threshold.

9. A system of claim 1, including a camera (52) for taking a visual image of the patient, and wherein said visual image information is transmitted to the database server (18, 25), along with the ultrasound information, to identify the patient.

10. A system of claim 1, including an audio recording assembly (54) for recording audio information associated with the ultrasound procedure, wherein the audio information is transmitted to the database server (18, 25), along with the ultrasound information.

11. A system of claim 1, including a plurality of ultrasound transducers (14) and associated transducer control assemblies, to provide an increased field of view of the body part being imaged.

12. A system of claim 1, wherein the transmitted information is sufficiently processed by the processor (25) that an ultrasound-skilled interpreter is not necessary for the medical analysis.

13. A system of claim 10, including a voice print system to identify the patient from the audio information.

14. A system of claim 13, wherein the plurality of ultrasound transducers (14) are controlled in such a manner that the ultrasound signals issuing therefrom do not interfere with each other.

15. A system of claim 1, wherein the database server (18, 25) includes means for accumulating information from successive ultrasound examinations of a given patient, thereby maintaining a patient history for said given patient.

16. A method for generating application-specific ultrasound information using an ultrasound data collection assembly (12), the method comprising:

selecting, by an operator of the ultrasound data collection assembly (12) from a list of application-specific programs, one application-specific program, the programs being configured to control the operation of the ultrasound data collection assembly (12);
downloading the selected one application-specific program from an internet based database server (18, 25) for carrying out an application-specific scanning of a part of a body;
scanning, based on the selected one application-specific program and at a first location using the ultrasound data collection assembly (12), the part of the body with ultrasound signals and receiving reflected ultrasound signals therefrom;
converting the received ultrasound signals into ultrasound medical information;
transmitting said ultrasound signals to the internet based database server (18, 25) at a second location remote from the first location; and
processing, at the second location, the information provided to the database server (18, 25) to produce an application-specific image of the part of the body for medical analysis.

17. A method of claim 16, wherein the step of scanning the body part includes transmitting a plurality of ultrasound signals in a sequence of individual planes, the planes being separated by a selected angle of rotation.

18. A method of claim 17, wherein the scanning covers 360°.

19. A method of claim 16, including the step of accumulating the ultrasound information from successive examinations of a given patient, thereby maintaining a patient history on said patient.

20. A method of claim 16, including the step of comparing the processed information with information results from another diagnostic tool, to produce a clinical evaluation of the effectiveness of the ultrasound analysis.

Patentansprüche

1. System zum Generieren von anwendungsspezifischen medizinischen Ultraschallinformationen, umfassend:

eine Ultraschall-Datensammlungsanordnung (12) zum Durchführen einer Ultraschalluntersuchung eines ausgewählten Teiles des menschlichen Körpers eines Patienten an einem vorgegebenen Ort und zum Erzeugen von Ultraschallinformationen daraus;
einen internetbasierten Datenbankserver (18), der konfiguriert ist, um: an ein entfernt von dem internetbasierten Datenbankserver (18) angeordnetes Nutzergerät eine Liste von anwendungsspezifischen Programmen, die dem Betrieb der Ultraschall-Datensammlungsanordnung (12) zugeordnet sind, zu liefern,

über das Nutzergerät eine Auswahl von einem der anwendungsspezifischen Programme von der Liste von anwendungsspezifischen Programmen zu empfangen, und
das ausgewählte eine Programm der anwendungsspezifischen Programme auf die Ultraschall-Datensammlungsanordnung herunterzuladen,
wobei die Ultraschall-Datensammlungsanordnung (12) konfiguriert ist, um die Ultraschalluntersuchung basierend auf dem ausgewählten einen Programm der anwendungsspezifischen Programme durchzuführen;
ein Datenübertragungssystem (17) zum Übertragen von mittels der Anordnung (12) beschafften Ultraschallinformationen an einen von dem Ort der Datensammtungsanordnung (12) entfernten Verarbeitungsort;
einen an dem Verarbeitungsort angeordneten Prozessor (25) zum ausreichenden Verarbeiten der übertragenen Informationen, um eine medizinischen Analyse des ausgewählten Körperteiles daraus zu gestatten;
wobei der internetbasierte Datenbankserver (18) eine Speicherstruktur umfasst, die konfiguriert ist, um Programminformationen für mehrere, von der Datensammlungsanordnung (12) durchzuführende Ultraschallprozeduren zu speichern und Informationen, die aus der Ultraschallprozedur für jeden Patienten erzeugt werden, zu speichern, und eine Datenverbindung zwischen der Speicherstruktur und der Datensammlungsanordnung (12) enthält,

2. System nach Anspruch 1, bei dem die Datensammlungsanordnung (12) einen Ultraschallwandler (14) und eine zugeordnete Wandler-Steuerungsanordnung zum Bewegen des Wandlers über einen bestimmten Winkel in einer Vielzahl von Abtastlinien enthält, wobei jede nachfolgende Abtastlinie durch einen ausgewählten Winkel getrennt ist.

3. System nach Anspruch 2, bei dem die Abtastlinien ungefähr 360° abdecken, und jede Abtastlinie durch ungefähr 1,5° getrennt ist.

4. System nach Anspruch 2, bei dem der ausgewählte Winkel 120° beträgt.

5. System nach Anspruch 1, bei dem die Ultraschallinformationen verarbeitet werden, um ein dreidimensionales Bild des menschlichen Körperteiles zu erzeugen.

6. System nach Anspruch 1, bei dem die Kommunikation zwischen der Datensammlungsanordnung (12) und dem Server bzw. der Datenbank (18, 25) eine Infrarot-Kommunikationsverbindung (15) enthält.

7. System nach Anspruch 1, bei dem das Datenübertragungssystem einen schlanken Server (17) mit einem Internet-Browser enthält, der bei der Datensammlungsanordnung (12) angeordnet ist, wobei der schlanke Server ein visuelles Bild des ausgewählten Körperteiles liefert, so dass eine Bedienungsperson die Ultraschallanordnung (12) richtig an dem menschlichen Körper positionieren kann, um die ausgewählte Ultraschallprozedur durchzuführen.

8. System nach Anspruch 1, das mindestens einen Beschleunigungsmesser (50) zum Anzeigen einer Bewegung der Ultraschallanordnung (12) oder des Patienten während der Ultraschallprozedur enthält, wobei das System konfiguriert ist, um:

die Bewegung auszugleichen oder
einen Hinweis zu geben, dass die Ultraschalluntersuchung infolge der Feststellung, dass die Bewegung einen Schwellenwert übersteigt, wiederholt werden muss.

9. System nach Anspruch 1, das eine Kamera (52) zum Aufnehmen eines visuellen Bildes des Patienten enthält, wobei die visuellen Bildinformationen zusammen mit den Ultraschallinformationen an den Datenbankserver (18, 25) übertragen werden, um den Patienten zu erkennen.

10. System nach Anspruch 1, das eine Audioaufnahmeanordnung (54) zum Aufnehmen von zu der Ultraschallprozedur gehörenden Audioinformationen enthält, wobei die Audioinformationen zusammen mit den Ultraschallinformationen an den Datenbankserver (18, 25) übertragen werden.

11. System nach Anspruch 1, das mehrere Ultraschallwandler (14) und zugehörige Wandler-Steuerungsanordnungen enthält, um ein vergrößertes Sichtfeld von dem Körperteil, der abgebildet wird, zu liefern.

12. System nach Anspruch 1, bei dem die übertragenen Informationen von dem Prozessor (25) ausreichend bearbeitet werden, dass ein in Ultraschall qualifizierter Deuter nicht nötig für die medizinische Analyse ist.

13. System nach Anspruch 10, das ein Stimmenabdrucksystem zum Erkennen des Patienten aus den Audioinformationen enthält.

14. System nach Anspruch 13, bei dem die mehreren Ultraschallwandler (14) derart gesteuert werden, dass sich die aus ihnen austretenden Ultraschallsignale nicht gegenseitig stören.

15. System nach Anspruch 1, bei dem der Datenbank-

server (18, 25) Mittel zum Speichern von Informationen aus aufeinanderfolgenden Ultraschalluntersuchungen eines bestimmten Patienten enthält, wodurch eine Patientenhistorie für den bestimmten Patienten unterhalten wird.

16. Verfahren zum Generieren von anwendungsspezifischen Ultraschallinformationen unter Verwendung einer Ultraschall-Datensammlungsanordnung (12), wobei das Verfahren umfasst:

Auswählen eines anwendungsspezifischen Programms aus einer Liste von anwendungsspezifischen Programmen durch eine Bedienungsperson der Ultraschall-Datensammlungsanordnung (12), wobei die Programme konfiguriert sind, um den Betrieb der Ultraschall-Datensammlungsanordnung (12) zu steuern;
Herunterladen des ausgewählten einen anwendungsspezifischen Programms von einem internetbasierten Server (18, 25) zum Durchführen eines anwendungsspezifischen Abtastens eines Teiles eines Körpers;
Abtasten des Körperteiles mit Ultraschallsignalen und Empfangen von davon reflektierten Ultraschallsignalen auf der Grundlage des ausgewählten einen anwendungsspezifischen Programms und an einem ersten Ort unter Verwendung der Ultraschall-Datensammlungsanordnung (12);
Umwandeln der empfangenen Ultraschallsignale in medizinische Ultraschallinformationen;
Übertragen der Ultraschallsignale zu dem internetbasierten Datenbankserver (18, 25) an einem von dem ersten Ort entfernten zweiten Ort; und
Verarbeiten der an den Datenbankserver (18, 25) gelieferten Informationen an dem zweiten Ort, um ein anwendungsspezifisches Bild des Körperteiles zur medizinischen Analyse zu erzeugen.

17. Verfahren nach Anspruch 16, bei dem der Schritt des Abtastens des Körperteiles das Übertragen einer Vielzahl von Ultraschallsignalen in einer Abfolge von einzelnen Ebenen enthält, wobei die Ebenen durch einen ausgewählten Drehwinkel voneinander getrennt sind.

18. Verfahren nach Anspruch 17, bei dem das Abtasten 360° abdeckt.

19. Verfahren nach Anspruch 16, das den Schritt des Speicherns der Ultraschallinformationen aus aufeinanderfolgenden Untersuchungen eines bestimmten Patienten enthält, wodurch eine Patientenhistorie über den Patienten unterhalten wird.

20. Verfahren nach Anspruch 16, das den Schritt des Vergleichens der bearbeiteten Informationen mit Informationsergebnissen von einem anderen diagnostischen Werkzeug enthält, um eine klinische Bewertung der Leistungsfähigkeit der Ultraschallanalyse zu erzeugen.

Revendications

1. Système pour générer des informations ultrasonores médicales spécifiques à une application, comprenant :

un ensemble de collecte de données ultrasonores (12) pour effectuer un balayage ultrasonore d'une partie sélectionnée du corps humain d'un patient à un emplacement donné et pour produire des informations ultrasonores à partir de celle-ci ;
un serveur de base de données sur Internet (18) configuré pour :

fournir, à un dispositif utilisateur situé à distance du serveur de base de données basé sur Internet (18), une liste de programmes spécifiques à une application associés au fonctionnement de l'ensemble de collecte de données ultrasonores (12),
recevoir une sélection, via le dispositif utilisateur, de l'un des programmes spécifiques à une application parmi la liste de programmes spécifiques à une application, et
télécharger le programme sélectionné parmi les programmes spécifiques à une application dans l'ensemble de collecte de données ultrasonores,
dans lequel l'ensemble de collecte de données ultrasonores (12) est configuré pour effectuer le balayage ultrasonore sur la base du programme sélectionné parmi les programmes spécifiques à une application ;
un système de transmission de données (17) pour transmettre des informations ultrasonores obtenues par l'ensemble (12) à un emplacement de traitement éloigné de l'emplacement de l'ensemble de collecte de données (12) ;
un processeur (25) situé à l'emplacement de traitement pour traiter les informations transmises suffisamment pour permettre une analyse médicale de la partie de corps sélectionnée à partir de celles-ci ;
dans lequel le serveur de base de données sur Internet (18) comprend une structure de mémoire configurée pour stocker des informations de programme pour une pluralité de procédures ultrasonores à exécuter par

l'ensemble de collecte de données (12), et pour stocker des informations produites par la procédure ultrasonore pour chaque patient, et comprend une liaison de données entre la structure de mémoire et l'ensemble de collecte de données (12).

2. Système selon la revendication 1, dans lequel l'ensemble de collecte de données (12) comprend un transducteur à ultrasons (14) et un ensemble de commande de transducteur associé pour déplacer le transducteur selon un angle spécifié dans une pluralité de lignes de balayage, chaque ligne de balayage successive étant séparée d'un angle sélectionné.

3. Système selon la revendication 2, dans lequel les lignes de balayage couvrent environ 360 °, et chaque ligne de balayage est séparée d'environ 1,5 °.

4. Système selon la revendication 2, dans lequel l'angle sélectionné est de 120 °.

5. Système selon la revendication 1, dans lequel les informations ultrasonores sont traitées pour produire une image tridimensionnelle de la partie de corps humain.

6. Système selon la revendication 1, dans lequel une communication entre l'ensemble de collecte de données (12) et le serveur/base de données (18, 25) comprend une liaison de communication infrarouge (15).

7. Système selon la revendication 1, dans lequel le système de transmission de données comprend un serveur léger (17) avec un navigateur Internet situé avec l'ensemble de collecte de données (12), le serveur léger (17) fournissant une image visuelle de la partie sélectionnée du corps, de sorte qu'un opérateur peut positionner correctement l'ensemble à ultrasons (12) sur le corps humain pour effectuer la procédure ultrasonore sélectionnée.

8. Système selon la revendication 1, comprenant au moins un accéléromètre (50) pour indiquer un mouvement de l'ensemble à ultrasons (12) ou du patient pendant la procédure ultrasonore,
dans lequel le système est configuré pour :

corriger le mouvement, ou
fournir une indication que le balayage ultrasonore doit être refait, en réponse à la détermination que le mouvement dépasse un seuil.

9. Système selon la revendication 1, comprenant un dispositif de prise de vue (52) pour prendre une image visuelle du patient, et dans lequel lesdites informations d'image visuelle sont transmises au serveur de base de données (18, 25), ensemble avec les informations ultrasonores, pour identifier le patient.

10. Système selon la revendication 1, comprenant un ensemble d'enregistrement audio (54) pour enregistrer des informations audio associées à la procédure ultrasonore, dans lequel les informations audio sont transmises au serveur de base de données (18, 25), ensemble avec les informations ultrasonores.

11. Système selon la revendication 1, comprenant une pluralité de transducteurs à ultrasons (14) et des ensembles de commande de transducteur associés, pour fournir un champ de vision accru de la partie du corps qui est représentée.

12. Système selon la revendication 1, dans lequel les informations transmises sont suffisamment traitées par le processeur (25) pour qu'un interprète spécialisé en ultrasons ne soit pas nécessaire pour l'analyse médicale.

13. Système selon la revendication 10, comprenant un système d'empreinte vocale pour identifier le patient d'après les informations audio.

14. Système selon la revendication 13, dans lequel la pluralité de transducteurs à ultrasons (14) est commandée de telle manière que les signaux ultrasonores qui sortent de ceux-ci n'interfèrent pas les uns avec les autres.

15. Système selon la revendication 1, dans lequel le serveur de base de données (18, 25) comprend des moyens pour accumuler des informations à partir d'examens ultrasonores successifs d'un patient donné, de manière à conserver un historique de patient pour ledit patient donné.

16. Procédé pour générer des informations ultrasonores spécifiques à une application en utilisant un ensemble de collecte de données ultrasonores (12),
le procédé comprenant les étapes consistant à :

sélectionner, par un opérateur de l'ensemble de collecte de données ultrasonores (12), à partir d'une liste de programmes spécifiques à une application, un programme spécifique à une application, les programmes étant configurés pour commander le fonctionnement de l'ensemble de collecte de données ultrasonores (12) ;
télécharger le programme spécifique à une application sélectionné à partir d'un serveur de base de données sur Internet (18, 25) pour effectuer un balayage spécifique à une application d'une partie d'un corps ;
balayer, sur la base du programme spécifique à une application sélectionné et à un premier

emplacement en utilisant l'ensemble de collecte de données ultrasonores (12), la partie du corps à l'aide de signaux ultrasonores et recevoir des signaux ultrasonores réfléchis par celle-ci ;
convertir les signaux ultrasonores reçus en informations médicales ultrasonores ;
transmettre lesdits signaux ultrasonores au serveur de base de données sur Internet (18, 25) à un second emplacement éloigné du premier emplacement ; et
traiter, au second emplacement, les informations fournies au serveur de base de données (18, 25) pour produire une image spécifique à une application de la partie du corps pour analyse médicale.

17. Procédé selon la revendication 16, dans lequel l'étape de balayage de la partie de corps comprend la transmission d'une pluralité de signaux ultrasonores dans une séquence de plans individuels, les plans étant séparés d'un angle de rotation sélectionné.

18. Procédé selon la revendication 17, dans lequel le balayage couvre 360 °.

19. Procédé selon la revendication 16, comprenant l'étape consistant à accumuler les informations ultrasonores à partir d'examens successifs d'un patient donné, de manière à conserver un historique de patient concernant ledit patient.

20. Procédé selon la revendication 16, comprenant l'étape consistant à comparer les informations traitées à des résultats d'informations provenant d'un autre outil de diagnostic, pour produire une évaluation clinique de l'efficacité de l'analyse ultrasonore.

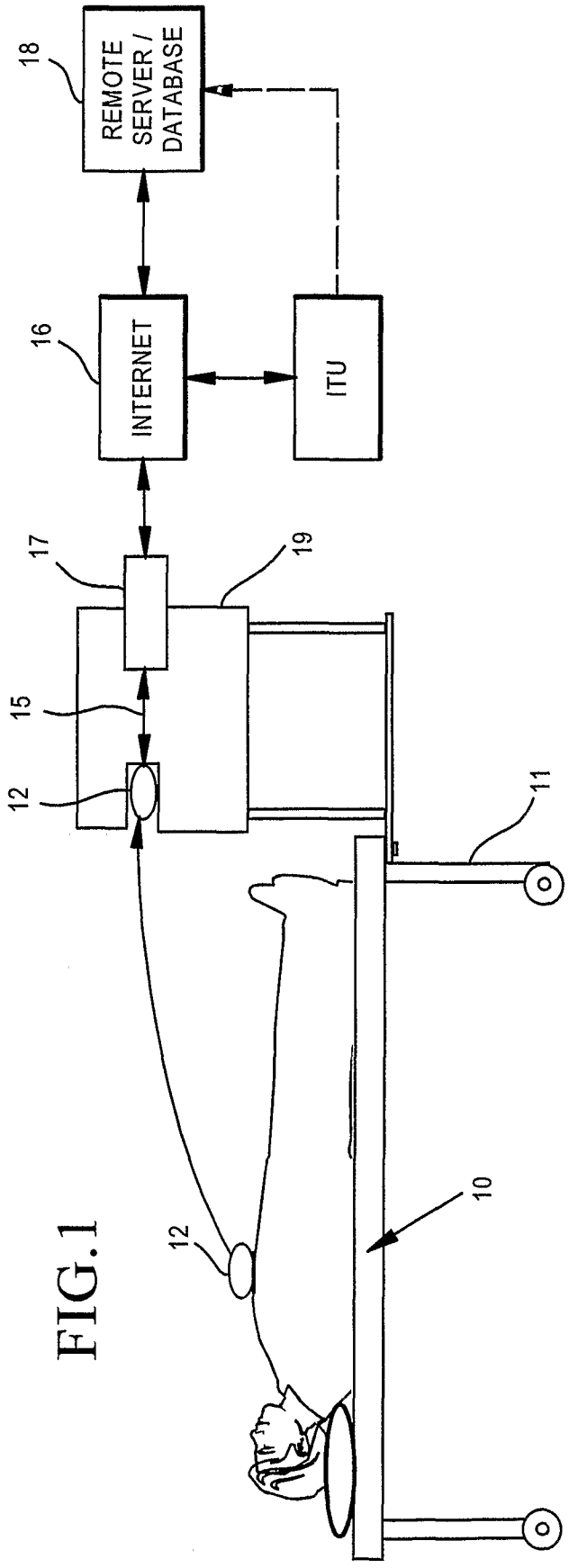


FIG.1

FIG.1A

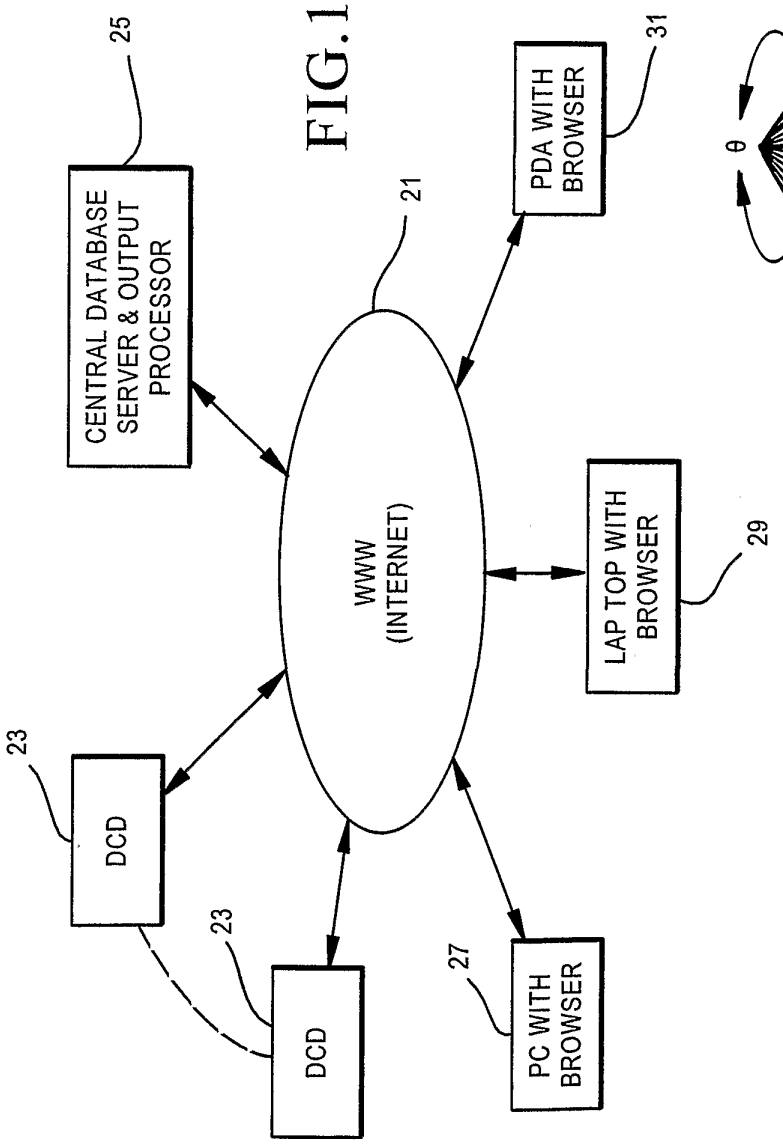

CENTRAL DATABASE SERVER & OUTPUT PROCESSOR
25
WWW (INTERNET)
21
PDA WITH BROWSER
31
LAP TOP WITH BROWSER
29
PC WITH BROWSER
27
DCD
23
DCD
23

FIG.2

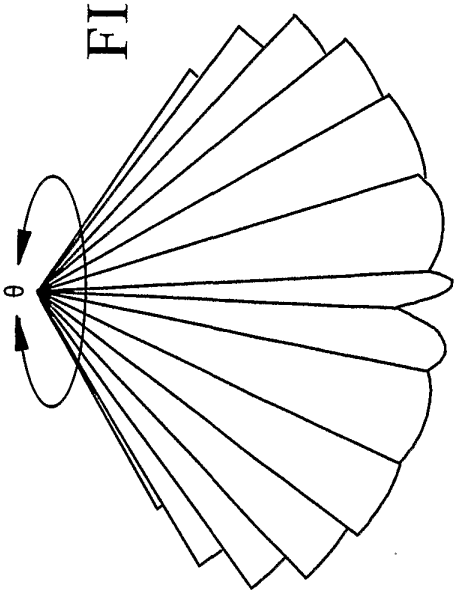

θ

FIG.3

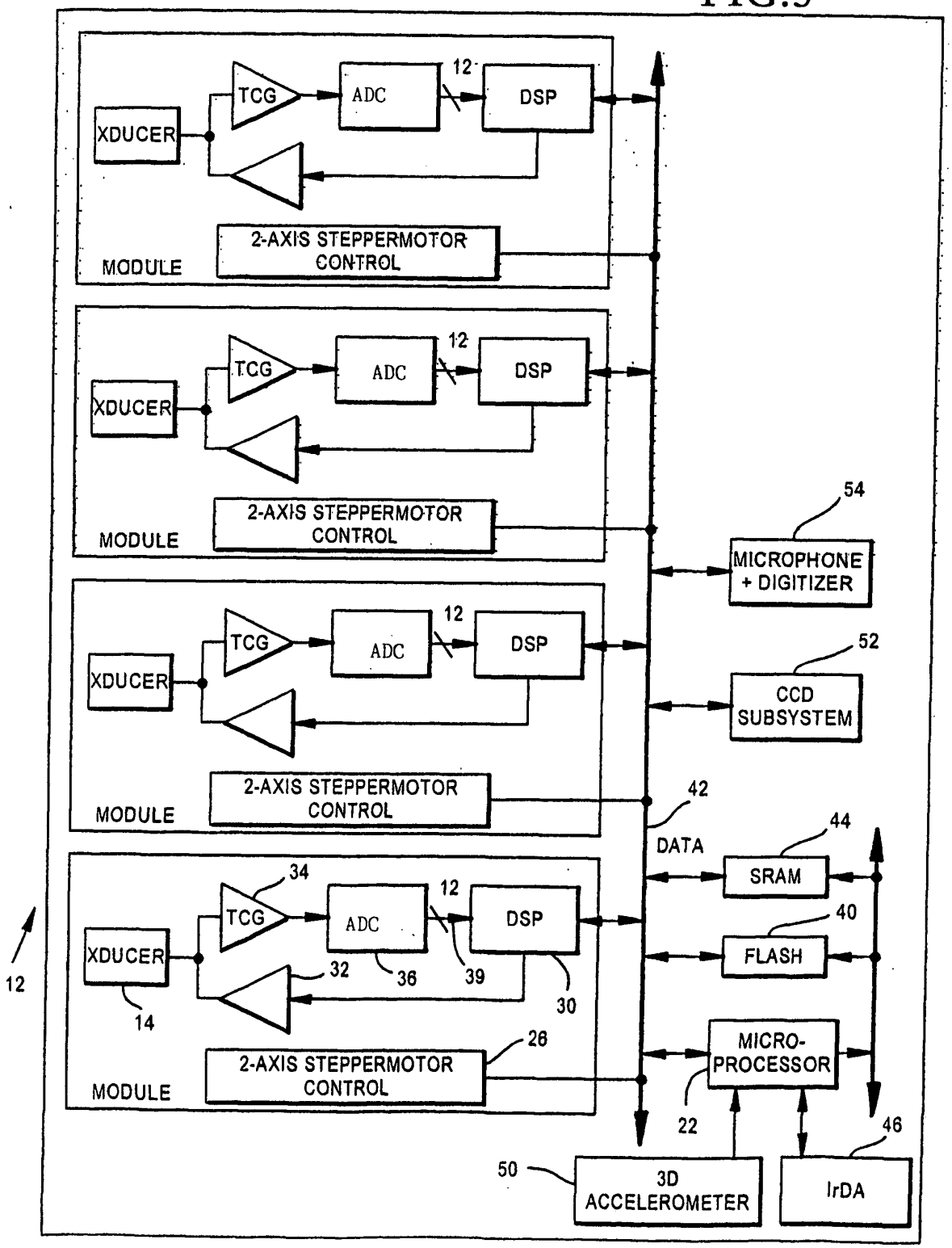
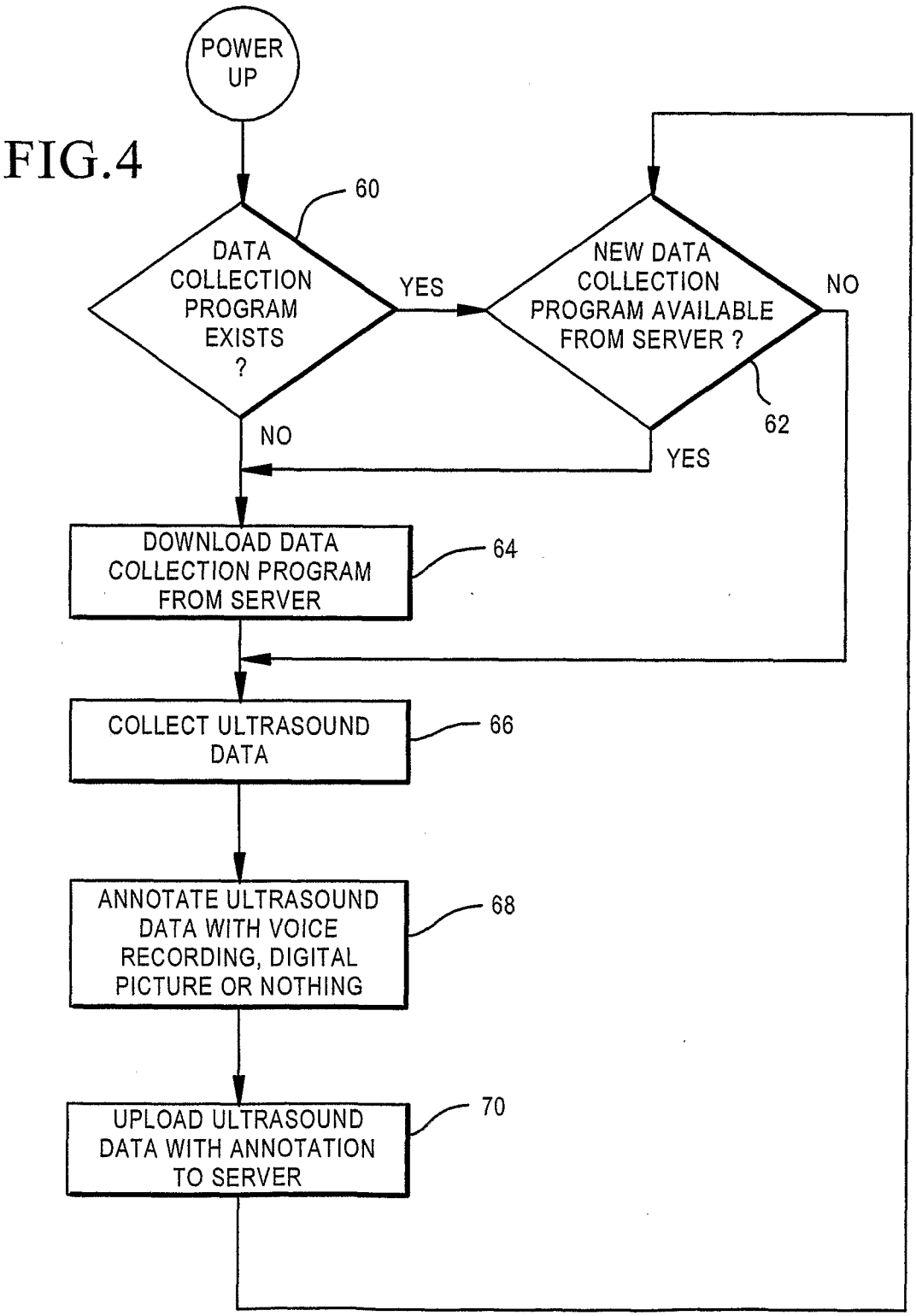

12
TCG
ADC
12
DSP
XDUCER
2-AXIS STEPPERMOTOR CONTROL
MODULE
54
MICROPHONE + DIGITIZER
52
CCD SUBSYSTEM
42
DATA
44
SRAM
40
FLASH
34
32
36
39
30
14
26
MICRO-PROCESSOR
22
46
50
3D ACCELEROMETER
IrDA

FIG.4


POWER UP
60
DATA COLLECTION PROGRAM EXISTS ?
YES
NEW DATA COLLECTION PROGRAM AVAILABLE FROM SERVER ?
NO
62
NO
YES
DOWNLOAD DATA COLLECTION PROGRAM FROM SERVER
64
COLLECT ULTRASOUND DATA
66
ANNOTATE ULTRASOUND DATA WITH VOICE RECORDING, DIGITAL PICTURE OR NOTHING
68
UPLOAD ULTRASOUND DATA WITH ANNOTATION TO SERVER
70

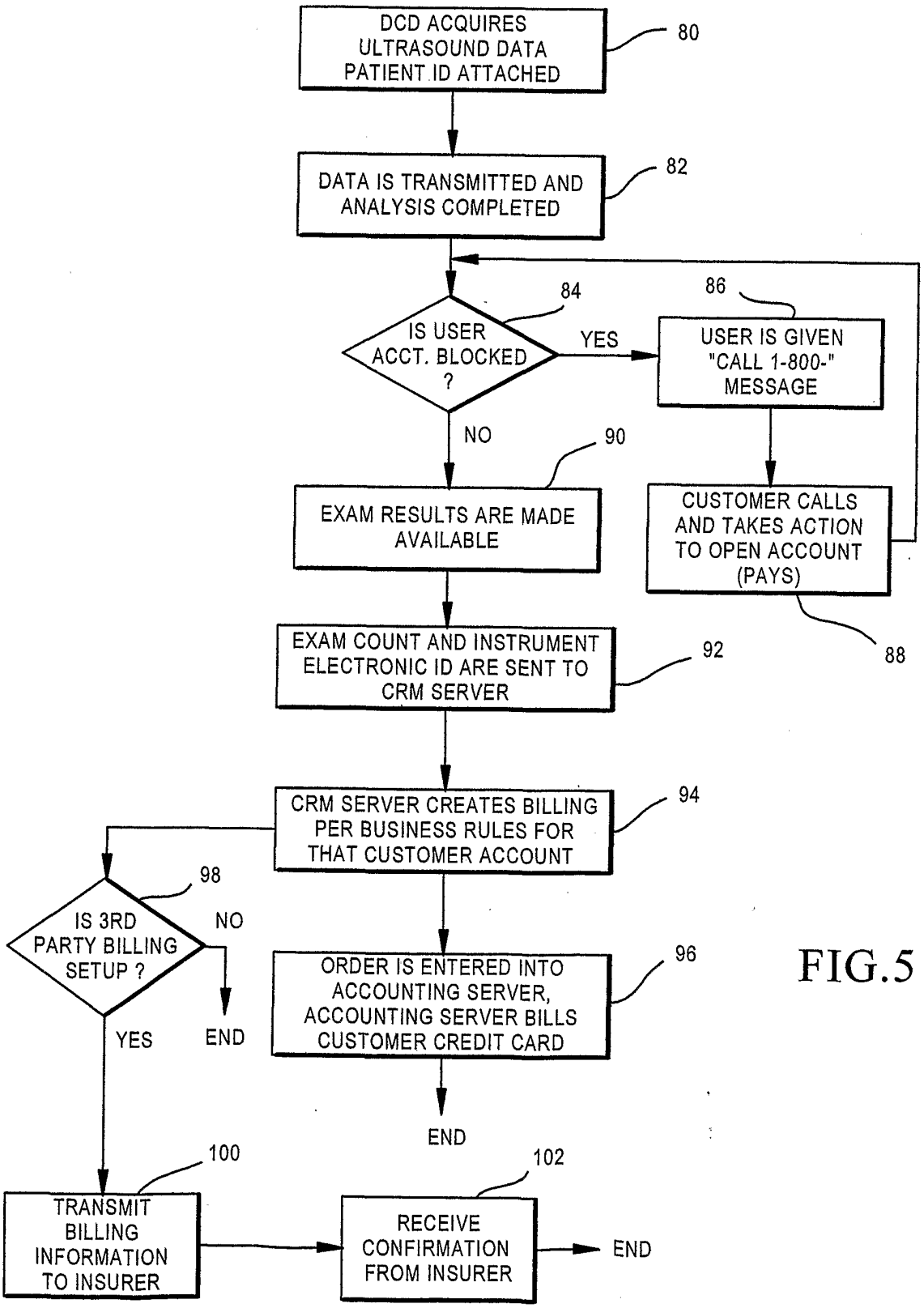

DCD ACQUIRES ULTRASOUND DATA PATIENT ID ATTACHED
80
DATA IS TRANSMITTED AND ANALYSIS COMPLETED
82
IS USER ACCT. BLOCKED ?
84
YES
USER IS GIVEN "CALL 1-800-" MESSAGE
86
NO
90
EXAM RESULTS ARE MADE AVAILABLE
CUSTOMER CALLS AND TAKES ACTION TO OPEN ACCOUNT (PAYS)
88
EXAM COUNT AND INSTRUMENT ELECTRONIC ID ARE SENT TO CRM SERVER
92
CRM SERVER CREATES BILLING PER BUSINESS RULES FOR THAT CUSTOMER ACCOUNT
94
IS 3RD PARTY BILLING SETUP ?
98
NO
END
YES
ORDER IS ENTERED INTO ACCOUNTING SERVER, ACCOUNTING SERVER BILLS CUSTOMER CREDIT CARD
96
END
TRANSMIT BILLING INFORMATION TO INSURER
100
RECEIVE CONFIRMATION FROM INSURER
102
END

FIG.5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 9966841 A **[0003]**
- US 4926871 A **[0004]**
- US 5235985 A **[0004]**

专利名称(译)	一种用于远程评估由编程的应用程序专用数据收集设备获得的超声信息的系统		
公开(公告)号	EP1367942B1	公开(公告)日	2018-05-30
申请号	EP2001959119	申请日	2001-07-20
[标]申请(专利权)人(译)	诊断超声		
申请(专利权)人(译)	超声诊断CORPORATION		
当前申请(专利权)人(译)	VERATHON INC.		
[标]发明人	MC MORROW GERALD J BARNARD WILLIAM L HAUGAARD ERIC		
发明人	MC MORROW, GERALD, J. BARNARD, WILLIAM, L. HAUGAARD, ERIC		
IPC分类号	A61B8/00 G06F19/00 G06Q50/24 G16H10/60		
CPC分类号	A61B8/00 A61B8/56 A61B8/565 G06F19/3418 G06Q40/08 G06Q50/24 G16H30/20 G16H40/67		
优先权	09/620766 2000-07-21 US		
其他公开文献	EP1367942A2 EP1367942A4		
外部链接	Espacenet		

摘要(译)

一种系统，包括至少一个超声数据采集装置，该装置可编程以在患者的人体的选定部分上执行特定的超声程序。产生的超声数据通过数据收集设备的站点上的本地服务器传输到因特网，并从那里传输到处理原始超声数据并提供特定于应用的信息的网络数据库服务器，例如三维模型，这可以用于诊断解释由适合用于治疗患者的超声成像的身体部位。