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(54) **METHOD AND SYSTEM FOR ORGANIZING STORED ULTRASOUND DATA**

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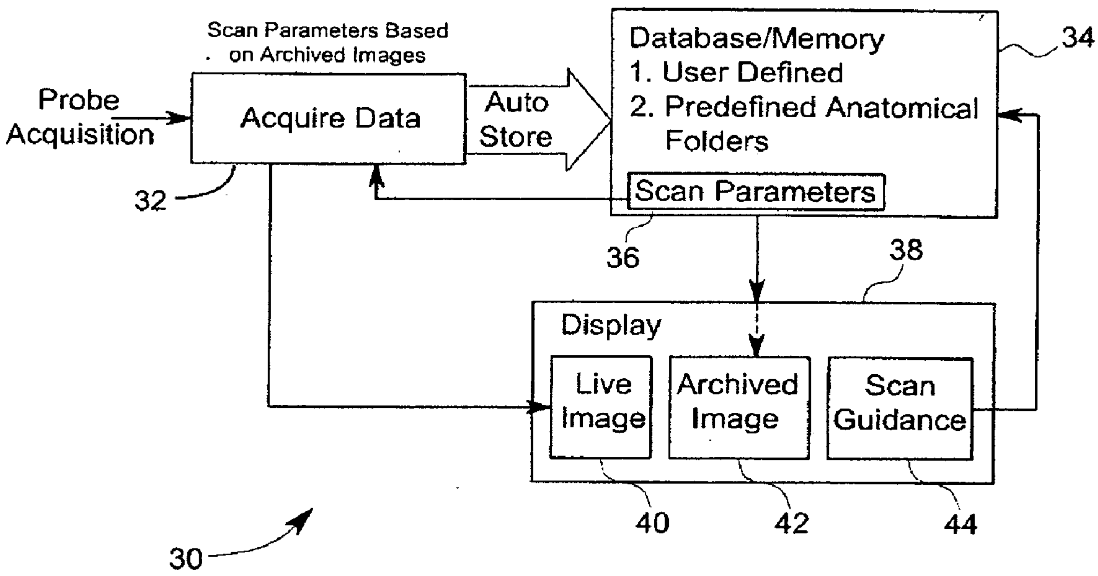
(57) **ABSTRACT**

Methods and systems for organizing stored ultrasound data are provided. One method includes displaying selectable anatomical identification guidance information having a plurality of identifiers corresponding to a plurality of anatomical portions of an anatomical region and receiving a user input selecting one of the plurality of identifiers. The method further includes storing a subsequently acquired image and associating the stored image with the anatomical potion of the anatomical region corresponding to the selected identifier.



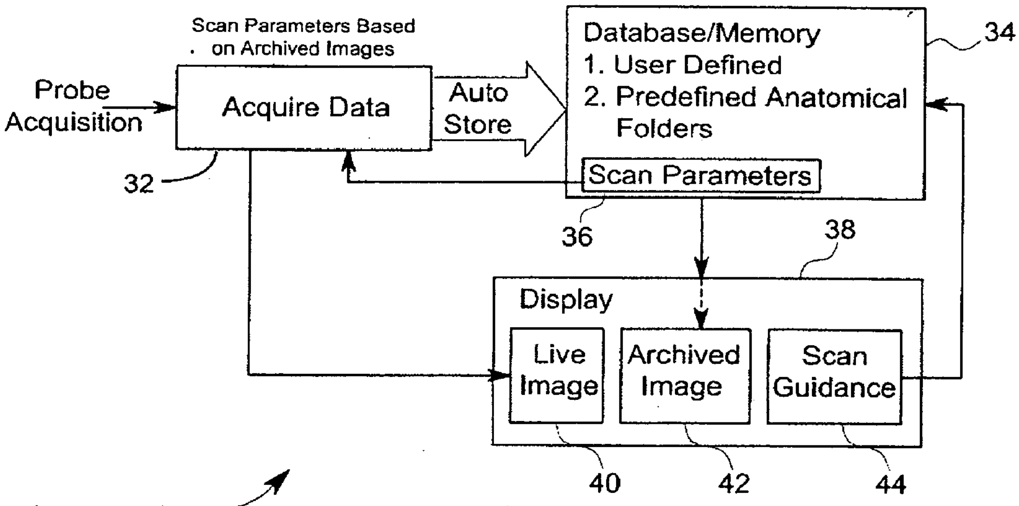

Scan Parameters Based on Archived Images
Probe Acquisition
Acquire Data
Auto Store
Database/Memory
1. User Defined
2. Predefined Anatomical Folders
Scan Parameters
Display
Live Image
Archived Image
Scan Guidance
32
34
36
38
40
42
44
30

FIG. 1

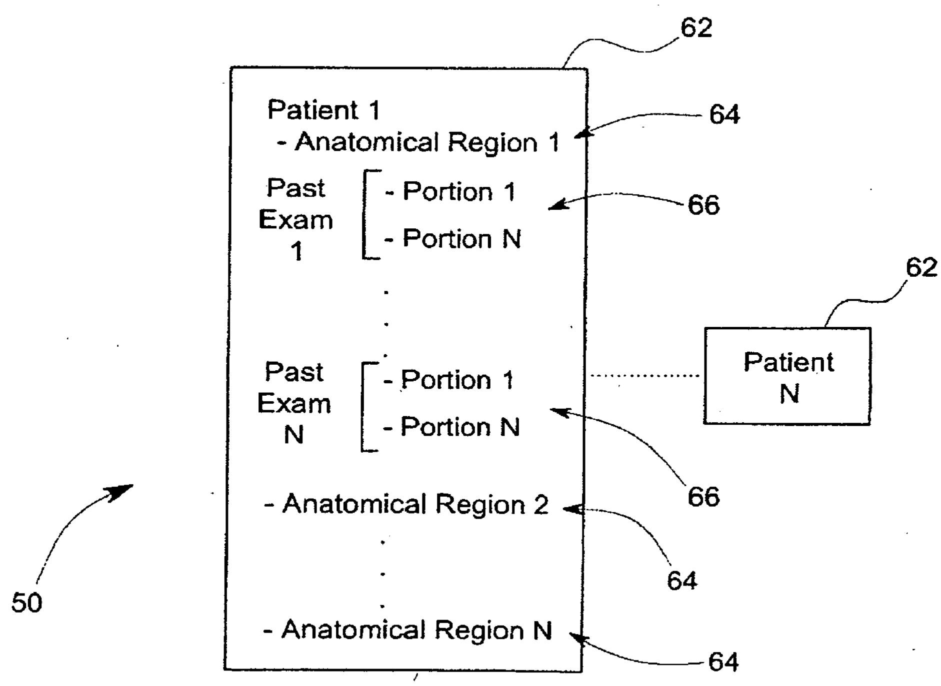

Patient 1
- Anatomical Region 1
Past Exam 1
- Portion 1
- Portion N
Past Exam N
- Portion 1
- Portion N
- Anatomical Region 2
- Anatomical Region N
Patient N
62
64
66
62
66
64
64
50

FIG. 2

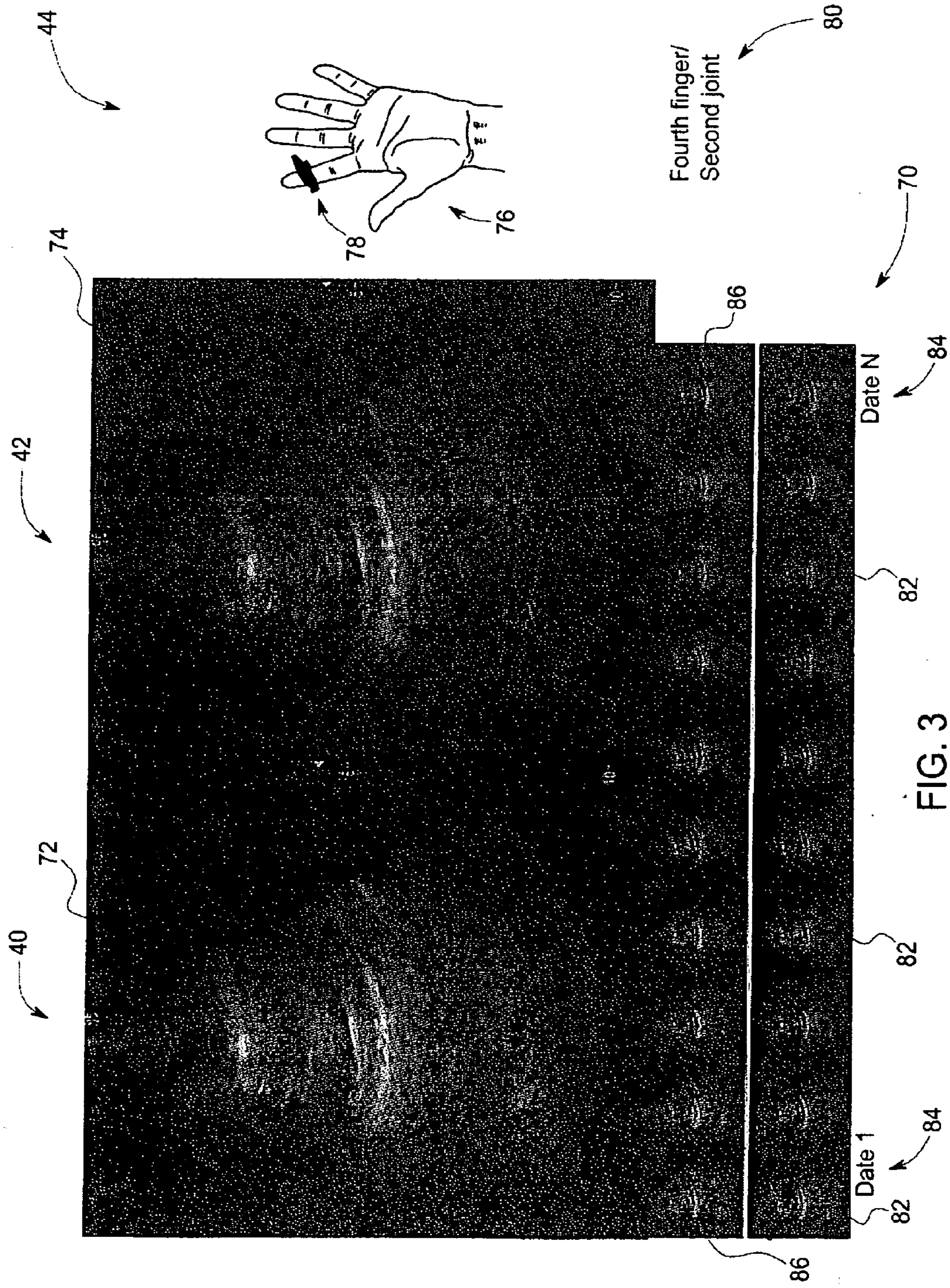
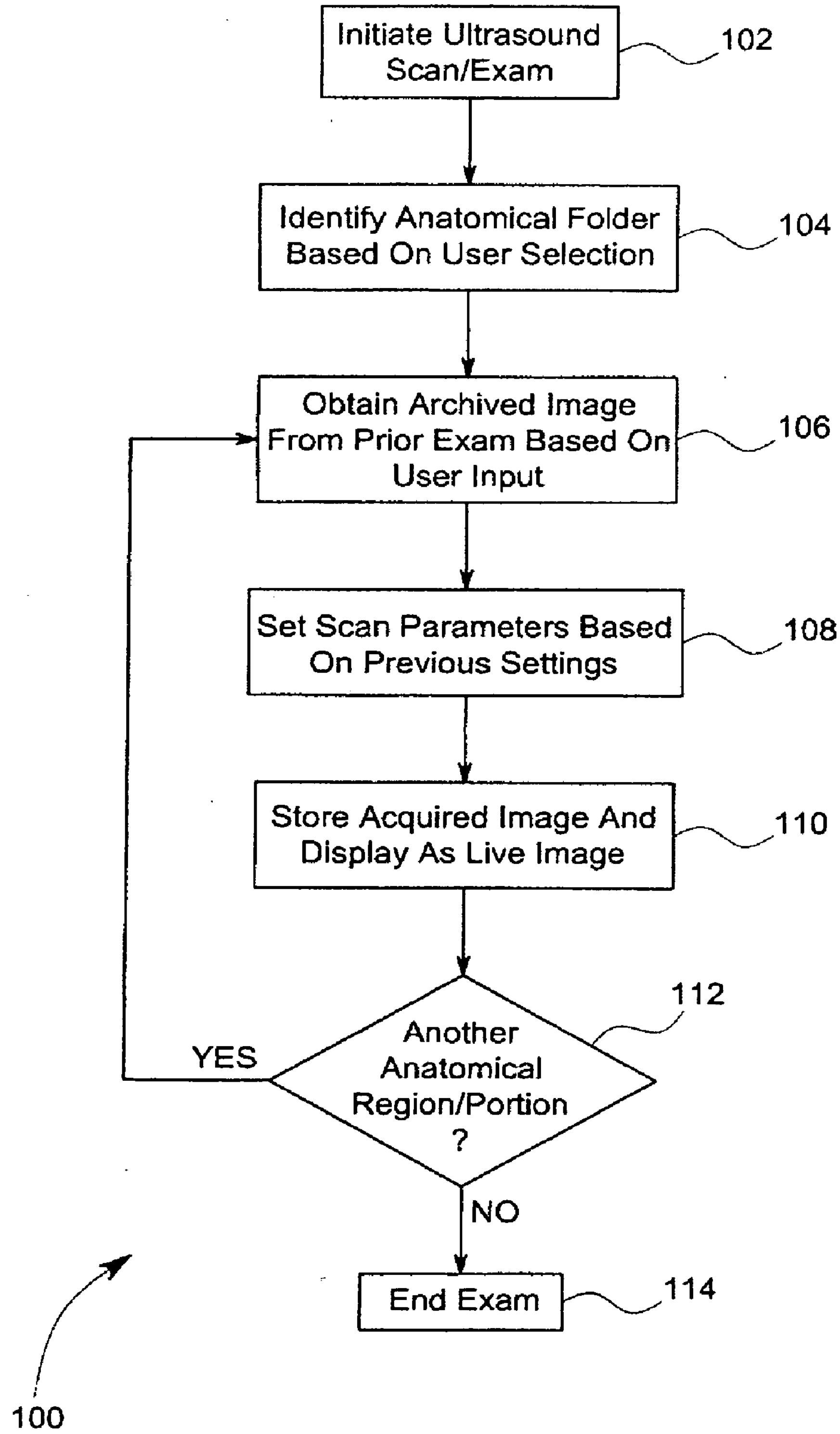

44
42
40
74
72
78
76
Fourth finger/
Second joint
80
70
86
86
Date N
Date 1
84
84
82
82
82

FIG. 3


Left Hand
First Finger
Fourth Finger
First Joint
Nail
Second Joint
Third Joint
Second Joint
Third Finger
Thumb
First Joint
Nail
Second Joint
Date 1
Date N
40
42
44
72
74
82
86
90
92
94

FIG. 4



Initiate Ultrasound Scan/Exam
102
Identify Anatomical Folder Based On User Selection
104
Obtain Archived Image From Prior Exam Based On User Input
106
Set Scan Parameters Based On Previous Settings
108
Store Acquired Image And Display As Live Image
110
Another Anatomical Region/Portion ?
112
YES
NO
End Exam
114
100

FIG. 5

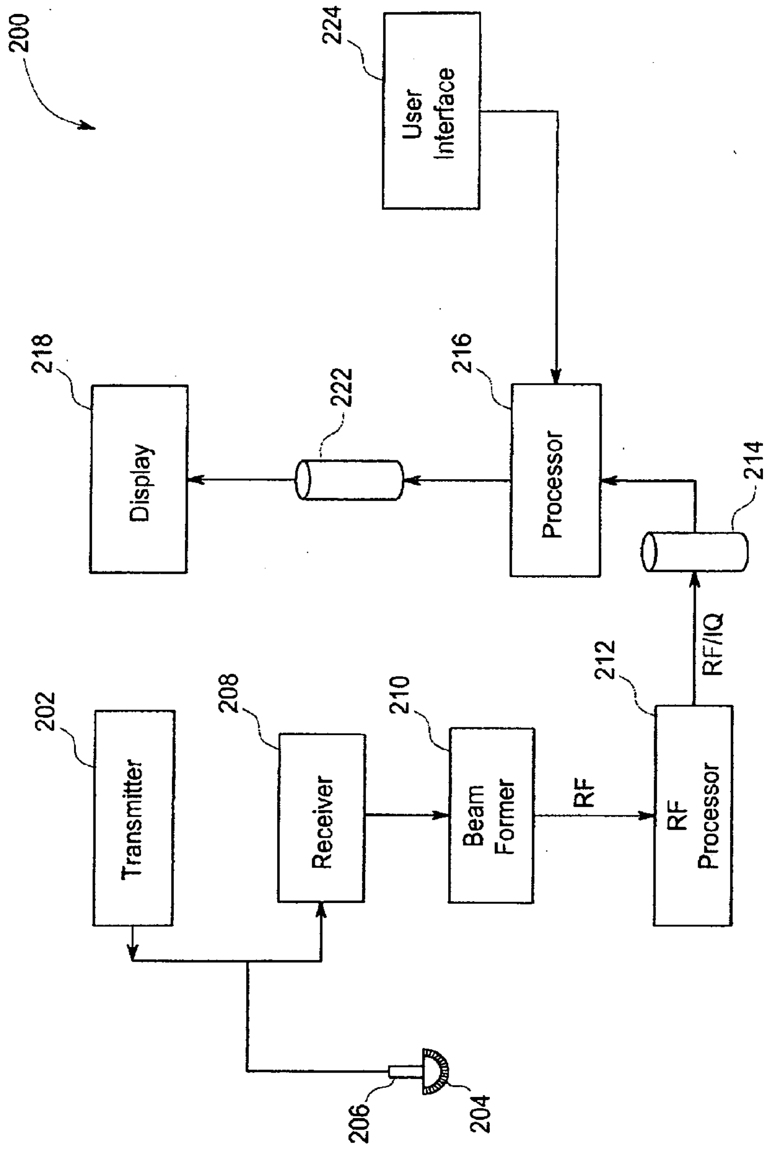

200
202
Transmitter
208
Receiver
210
Beam Former
RF
212
RF Processor
RF/IQ
214
216
Processor
222
218
Display
224
User Interface
206
204

FIG. 6

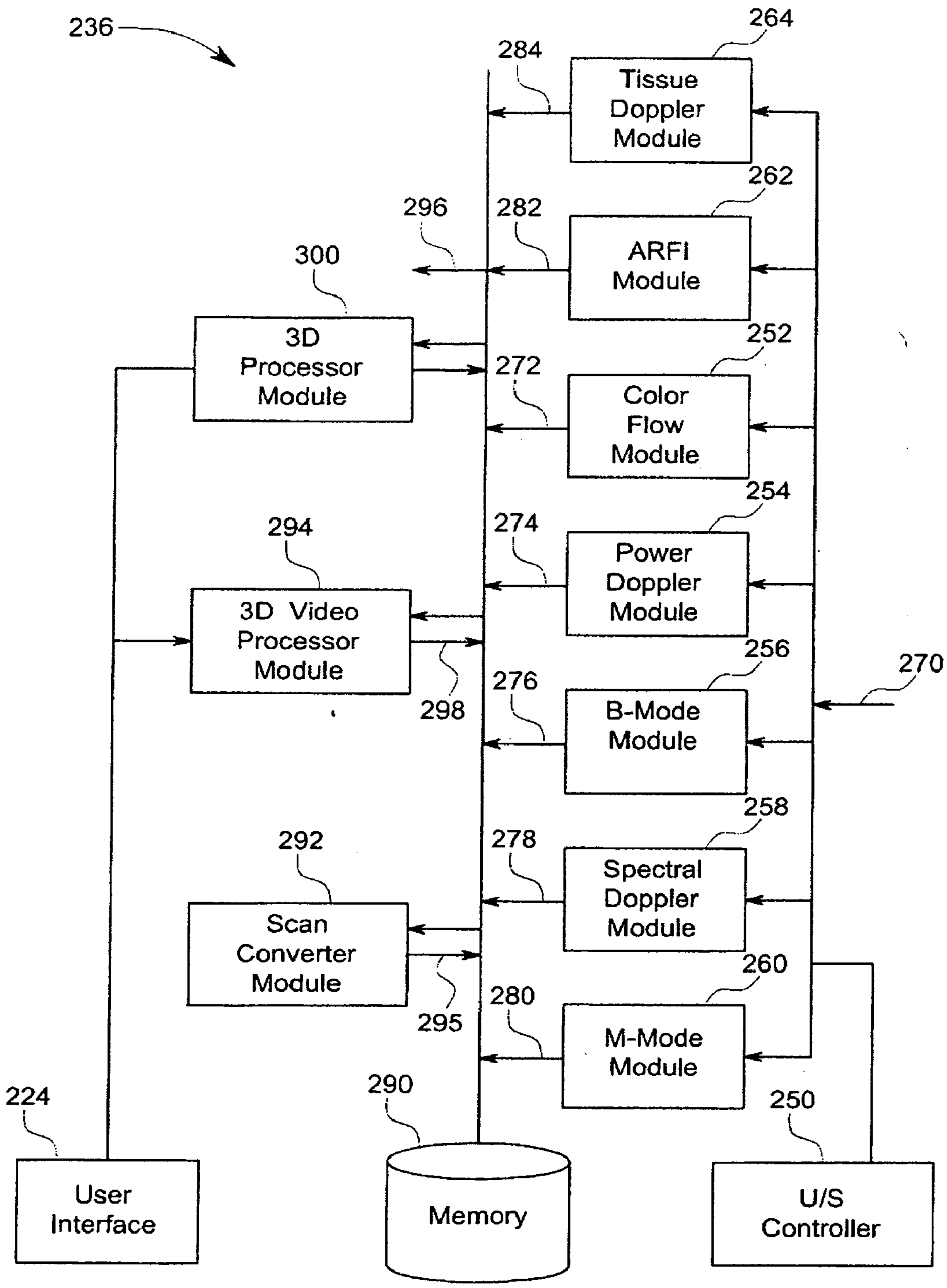

236
264
284
Tissue Doppler Module
296
282
262
300
ARFI Module
3D Processor Module
252
272
Color Flow Module
254
294
274
Power Doppler Module
3D Video Processor Module
256
270
298
276
B-Mode Module
292
278
258
Spectral Doppler Module
Scan Converter Module
260
295
280
M-Mode Module
224
290
250
User Interface
Memory
U/S Controller

FIG. 7

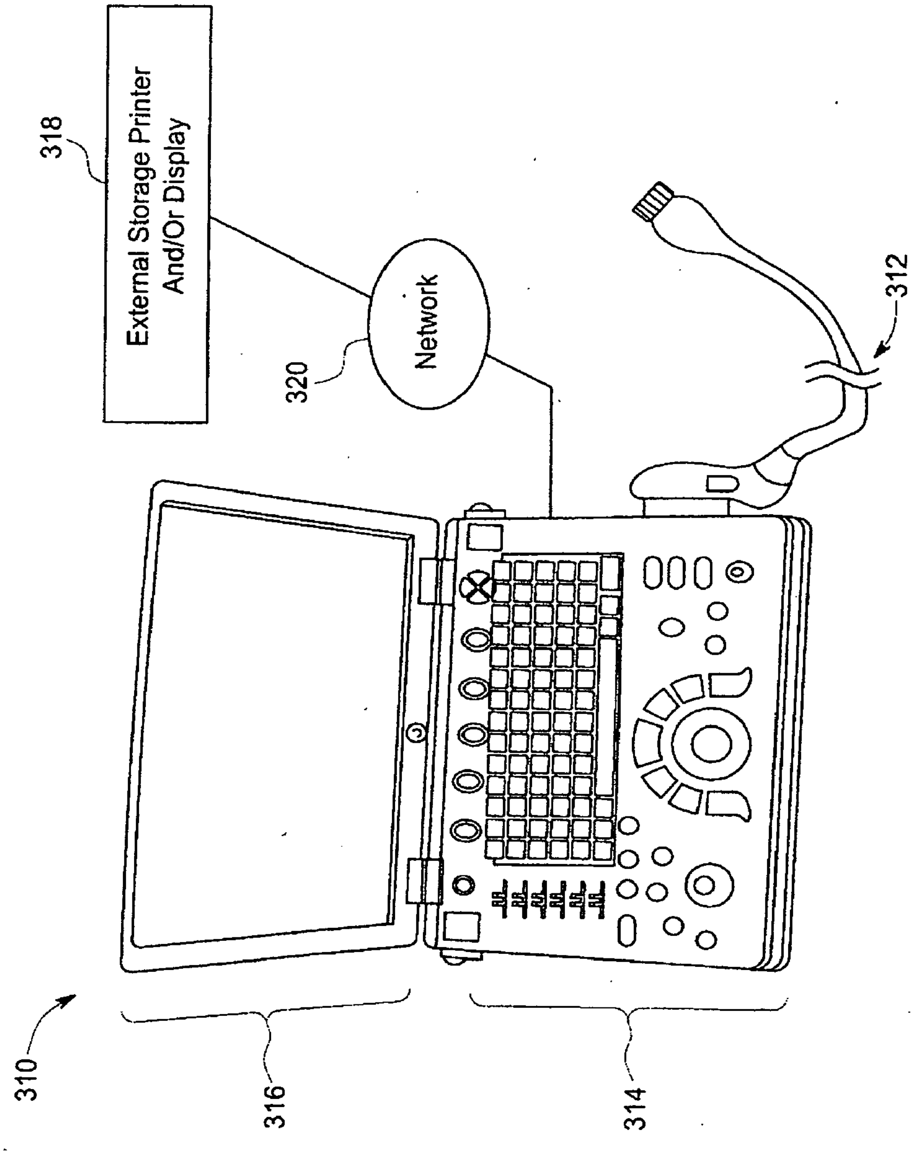

318
External Storage Printer
And/Or Display
320
Network
312
310
316
314

FIG. 8

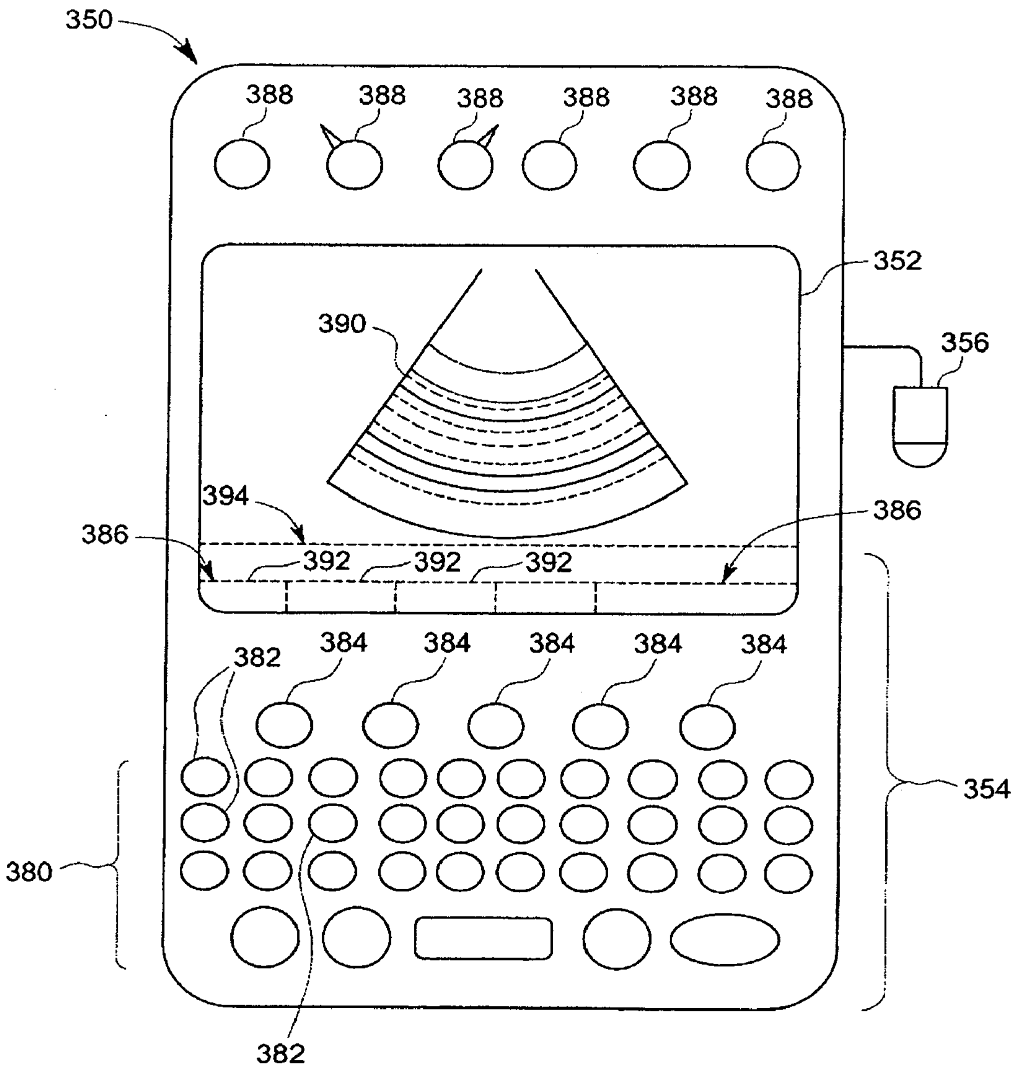

350
388
388
388
388
388
388
352
356
390
394
386
386
392
392
392
382
384
384
384
384
384
354
380
382

FIG. 9

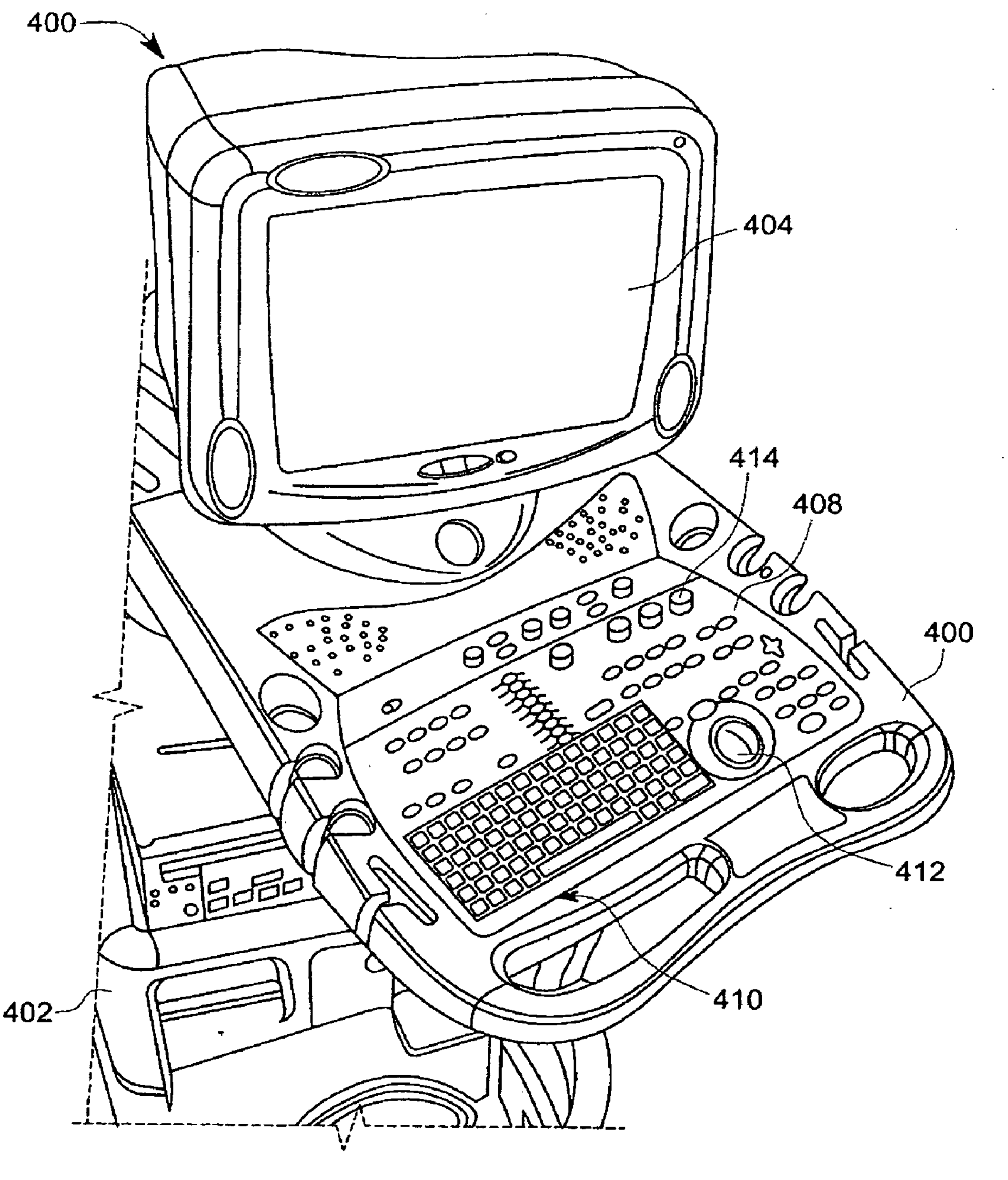


FIG. 10

METHOD AND SYSTEM FOR ORGANIZING STORED ULTRASOUND DATA

BACKGROUND OF THE INVENTION

[0001] The subject matter disclosed herein relates generally to methods and systems for organizing stored ultrasound data, and more particularly to organizing ultrasound data stored over time to be subsequently displayed.

[0002] Diagnostic medical imaging systems typically include a scan portion and a control portion having a display. For example, ultrasound imaging systems usually include ultrasound scanning devices, such as ultrasound probes having transducers that are connected to an ultrasound system to control the acquisition of ultrasound data by performing various ultrasound scans (e.g., imaging a volume or body). The ultrasound systems are controllable to operate in different modes of operation and to perform different scans. The acquired ultrasound data then may be displayed, which may include images of a region of interest.

[0003] When using ultrasound for anatomical based procedures, such as scanning the same portion of a patient (e.g., a finger) over time to determine the effectiveness of a treatment, the conventional review process is very time consuming. For example, using conventional ultrasound systems, it is very time consuming for doctors to perform comparative image analysis on the ultrasound system to review an image from a past exam while performing a live exam. In particular, the doctor may have to search through a large number of stored images to review the image from the past exam, thereafter remember the area he or she is looking at, and then switch back to the live exam or view a live image on another display. This process is not only time consuming, but can lead to errors, such as by selecting the wrong past image or when switching between image views.

[0004] Moreover, when performing ultrasound scanning, the scanning parameters are unique to each piece or portion of anatomy being scanned. Using conventional ultrasound systems, the user has to remember or manually modify each parameter for the anatomy being scanned. This is also a time consuming process and can lead to the potential for error when different scan parameters are used between exams.

[0005] Thus, when performing long term treatment assessment using ultrasound data, the review process, as well as the process for performing subsequent scans for comparison can be time consuming and prone to errors in review.

BRIEF DESCRIPTION OF THE INVENTION

[0006] In accordance with various embodiments, a method for storing ultrasound data is provided. The method includes displaying selectable anatomical identification guidance information having a plurality of identifiers corresponding to a plurality of anatomical portions of an anatomical region and receiving a user input selecting one of the plurality of identifiers. The method further includes storing a subsequently acquired image and associating the stored image with the anatomical potion of the anatomical region corresponding to the selected identifier.

[0007] In accordance with other various embodiments, an ultrasound display is provided that includes a first section displaying a currently acquired ultrasound image of an anatomical portion of a patient and a second section displaying an archived ultrasound image of the anatomical portion of the patient. The ultrasound display further includes a third section displaying selectable anatomical identification guidance information having a highlighted identifier corresponding to the anatomical portion.

[0008] In accordance with yet other various embodiments, an ultrasound system is provided that includes a probe configured to acquire ultrasound image data and a memory storing the acquired ultrasound image data using a predefined anatomical identification arrangement. The ultrasound system further includes a processor configured to obtain archived ultrasound image data and a display configured to display an image based on the acquired image data and an image based on the archived image data stored in the memory. The display further displays selectable anatomical identification guidance information having a highlighted identifier corresponding to an anatomical portion for the displayed images.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a block diagram illustrating a process for organizing archived ultrasound data in accordance with various embodiments.

[0010] FIG. **2** is a diagram illustrating an exemplary database organization structure for storing ultrasound data accordance with various embodiments.

[0011] FIG. **3** is a screenshot of an exemplary display in accordance with an embodiment.

[0012] FIG. **4** is a screenshot of an exemplary display in accordance with another embodiment.

[0013] FIG. **5** is a flowchart of a method to acquire and store ultrasound data in accordance with various embodiments.

[0014] FIG. **6** is a block diagram of an ultrasound system in which various embodiments may be implemented.

[0015] FIG. **7** is a block diagram of an ultrasound processor module of the ultrasound system of FIG. **6** formed in accordance with various embodiments.

[0016] FIG. **8** is a diagram illustrating a three-dimensional (3D) capable miniaturized ultrasound system in which various embodiments may be implemented.

[0017] FIG. **9** is a diagram illustrating a 3D capable hand carried or pocket-sized ultrasound imaging system in which various embodiments may be implemented.

[0018] FIG. **10** is a diagram illustrating a 3D capable console type ultrasound imaging system in which various embodiments may be implemented.

DETAILED DESCRIPTION OF THE INVENTION

[0019] The foregoing summary, as well as the following detailed description of certain embodiments will be better understood when read in conjunction with the appended drawings. To the extent that the figures illustrate diagrams of the functional blocks of various embodiments, the functional blocks are not necessarily indicative of the division between hardware circuitry. Thus, for example, one or more of the functional blocks (e.g., processors or memories) may be implemented in a single piece of hardware (e.g., a general purpose signal processor or a block of random access memory, hard disk, or the like) or multiple pieces of hardware. Similarly, the programs may be stand alone programs, may be incorporated as subroutines in an operating system, may be functions in an installed software package, and the like. It should be understood that the various embodiments are not limited to the arrangements and instrumentality shown in the drawings.

[0020] As used herein, an element or step recited in the singular and proceeded with the word "a" or "an" should be understood as not excluding plural of said elements or steps, unless such exclusion is explicitly stated. Furthermore, references to "one embodiment" are not intended to be interpreted as excluding the existence of additional embodiments that also incorporate the recited features. Moreover, unless explicitly stated to the contrary, embodiments "comprising" or "having" an element or a plurality of elements having a particular property may include additional elements not having that property.

[0021] Various embodiments provide a system and method for organizing stored ultrasound data, such as archived ultrasound data from multiple exams over time. For example, the stored ultrasound data may be acquired from multiple exams for a particular anatomical region to assess the images, such as to compare images of the same anatomical regions over time. At least one technical effect of various embodiments is easier access and display of archived ultrasound images from previous ultrasound exams. By practicing various embodiments, the evaluation of historical ultrasound images for comparison may be provided to determine, for example, treatment progress.

[0022] One embodiment of a process **30** for organizing archived ultrasound data and controlling the acquisition of ultrasound data for a plurality of exams over time is illustrated in FIG. **1**. The process **30** includes acquiring ultrasound data at **32**, which may include image data for a particular anatomical region of interest, such as one or more fingers of a patient. For example, an ultrasound probe is used to acquire image data with the scan parameters optionally set or adjusted based on scan parameters corresponding to previously acquired ultrasound images for the same anatomical region. Thus, the scan parameters for a current ultrasound scan may be based on user defined settings, predefined settings for the particular exam, or based on scan parameters corresponding to archived images and to which the currently acquired images are to be compared.

[0023] As the ultrasound image data is acquired, the ultrasound image data is stored, and more particularly, automatically stored at **34** in a database or memory. The image data is stored automatically for the particular patient being imaged such that the image data is subsequently accessible for that patient. Additionally, the image data is automatically organized in the database or memory. In various embodiments, the automatic storage of the image data may include storing the image data based on user defined settings and/or in predefined anatomical folders corresponding to the anatomical region being imaged. The archived image data is thereafter accessible based on a selected anatomical region or area such that in various embodiments only archived ultrasound images for a selected anatomical region or area are accessible and presented to a user for display. The archived image data may be stored in a hierarchical manner in memory with the particular memory locations associated with the anatomical regions or areas.

[0024] It should be noted that the scan parameters, for example, user defined settings for scan parameters **36** corresponding to the archived images also may be stored and associated with each of the images. Accordingly, the scan parameters for subsequent scans of the same anatomical region or area may be selected or automatically set based on the stored scan parameters **36**. It should be noted that other information may be stored in connection with or associated with the stored ultrasound image data. For example, in some embodiments a definition of the image processing algorithm used to process the image data is also stored with the stored images. Accordingly, if the system software is, for example, upgraded, then a follow-up scan may be performed using the same algorithms (and parameters) as in the previous exam. The algorithms may be any suitable types of algorithms including, for example, Power Doppler processing, Speckle Reduction, etc.

[0025] The process **30** also includes displaying image data at **38**, such as on a display having multiple display portions or sections. Thus, a single display may present to a user multiple pieces of information for a particular anatomical region or area. For example, in various embodiments, a first section **40** of the display screen may display a live image or real-time image received from the ultrasound probe and corresponding to a currently acquired image, such as an image of an anatomical region or area being imaged as part of a current ultrasound exam. A second section **42** of the display screen may display an archived image from a prior exam corresponding to the same anatomical region or area as the live image. For example, the images in the first and second sections **40** and **42** may be displayed in a side by side manner in a simultaneous or concurrent manner. A third section **44** of the display screen may display scan guidance information corresponding to the anatomical region or area being imaged and selectable by a user. For example, the third section **44** may include an anatomical image legend highlighting the anatomical region or area corresponding to the displayed archived image. In other embodiments, the third section **44** may include a customized user-defined table, which includes text, such as a hierarchical tree structure, that describes and corresponds to the archived ultrasound images to facilitate scanning the same area. This correlation of the information in the third section **44** with the images displayed in the first and section sections **40** and **42** facilitates displaying appropriate images (e.g., images from the same anatomical region) for comparison.

[0026] In operation, as the user navigates through the legend or user-defined table, such as by making different selections, the archived ultrasound image(s) corresponding to the selection is made accessible and/or displayed automatically. Additionally, during this navigation process, which can define the different image views to be acquired for an exam or a portion thereof, the scan parameters or imaging presets of the ultrasound device acquiring the image(s) may be automatically set or adjusted to the settings used from a prior exam, for example, corresponding to the archived image being displayed. Thus, the scanning parameters of the ultrasound device in some embodiments are automatically changed based on each archived image that is selected, which can allow a user (e.g., a doctor) to more easily and/or quickly access optimized images for each portion of anatomy being scanned.

[0027] In various embodiments, a database organization structure **60**, such as an organization structure for automatically organizing archived ultrasound data in a patient and anatomical associated manner is illustrated in FIG. **2**. The structure **60**, which may be stored in any suitable manner and using any suitable storage technique, includes storing image data for each patient in a corresponding patient record **62** such that all images for a particular patient are accessible by selecting a particular patient record. For example, a user may enter a patient's name or identification number in the ultrasound system to access the patient record **62**. It should be noted that although specific details for only one patient record **62** is shown, additional patient records for the same or different patients may be provided in a similar manner.

[0028] The structure **60** is organized in an anatomical based arrangement, which may be provided, for example, as a hierarchical anatomical based storage arrangement. In some embodiments, for each patient record **62**, a plurality of anatomically defined and associated memory locations is provided for each patient record **62**. For example, anatomical region memory locations **64** are provided that identify memory for storing images for a particular anatomical region or area, such as a hand or finger for each of a plurality of past exams. Each of the anatomical region memory locations **64** may further be defined or divided based on anatomical portions, such as corresponding to images of joints of a finger, to thereby define anatomical portion memory locations **66**.

[0029] The archived ultrasound image data, and any associated or accompanying data, may be stored either locally (e.g., stored within the ultrasound system) or remotely, such as over a wired, wireless and/or interne network, among others. Thus, the storage size is not limited to the storage capabilities of the ultrasound system. Additionally, with remote storage and subsequent access of the archived data, subsequent follow-up exams may be performed, for example, on another ultrasound system (that includes similar capabilities as described herein).

[0030] Various embodiments provide for organizing archived data that is accessible based on user selection with a user interface, such as illustrated in FIGS. **3** and **4**, showing exemplary displays of an ultrasound system. For example, a wide screen display of an ultrasound display may include different sections as described in more detail herein. With the display, a user can use the anatomical legend or customize a table to define a scan sequence and provide scan guidance for a user. In some embodiments, the scan guidance can be a customized study, which may be based on a particular practice or department. Additionally, ultrasound user per image scan parameters are provided without having to manually document or remember the parameters.

[0031] With the display **70** of FIG. **3** or the display **90** of FIG. **4**, selectable anatomical information (e.g., scan guidance information) allows for loading the correct anatomical reference image (e.g., archived image), re-calibrating all scan parameters based on the archived image and resuming scanning with a live image displayed. Such selectable operation may be provided with single selection functionality (e.g., one click operation), by selecting the anatomical region or area of interest to be scanned next.

[0032] More particularly, FIG. **3** illustrates the display **70** with the first section **40**, second section **42** and third section **44**. In the display **70**, the first and second sections **40** and **42** define image display regions, which in some embodiments display a live and archived image, respectively, of the same anatomical region. However, it should be noted that variations and modifications are contemplated. For example, the order of the displayed images may be changed or two archived images may be displayed instead.

[0033] In the illustrated embodiment, the first section **40** displays a live ultrasound image **72** and the second section **42** displays an archived image **74**. The images **72** and **74** correspond to an imaged anatomical region identified and/or selected in the third section **44**. For example, the third section **44** in this embodiment includes an anatomical image legend **76**, which in this embodiment is a hand. However, it should be noted that any anatomical region or area may be represented by the anatomical image legend **76**. For example, a plurality of preloaded and/or predefined anatomical image legends **76** may be provided based on the images to be acquired and displayed. In other embodiments, a user may create and/or modify the anatomical image legend **76**, for example, based on the particular exam, particular patient characteristics, etc.

[0034] The anatomical image legend **76** is selectable, such as with a pointer and user input device (e.g., mouse). For example, in some embodiments a plurality of selectable portions **78** (one is shown highlighted in the FIG. **3**) of the anatomical image legend **76** may be defined, such that a user can select any one of the portions **78**. Accordingly, in these embodiments, user selectable "hot spots" on which a user may click or select are provided. However, in other embodiments, any portion of the anatomical image legend **76** may be selected by a user. The portions **78** may correspond, for example, to those portions of the anatomical region that are scanned as part of an ultrasound exam. When the portion **78** is selected by a user, that portion **78** is identified on the display, for example, by highlighting (e.g., yellow highlighting) that portion **78**, which is illustrated as a joint of a finger of the hand in the anatomical image legend **76**. However, any type of highlighting may be provided. Additionally, a text description **80** of the selected portion **78** may be provided, such as a text description of the selected joint. For example, in the illustrated embodiment, the text description **80** defines or labels the selected finger and joint. This descriptor may be assigned to all images stored in memory corresponding to this portion **78** of the anatomical image legend **76** and for which the anatomy is scanned.

[0035] When a user selects a portion **78**, the user also identifies the next scan portion of the anatomical region patient that is going to be acquired (or identifying a portion corresponding to archived images of interest). Upon selecting the portion **78**, archived images **82** for that portion **78** are displayed, such as thumbnail images. For example, the archived images **82** may correspond to images from some or all of the previous scans for the particular finger and joint. A user may scroll through the archived images **82** and not all of which may be displayed on the screen. Each displayed archived image **82** also may include a date identifier **84** corresponding to the date on which each of the archived images **82** were acquired. Thus, the archived images **82** for the selected portion **78** are automatically accessed and displayed, which are then selectable by a user. Upon selection of one of the displayed archived images **82** that image is displayed in the second section **42**, for example, as the enlarged image **74**. Upon acquisition of a current image of the portion **78**, that image is displayed in the first section **40**, for example, as the enlarged image **72**. It should be noted that live images **86** for all of the portions **78** previously scanned during the current exam also may be displayed, for example, as thumbnail images.

[0036] It should be noted that in various embodiments, when displaying images from multiple exams, some post-processing parameters may be applied to all of the displayed images, which may be performed simultaneously or currently to all of the displayed images. For example, a Gain or Look Up Table selection affects all displayed images (and not just the active image) such that all of the images maintain the same scan setup. Accordingly, this post-processing may be performed on all displayed images.

[0037] As another example, and as illustrated in FIG. **4**, the display **90** includes a table **92**, which is illustrated as a list arranged as a hierarchical tree that includes text descriptors **94** of the various portions of the anatomical region for the particular exam. Similar to the anatomical image legend **76**, the table **92** identifies the portions of the anatomical region to be scanned with a user selected text descriptor **94** corresponding to a next region to be scanned. The operation of the system is the same as that described in connection with FIG. **3**. However, in this embodiment, instead of the graphically displayed scan guidance, a textual based scan guidance is provided.

[0038] In this embodiment, the table **92** may be a list of portions of the anatomical region to be scanned or that have been scanned, which may be predetermined, predefined or created by a user, such as based on a desired or required order for scanning the anatomical region. Thus, the table **92** can guide a user as to the order of the scan to identify the next portion of the anatomical region to be scanned. The hierarchical tree structure of the table **92** in various embodiments corresponds to the predefined anatomical folders in memory where acquired images from the current and past exams are stored as described in more detail herein.

[0039] Thus, the various embodiments allow a user (e.g., a doctor) to compare past studies with current images to verify treatment progress. A user can use the anatomical legend or customize a table to define a scan sequence, such that a customized study may be provided. Single selection (e.g., one click) operation is also provided to load the correct anatomical reference image, re-calibrate all scan parameters based on the archived image and resume scanning.

[0040] A method **100** as illustrated in FIG. **5** also may be provided in accordance with various embodiments to acquire and store ultrasound data. The method includes initiating an ultrasound scan or exam at **102**. For example, a particular ultrasound scan or exam may be selected by a user with a corresponding probe used to acquire image data for that scan or exam. The initiation may set default scan parameters, which subsequently may be adjusted as described herein. Additionally, a display that includes user guidance is provided to allow selection of a particular portion of an anatomical region to be scanned.

[0041] A user input selecting the anatomical portion is used to identify an anatomical folder at **104** wherein archived images for the patient being scanned are stored. The anatomical folder may correspond to memory locations where the archived images are stored and organized based on the anatomical regions and portions. Thereafter, an archived image (if any) corresponding to the user input, namely a selected anatomical portion, is obtained at **106**. The archived image is an image of the scanned anatomical portion for the patient acquired during an earlier exam, which may be days, weeks, months or years, prior to the current exam.

[0042] Based on the previous settings for the ultrasound system when the archived image was acquired, the current scan parameters are set the same. It should be noted that a user may modify or adjust the settings if desired or needed. It also should be noted that this setting of the scan parameters is optionally performed.

[0043] Thereafter, an image of the selected anatomical portion is acquired using the ultrasound probe and the image stored in the corresponding anatomical folder at **108**. Additionally, the live image is displayed at **108** with the archived image. A determination is then made if another anatomical region or portion is to be scanned, such as based on another user selection in the scan guidance portion of the display. If another anatomical region or portion is selected, then another archived image for that region or portion is obtained at **106** and the method proceeds as described above. If another anatomical region or portion is not selected, then the exam ends at **114**.

[0044] The various embodiments may also provide additional functionality or processing. For example, a report may be automatically generated with some (or all) of the anatomically aligned images (e.g., images of the same anatomy from multiple scans) grouped together and labeled with the date of the exam. The report can be stored in different formats, and may be stored digitally (e.g., a PDF file, etc.), communicated over a network or printed out.

[0045] Thus, the various embodiments provide a system and method for displaying and storing in an anatomical based arrangement ultrasound images from an exam. The selection of the particular anatomical region or portion is performed using, for example, an anatomical image legend highlighting the anatomical region or area corresponding to the displayed archived image, or a customized user-defined table, which includes text, such as a hierarchical tree structure. It should be noted that the user guidance may include any text or graphics to allow a user to select a particular anatomical region or portion of interest and is not limited to the described embodiments.

[0046] The various embodiments may be implemented in connection with an ultrasound system **200** as illustrated in FIG. **6**. The ultrasound system includes a probe **206** for acquiring ultrasound data (e.g., image data) from a patient, which may be used to generate one or more images for display on a display **218**. The ultrasound system **200** is capable of electrical or mechanical steering of a soundbeam (such as in 3D space) and is configurable to acquire information corresponding to a plurality of 2D representations or images of a region of interest (ROI) in a subject or patient, which may be defined or adjusted as described in more detail herein. The ultrasound system **200** is configurable to acquire 2D images in one or more planes of orientation.

[0047] The ultrasound system **200** includes a transmitter **202** that, under the guidance of a beamformer **210**, drives an array of elements **204** (e.g., piezoelectric elements) within the probe **206** to emit pulsed ultrasonic signals into a body. A variety of geometries may be used. The ultrasonic signals are back-scattered from structures in the body, like blood cells or muscular tissue, to produce echoes that return to the elements **204**. The echoes are received by a receiver **208**. The received echoes are passed through the beamformer **210**, which performs receive beamforming and outputs an RF signal. The RF signal then passes through an RF processor **212**. Alternatively, the RF processor **212** may include a complex demodulator (not shown) that demodulates the RF signal to form IQ data pairs representative of the echo signals. The RF or IQ signal data may then be routed directly to a memory **214** for storage.

[0048] In the above-described embodiment, the beamformer **210** operates as a transmit and receive beamformer. In an alternative embodiment, the probe **206** includes a 2D array with sub-aperture receive beamforming inside the probe. The beamformer **210** may delay, apodize and sum each electrical signal with other electrical signals received from the probe **206**. The summed signals represent echoes from the ultrasound beams or lines. The summed signals are output from the beamformer **210** to an RF processor **212**. The RF processor **212** may generate different data types, e.g. B-mode, color Doppler (velocity/power/variance), tissue Doppler (velocity), and Doppler energy, for multiple scan planes or different scanning patterns. For example, the RF processor **212** may generate tissue Doppler data for multi-scan planes. The RF processor **212** gathers the information (e.g. I/Q, B-mode, color Doppler, tissue Doppler, and Doppler energy information) related to multiple data slices and stores the data information, which may include time stamp and orientation/rotation information, in the memory **214**. It should be noted that in some embodiments a software beamformer (not shown) may be provided in a back end of the ultrasound system **200** such that the ultrasound data is stored in raw form prior to beamforming.

[0049] The ultrasound system **200** also includes a processor **216** to process the acquired ultrasound information (e.g., RF signal data or IQ data pairs) and prepare frames of ultrasound information for display on the display **218**. The processor **216** is adapted to perform one or more processing operations according to a plurality of selectable ultrasound modalities on the acquired ultrasound data. Acquired ultrasound data may be processed and displayed in real-time during a scanning session as the echo signals are received. Additionally or alternatively, the ultrasound data may be stored temporarily in memory **214** during a scanning session and then processed and displayed in an off-line operation.

[0050] The processor **216** is connected to a user interface **224** (which may include a mouse, keyboard, etc.) that may control operation of the processor **116** as explained below in more detail. The display **218** includes one or more monitors that present patient information, including diagnostic ultrasound images to the user for diagnosis and analysis. One or both of memory **214** and memory **222** may store two-dimensional (2D) or three-dimensional (3D) data sets of the ultrasound data, where such 2D and 3D data sets are accessed to present 2D (and/or 3D images) or physiological monitoring data. The acquired image data may be stored in an anatomical based arrangement as described herein. The images may be modified and the display settings of the display **218** also manually adjusted using the user interface **224**.

[0051] It should be noted that although the various embodiments may be described in connection with an ultrasound system, the methods and systems are not limited to ultrasound imaging or a particular configuration thereof. The various embodiments may be implemented in connection with different types of imaging systems, including, for example, x-ray imaging systems, magnetic resonance imaging (MRI) systems, computed-tomography (CT) imaging systems, positron emission tomography (PET) imaging systems, or combined imaging systems, among others. Further, the various embodiments may be implemented in non-medical imaging systems, for example, non-destructive testing systems such as ultrasound weld testing systems or airport baggage scanning systems.

[0052] FIG. **7** illustrates an exemplary block diagram of an ultrasound processor module **236**, which may be embodied as the processor **216** of FIG. **6** or a portion thereof. The ultrasound processor module **236** is illustrated conceptually as a collection of sub-modules, but may be implemented utilizing any combination of dedicated hardware boards, DSPs, processors, etc. Alternatively, the sub-modules of FIG. **10** may be implemented utilizing an off-the-shelf PC with a single processor or multiple processors, with the functional operations distributed between the processors. As a further option, the sub-modules of FIG. **7** may be implemented utilizing a hybrid configuration in which certain modular functions are performed utilizing dedicated hardware, while the remaining modular functions are performed utilizing an off-the shelf PC and the like. The sub-modules also may be implemented as software modules within a processing unit.

[0053] The operations of the sub-modules illustrated in FIG. **7** may be controlled by a local ultrasound controller **250** or by the processor module **236**. The sub-modules **252-264** perform mid-processor operations. The ultrasound processor module **236** may receive ultrasound data **270** in one of several forms. In the embodiment of FIG. **6**, the received ultrasound data **270** constitutes I,Q data pairs representing the real and imaginary components associated with each data sample. The I,Q data pairs are provided to one or more of a color-flow sub-module **252**, a power Doppler sub-module **254**, a B-mode sub-module **256**, a spectral Doppler sub-module **258** and an M-mode sub-module **260**. Optionally, other sub-modules may be included such as an Acoustic Radiation Force Impulse (ARFI) sub-module **262** and a Tissue Doppler (TDE) sub-module **264**, among others.

[0054] Each of sub-modules **252-264** are configured to process the I,Q data pairs in a corresponding manner to generate color-flow data **272**, power Doppler data **274**, B-mode data **276**, spectral Doppler data **278**, M-mode data **280**, ARFI data **282**, and tissue Doppler data **284**, all of which may be stored in a memory **290** (or memory **214** or memory **222** shown in FIG. **5**) temporarily before subsequent processing. For example, the B-mode sub-module **256** may generate B-mode data **276** including a plurality of B-mode image planes, such as in a biplane or triplane image acquisition as described in more detail herein.

[0055] The data **272-284** may be stored, for example, as sets of vector data values, where each set defines an individual ultrasound image frame. The vector data values are generally organized based on the polar coordinate system.

[0056] A scan converter sub-module **292** accesses and obtains from the memory **290** the vector data values associated with an image frame and converts the set of vector data values to Cartesian coordinates to generate an ultrasound image frame **294** formatted for display. The ultrasound image frames **295** generated by the scan converter module **292** may be provided back to the memory **290** for subsequent processing or may be provided to the memory **214** or the memory **222**.

[0057] Once the scan converter sub-module **292** generates the ultrasound image frames **295** associated with, for example, B-mode image data, and the like, the image frames may be restored in the memory **290** or communicated over a bus **296** to a database (not shown), the memory **214**, the memory **222** and/or to other processors.

[0058] The scan converted data may be converted into an X,Y format for video display to produce ultrasound image frames. The scan converted ultrasound image frames are provided to a display controller (not shown) that may include a video processor that maps the video to a grey-scale mapping for video display. The grey-scale map may represent a transfer function of the raw image data to displayed grey levels. Once the video data is mapped to the grey-scale values, the display controller controls the display **218** (shown in FIG. **6**), which may include one or more monitors or windows of the display, to display the image frame. The image displayed in the display **218** is produced from image frames of data in which each datum indicates the intensity or brightness of a respective pixel in the display.

[0059] Referring again to FIG. **7**, a 2D video processor sub-module **294** combines one or more of the frames generated from the different types of ultrasound information. For example, the 2D video processor sub-module **294** may combine a different image frames by mapping one type of data to a grey map and mapping the other type of data to a color map for video display. In the final displayed image, color pixel data may be superimposed on the grey scale pixel data to form a single multi-mode image frame **298** (e.g., functional image) that is again re-stored in the memory **290** or communicated over the bus **296**. Successive frames of images may be stored as a cine loop in the memory **290** or memory **222** (shown in FIG. **6**). The cine loop represents a first in, first out circular image buffer to capture image data that is displayed to the user. The user may freeze the cine loop by entering a freeze command at the user interface **224**. The user interface **224** may include, for example, a keyboard and mouse and all other input controls associated with inputting information into the ultrasound system **200** (shown in FIG. **6**).

[0060] A 3D processor sub-module **300** is also controlled by the user interface **124** and accesses the memory **290** to obtain 3D ultrasound image data and to generate three dimensional images, such as through volume rendering or surface rendering algorithms as are known. The three dimensional images may be generated utilizing various imaging techniques, such as ray-casting, maximum intensity pixel projection and the like.

[0061] The ultrasound system **200** of FIG. **6** may be embodied in a small-sized system, such as laptop computer or pocket sized system as well as in a larger console-type system. FIGS. **8** and **9** illustrate small-sized systems, while FIG. **10** illustrates a larger system.

[0062] FIG. **8** illustrates a 3D-capable miniaturized ultrasound system **310** having a probe **312** that may be configured to acquire 3D ultrasonic data or multi-plane ultrasonic data. For example, the probe **312** may have a 2D array of elements **204** as discussed previously with respect to the probe **206** of FIG. **6**. A user interface **314** (that may also include an integrated display **316**) is provided to receive commands from an operator. As used herein, "miniaturized" means that the ultrasound system **310** is a handheld or hand-carried device or is configured to be carried in a person's hand, pocket, briefcase-sized case, or backpack. For example, the ultrasound system **310** may be a hand-carried device having a size of a typical laptop computer. The ultrasound system **330** is easily portable by the operator. The integrated display **316** (e.g., an internal display) is configured to display, for example, one or more medical images.

[0063] The ultrasonic data may be sent to an external device **318** via a wired or wireless network **320** (or direct connection, for example, via a serial or parallel cable or USB port). In some embodiments, the external device **318** may be a computer or a workstation having a display, or the DVR of the various embodiments. Alternatively, the external device **318** may be a separate external display or a printer capable of receiving image data from the hand carried ultrasound system **310** and of displaying or printing images that may have greater resolution than the integrated display **316**.

[0064] FIG. **9** illustrates a hand carried or pocket-sized ultrasound imaging system **350** wherein the display **352** and user interface **354** form a single unit. By way of example, the pocket-sized ultrasound imaging system **350** may be a pocket-sized or hand-sized ultrasound system approximately 2 inches wide, approximately 4 inches in length, and approximately 0.5 inches in depth and weighs less than 3 ounces. The pocket-sized ultrasound imaging system **350** generally includes the display **352**, user interface **354**, which may or may not include a keyboard-type interface and an input/output (I/O) port for connection to a scanning device, for example, an ultrasound probe **356**. The display **352** may be, for example, a 320×320 pixel color LCD display (on which a medical image **190** may be displayed). A typewriter-like keyboard **380** of buttons **382** may optionally be included in the user interface **354**.

[0065] Multi-function controls **384** may each be assigned functions in accordance with the mode of system operation (e.g., displaying different views). Therefore, each of the multi-function controls **384** may be configured to provide a plurality of different actions. Label display areas **386** associated with the multi-function controls **384** may be included as necessary on the display **352**. The system **350** may also have additional keys and/or controls **388** for special purpose functions, which may include, but are not limited to "freeze," "depth control," "gain control," "color-mode," "print," and "store."

[0066] One or more of the label display areas **386** may include labels **392** to indicate the view being displayed or allow a user to select a different view of the imaged object to display. The selection of different views also may be provided through the associated multi-function control **384**. The display **352** may also have a textual display area **394** for displaying information relating to the displayed image view (e.g., a label associated with the displayed image).

[0067] It should be noted that the various embodiments may be implemented in connection with miniaturized or small-sized ultrasound systems having different dimensions, weights, and power consumption. For example, the pocket-sized ultrasound imaging system **350** and the miniaturized ultrasound system **300** may provide the same scanning and processing functionality as the system **200** (shown in FIG. **6**).

[0068] FIG. **10** illustrates an ultrasound imaging system **400** provided on a movable base **402**. The portable ultrasound imaging system **400** may also be referred to as a cart-based system. A display **404** and user interface **406** are provided and it should be understood that the display **404** may be separate or separable from the user interface **406**. The user interface **406** may optionally be a touchscreen, allowing the operator to select options by touching displayed graphics, icons, and the like.

[0069] The user interface **406** also includes control buttons **408** that may be used to control the portable ultrasound imaging system **400** as desired or needed, and/or as typically provided. The user interface **406** provides multiple interface options that the user may physically manipulate to interact with ultrasound data and other data that may be displayed, as well as to input information and set and change scanning parameters and viewing angles, etc. For example, a keyboard **410**, trackball **412** and/or multi-function controls **414** may be provided.

[0070] It should be noted that the various embodiments may be implemented in hardware, software or a combination thereof. The various embodiments and/or components, for example, the modules, or components and controllers therein, also may be implemented as part of one or more computers or processors. The computer or processor may include a computing device, an input device, a display unit and an interface, for example, for accessing the Internet. The computer or processor may include a microprocessor. The microprocessor may be connected to a communication bus. The computer or processor may also include a memory. The memory may include Random Access Memory (RAM) and Read Only Memory (ROM). The computer or processor further may include a storage device, which may be a hard disk drive or a removable storage drive such as a floppy disk drive, optical disk drive, solid state disk drive (e.g., flash drive of flash RAM) and the like. The storage device may also be other similar means for loading computer programs or other instructions into the computer or processor.

[0071] As used herein, the term "computer" or "module" may include any processor-based or microprocessor-based system including systems using microcontrollers, reduced instruction set computers (RISC), ASICs, logic circuits, and any other circuit or processor capable of executing the functions described herein. The above examples are exemplary only, and are thus not intended to limit in any way the definition and/or meaning of the term "computer".

[0072] The computer or processor executes a set of instructions that are stored in one or more storage elements, in order to process input data. The storage elements may also store data or other information as desired or needed. The storage element may be in the form of an information source or a physical memory element within a processing machine.

[0073] The set of instructions may include various commands that instruct the computer or processor as a processing machine to perform specific operations such as the methods and processes of the various embodiments of the invention. The set of instructions may be in the form of a software program. The software may be in various forms such as system software or application software and which may be embodied as a tangible and non-transitory computer readable medium. Further, the software may be in the form of a collection of separate programs or modules, a program module within a larger program or a portion of a program module. The software also may include modular programming in the form of object-oriented programming. The processing of input data by the processing machine may be in response to operator commands, or in response to results of previous processing, or in response to a request made by another processing machine.

[0074] As used herein, the terms "software" and "firmware" are interchangeable, and include any computer program stored in memory for execution by a computer, including RAM memory, ROM memory, EPROM memory, EEPROM memory, and non-volatile RAM (NVRAM) memory. The above memory types are exemplary only, and are thus not limiting as to the types of memory usable for storage of a computer program.

[0075] It is to be understood that the above description is intended to be illustrative, and not restrictive. For example, the above-described embodiments (and/or aspects thereof) may be used in combination with each other. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the various embodiments without departing from their scope. While the dimensions and types of materials described herein are intended to define the parameters of the various embodiments, the embodiments are by no means limiting and are exemplary embodiments. Many other embodiments will be apparent to those of skill in the art upon reviewing the above description. The scope of the various embodiments should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. In the appended claims, the terms "including" and "in which" are used as the plain-English equivalents of the respective terms "comprising" and "wherein." Moreover, in the following claims, the terms "first," "second," and "third," etc. are used merely as labels, and are not intended to impose numerical requirements on their objects. Further, the limitations of the following claims are not written in means-plus-function format and are not intended to be interpreted based on 35 U.S.C. §112, sixth paragraph, unless and until such claim limitations expressly use the phrase "means for" followed by a statement of function void of further structure.

[0076] This written description uses examples to disclose the various embodiments, including the best mode, and also to enable any person skilled in the art to practice the various embodiments, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the various embodiments is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if the examples have structural elements that do not differ from the literal language of the claims, or if the examples include equivalent structural elements with insubstantial differences from the literal languages of the claims.

What is claimed is:

1. A method for storing ultrasound data, the method comprising:

displaying selectable anatomical identification guidance information having a plurality of identifiers corresponding to a plurality of anatomical portions of an anatomical region;

receiving a user input selecting one of the plurality of identifiers; and

storing a subsequently acquired image and associating the stored image with the anatomical potion of the anatomical region corresponding to the selected identifier.

2. The method of claim **1**, further comprising displaying at least one archived image corresponding to a selected anatomical portion of the anatomical region.

3. The method of claim **2**, further comprising setting scan parameters for an ultrasound probe to settings based on settings used to acquire the at least one archived image.

4. The method of claim **1**, wherein the storing comprises storing images in predefined anatomical folders corresponding to the anatomical portion and region.

5. The method of claim **1**, further comprising displaying a plurality of selectable thumbnail archived images from previous exams.

6. The method of claim **1**, further comprising storing with the subsequently acquired image, scan parameters used to acquire the image.

7. The method of claim **1**, wherein the selectable anatomical identification guidance information comprises an anatomical image legend and further comprising highlighting a selected portion.

8. The method of claim **7**, wherein the anatomical image legend defines a shape corresponding to the anatomical region to be imaged.

9. The method of claim **7**, further comprising displaying text corresponding to a portion of the anatomical image legend selected.

10. The method of claim **1**, wherein the selectable anatomical identification guidance information comprises a text table and further comprising highlighting a selected table entry.

11. The method of claim **10**, wherein the text table is user defined.

12. The method of claim **10**, wherein the text table comprises a hierarchical arrangement of the anatomical portions and regions.

13. The method of claim **1**, wherein the storing comprises archiving stored image data one of locally on an ultrasound system or remotely from the ultrasound system, the remote storage communicatively coupled to the ultrasound system via one of a wired, wireless or internet network.

14. The method of claim **1**, further comprising storing, in connection with stored images, a definition of the image processing algorithm used to process the stored images.

15. The method of claim **1**, further comprising displaying at least one live image and at least one stored image of an identified anatomical portion based on the selected identifier, and applying post-processing parameters to the displayed live and stored images.

16. The method of claim **1**, further comprising automatically generating a report having a plurality of images grouped together for an identified anatomical portion based on the selected identifier.

17. An ultrasound display comprising:

a first section displaying a currently acquired ultrasound image of an anatomical portion of a patient;

a second section displaying an archived ultrasound image of the anatomical portion of the patient; and

a third section displaying selectable anatomical identification guidance information having a highlighted identifier corresponding to the anatomical portion.

18. The ultrasound display of claim **17**, wherein the currently acquired image and the archived ultrasound image are displayed side by side.

19. The ultrasound display of claim **17**, wherein the selectable anatomical identification guidance information comprises an anatomical image legend and the highlighted identifier corresponds to a portion of the anatomical image legend selected.

20. The ultrasound display of claim **19**, wherein the anatomical image legend is a displayed shape corresponding to the anatomical region to be imaged.

21. The ultrasound display of claim **20**, further comprising text displayed corresponding to a portion of the anatomical image legend selected.

22. The ultrasound display of claim **17**, wherein the selectable anatomical identification guidance information comprises a text table and the highlighted identifier corresponds to a selected table entry.

23. An ultrasound system comprising:

a probe configured to acquire ultrasound image data;

a memory storing the acquired ultrasound image data using a predefined anatomical identification arrangement;

a processor configured to obtain archived ultrasound image data; and

a display configured to display an image based on the acquired image data and an image based on the archived image data stored in the memory, and further displaying selectable anatomical identification guidance information having a highlighted identifier corresponding to an anatomical portion for the displayed images.

24. The ultrasound system of claim **23**, wherein the selectable anatomical identification guidance information comprises one of (i) an anatomical image legend and the highlighted identifier corresponds to a portion of the anatomical image legend selected or (ii) a text table and the highlighted identifier corresponds to a selected table entry.

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摘要(译)

提供了用于组织存储的超声数据的方法和系统。一种方法包括显示可选择的解剖学识别指导信息，该信息具有对应于解剖区域的多个解剖部分的多个标识符，并且接收选择多个标识符之一的用户输入。该方法还包括存储随后获取的图像并将存储的图像与对应于所选择的标识符的解剖区域的解剖部分相关联。