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(54) LIVE ULTRASOUND IMAGE AND HISTORICAL ULTRASOUND IMAGE FRAME OVERLAPPING

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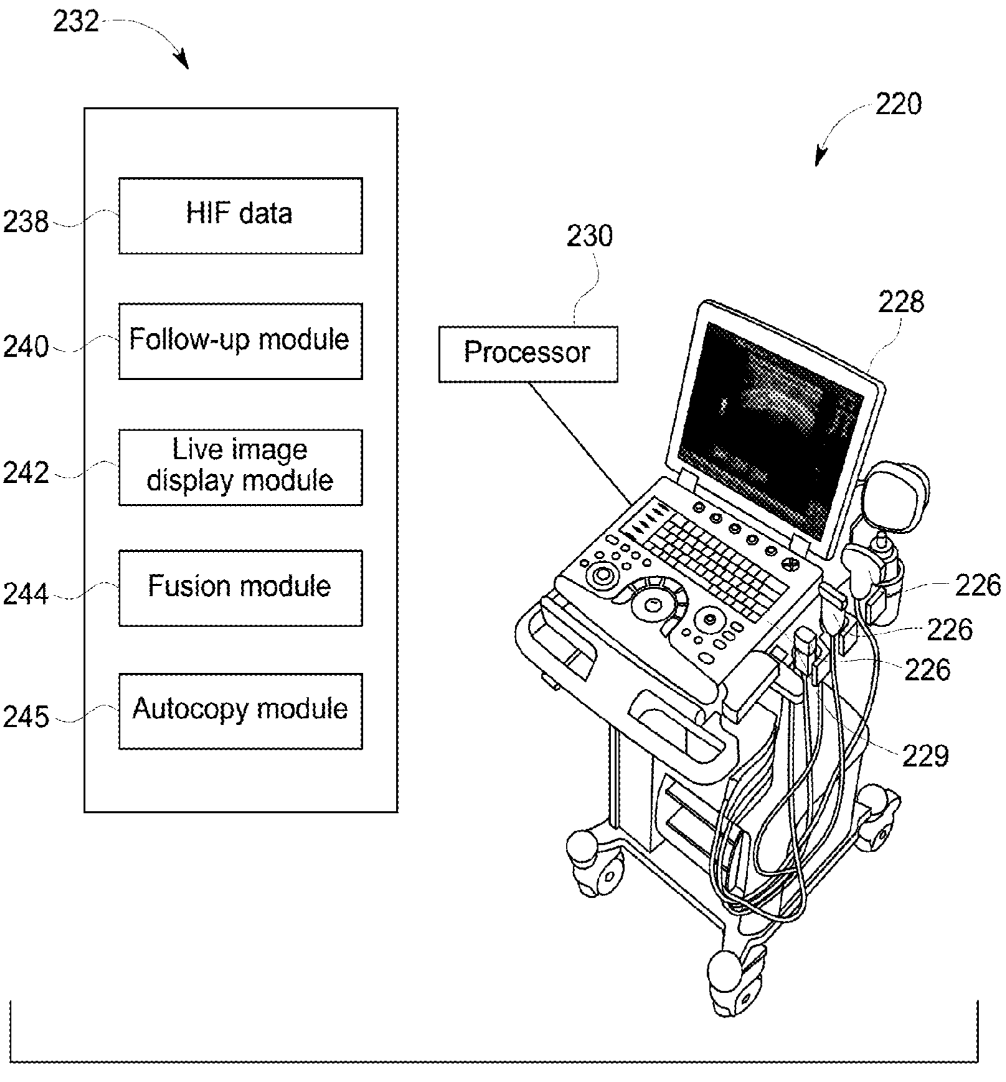
(57) **ABSTRACT**

A method and apparatus present a live ultrasound image on a display of an ultrasound imaging system, retrieve a historical ultrasound image frame; and overlap at least portions of the historical ultrasound image frame with the live ultrasound image. A method and apparatus retrieve a historical ultrasound image frame, retrieve stored coordinates of a historical region of interest in the historical ultrasound image frame, display a selected ultrasound image frame from a live ultrasound image and display a current region of interest in the selected ultrasound image frame, the current region of interest having coordinates in the selected ultrasound image frame based upon the stored coordinates retrieved from the historical region of interest in the historical ultrasound image frame.



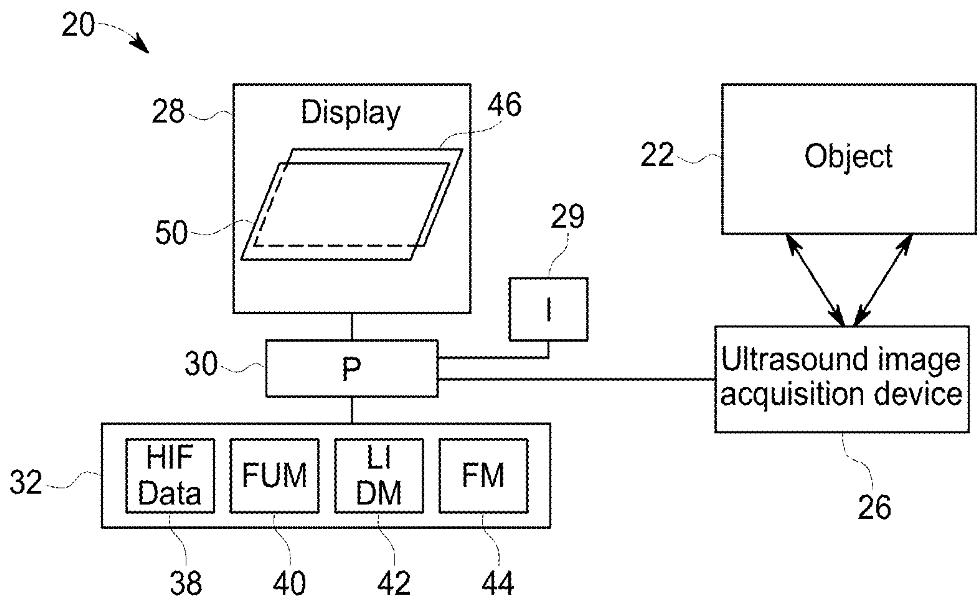

20
28
Display
46
50
22
Object
29
I
30
P
Ultrasound image acquisition device
32
HIF Data
FUM
LI DM
FM
26
38
40
42
44

FIG. 1

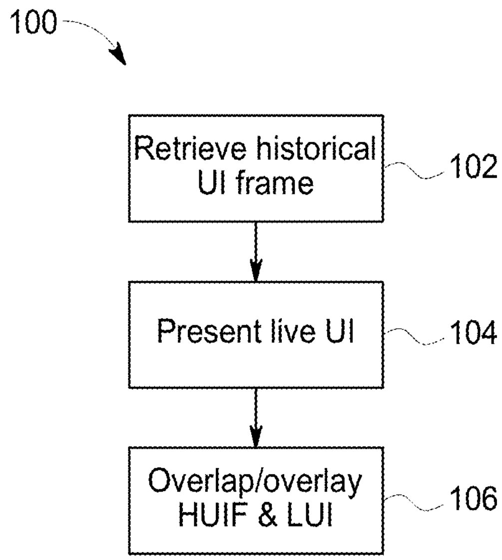

100
Retrieve historical UI frame
102
Present live UI
104
Overlap/overlay HUIF & LUI
106

FIG. 2

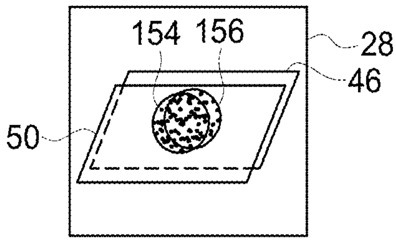


FIG. 3

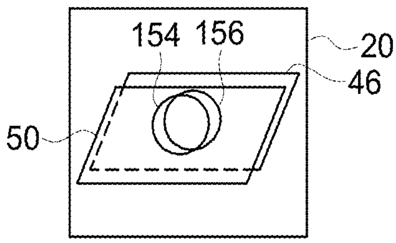


FIG. 4

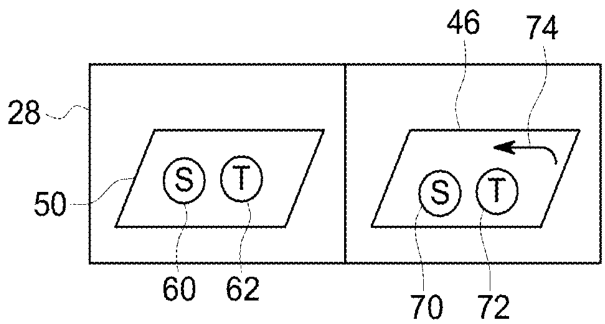


FIG. 5

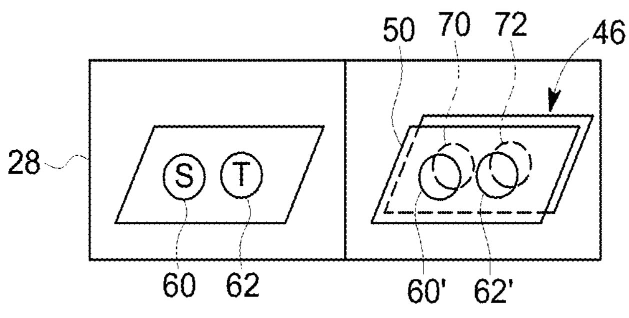


FIG. 6

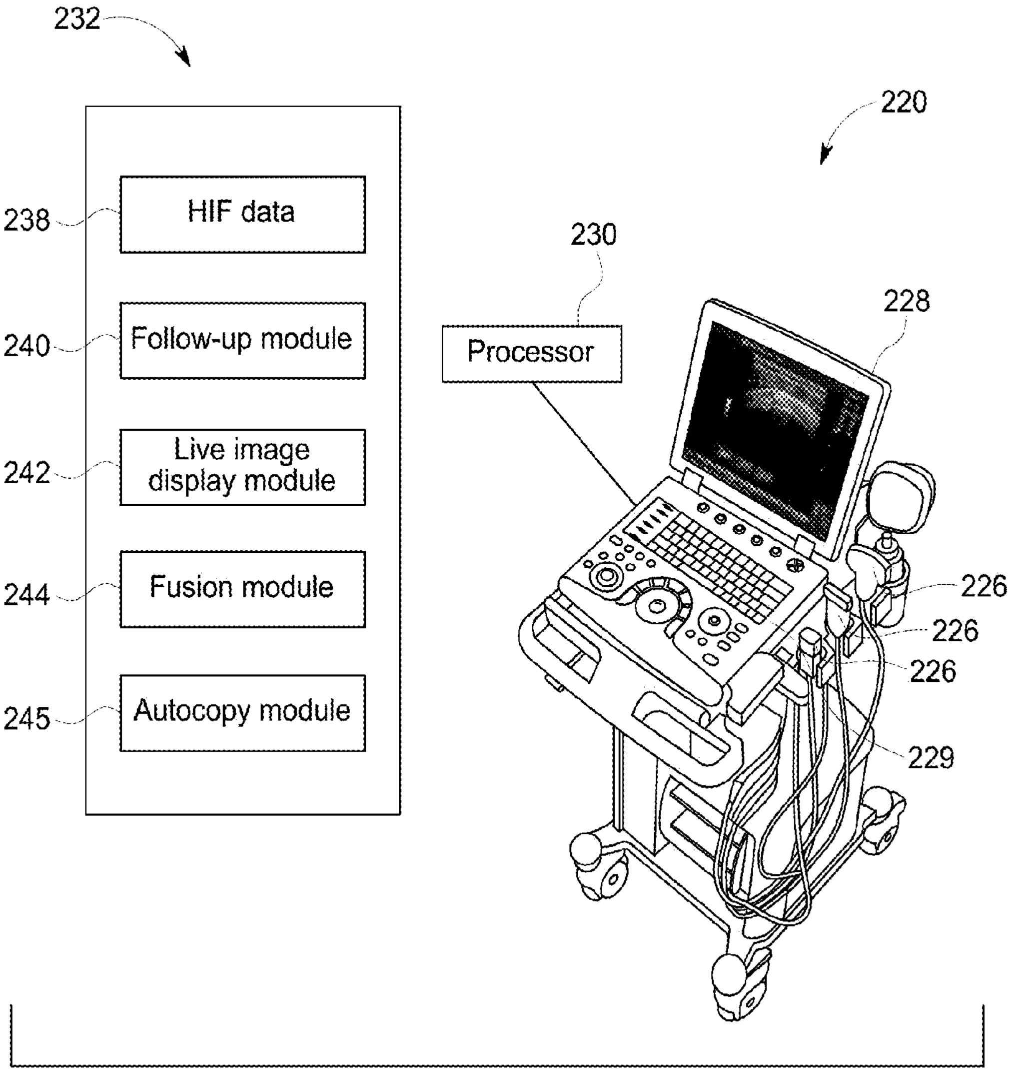

232
238
HIF data
240
Follow-up module
242
Live image display module
244
Fusion module
245
Autocopy module
220
230
Processor
228
226
226
226
229

FIG. 7

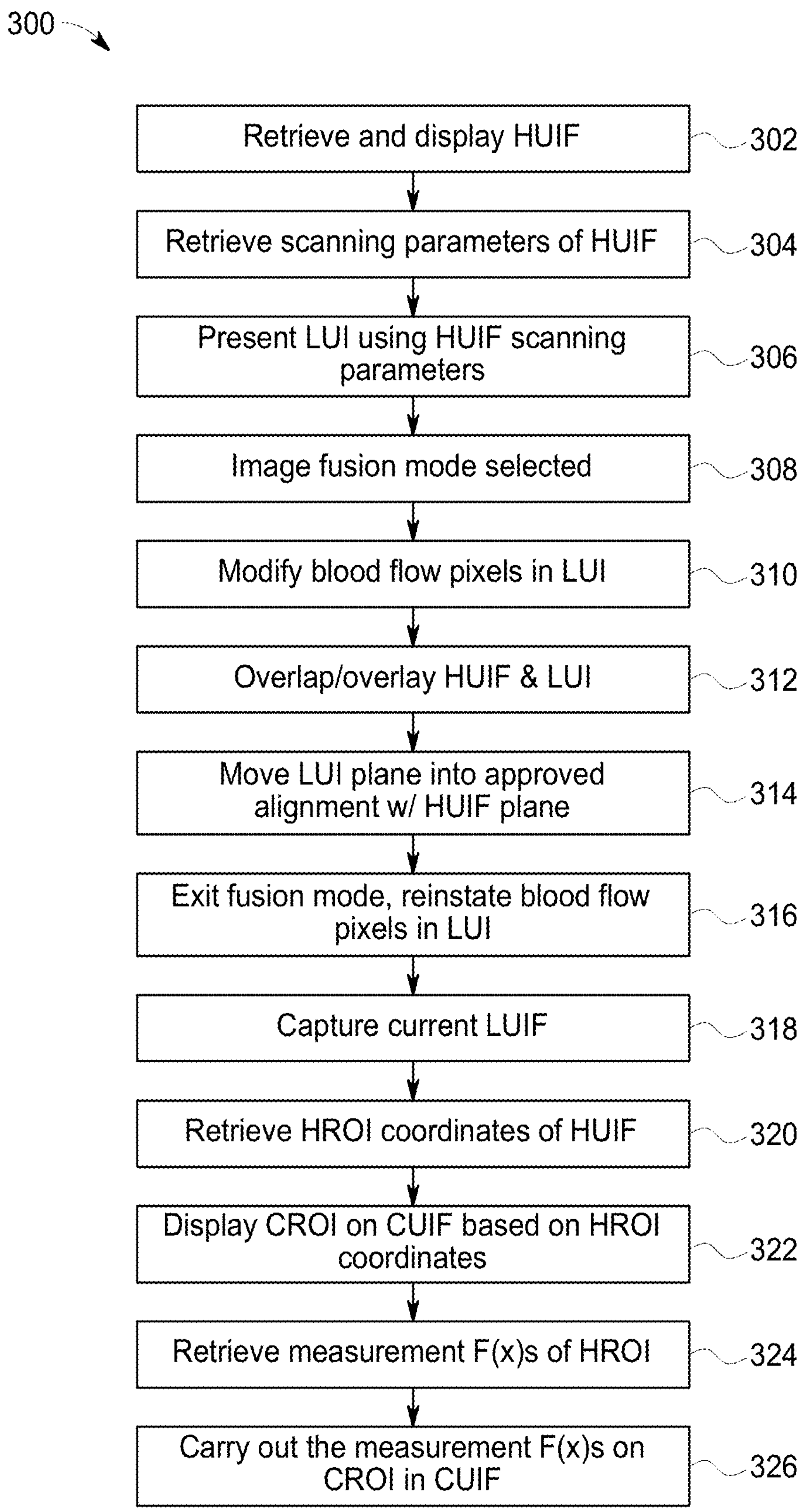

300
Retrieve and display HUIF
302
Retrieve scanning parameters of HUIF
304
Present LUI using HUIF scanning parameters
306
Image fusion mode selected
308
Modify blood flow pixels in LUI
310
Overlap/overlay HUIF & LUI
312
Move LUI plane into approved alignment w/ HUIF plane
314
Exit fusion mode, reinstate blood flow pixels in LUI
316
Capture current LUIF
318
Retrieve HROI coordinates of HUIF
320
Display CROI on CUIF based on HROI coordinates
322
Retrieve measurement F(x)s of HROI
324
Carry out the measurement F(x)s on CROI in CUIF
326

FIG. 8

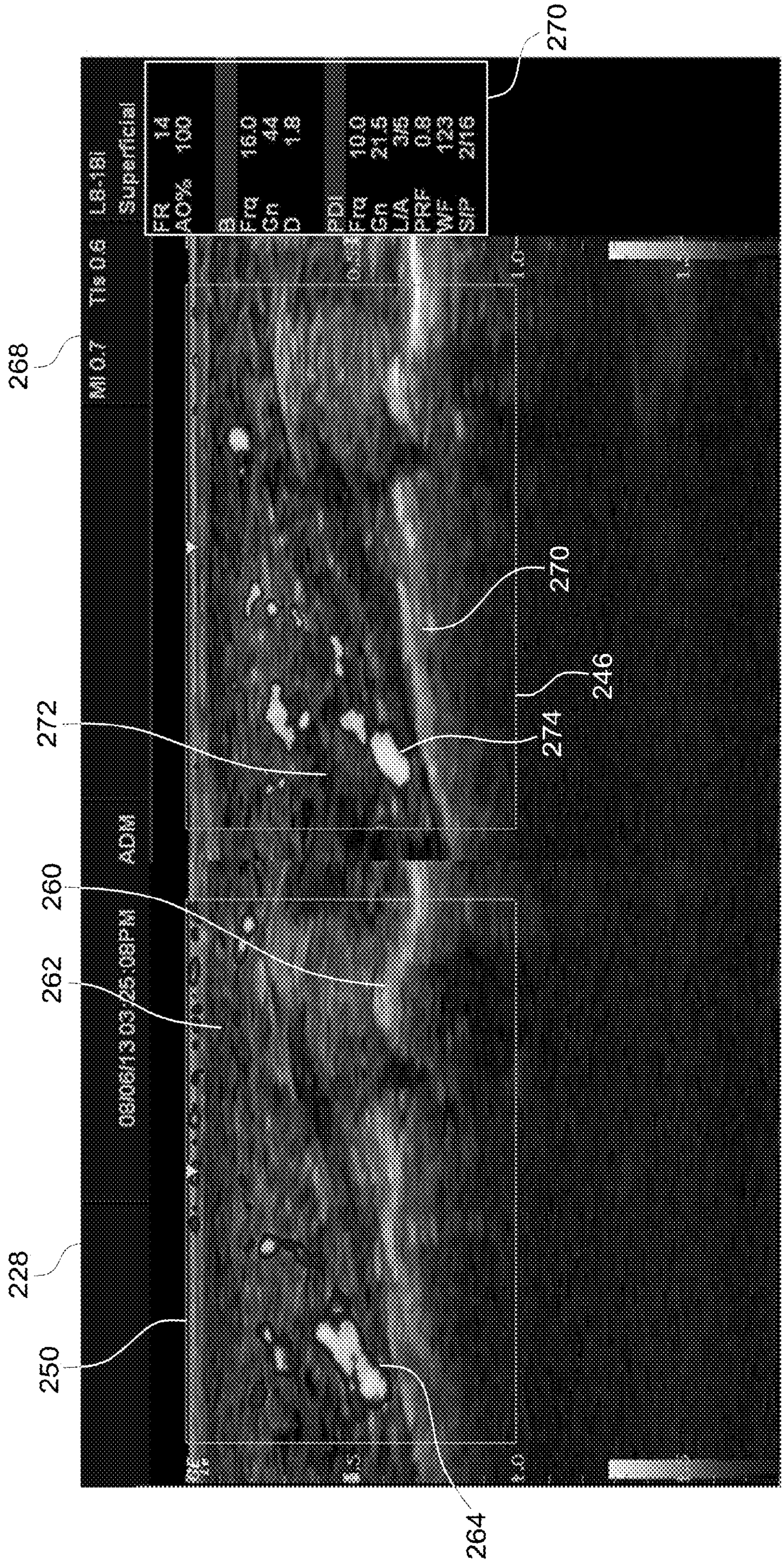

270
268
MI 0.7
TIs 0.6
Superficial
FR 14
AO% 100
B
Frq 16.0
Gn 44
D 1.8
PDI
Frq 10.0
Gn 21.5
PRF 0.8
WF 123
ADM
272
260
262
228
250
264
270
246
274

FIG. 9

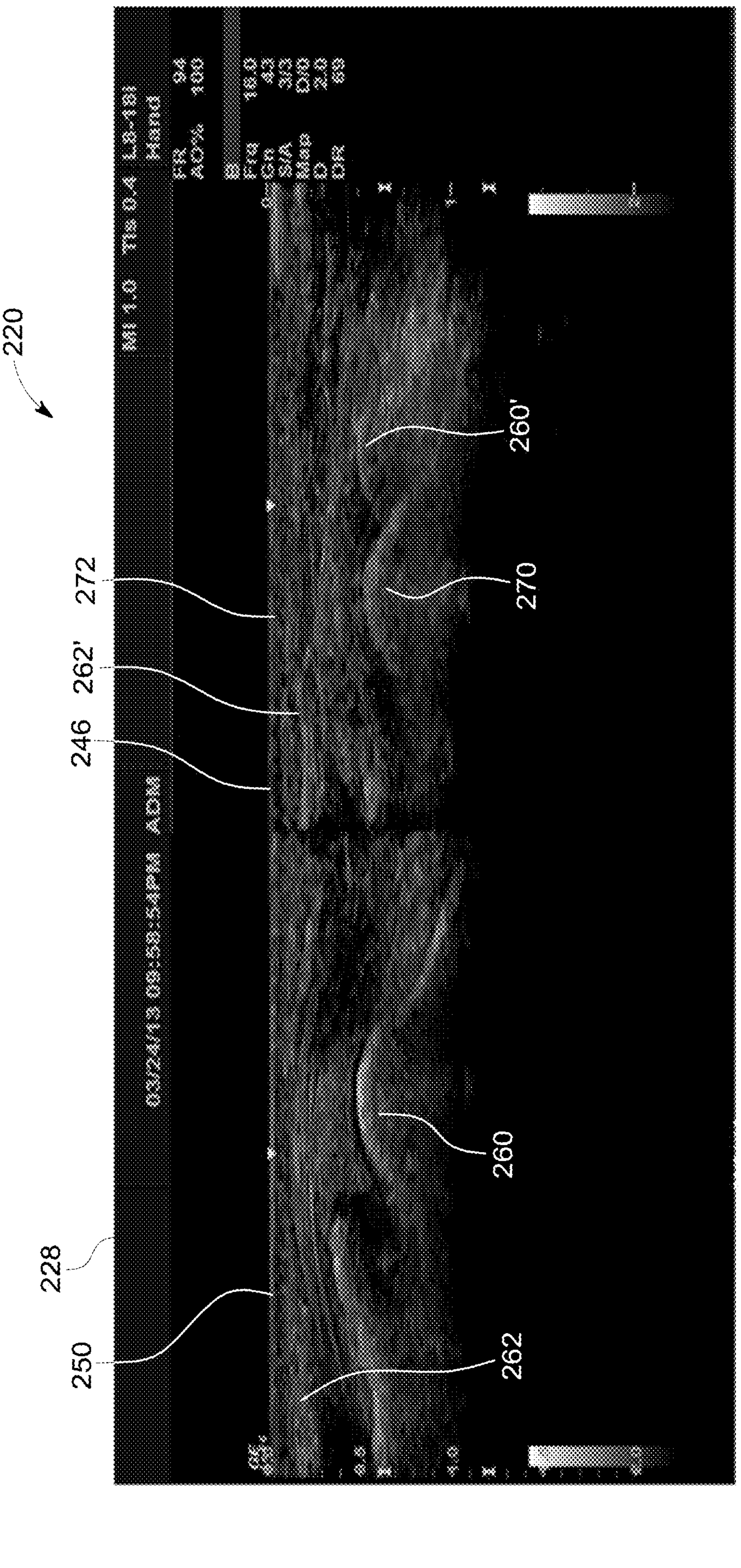


FIG. 10

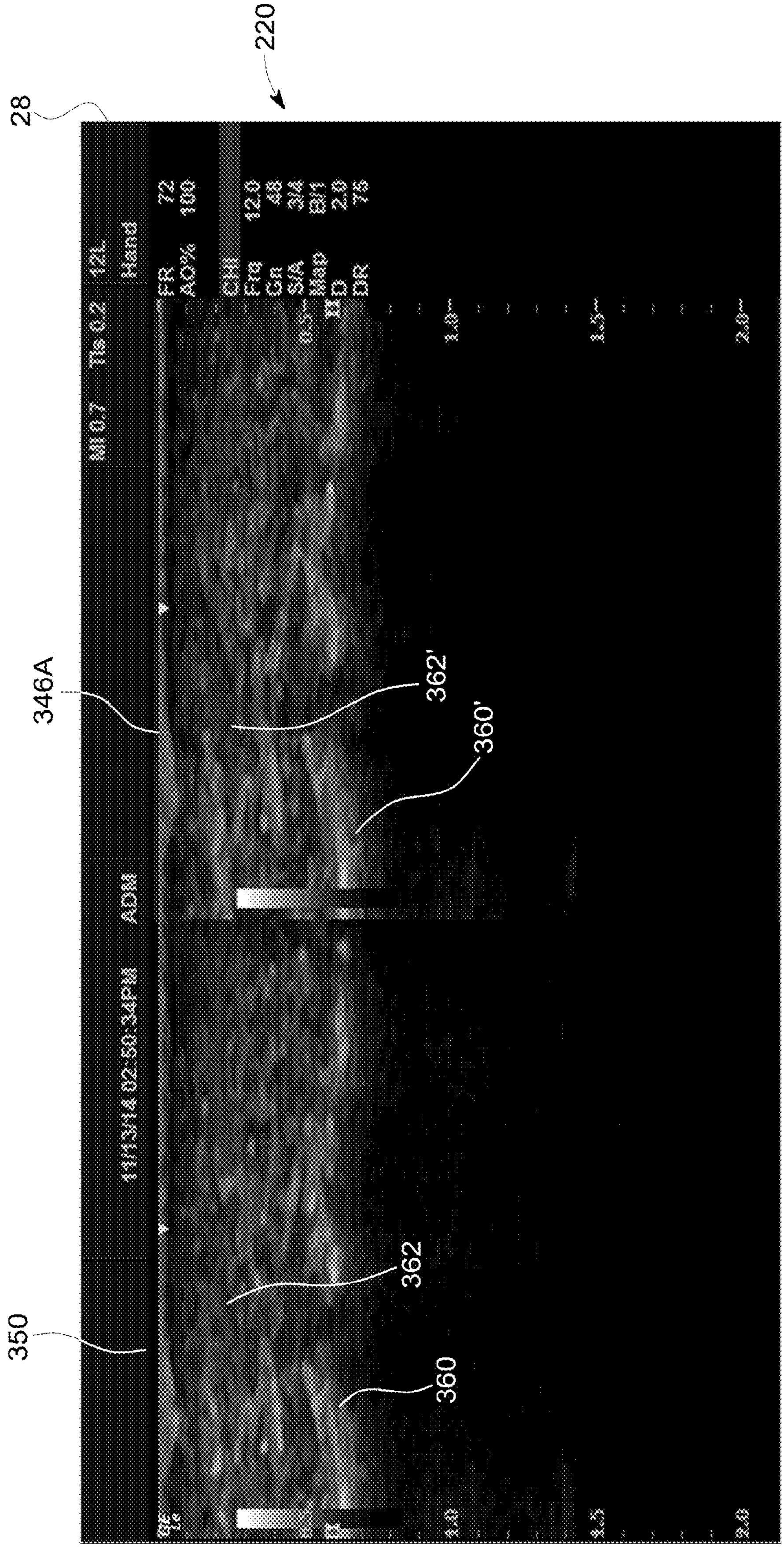

220
28
346A
362'
360'
350
362
360
11/13/14 02:50:34PM
ADM
MI 0.7
TIs 0.2
12L
Hand
FR 72
AO% 100
CHI
Frq 12.0
Gn 48
S/A 3/4
Map B/1
D 2.0
DR 75

FIG. 11

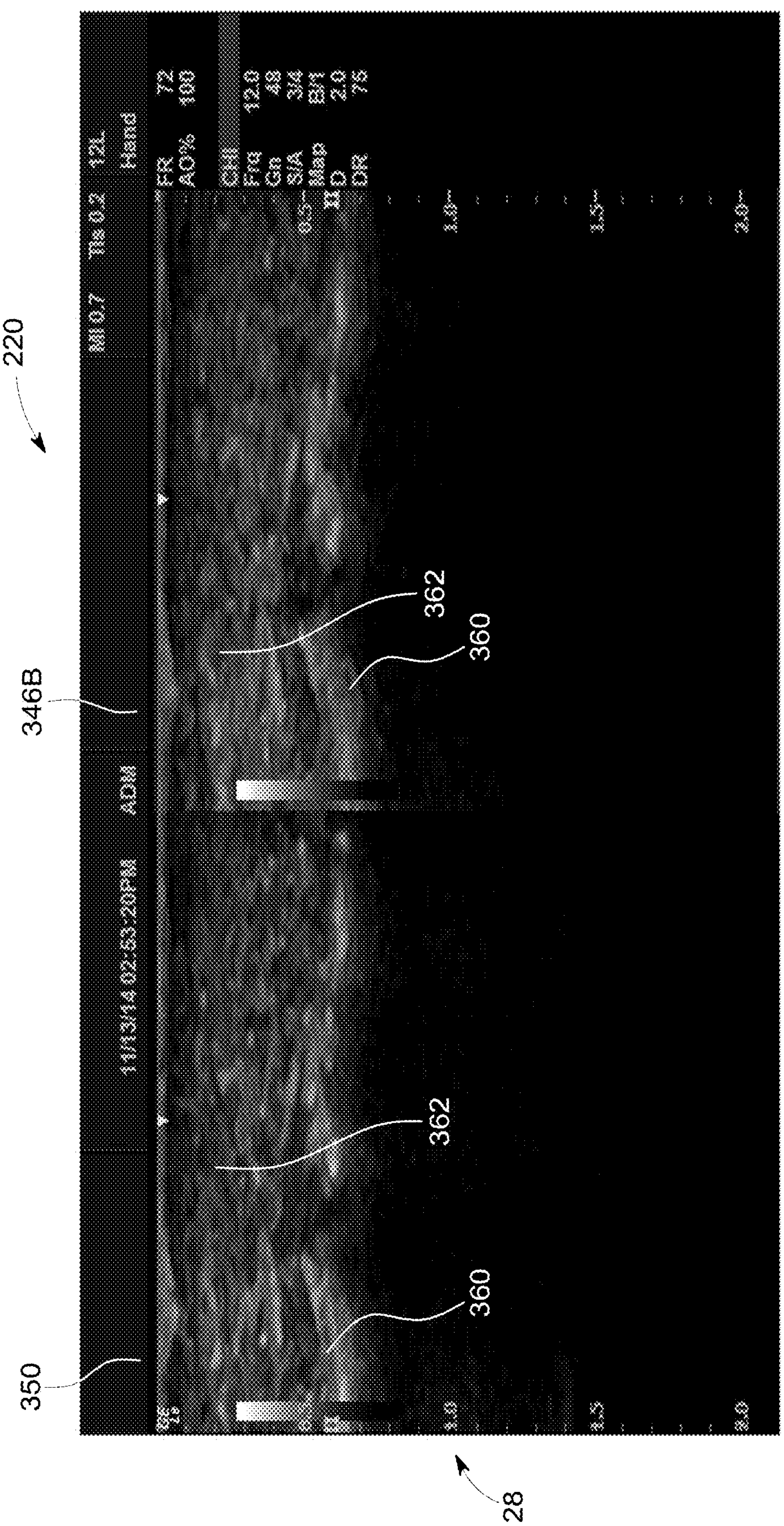


FIG. 12

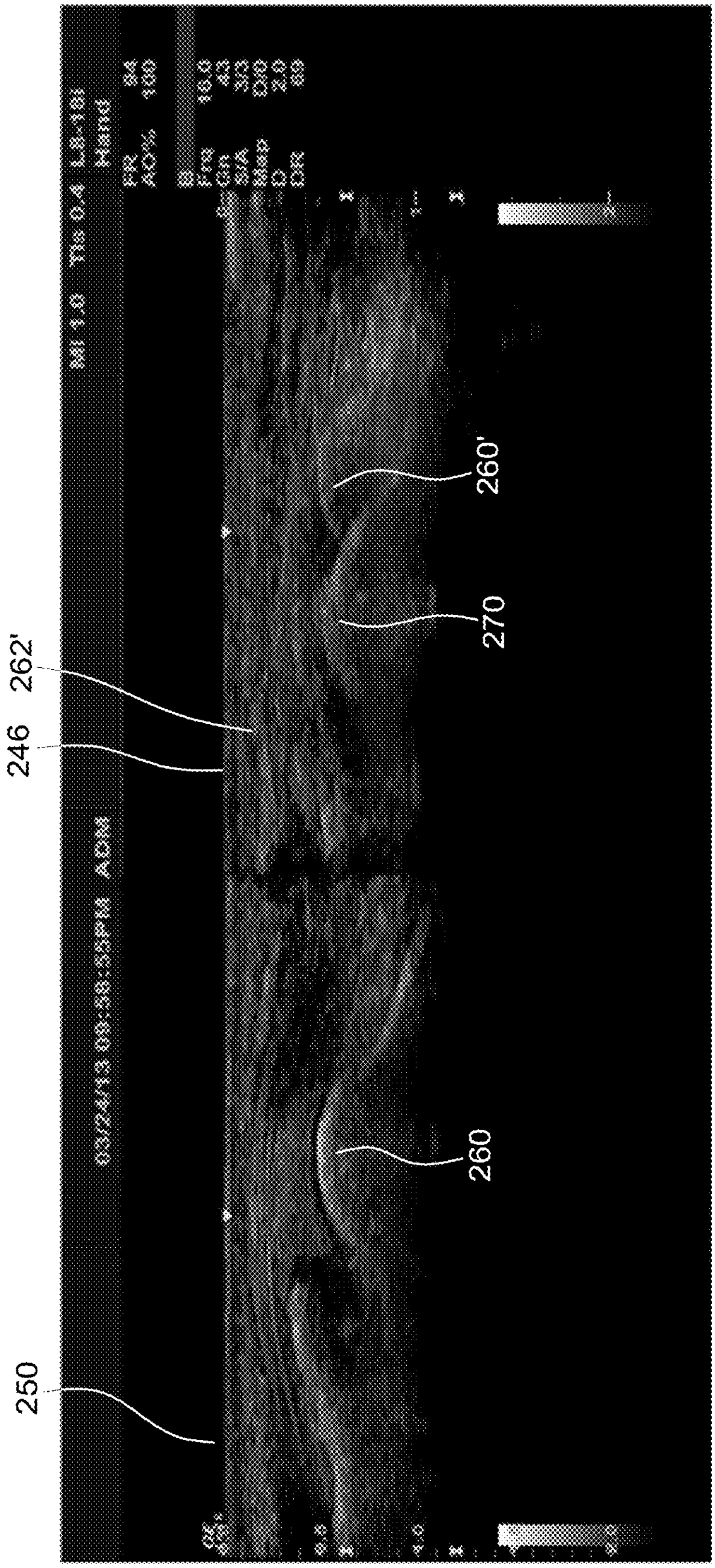


FIG. 13

FIG. 14

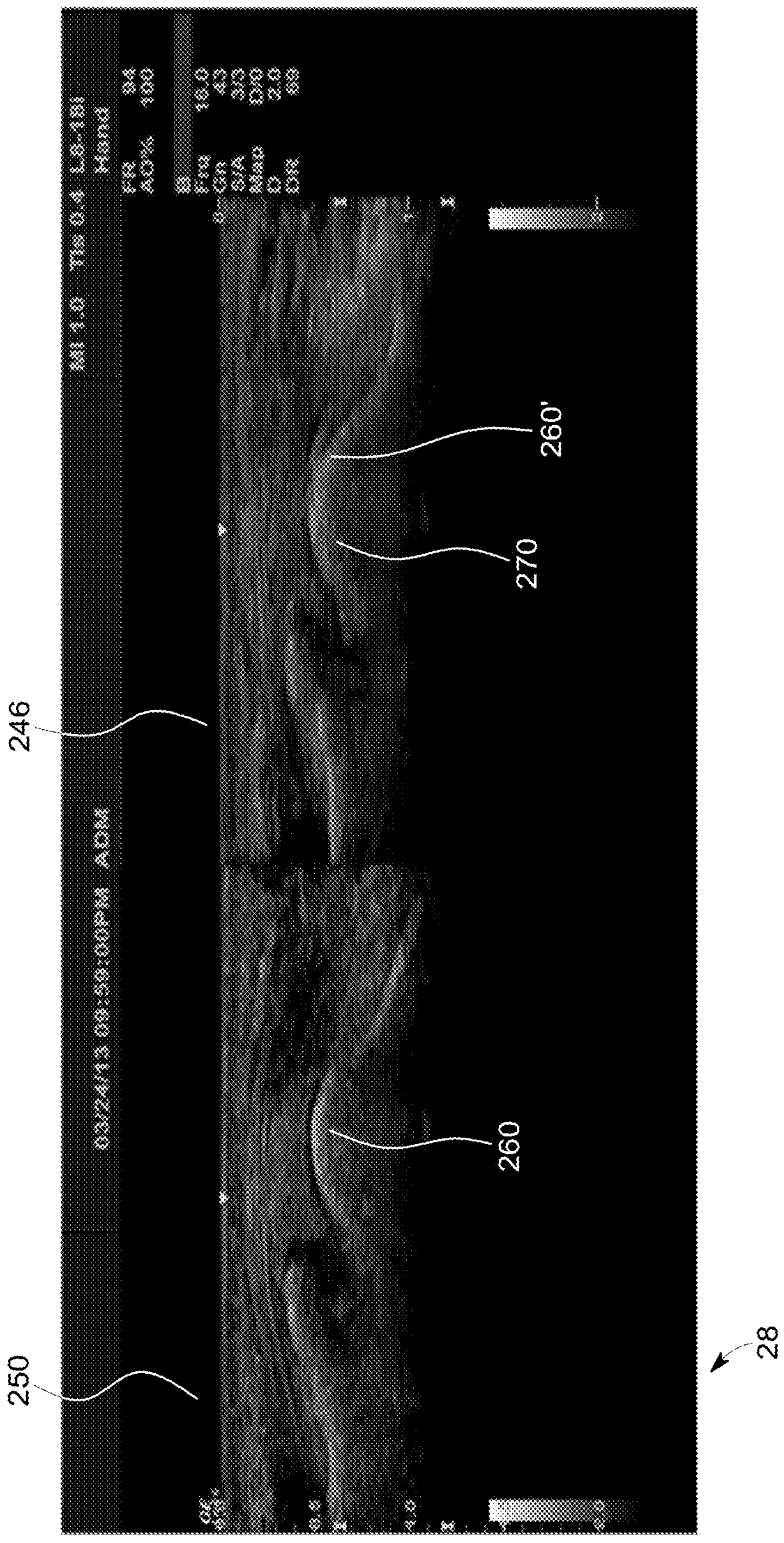


FIG. 15

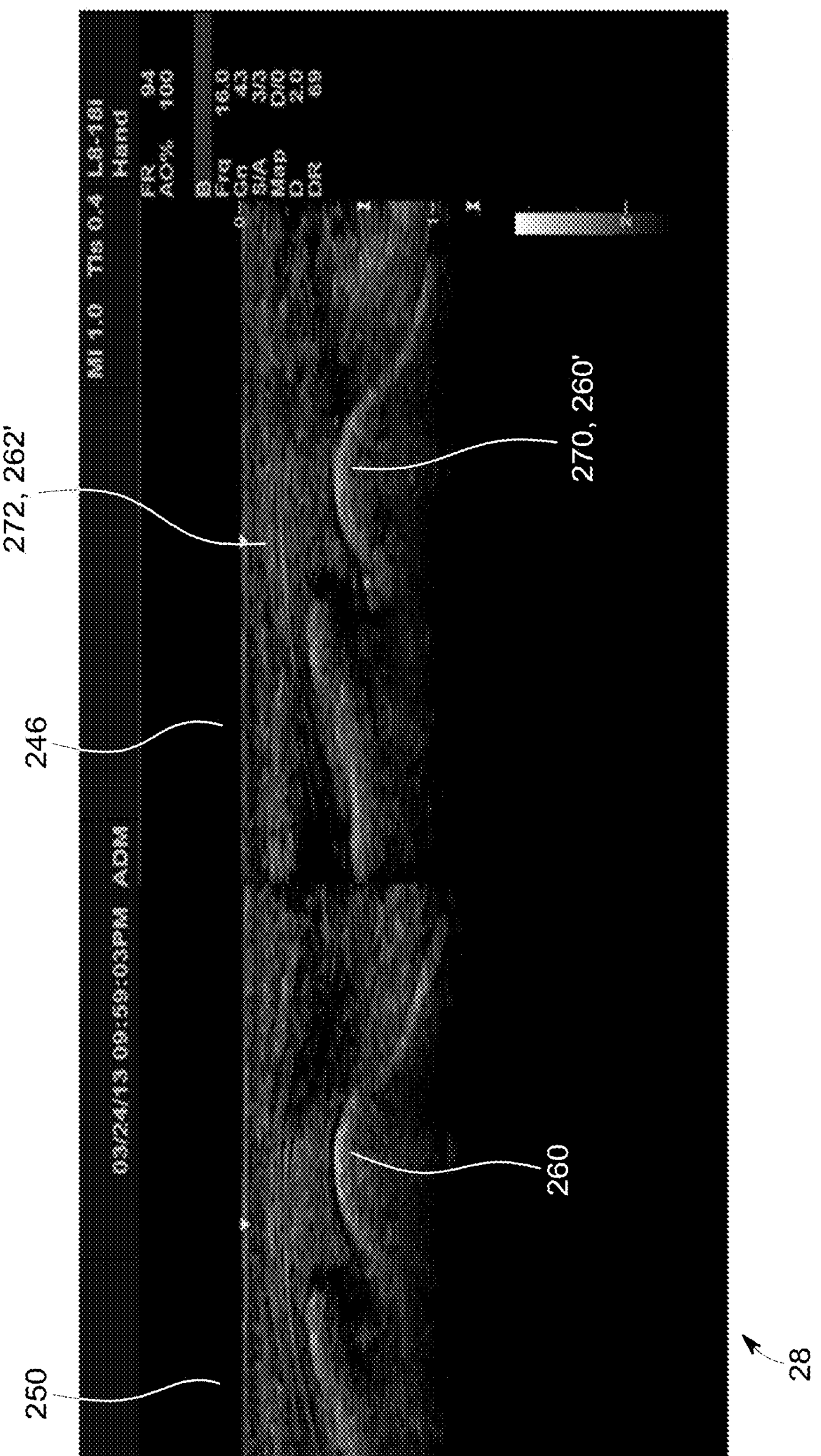

272, 262'
246
250
260
270, 260'
28
03/24/13 09:59:03PM ADM
MI 1.0 TIs 0.4 L8-18i
Hand

FIG. 16


228
220
461
450
460
446
460', 470
08/06/13 03:27:35PM
ADM
MI 0.7
TIs 0.6
L8-18I
Superficial

FIG. 17

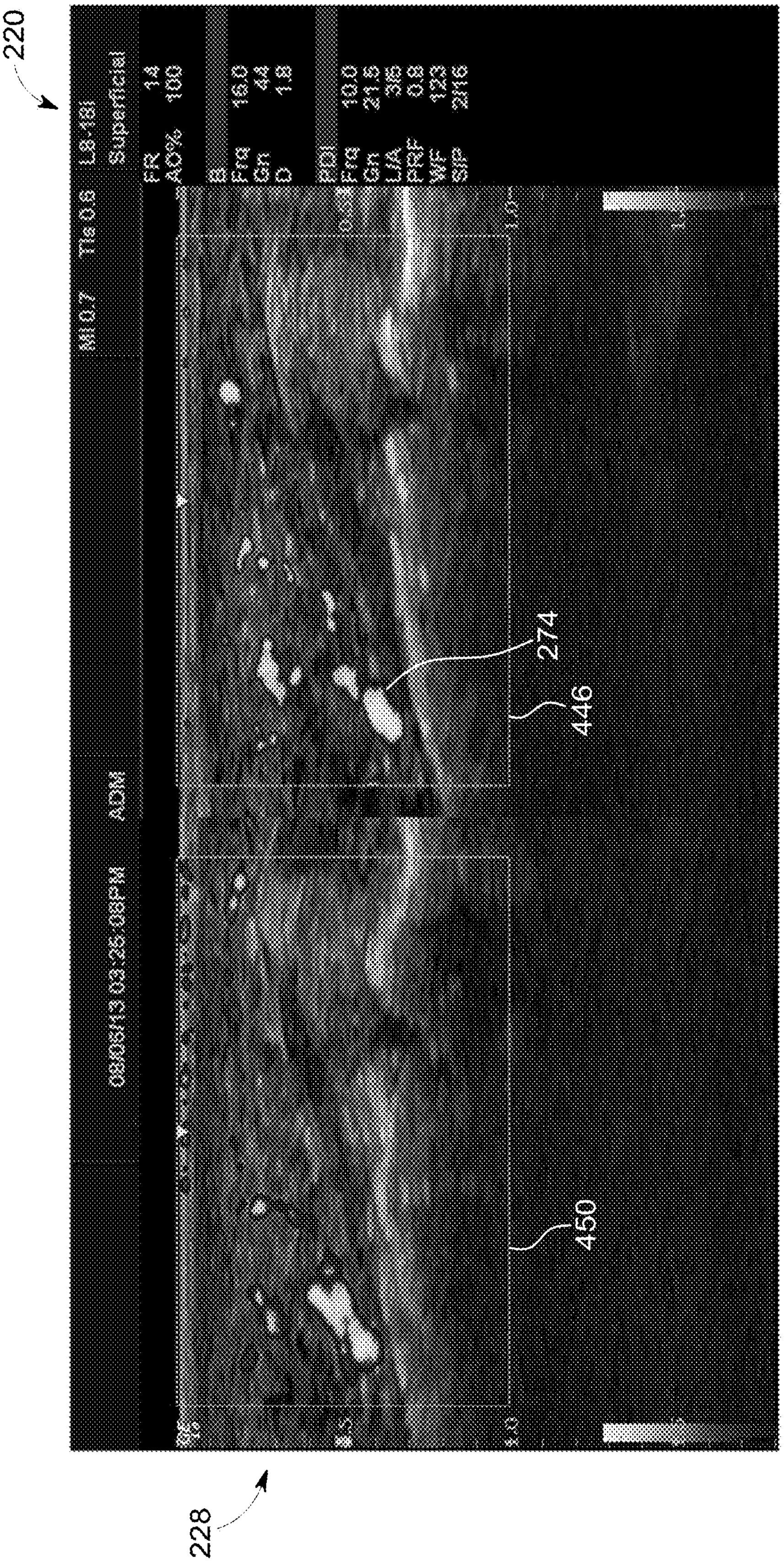

220
228
274
446
450
08/05/13 03:26:08PM
ADM
MI 0.7
TIs 0.6
L8-18i
Superficial

FIG. 18

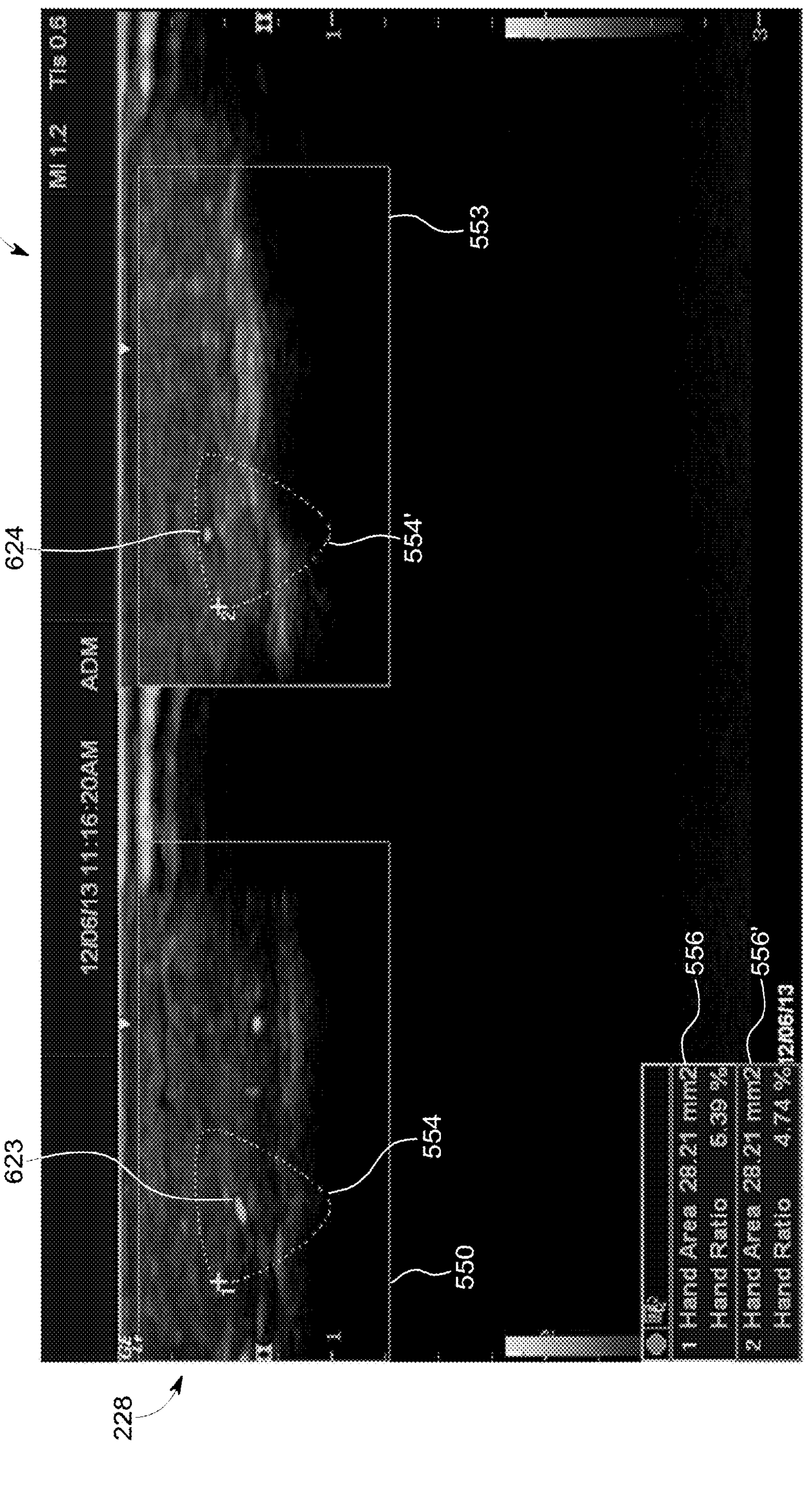

220
228
12/06/13 11:16:20AM
ADM
MI 1.2
TIs 0.8
623
624
553
554
554'
550
556
556'
1 Hand Area 28.21 mm2
Hand Ratio 6.39 %
2 Hand Area 28.21 mm2
Hand Ratio 4.74 %

FIG. 19

LIVE ULTRASOUND IMAGE AND HISTORICAL ULTRASOUND IMAGE FRAME OVERLAPPING

BACKGROUND

[0001] Ultrasound images are often used to diagnose injuries or diseases. Different ultrasound images taken at different times are often used to determine how the injuries or diseases are changing. Obtaining accurate comparisons of the different ultrasound images is often tedious, time-consuming and prone to error.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] FIG. **1** is a schematic diagram of an example ultrasound imaging system.

[0003] FIG. **2** is a flow diagram of an example method in which a historical ultrasound image frame and a live ultrasound image are overlapped.

[0004] FIG. **3** is a schematic diagram illustrating one example overlapping of a historical ultrasound image frame with respect to a live ultrasound image.

[0005] FIG. **4** is a schematic diagram illustrating another example overlapping of a historical ultrasound image frame with respect to a live ultrasound image.

[0006] FIG. **5** is a schematic diagram of an example side-by-side display of a historical ultrasound image frame and a live ultrasound image.

[0007] FIG. **6** is a schematic diagram of a side-by-sigh display of the historical ultrasound image frame and the live ultrasound image being overlapped by the historical ultrasound image frame.

[0008] FIG. **7** is a perspective view of another ultrasound imaging system, an example implementation of the imaging system of FIG. **1**.

[0009] FIG. **8** is a flow diagram of another example method for capturing and analyzing ultrasound information.

[0010] FIG. **9** is an example screenshot of an example side-by-side display of a historical ultrasound image frame and a live ultrasound image.

[0011] FIG. **10** is an example screenshot of an example side-by-side display of another historical ultrasound image frame and another live ultrasound image being overlapped by the historical ultrasound image frame.

[0012] FIG. **11** is an example screenshot of an example side-by-side display of another historical ultrasound image frame and another live ultrasound image being overlapped by the historical ultrasound image frame at first skeletal and background display settings.

[0013] FIG. **12** is an example screenshot of an example side-by-side display of the historical ultrasound image frame and the live ultrasound image of FIG. **11** being overlapped by the historical ultrasound image frame at second skeletal and background display settings.

[0014] FIGS. **13-16** are example screenshots illustrating the historical ultrasound image frame and the live ultrasound image of FIG. **10** with their scan planes being progressively moved into alignment with one another.

[0015] FIG. **17** is an example screenshot of an example side-by-side display of a historical ultrasound image frame and a live ultrasound image without depiction of blood flow overlapped by portions of the historical ultrasound image frame.

[0016] FIG. **18** is an example screenshot of an example side-by-side display of the historical ultrasound image frame of FIG. **17** and the live ultrasound image of FIG. **17** with reinstated depiction of blood flow.

[0017] FIG. **19** is an example screenshot of an example side-by-side display of another historical ultrasound image frame with a region of interest for which measurement functions were performed and for which results are displayed and a current ultrasound image frame with the same region of interest and having the same measurement function results displayed.

DETAILED DESCRIPTION OF EXAMPLES

[0018] FIG. **1** schematically illustrates an example ultrasound imaging system **20**. Ultrasound imaging system **20** facilitates enhanced alignment of a live ultrasound scan plane of an object **22** with an scan plane of a prior or historical ultrasound image frame of the object or other objects. Once approved alignment of an scan plane of the live ultrasound image and the scan plane of the historical ultrasound image frame have been achieved, current ultrasound image frames are captured from the live ultrasound image for comparison with the historical ultrasound image frame. As will be described hereafter, ultrasound imaging system **20** further facilitates more reliable and accurate comparison between the current ultrasound image frame and the prior captured ultrasound image frame. For example, in one implementation, ultrasound imaging system **20** facilitates the capture of a current ultrasound image frame illustrating inflammation symptoms associated with rheumatoid arthritis of joints and further facilitates comparison of the current ultrasound image frame with historical ultrasound image frames of the joints to facilitate accurate diagnosis.

[0019] Ultrasound imaging system **20** comprises ultrasound image acquisition device **26**, display **28**, input **29**, processor **30** and memory **32**. Ultrasound image acquisition device **26** comprises a device by which ultrasound (ultrasonic) waves or pulses are directed into object **22**, such as the anatomy of a person or animal, and by which reflections of such waves are sensed to produce signals. In one implementation, the ultrasound image acquisition device comprises a transducer having quartz crystals, piezoelectric crystals, that change shape in response to application of electrical currents so as to produce vibrations or sound waves. Likewise, the impact a sound or pressure waves upon such crystals produces electrical currents. As a result, such crystals send and receive sound waves. In one implementation, ultrasound acquisition device **26** comprises ultrasound scanning device in which the transducer is mechanically positioned with respect to object **22**. In another implementation, ultrasound acquisition device **26** comprises a manually positioned device, such as a hand-held probe. In one implementation, the probe may be positioned against the exterior of an anatomy or object being imaged. In another implementation, the probe may be partially inserted into the anatomy or object. Signals output by ultrasound image acquisition device **26** are transmitted to processor **30** for the generation display of images on display **28**.

[0020] Display **28** comprises a screen or other display by which the results from ultrasound image acquisition device **26** are visibly presented to a caretaker, such as a doctor or nurse. In one implementation, display **28** comprises a single monitor or screen associated with processor **30** or in communication with processor **30**. In another implementation, display **20** comprises multiple screens under the control of processor **30**.

[0021] Input **29** comprises one or more devices by which a user may enter inputs, commands or selections to system **20**. In one implementation, input **29** comprises a keyboard. In another implementation, input **29** comprises switches, slider bars, pushbuttons, a keypad, a touchpad, a mouse, a microphone with associated speech recognition software, a stylus or touchscreen capabilities associated with display **28**. Ibid. **29** facilitates the entry of data as well as the input of selections or commands selecting modes of operation and indicating when to enter and exit different modes of operation, such as a fusion mode as will be described hereafter.

[0022] Processor **30** comprises one or more processing units which control presentation of ultrasound images upon display **28**. In one implementation, processor **30** additionally generates the ultrasound images using signals received from ultrasound image acquisition device **26**. For purposes of this application, the term "processing unit" shall mean a presently developed or future developed processing unit that executes sequences of instructions contained in a memory **32**. In the example illustrated, memory **32** comprises a non-transient or non-transitory computer-readable medium containing computer code for the direction of controller processor **30**. Execution of the sequences of instructions causes the processing unit comprising processor **30** to perform steps such as generating control signals. The instructions may be loaded in a random access memory (RAM) for execution by the processing unit from a read only memory (ROM), a mass storage device, or some other persistent storage. In other embodiments, hard wired circuitry may be used in place of or in combination with software instructions to implement the functions described. For example, processor **30** may be embodied as part of one or more application-specific integrated circuits (ASICs). Unless otherwise specifically noted, the controller is not limited to any specific combination of hardware circuitry and software, nor to any particular source for the instructions executed by the processing unit.

[0023] As schematically illustrated by FIG. **1**, memory **32** comprises historical image frame data section or storage **38**, follow-up module **40**, live image display module **40** and fusion module **44**. Historical image frame data section or storage **38** comprises data or files associated with historical ultrasound image frames, each historical ultrasound image frame comprising a previously captured individual or static ultrasound image frame. In one implementation, the historical image frame data section or storage **38** comprises B-mode ultrasound image frames. In other implementations, the historical ultrasound image frames may comprise other image formats depicting additional information.

[0024] Such historical image frame data **38** comprises ultrasound image frames captured from one or more previous live ultrasound images at a prior imaging or scanning session. For example, such historical image frame data may have been captured hours, days, weeks, months or even years prior to the present time at which the live ultrasound image **46** is being taken. In one implementation, each historical ultrasound image frame stored in data storage **38** has one or more files, or links to files, containing the scanning parameters or settings of ultrasound image acquisition device **26** (or a different ultrasound image acquisition device **26**) that were utilized during the generation of the historical ultrasound image frame. In one implementation, each historical ultrasound image frame stored in data storage **38** additionally or alternatively comprises one or more files, or links to files, containing the previously selected or identified historical regions of interest and the particular measurement functions that were carried out with respect to the historic ultrasound image frame or the historical regions of interest in the historical ultrasound image frame.

[0025] Follow-up module **40**, live image display module **40**, and fusion module **44** each comprise software, code, integrated circuitry or other types of program logic that direct or control processor **30** in the concurrent overlapping display of a historical ultrasound image frame and live stream of ultrasound images. In the example illustrated, follow-up module **40**, live image display module **40**, and fusion module **44** cooperate to carry out the example method **100** set forth in FIG. **2**.

[0026] As indicated by block **102** in FIG. **2**, follow-up module **40** directs processor **30** to retrieve an individual historical ultrasound image frame from data storage **38**. In one implementation, follow-up module **40** retrieves the historical image frame from a data storage or data store which is part of memory **32** local to processor **30**. In another implementation, follow-up module **40** retrieves the historical image frame from a remote memory, such as from a remote database or remote server, across a local area network or wide area network, such as the Internet. In one implementation, follow-up module **40** retrieves multiple historical ultrasound image frames or retrieves multiple links to multiple historical ultrasound image frames, wherein the files or links are displayed on display **28** for selection by a physician, nurse or practitioner through a touchscreen, manipulation of a cursor, speech recognition or the like.

[0027] In one implementation, such image frames comprise historical ultrasound image frames of the same object or same patient being examined, whether such image frames have been captured and stored days, weeks or months prior to the current exam. In yet other implementations, the retrieved historical ultrasound image frame comprises a model or a standard image frame to be used for comparison with the live ultrasound image or individual frames captured from the live ultrasound image. For example, in one implementation, the historical ultrasound image frame comprises an ultrasound image frame of a healthy individual, a healthy anatomy or the like of the same object currently being examined, from another real object or anatomy or from a generated hypothetical model of the anatomy.

[0028] Follow-up module **40** retrieves or extracts, from the files associated with the retrieved ultrasound image frame, the scanning or imaging parameters previously used by the ultrasound image acquisition device **26** (or another ultrasound image acquisition device) when the retrieved ultrasound image frame was generated or captured. As will be described hereafter with respect to FIGS. **5** and **6**, in one user selected mode of operation, follow-up module **40** additionally directs processor **30** to display the retrieved historical ultrasound image frame for viewing, either by itself on a single screen or side-by-side (as seen in FIGS. **5** and **6**) with the live ultrasound image for comparison.

[0029] As indicated by block **104** in FIG. **2**, live image display module **42** directs processor **30** to output control signals causing display **28** to present a live or real time ultrasound image **46** based upon signals received from ultrasound image acquisition device **26**. The live ultrasound image presented on display **28** comprises a series of ultrasound image frames presented at a high frequency in real time. The live ultrasound image presented on display **28** by module **42** is a result of the live stream of ultrasound image signals received from ultrasound image acquisition device **26**. Movement of object **22** or movement of the ultrasound image acquisition device **26** causes movement of the live ultrasound image **46** such that different scan planes are presented as device **26** and/or object **22** are moved relative to one another.

[0030] In one implementation, the live ultrasound image **46** comprises a B-mode image. In another implementation, the live ultrasound image **46** comprises a color flow image, a power Doppler image (PDI) or a high resolution PDI image. As will be described hereafter, in some implementations, the live ultrasound image presented on display **28** is further modified by fusion module **44** to enhance viewing of the overlapped live ultrasound image and historical ultrasound image frame. In yet other implementations, the live ultrasound image **46** may comprise other imaging formats or modes.

[0031] In the example illustrated, live image display module **42** further adjusts or controls the operational settings or scanning parameters of ultrasound image acquisition device **26**. In one implementation, live image display module **42** automatically receives the retrieved scanning parameters associated with the retrieved historical ultrasound image frame and automatically controls ultrasound image acquisition device **26** based upon the prior retrieved scanning parameters previously used when the historical ultrasound image frame was generated. In one implementation, live image display module **42** automatically utilizes the same scanning parameters associated with the retrieved historical ultrasound image frame for the generation of the live ultrasound image. In another implementation, live image display module **42** performs adjustments or modifications upon the prior scanning parameters.

[0032] In yet other implementations, live image display module **42** prompts for and receives input or manual entry of the scanning parameters for the ultrasound image acquisition device **26** to generate the live ultrasound image. In one such implementation, live image display **42** displays and suggests use of the prior scanning parameters associated with the historical ultrasound image frame. In such an implementation, the user may enter or input the exact same prior scanning parameters or may make adjustments to the prior scanning parameters.

[0033] As indicated by block **106** of FIG. **2**, fusion module **44** directs processor **30** to "fuse" the live ultrasound image with the historical ultrasound image frame. Fusion module **42** outputs control signals causing display **28** to present the retrieved historical ultrasound image frame **50** in an overlapping or overlaid relationship with respect to the live ultrasound image **46** being displayed on display **28**. In the example illustrated, the overlapping live image or the overlapping historical image frame is outlined or is made at least semi-transparent such that the underlying live image or the underlying historical image frame is viewable or discernible through the overlying live image or the historical image frame. In the example illustrated in FIG. **1**, the historical image frame is placed on top of or in overlapping relationship with the underlying live image.

[0034] Because the underlying image, whether it be live image **46** or the historical ultrasound image frame **50**, is viewable through the overlying image, the user may reposition either object **22** and/or the ultrasound image acquisition device **26** relative to one another to reposition the scan plane of the live image **46** until the scan plane of the live image **46** has sufficient alignment with the historical ultrasound image frame **50**. In one implementation, such alignment is determined by the user of system **20** based upon the user's perception of alignment. For example, the ultrasound system **20** may align the underlying scan plane of the live image **46**/historical ultrasound image frame **50** and the overlying scan plane of the live image **46**/historical ultrasound image frame **50** by aligning distinctive anatomical features or landmarks, such as skeletal structures/bones or muscle/tissue. Once the ultrasound image acquisition device **26** and object **22** are appropriately positioned relative to one another such that the scan planes of the live ultrasound image **46** and of the historic ultrasound image frame **50** are in user approved, sufficient alignment, at least one individual current image frame of the stream of image frames forming the live ultrasound image **46** may be frozen or captured for direct subsequent comparison and analysis with respect to the historical ultrasound image frame **50**. Because the current ultrasound image frame being compared with the historical ultrasound image frame has substantially the same scan plane, the results of the comparison are more accurate and valid.

[0035] In one implementation, in addition to overlapping the live ultrasound image and the historic ultrasound image frame, fusion module **44** additionally carries out modifications upon one or both of the live ultrasound image and the historical ultrasound image frame to facilitate user manipulated alignment of the live ultrasound image and the historical ultrasound image frame. For example, in one implementation, the live ultrasound image, depending upon its format, may include blood flow data or color flow data. In such an implementation, when in the fusion mode in which the live image and the historical image are being overlapped, fusion module **44** automatically modifies the depiction of the blood flow or color flow in the live ultrasound image. For example, in one implementation, fusion module **44** completely removes the blood flow or color flow pixels depicting blood flow. For purposes of this disclosure, "removal" of such pixels encompasses making such textiles completely transparent, removal of such pixels and replacement of such pixels with other pixels, or changing the color or other characteristics of such pixels such that they are not distinguishable from surrounding pixels. In one implementation, fusion module **44** maintains such color flow pixels, but reduces their visibility in the live ultrasound image.

[0036] In one implementation, fusion module **44** additionally or alternatively modifies portions of the historical image frame being overlapped with the live ultrasound image to facilitate discernment between the live ultrasound image and the historical ultrasound image frame. For example, in one implementation, fusion module **44** applies one or more colors to the entire historical ultrasound image frame or features of the historical ultrasound image frame, wherein the color or colors are different from the color colors associated with the live ultrasound image. In another implementation, fusion module **44** modifies the line thickness, brightness, intensity, flashing frequency or the like of the entire historical ultrasound image frame or features of the historical ultrasound image frame so as to visibly distinguish the historical ultrasound image frame with respect to the live ultrasound image.

[0037] As noted above, fusion module **46** presents the live ultrasound image **46** and the historical ultrasound image frame **50** in an overlapping or overlaying relationship, wherein the underlying live image **46** or the underlying historical image frame **50** are viewable or discernible through the overlying live image **46** or the overlying historical image frame **50**. FIGS. **3** and **4** schematically illustrate an implementation where the live ultrasound image **46**, the stream of high-frequency frames forming the live image, are displayed beneath the overlying historical ultrasound image frame **50**. As shown by FIGS. **3** and **4**, in the example illustrated, system **20** is operable in two user selectable modes. In the first mode shown in FIG. **3**, anatomical structures **154**, such as muscle, tissue, skeletal or bone, of the overlying historical ultrasound image frame **50** are semi-transparently displayed such that the anatomical structures **156** of the ever-changing live ultrasound image **46** may viewed beneath or through such anatomical structures **154**. In the second mode shown in FIG. **4**, perimeters, boundaries or edges of identified anatomical structures **154** are presented in solid lines while the interiors of such boundaries or edges are transparent (not illustrated) or semi-transparent. In the second mode of operation, outlines of anatomical structures **154** of the historical ultrasound image **50** are presented, allowing the anatomical structures **156** of the underlying, ever-changing live ultrasound image **46** are viewable through or within the outline of the overlying anatomical structures **154**.

[0038] In yet additional user selectable modes of operation, system **20** further visibly distinguishes at least one of the overlying anatomical structure **154** or the underlying anatomic structure **156**. In one implementation, fusion module **44** directs processor **30** to highlight one of the underlying or overlying anatomical structures. In one implementation, fusion module **44** directs processor **30** to highlight the overlying anatomical structure or structures **154** of the historical ultrasound image **50**. In one implementation, such highlighting is performed by providing the overlying anatomical structure or structures **154** with a color, shade or brightness distinct from that of the color, shade or brightness of the underlying anatomical structures **156** of the live ultrasound image **46**. In another mode, such highlighting is achieved by presenting or displaying the overlying anatomical structures **154** such that the overlying anatomical structures **154** flash or changing color, shade or brightness at a frequency distinct from the underlying live image **46**. In yet another user selectable mode of operation, such highlighting is achieved by identifying edges, boundaries or an outline of the overlying anatomic structure **154** and displaying the identified outline, boundary or edges with a color, shade, brightness, line thickness or display frequency different than that of the underlying anatomical structure **156** of the real-time, live ultrasound image **46**.

[0039] FIGS. **5** and **6** schematically illustrate yet another user selectable mode of operation for system **20**. As shown by FIGS. **5** and **6**, follow-up module **40** and live image display module **42** direct processor **30** to generate control signals presenting side-by-side ultrasound images on display **28**, concurrently presenting the historical ultrasound image frame **50** and the live ultrasound image **46**. Although the side-by-side images are illustrated as being concurrently presented on two adjacent portions of display **28**, in other implementations, such side-by-side images are presented on multiple display monitors or screens.

[0040] FIG. **5** illustrates a comparison or follow-up mode in which the live ultrasound image **46** is presented, without overlap, alongside the historical ultrasound image frame **50**. As shown by FIG. **5**, follow-up module directs processor **32** present historical ultrasound image **50**. Historical ultrasound image frame **50** comprises images or visible depictions of substantially stationary structures such as bones or skeletal structures **60** and muscle structures or tissue **62**. The skeletal structures may be organic or may be inorganic, artificial. In some implementations, the historical ultrasound image frame **50** may additionally comprise images or depictions of other substantially stationary structures or objects such as implants amongst the tissue and bones. In one implementation, historical ultrasound image **50** comprise a B-mode image frame.

[0041] As further shown by FIG. **5**, live ultrasound images lay module **42** concurrently displays live ultrasound image **46**. Live ultrasound image **46** comprises skeletal structure **70**, tissue **72** and depictions of dynamic features, such as blood flow **74**. In one implementation, the live ultrasound image may comprise color flow data, PDI data or high resolution PDI data. As noted above, in one implementation, live ultrasound image display module **42** controls ultrasound image acquisition device **26** (shown in FIG. **1**) such that the device **26** captures the live ultrasound image **46** using scanning parameters or settings based upon, if not the same as, the same scan parameters or settings that were used to capture the displayed historical ultrasound image frame **50**.

[0042] FIG. **6** illustrates an example fusion mode. In the fusion mode shown FIG. **6**, the historical ultrasound image **50**, shown on the left side of display **28**, is copied over and overlapped upon the live ultrasound image **46** on the right side of display **28** to form skeletal structures **60'** and tissue **62'**. Those portions of the historical sun image frame **50** that are copied over and overlaid upon the underlying live image **46** are modified or otherwise presented so as to permit viewing of at least portions of the overlap and underlying live ultrasound image **46**. As noted above, in one implementation, skeletal structure **60'** and tissue **62'** corresponding to structure **60** and tissue **62**, respectively, of the historical sun image **50** are either outlined or made semi-transparent.

[0043] As shown by the right side of display **28** in FIG. **6**, fusion module **44** continues to display or present the skeletal structures **70** and the tissue **72** in the live ultrasound image, but removes or at least diminishes the dynamic features, such as blood flow **74** (shown in FIG. **5**) in the live ultrasound image **46**. In one implementation, fusion module **44** additionally highlights one or both of skeletal structures **60'** and tissue **62'** of the historical ultrasound image frame **50** when being overlapped with the live ultrasound image **46**. As described above, in one implementation, fusion module **44** applies one or more colors to skeletal structure **60'** and/or tissue **62'** of the historical ultrasound image frame **50** and/or modifies the intensity, brightness, pixel size, line width or the like of skeletal structure **60'** and/or tissue **62'** of the historical ultrasound image frame **50**. In one implementation, the historical ultrasound image frame presented on the left side of display **28** is not altered when in the fusion mode. In yet another implementation, the historical ultrasound image frame presented on the left side of display **28** is modified in a similar fashion to the copy of the historical sun image frame **50** that is overlapped upon the live ultrasound image when system **20** is in the fusion mode illustrated in FIG. **6**.

[0044] FIG. **7** illustrates ultrasound imaging system **220**, an example implementation of ultrasound imaging system **20**. Ultrasound imaging system **220** comprises ultrasound image acquisition devices **226**, display **228**, input **229**, processor **230** and memory **232** comprising historical ultrasound image frame data storage **238**, follow-up module **240**, live image display module **242**, fusion module **244** and auto copy module **246**. Ultrasound image acquisition devices **226** comprise devices by which ultrasound (ultrasonic) waves or pulses are directed into an object or patient, such as the anatomy of a person or animal, and by which reflections of such waves are sentenced to produce signals. In one implementation, the ultrasound image acquisition device comprises a transducer having quartz crystals, piezoelectric crystals, that change shape in response to application of electrical currents so as to produce vibrations or sound waves. Likewise, the impact of sound or pressure waves upon such crystals produce a lot of currents. As a result, such crystals send and receive sound waves. In the example illustrated, ultrasound image acquisition device **226** comprise manually positionable ultrasound probes. In other implementations, ultrasound image acquisition device **226** comprises a mechanical scanner which mechanically moves in positions one or more ultrasound transducers relative to a patient. In one implementation, the probe may be positioned against the exterior of an anatomy or object being imaged. In another implementation, the probe may be partially inserted into the anatomy are object. Signals output by ultrasound image acquisition devices **226** are transmitted to processor **230** for the generation display of images on display **228**.

[0045] Display **228** and input **229** are similar to display **28** and input **29**, respectively, described above except that display **228** and input **229** comprise specific implementations of display **28** and input **29**, respectively. Display **228** comprises a screen or other display by which the results from ultrasound image acquisition device **26** are visibly presented to a caretaker, such as a doctor or nurse. In the example illustrated, display **228** comprises a single monitor or screen associate with processor **230**.

[0046] Input **229** comprises one or more devices by which a user may enter inputs, commands or selections to system **20**. In the example illustrated, input **229** comprises a keyboard, various pushbuttons and a trackball. In another implementation, input **229** comprise other types of input devices such as other switches, slider bars, pushbuttons, a keypad, a touchpad, a mouse, a microphone with associated speech recognition software, a stylus or touchscreen capabilities associated with display **28**. As with input **29**, input **229** facilitates the entry of data as well as the input of selections or commands selecting modes of operation and indicating when to enter and exit different modes of operation, such as a fusion mode as will be described hereafter.

[0047] Processor **230** is similar to processor **30** described above. Processor **230** comprises one or more processing units which control presentation of ultrasound images upon display **28**. In the example illustrated, processor **230** additionally generates the ultrasound images using signals received from the particular ultrasound image acquisition device **226** being used. Processor **230** performs analysis and generates control signals for the operation of device **226** as well as display **228** following instructions provided by modules **240**, **242**, **244** and **246** of memory **232**.

[0048] Historical ultrasound image frame data storage **238** is similar to historical ultrasound image frame data storage **38** described above. Follow-up module **240** and fusion module **244** utilize files or data from data storage **238**. Follow-up module **240**, live image display module **242**, fusion module **244** and auto copy module **246** each comprise software, code, integrated circuitry or other program logic to direct processor **30**. Follow-up module **240**, live image display module **242**, fusion module **244** and auto copy module **246** cooperate to carry out the example method **300** outlined in FIG. **8**.

[0049] As indicated by block **302** in FIG. **8**, follow-up module **240** directs processor **230** to retrieve and display an individual historical ultrasound image frame from data storage **238**. In one implementation, follow-up module **240** retrieves the historical image frame from a data storage or data store which is part of memory **232** local to processor **230**. In another implementation, follow-up module **40** retrieves the historical image frame from a remote memory, such as from a remote database or remote server, across a local area network or wide area network, such as the Internet. In one implementation, follow-up module **240** retrieves multiple historical ultrasound image frames or retrieves multiple links to multiple historical ultrasound image frames, wherein the files or links are displayed on display **228** for selection by a physician, nurse or practitioner through a touchscreen, manipulation of a cursor, speech recognition or the like.

[0050] In one implementation, such image frames comprise historical ultrasound image frames of the same object or same patient being examined, whether such image frames have been captured and stored days, weeks or months prior to the current exam. In yet other implementations, the retrieved historical ultrasound image frame comprises a model or a standard image frame to be used for comparison with the live ultrasound image or individual frames captured from the live ultrasound image. For example, in one implementation, the historical ultrasound image frame comprises an ultrasound image frame of a healthy individual, a healthy anatomy or the like of the same object currently being examined, from another real object or anatomy or from a generated hypothetical model of the anatomy.

[0051] As indicated by block **304** in FIG. **8**, follow-up module **40** retrieves or extracts, from the files associated with the retrieved ultrasound image frame, the scanning or imaging parameters previously used by the ultrasound image acquisition device **226** when the retrieved ultrasound image frame was generated or captured. In one implementation, follow-up module **40** identifies on display screen **28**, the type of ultrasound acquisition device or the model of the ultrasound acquisition device that was used to obtain the prior historical ultrasound image frame being displayed.

[0052] As indicated by block **306** in FIG. **8**, live image display module **242** directs processor **30** to output control signals causing display **228** to present a live or real time ultrasound image based upon signals received from ultrasound image acquisition device **26**. The live ultrasound image presented on display **228** comprises a series of ultrasound image frames presented at a high frequency in real time. The live ultrasound image presented on display **228** by module **242** is a result of the live stream of ultrasound image signals received from the ultrasound image acquisition device **226**. Movement of the patient or movement of the ultrasound image acquisition device **226** causes movement of the live ultrasound image such that different scan planes are presented as device **226** and/or the patient or object are moved relative to one another.

[0053] FIG. **9** is an example screenshot of display **228** illustrating the concurrent display of an example historical ultrasound image frame **250** on display **228** per block **302** of FIG. **8** alongside the live ultrasound image **246** on display **228** per block **306** of FIG. **8**. As illustrated on the left side of FIG. **9**, historical ultrasound image frame **250** is an individual image frame captured and stored at a prior time, such as hours, days, weeks, months or years prior to the current ongoing live ultrasound scanning producing the live ultrasound image **246**. As shown by FIG. **9**, historical ultrasound image frame **250** comprises skeletal features **260**, tissue **262** and a still capture of blood flow **264**, represented by color flow images.

[0054] As illustrated by the right side of FIG. **9**, live ultrasound image **246** illustrates the dynamically changing depiction of skeletal features **260** and tissue **262** which change in response to relative movement between the ultrasound image acquisition device **26** being used in the patient. The live ultrasound image **246** further illustrates the dynamically changing depiction of blood flow **262**. As a result, display **20** provides the user with a concurrent display of a static historical ultrasound image frame **250** and a dynamically changing live ultrasound image **246** which continuously changes during its presentation.

[0055] As further shown by FIG. **9**, live image display module **42** provides additional information **268** such as the current date and time of the live image scan (08/06/13 03:25:08 PM), type or name of the ultrasound acquisition device currently being employed (L8-18i) and the type of scanning being done (superficial: Moscow skeletal superficial application, e.g. a hand or finger). Live image display module **42** further provides scanning parameter information. As noted above, live image display module **42** receives the scanning parameters of the historical ultrasound image frame **250** and utilizes the same scanning parameters for the current live scan or slightly modifies such prior scanning parameters for use with the live scan. In the example illustrated, such scanning parameters **270** utilized for the prior capture of ultrasound image frame **250** and the ongoing live ultrasound image **246** are presented on the right side of display screen **228**. In the example illustrated, information regarding the B-mode ultrasound image (B) include ultrasound image frame rate (FR: 14), the acoustic power output (AO %: 100), the current mode of the ultrasound image (B: B Mode Ultrasound Image), the scanning frequency (Frq: 16.0 in (MHZ) currently chosen for the B Mode scan), the B mode ultrasound scanning game (Gn: 44), the B mode ultrasound image scanning depth (in cm) from the skin surface (D: 1.8). Information regarding the power Doppler imaging (PDI), used for musculoskeletal and rheumatology diagnosis comprises the scanning frequency used for the PDI mode (Frq: 10.0), the PDI gain (Gn: 21.5), the line density and frame average (L/A: 3/5), the pulse repetition frequency (in kHz) (PRF: 0.8), the wall filter used to differentiate tissue motion in real flow (WF: 123), and the spatial filter and packet size (S/P: 2/16). In other implementations, other scanning parameter information is presented or less than all of the illustrated scanning parameter information is presented.

[0056] As indicated by block **308** in FIG. **8**, upon receiving a command or selection via input **229**, system **220** enters the fusion mode. As indicated by block **310** fusion module **244** modifies the pixels depicting blood flow **264** in the live ultrasound image **246** such that the blood flow pixels are less likely to obfuscate or interfere with user alignment of the live ultrasound image **246** and the historical ultrasound image frame **250**. In the example illustrated, as illustrated by FIG. **10**, fusion module **244** completely removes from the ongoing stream or live ultrasound image **246** those pixels that were previously colorized to represent blood flow **264**. In the example illustrated, fusion module **244**, without requiring further user input after switching to the fusion mode, automatically modifies or removes the pixels depicting blood flow **264** (shown in FIG. **9**) in the live ultrasound image **246**.

[0057] As further shown by FIG. **10**, fusion module **244** additionally highlights those portions, images of skeletal structures **260'** and tissue **262'**, of historical ultrasound image frame **250** that were copied and overlaid upon or on top of the dynamic live ultrasound image **246**. In the example illustrated, fusion module **244** directs processor **230** to add a color (blue in the example) distinct from the color (black, gray, or the like) to each of such structures **260'** and tissue **262'** that are overlapped or overlaid upon ultrasound live image **246**. In other implementations, system **220** provides prompts or other adjustable setting screens which allow a user to customize the color of such structures **260'** and/or **262'**. Because those portions of historical ultrasound image **250** that are copied over are colorized, such portions are more visibly discernible from the live ongoing ultrasound image **246**.

[0058] In one implementation, fusion module **244** automatically identifies, without user input or selection, anatomical landmarks in the historical image frame **250** and highlights such identified anatomical landmarks for use in aligning with the corresponding anatomical landmarks in the live ultrasound image frame **246**. Examples of anatomical landmarks include distinct skeletal structures. In the example illustrated in FIG. **10**, skeletal structures **260** serves as landmarks, wherein such identified landmarks are copied on top of the live ultrasound image **246** and highlighted with the color blue.

[0059] In the example illustrated, system **20** variably controls what anatomical landmarks, such as what skeletal structures, and what tissue features from a historical ultrasound image are highlighted in live ultrasound image such that they may be utilized as landmarks for alignment with corresponding landmarks in the live ultrasound image. For example, depending upon established opacity thresholds, some skeletal structures or some tissue features are highlighted (colorized in the example) in the live ultrasound image **246** while other skeletal structures or tissue features are not highlighted or colorized. In one implementation, a skeletal percentage value or setting controls or filters out what skeletal structures from the historical image frame **250**, based upon a comparison of their normalized opacity in the historical image frame with respect to a normalized threshold value corresponding to the skeletal percentage value, are highlighted in the live image **246**. A tissue or background percentage value or setting controls or filters out what tissue features from the historical image frame **250**, based upon a comparison of their normalized opacity in the historical image frame relative to a normalized threshold value corresponding to the background percentage value, are highlighted in the live image **246**. In one implementation, fusion module **44** applies default values for the skeletal percentage value and the background percentage value unless automatically adjusted based upon various image properties or adjusted manually by the user.

[0060] FIGS. **11** and **12** illustrate example screenshots illustrating the application of different skeletal and background percentage values to the same example historical ultrasound image frame **350** being overlaid upon two different live ultrasound images **346**A and **346**B having the same scan plane. In the example shown in FIG. **11**, the background percentage value is 20% while the landmark or skeletal percentage value is 6%. In the example shown in FIG. **12**, the background percentage setting or value is 30% while the skeletal percentage setting or value is 30%. As evident from a comparison of the live ultrasound images **346**A and **346**B in FIGS. **11** and **12**, respectively, the lower background percentage value and the lower skeletal percentage value in FIG. **11** results in fewer portions or a lesser extent of the features of historical ultrasound image **350** being highlighted with color in live ultrasound image **346**A. Conversely, the higher skeletal percentage setting and the higher tissue or background percentage setting in FIG. **12** results in a greater number of portions or a greater extent of the features of historical ultrasound image **350** being highlighted with color in live ultrasound image **346**B.

[0061] As indicated by block **312** and FIG. **8**, fusion module **244** overlaps or overlays portions of the historical ultrasound image frame, such as image frame **250** shown in FIG. **10**, upon the live ultrasound image **246** shown in FIG. **10**. As indicated by block **314** in FIG. **8**, the scan plane of the live ultrasound image is moved into an approved level of alignment with the scan plane of the historical ultrasound image frame. Because portions of the historical ultrasound image frame **250** are not copied over onto the live ultrasound image **246** or are semi-transparent, the user may visibly discern the live ultrasound image frame **246** beneath or about those portions of the historical ultrasound image frame **250** overlapped by those portions of the historical ultrasound image frame **250**. As a result, the user may reposition the ultrasound image acquisition device **26** relative to the patient to change the scan plane so as to sufficiently align the scan plane of the live ultrasound image **246** and its anatomical landmarks, skeletal structures and tissue features, with the corresponding anatomical landmarks of the scan plane of the historical image frame. As a result, system **220** allows a user to better align and match the scan plane of the live ultrasound image with the scan plane of the historical ultrasound image frame for more accurate comparisons with regard to what is seen in the historical ultrasound image frame and what is presently occurring or depicted in the live ultrasound image.

[0062] FIGS. **13-16** are example screenshots illustrating movement of the scan plane of the live ultrasound image **246**—resulting from movement of the ultrasound acquisition device **226**—into alignment a sufficient or approved level of alignment with the historical ultrasound image **250**. As shown by FIG. **13**, skeletal structures **270** depicted in the live ultrasound image **246** are initially to the left of their corresponding skeletal structures **260'** which are highlighted with a blue-collar. However, as shown by FIGS. **14-16**, movement of the ultrasound image acquisition device **26** moves the scan plane to the right such that skeletal structures **270** are also moved to the right into alignment with skeletal structures **260'** (shown in FIG. **16**). As shown by FIGS. **13-16**, tissue features **262'** overlaid upon the live ultrasound image may also be used to facilitate alignment of the scan plane of the live ultrasound image **246** and the scan plane of the historical ultrasound image frame **250**.

[0063] As indicated by block **316** in FIG. **8**, once the scan plane of the live ultrasound image has been sufficiently aligned to the scan plane of the historical ultrasound image frame, the user may provide input via input **229** to exit the fusion mode. In the example illustrated, in response to receiving a command to exit the fusion mode, system **220** automatically reinstates the earlier presented pixels depicting blood flow in the live ultrasound image. In one implementation, when in the fusion mode, the live ultrasound image is a B mode image while the power Doppler image providing the color flow or blood flow pixels is not presented. Upon exiting the fusion mode, system **220** automatically reinstates the power Doppler imaging to once again depict the blood flow pixels.

[0064] FIGS. **17** and **18** illustrate exiting from the fusion mode. FIG. **17** is a screenshot illustrating system **220** after the scan plane of example live ultrasound image **446** has been aligned with the scan plane of the example prior historical ultrasound image frame **450** to the satisfaction of the user. The left side of FIG. **17** depicts the historical ultrasound image frame **450** having skeletal structures **460** and further illustrating the captured state of blood flow **461** at the moment that the individual historical image frame **450** was captured. At the point in time depicted in FIG. **17**, the example live ultrasound image **446** is the B mode image that was used for the prior fusion mode. FIG. **17** illustrate skeletal structures **460'** aligned with skeletal structures **470** of the live ultrasound image **446**. As shown by FIG. **18**, upon exiting the fusion mode, system **220** automatically reinstates the flow signals such that the pixels depicting blood flow are once again presented. In the example illustrated, the color flow mode or the power Doppler imaging mode is reinstated to once again depict blood flow **274**.

[0065] As indicated by block **318** in FIG. **8**, system **220** captures a current ultrasound image frame during the presentation of the live ultrasound image. As with the historical ultrasound image frames described above, the current ultrasound image frame is an individual frame or snapshot at a particular moment in time at a particular scan plane. Because the color flow mode or the power Doppler imaging mode representing the depicted blood flow is reinstated upon exit of the fusion mode, the snapshot forming the current ultrasound image frame includes depictions of blood flow at the picker moment in time. Such depictions of blood flow may then be utilized as part of the analysis and comparison with respect to the historical ultrasound image frame.

[0066] For example, in one implementation, the right side of display **228** in FIG. **18** may be captured, similar to a snapshot or screenshot, to form the current ultrasound image frame for comparison with the historical ultrasound image frame. In one implementation, the user, through input **229**, selects the capture of the particular current ultrasound image frame from the live ultrasound image **446**, preferably while the scan plane of the live ultrasound image **446** remains in substantial or satisfactory alignment with the scan plane of the prior historical ultrasound image frame **450**.

[0067] Because system **220** facilitates more precise and accurate alignment of the scan planes of the historical ultrasound image frame and the current live ultrasound image frame, captured from a live ultrasound image, a more accurate comparison may be made between the two image frames. As shown by FIG. **7**, to facilitate such analysis, system **220** additionally comprises auto copy module **245**. Similar to fusion model **244**, auto copy module **245** comprises software, code, integrated circuitry or other program logic stored in memory **238** to direct processor **230** to carry out functions. In the example illustrated, auto copy module **245** comprise a program logic to direct processor **230** to carry out the steps set forth in blocks **320-326** shown in FIG. **8**. In other implementations, system to **20** omitted auto copy module **245**.

[0068] FIG. **19** illustrates an example screenshot of display **228** during one example use of auto copy module **245** according to blocks **320-326**. As shown by FIG. **19**, the left side of display **228** illustrates an example historical ultrasound image frame **550** while the left side of display **228** illustrates an example current ultrasound image frame **553** recently captured from a display live ultrasound image. In the example illustrated the historical ultrasound image frame and the current ultrasound image frame have substantially matching scan planes, achieved by operating system **220** in the fusion mode (described above) while aligning the scan plane of the live ultrasound image with the scan plane of the historical ultrasound image frame, prior to capturing the current ultrasound image frame **553**.

[0069] The historical ultrasound image frame **550** depicts a previous historical region of interest **554** that was previously selected for analysis. The region of interest **554** identifies a particular defined region of the historical ultrasound image frame **550** for which the contents are analyzed. In the example illustrated, the region of interest **554** encompasses blood flow pixels **623**. As indicated in the lower left-hand corner of display **228**, system **220** displays the results **556** of the analysis performed on the region of interest **554**. In the example illustrated, the ultrasound image frame is that of a hand. The region of interest has an area of 28.21 mm^2. In the example illustrated, the particular analysis on the contents of the region of interest **554** is to determine the ratio of depicted blood flow/inflammation (as represented by blood flow pixels **623**) to the area of the hand in the particular region of interest **554**. In the example illustrated, the ratio of blood flow/inflammation to the area of the hand in the region of interest is 5.39%.

[0070] As indicated by block **320** in FIG. **8**, when an auto copy function or mode has been selected, auto copy module **245** retrieves information regarding the configuration, size and location of the region of interest in the historical ultrasound image frame **550**. In the example illustrated, auto copy module **245** retrieves the locational coordinates of the historical ultrasound image frame region of interest **554**. For example, auto copy module **254** retrieves the X and Y coordinates of each pixel forming the boundary of the region of interest **554** with respect to the historical ultrasound image frame being presented. In one implementation, such data is found in metadata associated with the historical ultrasound image frame **554** or is located in separate data files linked to the historical ultrasound image frame **550**.

[0071] As indicated by block **322** in FIG. **8**, auto copy module **245** utilizes the retrieved location and configuration information for the region of interest **554** from the historical ultrasound image **550** to generate and display a corresponding current region of interest **554'** in the current ultrasound image frame **553**. The location as well as a configuration (size and shape) of the current region of interest **554'** is based upon the location and configuration (size and shape) of the historical region of interest **554**. In one implementation, the current region of interest **554'** has substantially the exact same shape and the exact same size as the historical region of interest **554**. In the example illustrated, both the historical region of interest **554** and the current region of interest **554'** have an area of 28.21 square mm. In such an implementation, the current region of interest **554'** also has pixels forming the boundary of the region of interest **554'**, wherein the pixels have identical coordinates as compared to the corresponding pixels forming the boundary of historical region of interest **554**. As a result, the regions of interest in both the historical image frame **550** and the current image frame **553** encompass substantially the precise same portions of the anatomy (portions of a hand in the illustrated example).

[0072] In other implementations, auto copy module **245** bases the configuration and location of the current region of interest **554'** upon the retrieved configuration and location values for the historical region of interest **554**, wherein auto copy module **245** makes slight adjustments to one or more of the size, shape or location attributes of the current region interest **554'** with respect to the historical region of interest **554**. Because the current region interest **554'** is automatically copied over or generated onto the current ultrasound image frame **553** by processor **230** under the direction of auto copy module **245** and based upon the historical region of interest in the previously stored and recorded historical ultrasound image frame **550**, the same regions of interest in the same scan planes of the two image frames may be directly compared to achieve more accurate or reliable results.

[0073] As indicated by blocks **324** and **326**, in one mode of operation, in lieu of having the user once again input those particular analytical functions or measurement functions that it be carried out for the contents of the region of interest or other characteristics of the region of interest, auto copy module **245** automatically retrieves the stored measurement functions that were applied to the region of interest **554** in the historical ultrasound image **550** and automatically carries out the same measurement functions for the current region of interest **554'** in the current ultrasound image frame **553**. As a result, the user is not only presented with substantially the same relative region of interest, but is also automatically provided with the same measurement functions or analysis functions that were carried out for the historical ultrasound image frame **550**.

[0074] As depicted in the lower left-hand corner of display **228**, in the example illustrated, per block **324**, auto copy module **245** retrieves metadata associated with historical ultrasound image frame **550** indicating that a measurement function comprising the determination of the percent of blood flow depicted in the region of interest was calculated upon the historical region of interest **554**. Per block **326**, auto copy module **245** carries out the same measurement function. In the example illustrated, auto copy module **245** has determined that, in the current ultrasound image frame **553**, 4.74% of the area within the region of interest **554'**, corresponding to the historical region of interest **554**, is blood flow, as represented by blood flow pixels **624**. The results **556'** are presented in the lower right-hand corner of display **228**. In the example illustrated, within the region of interest, the present area of blood flow has dropped from 5.39% to 4.74%, indicating reduced inflammation.

[0075] Although the present disclosure has been described with reference to example embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the claimed subject matter. For example, although different example embodiments may have been described as including one or more features providing one or more benefits, it is contemplated that the described features may be interchanged with one another or alternatively be combined with one another in the described example embodiments or in other alternative embodiments. Because the technology of the present disclosure is relatively complex, not all changes in the technology are foreseeable. The present disclosure described with reference to the example embodiments and set forth in the following claims is manifestly intended to be as broad as possible. For example, unless specifically otherwise noted, the claims reciting a single particular element also encompass a plurality of such particular elements.

What is claimed is:

1. A method comprising:

presenting a live ultrasound image on a display of an ultrasound imaging system;

retrieving a historical ultrasound image frame; and

overlapping at least portions of the historical ultrasound image frame with the live ultrasound image.

2. The method of claim 1, wherein at least one of the live ultrasound image and the portions of the historical ultrasound image frame that are being overlapped are outlined or semi-transparent.

3. The method of claim 1 further comprising identifying anatomical landmarks in the historical ultrasound image frame, wherein the portions of the historical ultrasound image frame that are overlapped with the live ultrasound image comprise the identified anatomical landmarks.

4. The method of claim 1 further comprising highlighting the portions of the historical ultrasound image frame that overlap with the current ultrasound image.

5. The method of claim 3, wherein the portions are highlighted based upon color of the portions.

6. The method of claim 1 further comprising moving and changing the live ultrasound image being displayed relative to the overlapping portions of the prior ultrasound image frame in response to movement of an ultrasound probe.

7. The method of claim 1, further comprising removing portions of the live ultrasound image being overlapped by the historical ultrasound image frame.

8. The method of claim 7, wherein the portions of the live ultrasound image that are removed comprise pixels depicting blood flow.

9. The method of claim 1, wherein the ultrasound imaging system is operable in a first mode and a second mode and wherein the method further comprises:

displaying the live ultrasound image including pixels depicting blood flow when in the first mode;

while the live ultrasound image including pixels depicting blood flow is being displayed in the first mode, receiving first user input requesting the second mode of operation, and in response to receipt of the first user input, automatically (A) removing the pixels in the live ultrasound image depicting blood flow and (B) overlapping the historical ultrasound image frame with the live ultrasound image that is without the pixels depicting blood flow; and

while overlapping of the historical ultrasound image frame with the live ultrasound image is displayed in the second mode, receiving second user input requesting the first mode of operation, and in response to receipt of the second user input, automatically (A) displaying the live ultrasound image without the historical ultrasound image frame and with reinstated pixels indicating blood flow.

10. The method of claim 1 further comprising:

retrieving stored coordinates of a historical region of interest in the historical ultrasound image frame;

displaying a selected ultrasound image frame from the live ultrasound image; and

displaying a current region of interest in the selected ultrasound image frame, the current region of interest having coordinates in the selected ultrasound image frame based upon the stored coordinates retrieved from the historical region of interest in the historical ultrasound image frame.

11. The method of claim 10 further comprising:

moving at least one of an ultrasound probe and a patient relative to one another to change an scan plane of the live ultrasound image to substantially align the scan plane of the live ultrasound image with an scan plane of the historical ultrasound image frame; and

capturing a frame of the live ultrasound image when the scan plane of the live ultrasound image is substantially aligned with the scan plane of the historical ultrasound image, the captured frame constituting the selected ultrasound image frame.

12. The method of claim 10 further comprising:

retrieving stored settings indicating measurement functions associated with the historical region of interest of the historical ultrasound image frame; and

carrying out the measurement functions with respect to the current region of interest in the selected ultrasound image frame.

13. The method of claim 1 further comprising:

receiving a threshold input; and

selecting the portions of the historical ultrasound image frame to be overlapped with the live ultrasound image based on the threshold input.

14. An apparatus comprising:

a non-transitory computer-readable medium to direct a processor to:

present a live ultrasound image on a display of an ultrasound imaging system;

retrieve a historical ultrasound image frame; and

overlap at least portions of the historical ultrasound image frame with the live ultrasound image.

15. The apparatus of claim 14, wherein at least one of the live ultrasound image and the portions of the historical ultrasound image frame that are being overlapped are outlined or semi-transparent.

16. The apparatus of claim 14, wherein the non-transitory computer-readable medium is to further direct the processor to highlight the portions of the historical ultrasound image frame that overlap with the current ultrasound image.

17. The apparatus of claim 14, wherein the non-transitory computer-readable medium is to further direct the processor to remove portions of the live ultrasound image being overlapped by the historical ultrasound image frame.

18. The apparatus of claim 14, wherein the portions of the live ultrasound image that are removed comprise pixels depicting blood flow.

19. An apparatus comprising:

a non-transitory computer-readable medium to direct a processor to:

retrieve a historical ultrasound image frame;

retrieve stored coordinates of a historical region of interest in the historical ultrasound image frame;

display a selected ultrasound image frame from a live ultrasound image; and

displaying a current region of interest in the selected ultrasound image frame, the current region of interest having coordinates in the selected ultrasound image frame based upon the stored coordinates retrieved from the historical region of interest in the historical ultrasound image frame.

20. The apparatus of claim **19**, wherein the non-transitory computer-readable medium is to further direct the processor to:

retrieve stored settings indicating measurement functions associated with the historical region of interest of the historical ultrasound image frame; and

carry out the measurement functions with respect to the current region of interest in the selected ultrasound image frame.

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摘要(译)

一种方法和设备在超声成像系统的显示器上呈现实时超声图像，检索历史超声图像帧;并且至少部分历史超声图像帧与实况超声图像重叠。一种方法和装置检索历史超声图像帧，检索历史超声图像帧中的历史感兴趣区域的存储坐标，从实时超声图像显示所选择的超声图像帧并在所选择的超声图像中显示当前感兴趣区域帧，当前感兴趣区域基于从历史超声图像帧中的历史感兴趣区域检索的存储坐标，在所选超声图像帧中具有坐标。