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(54) METHOD AND APPARATUS FOR CO-DISPLAY OF INVERSE MODE ULTRASOUND IMAGES AND HISTOGRAM INFORMATION

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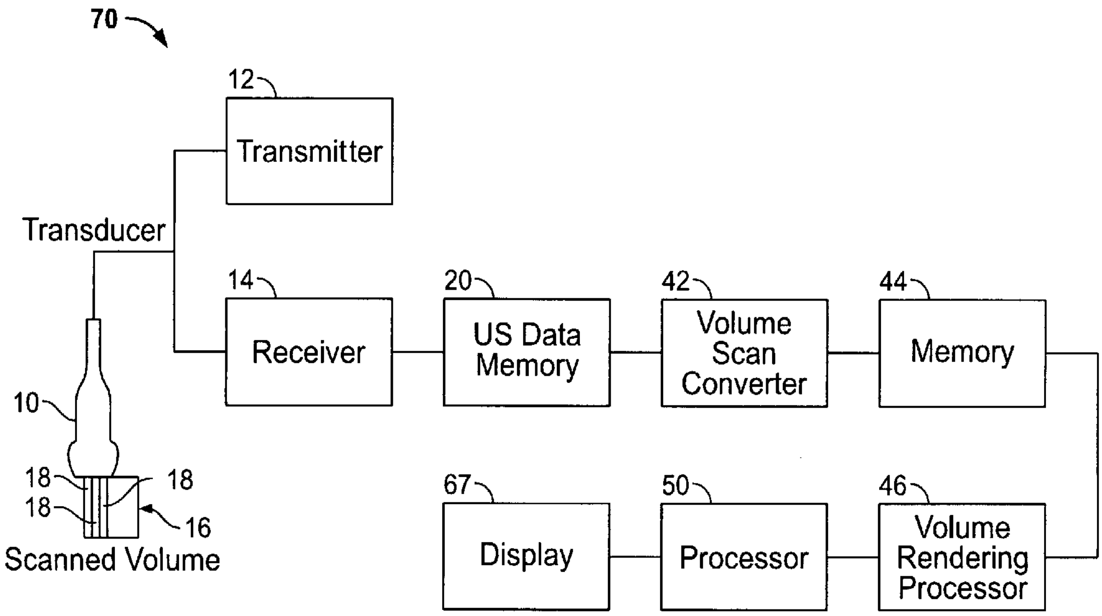
(57) **ABSTRACT**

An ultrasound system is provided for analyzing a region of interest. The ultrasound system includes a probe for acquiring ultrasound information associated with the region of interest and a memory for storing a volumetric data set corresponding to at least a subset of the ultrasound information for at least a portion of the region of interest. The system further includes at least one processor for generating histogram information based on the volumetric data set and for generating ultrasound images based on the volumetric data set. The processor formats the histogram information and the ultrasound images to be co-displayed. The system further includes a display for simultaneously co-displaying the histogram information and the ultrasound images.



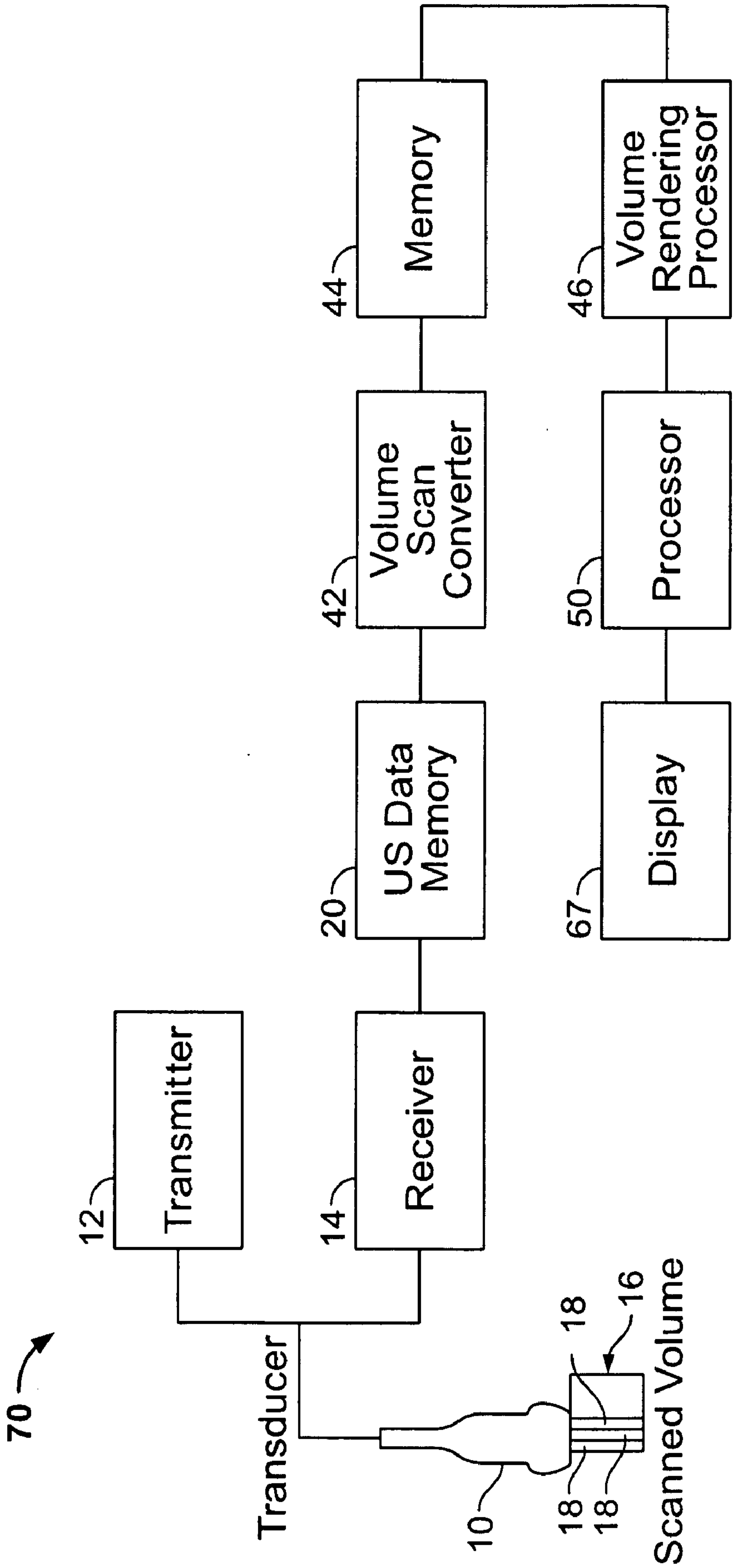

70
Transducer
10
Scanned Volume
16
18
18
18
12
Transmitter
14
Receiver
20
US Data Memory
42
Volume Scan Converter
44
Memory
46
Volume Rendering Processor
50
Processor
67
Display

FIG. 1

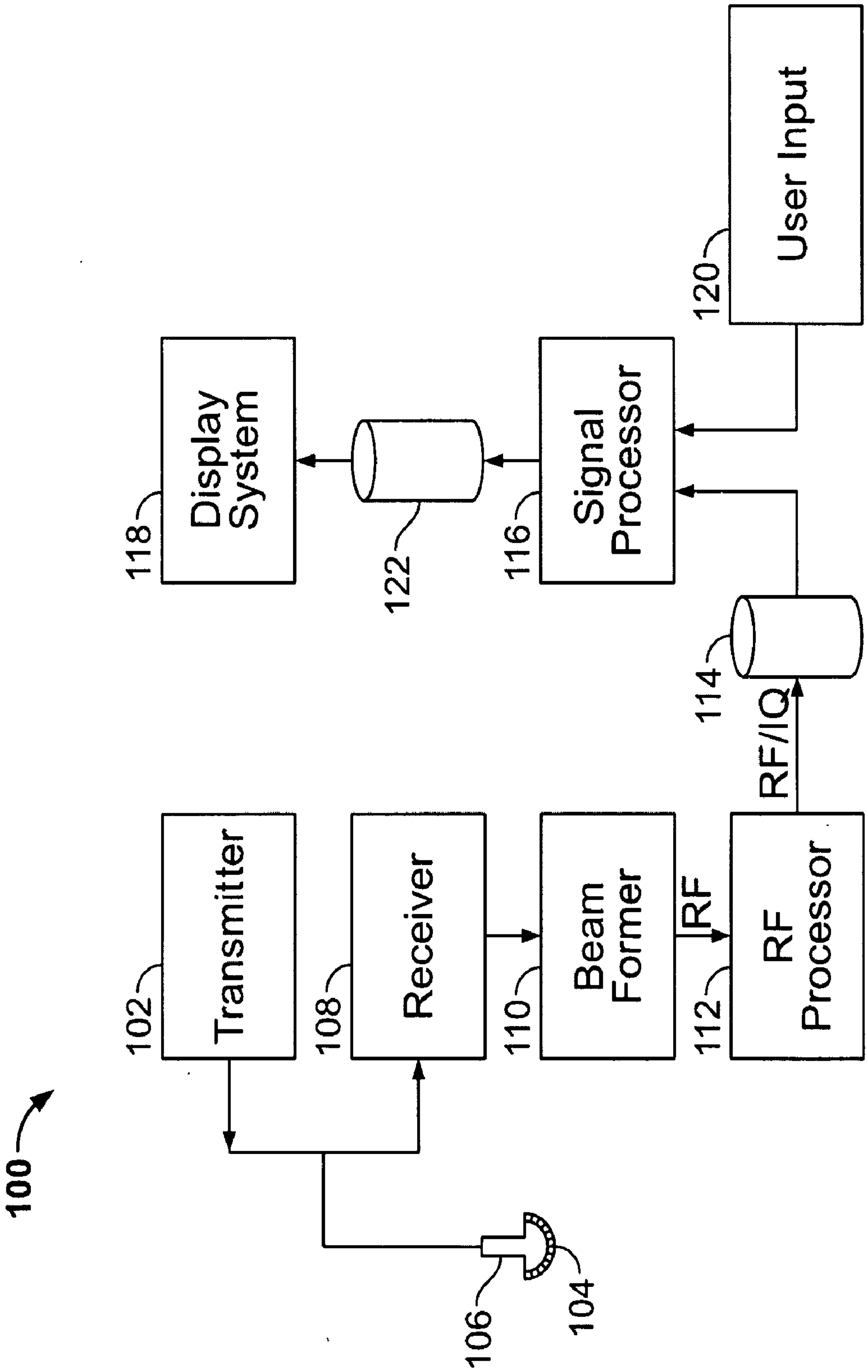

100
102
Transmitter
108
Receiver
110
Beam Former
RF
112
RF Processor
RF/IQ
114
116
Signal Processor
122
118
Display System
120
User Input
106
104

FIG. 2

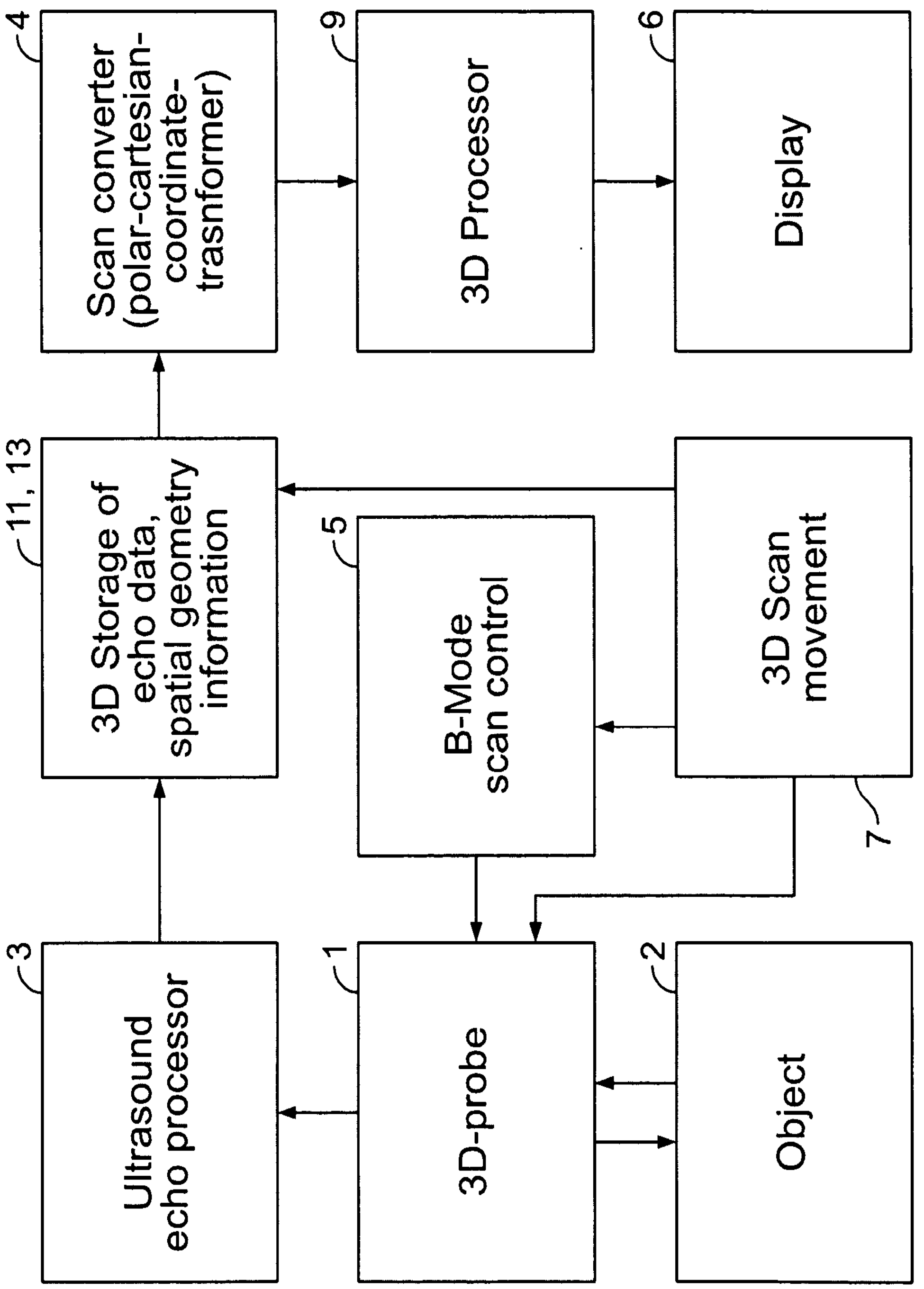

Scan converter (polar-cartesian-coordinate-trasnformer)
4
3D Processor
9
Display
6
3D Storage of echo data, spatial geometry information
11, 13
B-Mode scan control
5
3D Scan movement
7
Ultrasound echo processor
3
3D-probe
1
Object
2

FIG. 3

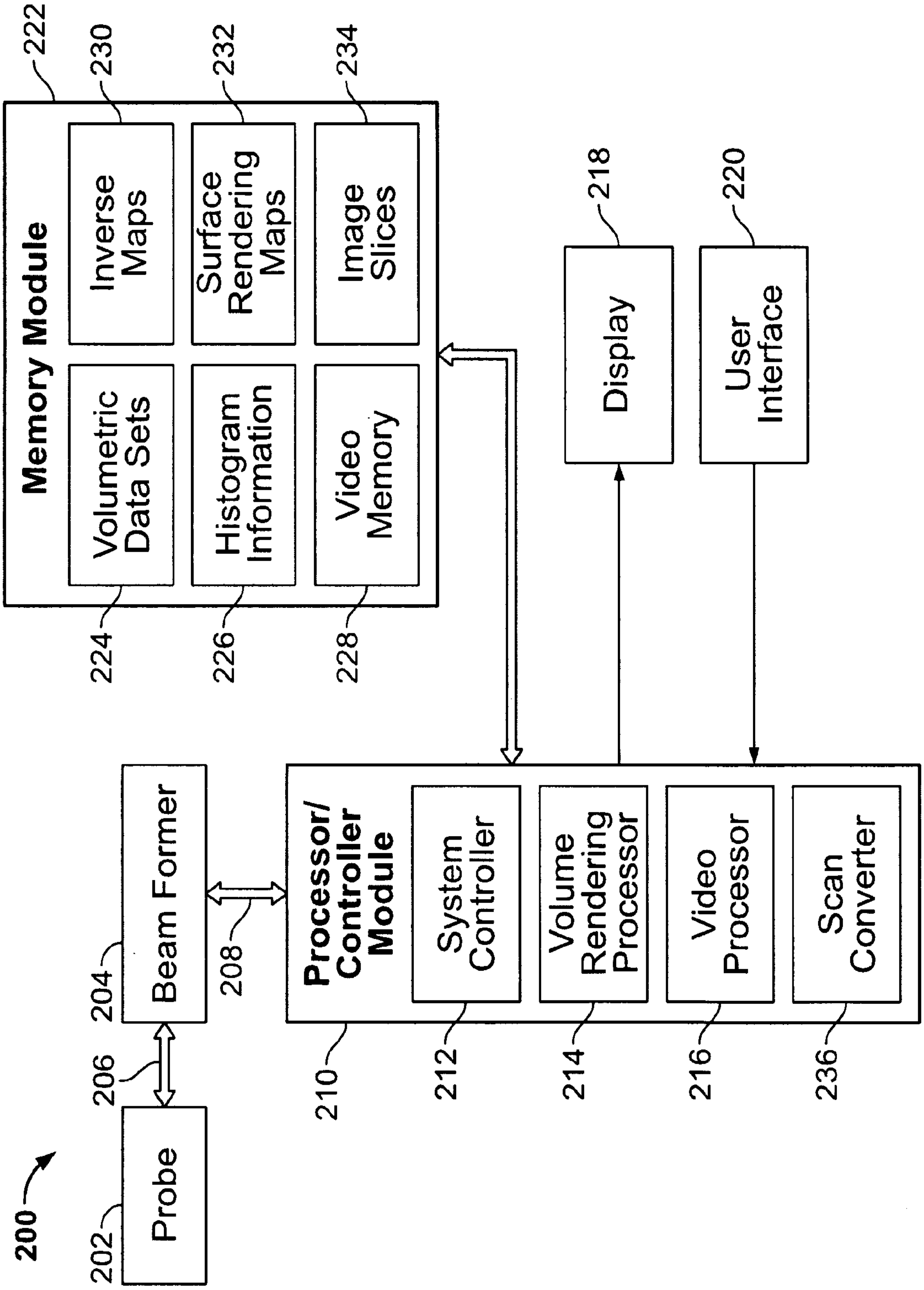

200
Probe
202
206
Beam Former
204
208
Processor/ Controller Module
210
System Controller
212
Volume Rendering Processor
214
Video Processor
216
Scan Converter
236
Memory Module
222
Volumetric Data Sets
224
Histogram Information
226
Video Memory
228
Inverse Maps
230
Surface Rendering Maps
232
Image Slices
234
Display
218
User Interface
220

FIG. 4

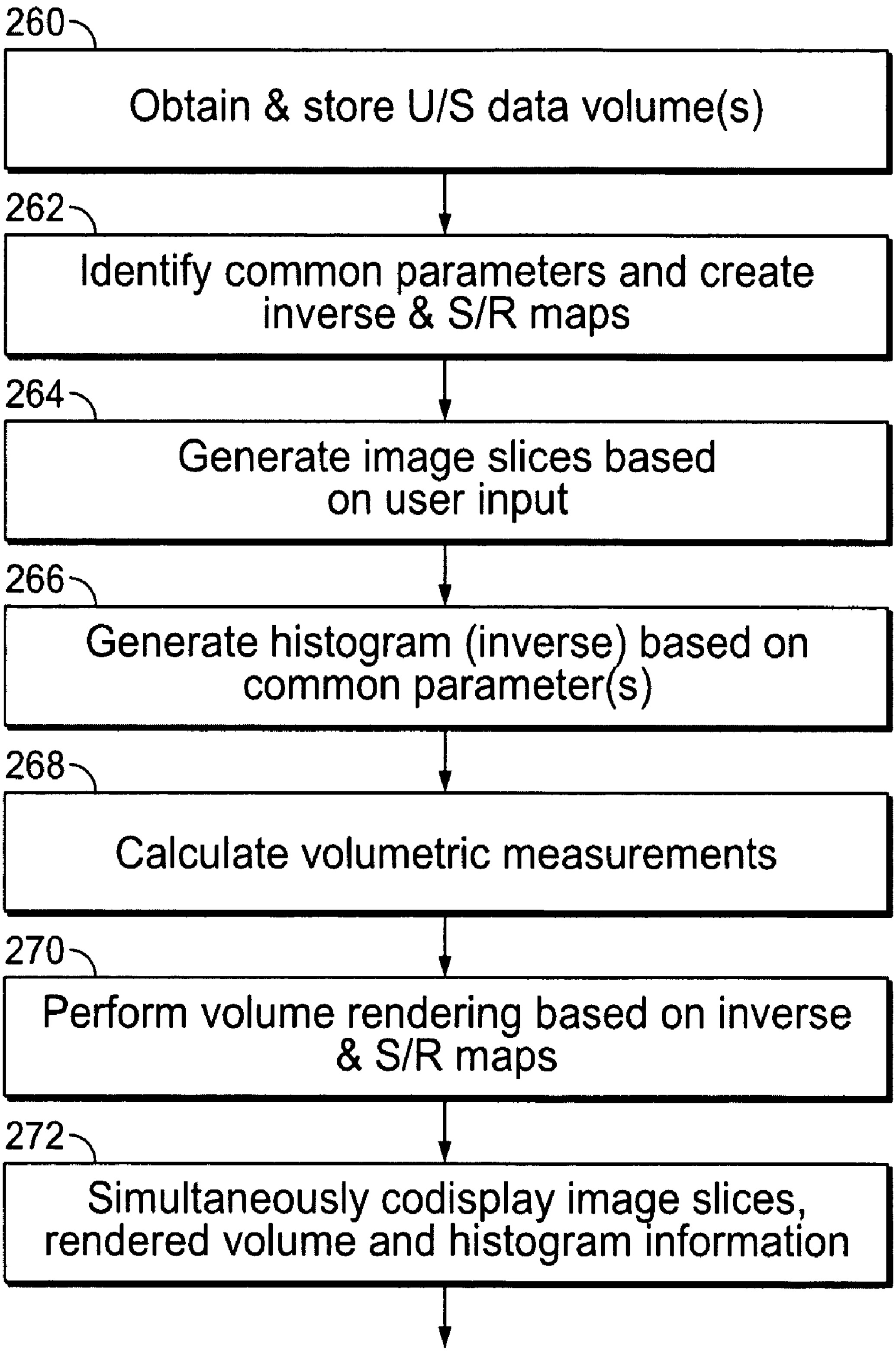

260
Obtain & store U/S data volume(s)
262
Identify common parameters and create inverse & S/R maps
264
Generate image slices based on user input
266
Generate histogram (inverse) based on common parameter(s)
268
Calculate volumetric measurements
270
Perform volume rendering based on inverse & S/R maps
272
Simultaneously codisplay image slices, rendered volume and histogram information

FIG. 5

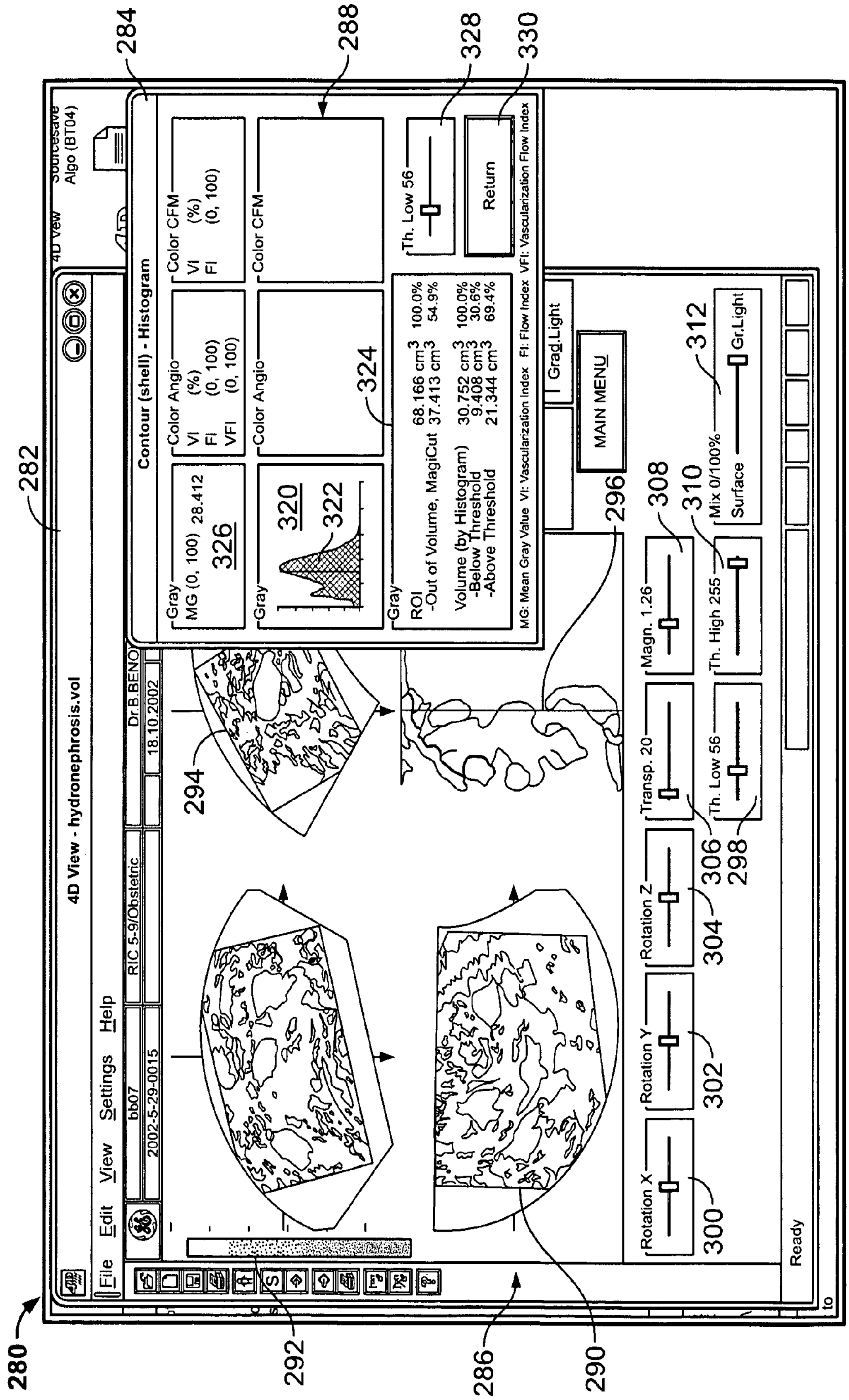

280
282
284
286
288
290
292
294
296
298
300
302
304
306
308
310
312
320
322
324
326
328
330
4D View - hydronephrosis.vol
File
Edit
View
Settings
Help
bb07
2002-5-29-0015
RIC 5-9/Obstetric
Dr.B.BENO
18.10.2002
Contour (shell) - Histogram
Gray
MG (0, 100) 28.412
Color Angio
VI (%)
FI (0, 100)
VFI (0, 100)
Color CFM
VI (%)
FI (0, 100)
ROI
-Out of Volume, MagiCut 68.166 cm3 100.0% 37.413 cm3 54.9%
Volume (by Histogram) 30.752 cm3 100.0%
-Below Threshold 9.408 cm3 30.6%
-Above Threshold 21.344 cm3 69.4%
MG: Mean Gray Value VI: Vascularization Index FI: Flow Index VFI: Vascularization Flow Index
Th. Low 56
Return
MAIN MENU
Grad.Light
Rotation X
Rotation Y
Rotation Z
Transp. 20
Magn. 1.26
Th. Low 56
Th. High 255
Mix 0/100%
Surface
Gr.Light
Ready
Algo (BT04)

FIG. 6

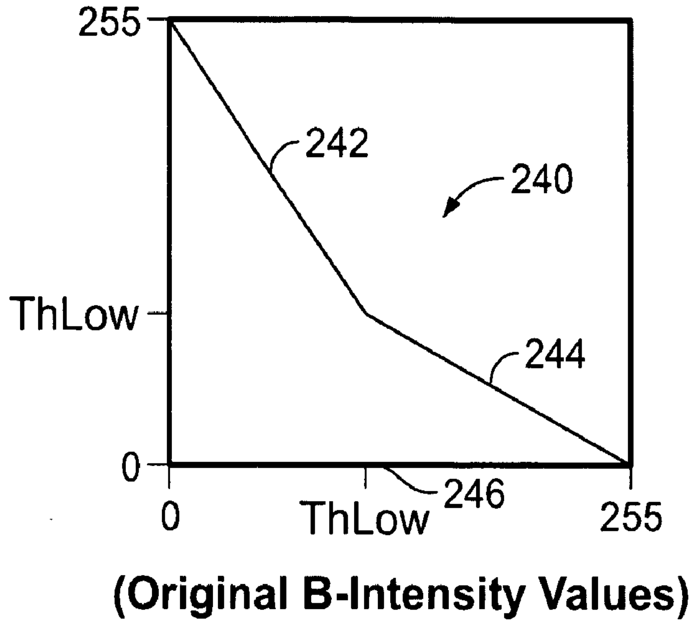

255
ThLow
0
242
240
244
246
0
ThLow
255
(Original B-Intensity Values)

FIG. 7

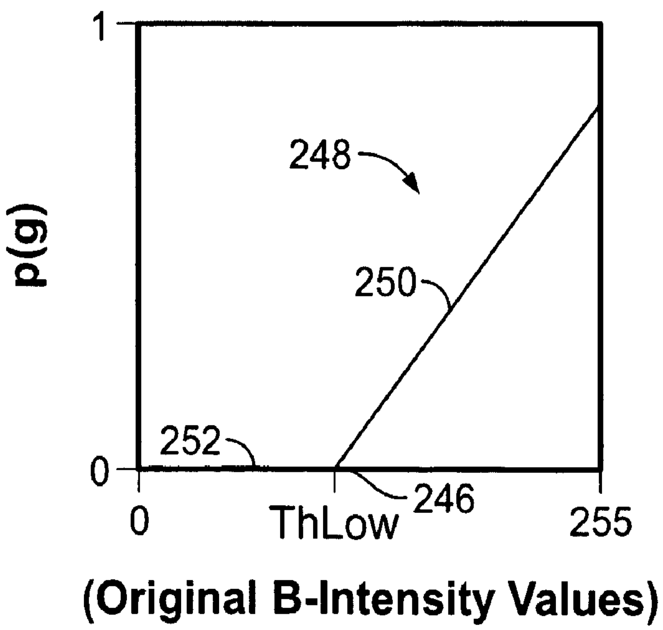

1
p(g)
0
248
250
252
246
0
ThLow
255
(Original B-Intensity Values)

FIG. 8

METHOD AND APPARATUS FOR CO-DISPLAY OF INVERSE MODE ULTRASOUND IMAGES AND HISTOGRAM INFORMATION

BACKGROUND OF THE INVENTION

[0001] The present invention generally related to an ultrasound method and apparatus for analyzing a region of interest and more particularly to a method and apparatus for co-displaying inverse mode ultrasound images and histogram information.

[0002] Ultrasound systems have long existed for analyzing various regions of interest, such as in medical applications and in non-medical fields. Conventional ultrasound systems display the ultrasound information in a variety of formats and configurations. By way of example, existing ultrasound systems may display a series of two dimensional images or slices based on a volume of acquired data where the position of each slice is determined by the user. Along with the set of two dimensional slices or images, a rendered image (e.g. a three dimensional representation) may be separately or simultaneously displayed with one or more of the two dimensional images or slices. Conventional systems provide the user with various functionality to rotate the images and adjust the parameters used to generate the images. The displayed images present the ultrasound information in various manners, such as gray scale levels representative of the intensity of echo signals received from each scan of the region of interest, as well as color information, inverse gray levels and the like.

[0003] Conventional systems also offer modes in which non-image based information is presented to the user, such as statistical measurements of particular physiologic parameters, graphs, bar charts and the like.

[0004] However, conventional systems have been unable to combine images and certain types of non-image information in an easily viewable and adjustable manner.

BRIEF DESCRIPTION OF THE INVENTION

[0005] An ultrasound system is provided for analyzing a region of interest. The ultrasound system includes a probe for acquiring ultrasound information associated with the region of interest and a memory for storing a volumetric data set corresponding to at least a subset of the ultrasound information for at least a portion of the region of interest. The system further includes at least one processor for generating histogram information based on the volumetric data set and for generating an ultrasound image based on the volumetric data set. The processor formats the histogram information and the ultrasound image to be co-displayed. The system further includes a display for simultaneously co-displaying the histogram information and the ultrasound image.

[0006] Optionally, the ultrasound image may comprise a collection of images that includes at least one of a volume rendered image and a set of orthogonal image slices, one or more of which are co-displayed with the histogram information. Optionally, the ultrasound images and/or the histogram information may be generated based upon inverse levels of gray scale values stored within voxels defining the volumetric data set. Optionally, the display may present the ultrasound images and the histogram information in separate first and second windows that at least partially overlap one another, with the positions of each window being adjustable by the user with click and drag functions of a mouse.

[0007] The system may further comprise an inverse map memory that stores an invert function. The processor may then calculate inverted data values based on the invert function and the volumetric data set. At least one of the histogram information and the ultrasound image may be representative of the inverted data values.

[0008] Optionally, the system may include a user interface configured to receive a threshold parameter. The processor may update histogram information and the ultrasound images in real-time based on user adjustment of the threshold parameter.

[0009] In accordance with at least one alternative embodiment, a method is provided for analyzing a region of interest. A method includes acquiring ultrasound information associated with the region of interest and storing a volumetric data set corresponding to at least a subset of the ultrasound information for at least a portion of the region of interest. The method further comprises generating histogram information based on the volumetric data set and generating an ultrasound image based on the volumetric data set. The method also includes formatting the histogram information and the ultrasound image to be co-displayed and then simultaneously co-displaying the histogram information and the ultrasound image.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] **FIG. 1** illustrates a block diagram of an ultrasound system formed in accordance with one embodiment of the present invention.

[0011] **FIG. 2** illustrates a block diagram of an ultrasound system formed in accordance with an alternative embodiment of the present invention.

[0012] **FIG. 3** illustrates a block diagram of an ultrasound system formed in accordance with an alternative embodiment of the present invention.

[0013] **FIG. 4** illustrates a block diagram of an ultrasound system formed in accordance with an alternative embodiment of the present invention.

[0014] **FIG. 5** illustrates a method setting forth steps carried out in accordance with at least one embodiment of the present invention.

[0015] **FIG. 6** illustrates a screen shot in which ultrasound images and histogram information are co-displayed simultaneously in accordance with one embodiment of the present invention.

[0016] **FIG. 7** illustrates an inverse map utilized in accordance with certain embodiments of present invention.

[0017] **FIG. 8** illustrates a surface rendering map utilized in accordance with certain embodiments of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0018] **FIG. 1** illustrates an ultrasound system **70** formed in accordance with one embodiment of the present invention. The system **70** includes a probe **10** connected to a transmitter **12** and a receiver **14**. The probe **10** transmits ultrasonic pulses and receives echoes from structures inside of a scanned ultrasound volume **16**. Memory **20** stores ultrasound data from the receiver **14** derived from the scanned ultrasound volume **16**. The volume **16** may be obtained by various techniques (e.g., 3D scanning, real-time 3D scanning, 2D scanning with transducers having positioning sensors, freehand scanning using a voxel correlation technique, 1.25D, 1.5D, 1.75D, 2D or matrix array transducers and the like).

[0019] The probe **10** is moved, such as along a linear or arcuate path, or electronically steered when using a 2D array, while scanning a region of interest (ROI). At each linear or arcuate position, the transducer **10** obtains scan planes **18**. The scan planes **18** are stored in the memory **20**, and then passed to a volume scan converter **42**. In some embodiments, the probe **10** may obtain lines instead of the scan planes **18**, and the memory **20** may store individual or subsets of lines obtained by the probe **10** rather than the scan planes **18**. The volume scan converter **20** may store lines obtained by the transducer **10** rather than the scan planes **18**. The volume scan converter **42** creates data slices from the US data memory **20**. The data slices are stored in slice memory **44** and are accessed by a volume rendering processor **46**. The volume rendering processor **46** performs volume rendering upon the data slices. The output of the volume rendering processor **46** is passed to the processor **50** and display **67**.

[0020] **FIG. 2** illustrates a block diagram of an ultrasound system **100** formed in accordance with an embodiment of the present invention. The ultrasound system **100** includes a transmitter **102** which drives transducers **104** within a probe **106** 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 which return to the transducers **104**. The echoes are received by a receiver **108**. The received echoes are passed through a beamformer **110**, which performs beamforming and outputs an RF signal. The RF signal then passes through an RF processor **112**. Alternatively, the RF processor **112** 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 RF/IQ buffer **114** for temporary storage. A user input **120** may be used to input patient data, scan parameters, a change of scan mode, and the like.

[0021] The ultrasound system **100** also includes a signal processor **116** to process the acquired ultrasound information (i.e., RF signal data or IQ data pairs) and prepare frames of ultrasound information for display on display system **118**. The signal processor **116** is adapted to perform one or more processing operations according to a plurality of selectable ultrasound modalities on the acquired ultrasound information. Acquired ultrasound information may be processed in real-time during a scanning session as the echo signals are received. Additionally or alternatively, the ultrasound information may be stored temporarily in RF/IQ buffer **114** during a scanning session and processed in less than real-time in a live or off-line operation.

[0022] The ultrasound system **100** may continuously acquire ultrasound information at a frame rate that exceeds 50 frames per second—the approximate perception rate of the human eye. The acquired ultrasound information is displayed on the display system **118** at a slower frame-rate. An image buffer **122** is included for storing processed frames of acquired ultrasound information that are not scheduled to be displayed immediately. Preferably, the image buffer **122** is of sufficient capacity to store at least several seconds worth of frames of ultrasound information. The frames of ultrasound information are stored in a manner to facilitate retrieval thereof according to its order or time of acquisition. The image buffer **122** may comprise any known data storage medium.

[0023] **FIG. 3** illustrates a system for the continuous volume scanning of an object by the means of ultrasound waves. The system includes an ultrasound-echo-processor **3**, polar cartesian-coordinate transformer ("Scanconverter") **4**, B-mode scan-control **5** and display **6**. The system also includes a 3D or volume scanning probe **1**, controller for the volume scan movement **7**, control-unit for B-mode scanning, 3D-processor **9**, 3D-storage of echo data **11** and a unit to store spatial geometry information **13**.

[0024] **FIG. 4** illustrates an ultrasound system **200** formed in accordance with an alternative embodiment of the present invention.

[0025] The ultrasound system **200** includes a probe **202** which communicates with a beamformer **204** over a transmit/receive link **206**. The transmit/receive link **206** conveys transmit information to the probe **204** and conveys received echo-data from the probe **202** to the beamformer **204**. The beamformer **204** is connected at link **208** to a processor/controller module **210** which comprises one or more controllers and processors. The module **210** may comprise a single processor (such as in a personal computer and the like) which performs all processing operations explained throughout the present application. Alternatively, the module **210** may include multiple processors arranged to carry out multi-processing in a shared manner. Alternatively, the module **210** may represent a hardware implemented configuration of individual boards provided in a cage where each board includes dedicated processors and memory and related components associated with the various functions of the ultrasound system **200**.

[0026] In the example of **FIG. 4**, the module **210** includes and performs the functionality of a system controller **212**, a volume rendering processor **214** and a video processor **216**. The volume rendering processor **214** performs, at least, volume rendering operations to generate rendered images based upon stored ultrasound data for one or more volumes. The video processor **216** controls formatting, writing to and reading from one or more video memory buffers to control the information presented on the display **218**. The system controller **212** coordinates and controls operation of at least processors **214** and **216**. A user interface **220** is provided to permit the user to enter various types of information. The user interface **220** may include a keyboard, a mouse, a track ball and the like.

[0027] The ultrasound system **200** also includes a memory module **222** that is denoted in **FIG. 4** as a common block. Optionally, one or more separate memory sections may be utilized in connection with each of the various types of stored information. For example, the memory module **222** may include a personal computer hard drive, a remote data base interconnected to the ultrasound system **200** over the internet or some other networking link. Optionally, the memory module **222** may include various buffers, cash memory, RAM, ROM and the like, distributed within the ultrasound system **200** on various boards, chips and the like. The memory module **222** includes common or separate memory space for storing volumetric data sets **224**, histogram information **226**, video memory **228**, invert maps **230**, surface rendering maps **232** and image slices **234**.

[0028] The volumetric data sets **224** comprise one or more sets of ultrasound data representative of a volume within the region of interest. Successive volumetric data sets **224** may be stored in separate memories, such as scan converter memories or alternatively in a common FIFO type buffer in which each new successive volume is acquired and pushed into the front end of the buffer, while the oldest volumetric data set within the buffer is being processed and/or read out. Each volumetric data set comprises a three dimensional array of voxels, each voxel of which contains a gray scale value associated with a particular point in object space within the region of interest. Optionally, the voxels may store not only gray scale values, but also information related to motion within the corresponding object space (e.g. a Doppler value).

[0029] The histogram information **226** includes one or more parameters utilized when analyzing the gray scale values of the voxels within a volumetric data set **224**. By way of example, the parameters may include high and low threshold parameters selected and adjustable by the user denoting cutoff points in grayscale value intensity. The histogram information **226** also contains the results of a histogram analysis of a corresponding volumetric data set **224**. Histograms include a count of the member of voxels at each gray level. The low threshold parameter is user adjustable along the range of potential gray levels.

[0030] For example, when a user selects a desired low threshold parameter and a corresponding volumetric data set **224** is analyzed, the histogram information **226** may count the number of voxels above and below the threshold parameters. Based on the number of voxels above and below the threshold various subvolumes within the volumetric data set **224** may also be calculated since each voxel is of equal and known size. By way of example only, if a voxel is a 0.5 millimeter cube, by counting the number of voxels above and below the threshold, the volumes of the region of interest above and below the threshold are determined.

[0031] The invert maps **230** stored in memory module **222** may include one or more maps representing function(s) utilized by the processor/control module **210** to generate inverted gray scale or level intensity values.

[0032] **FIG. 7** illustrates a graph of an exemplary inverse function **240** where the horizontal axis of the graph represents the input gray scale and the vertical axis represents the output gray scale. The invert function **240** is a non-linear function, having first and second sections **242** and **244**. In the example of **FIG. 7**, sections **242** and **244** are both linear, but have different slopes and intersect at the threshold parameter **246**. Section **242** has a steeper negative slope than that of section **244**. Alternatively, sections **242** and **244** may be defined by a common or different non-linear functions. The invert function **240** is used by the volume rendering processor **214** to produce invert rendered images from gray scale values in the accessed volumetric data set **224**.

[0033] Returning to **FIG. 4**, the memory module **222** further includes one or more surface rendering maps **232** that are utilized by the volume rendering processor **214** to construct a rendered volume that is subsequently displayed by display **218**.

[0034] **FIG. 8** illustrates a graph of an exemplary surface rendering function **248**. The horizontal axis of the graph represents the input gray scale, while the vertical axis represents the output opacity value. The surface rendering function **242** also includes a complex structure with sections **250** and **252** having different slopes and intersecting at the threshold parameter **246**. The threshold parameter **246** in **FIG. 8** represents the same threshold parameter as illustrated in **FIG. 7** that defined the intersection between sections **242** and **244** of the inverse map **240**. The threshold parameter **246** is adjustable by the user in real-time, in that as the user adjusts the threshold parameter, new images and histogram information are presented shortly thereafter (e.g. in less than 0.25 to 5 sec). The term real-time as used throughout is intended to indicate that ultrasound images or histogram information is displayed to the user in a sufficiently short period of time after the user adjusts the threshold parameter, that the user considers it to be real-time (e.g. in less than 0.25 to 5 sec).

[0035] Returning to **FIG. 4**, the memory module **222** also stores image slices **234** which are produced by the volume scan converter **236** based upon selections by the user, via the user interface **220**. For example, the user may identify, through the user interface **220**, the position of desired planes along which image slices are desired. With this information, the volume scan converter **236** operates upon a corresponding volumetric data set **224** to generate the image slices. When generating the image slices, the volume scan converter **236** may produce inverted images (e.g., images comprised of gray levels inverted based on the invert function **240**) such as to generate A-plane, B-plane, C-plane images and the like. It is also possible that the image slices are presented with the original gray scales where values below the threshold **246** are marked in color. (e.g. pink)

[0036] **FIG. 5** illustrates a processing sequence carried out in accordance with an embodiment of the present invention. In **FIG. 5**, at step **260**, ultrasound data is obtained and stored in one or more volumetric data sets in the memory module **222**. At step **262**, a common parameter, such as the threshold parameter **246**, is identified and used to create an invert map **230** and a surface rendering map **232**. With reference to **FIGS. 7 and 8**, once the threshold parameter **246** is identified, at step **262**, the invert function **240** and the surface rendering functions **248** are generated by the processor **214**.

[0037] At step **264**, image slices **234** are generated based on a user input, such as identifying a particular point or series of locations in the volumetric data set **224**. The image slices **234** may be orthogonal to one another, but need not necessarily be orthogonal. Examples of image slices include the A plane, the B plane, the C plane, the I plane and the like.

[0038] At step **266**, a histogram is generated and stored in the histogram information **226**. The histogram maybe generated based on a volumetric data set **224**.

[0039] At step **268**, the histogram is analyzed to calculate volume related histogram information. At step **270**, the volume rendering processor **214** performs a volume rendering operation based on the invert and surface rendering maps **230** and **232** and on a corresponding volumetric data set **224**. At step **272**, the image slices **234**, rendered image and histogram information are simultaneously co-displayed under control of the video processor **216** by the display **218**.

[**0040**] **FIG. 6** illustrates a screen shot **280** of the information that is co-displayed simultaneously on the display **218** to the user. The screen shot **280** includes windows **282** and **284** that overlap one another and may be moved by the user using a click and drag function of a trackball or mouse. While the window **284** overlaps in front of window **282**, they may be reversed when the user simply clicks on window **282**. Each window **282** and **284** may be adjusted in size by the user through the mouse by grabbing a boarder of the corresponding window **282** and **284** and dragging it a desired distance. Window **282** includes ultrasound images generally denoted at reference numeral **286**, while window **284** generally illustrates histogram information denoted by reference numeral **288**. The ultrasound images **286** include a set of image slices **290**, **292** and **294** which, in the example of **FIG. 6**, correspond to orthogonal image planes (e.g. the A plane, B plane and C plane). The ultrasound images **286** also include a rendered image **296** which in the example of **FIG. 6** constitutes an invert rendered image in that each gray level of the underlying volumetric data set **224** has been converted based upon a corresponding invert map **230** prior to generation of the surface rendered image **296**.

[**0041**] The window **282** also includes multiple adjustable parameters including a threshold parameter bar **298** that is graphically illustrated as a bar that may be grabbed and pulled utilizing the mouse and/or a track ball. As the threshold parameter bar **298** is adjusted between left-most and right most extremes, the value of the threshold parameter **246** is similarly adjusted. The value of the threshold parameter **246** is also identified (in the example of **FIG. 6** it is denoted as "**56**").

[**0042**] The window **282** include other adjustment sliders or bars, such an X-rotation bar **300**, Y-rotation bar **302**, Z-rotation bar **304**, transparency bar **306**, magnification bar **308**, high threshold parameter bar **310** and surface mix bar **312**. As the user adjust one or more of the parameters denoted by bars **298**-**312**, the ultrasound images **286** and the histogram information **288** are updated in real-time (e.g. in less than 0.25 to 5 sec).

[**0043**] Turning to the histogram information **288**, a graph **320** is presented where the horizontal axis denotes each discrete gray scale intensity and the vertical axis denotes the number of counts at each intensity within the corresponding volumetric data set **224**. The graph **320** includes a threshold marker **322** identifying the gray scale value associated with the low threshold tab **298**. The histogram information **288** also includes a series of gray scale statistics **324**, such as the volume in cubic centimeters 1) of the region of interest, 2) of the "out of volume" area, 3) of the "in volume" area, 4) the "in volume" area below the threshold and 5) the "in volume" area above the threshold. The "out of volume" area represents a section of the volumetric data set **224** that the user has identified to be removed from the subsequent histogram analysis and thus is not reflected in the graph **320**.

[**0044**] As the threshold parameter bar **298** is adjusted, the corresponding threshold parameter **246** is adjusted and the appropriate processor within the processor/controller module **210** adjusts both of the inverse function **240** and the surface rendering function **248**. Once the inverse function **240** and surface rendering function **248** are adjusted, subsequent image slices **234** or rendered images are generated based on the updated functions and thus reflect changes in how gray level values are mapped. Also, the appropriate processor within the processor/controller module **210**, performs subsequent histogram calculations based on the updated inverse and surface rendered functions **240** and **248**. The histogram information **288** and ultrasound images **286** generated based on the adjusted threshold parameter **246** are displayed immediately upon generation. Hence, the user views, in real time (e.g., less than 0.25 to 5 sec.) the results of changing the threshold parameter **246** in the ultrasound images **286** and histogram information **288**.

[**0045**] The histogram information **288** also includes the mean gray value **326**, the vascular index (VI) the flow index (FI), and the vascularzation flow index (VFI) for various modes, such as color angio and color CFM. The window **284** also includes a threshold parameter bar **328** which performs the same function as the threshold parameter bar **298** in window **282**. Offering the same threshold parameter bar **328** and **298** on different windows permits the user added ease in adjusting the parameter. A return button **330** is included in window **284**. The user selects the return tab **330** when it is desired to switch to a different window (e.g. window **282**).

[**0046**] In accordance with the forgoing, method and apparatus are provided which permit the user to invert a volumetric data set **224** before performing a volume rendering operation. The volume rendering operation may constitute surface rendering, surface rendering utilizing gradient light, surface rendering with depth shading, maximum intensity projection (MIP), minimum intensity projection, and the like. When the image slices are displayed, they may be displayed with invert intensities and they may be shown in color to further highlight regions having very low gray scale levels.

[**0047**] When the user desires to remove a section of the volume from the statistical analysis, (otherwise known as "MagiCut"), the user selects the section to be removed prior to the volume rendering and histogram calculation operations.

[**0048**] While the invention has been described in terms of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.

What is claimed is:

1. An ultrasound system, comprising:

a probe acquiring ultrasound information associated with a region of interest;

memory storing a volumetric data set corresponding to at least a subset of said ultrasound information for at least a portion of the region of interest;

a processor generating histogram information based on said volumetric data set and generating an ultrasound image based on said volumetric data set, said processor formatting said histogram information and said ultrasound image to be co-displayed; and

a display simultaneously co-displaying said histogram information and said ultrasound image.

2. The ultrasound system of claim 1, wherein said processor generates at least one of a volume rendered image and a set of orthogonal image slices as said ultrasound image to be co-displayed with said histogram information.

3. The ultrasound system of claim 1, wherein said volumetric data set comprises voxels of gray-scale values, said processor generating said ultrasound image based on inverted values of said gray-scale values.

4. The ultrasound system of claim 1, wherein said volumetric data set comprises voxels of gray-scale values, said processor generating said histogram based on inverted values of said gray-scale values.

5. The ultrasound system of claim 1, wherein said volumetric data set comprises voxels of gray-scale values, said histogram information and said ultrasound image representing inverted values of said gray-scale values.

6. The ultrasound system of claim 1, wherein said display presents said ultrasound image and said histogram information in first and second windows.

7. The ultrasound system of claim 1, wherein said display presents said ultrasound image and said histogram information in first and second windows that at least partially overlap one another.

8. The ultrasound system of claim 1, further comprising invert map memory storing an invert function, said processor calculating inverted data values based on said invert function and said volumetric data set, at least one of said histogram information and said ultrasound image being representative of said invert data values.

9. The ultrasound system of claim 1, further comprising an user interface configured to receive a threshold parameter, said processor updating said histogram information and said ultrasound image in real-time based on user adjustment of said threshold parameter.

10. The ultrasound system of claim 1, further comprising memory storing a threshold parameter, said processor counting an amount of said volumetric data set above and below said threshold parameter to generate said histogram information.

11. The ultrasound system of claim 1, further comprising memory storing a threshold parameter, said processor shading pixels in said ultrasound image with one of first and second gray-scale levels depending on whether corresponding data values in said volumetric data set are above/below said threshold parameter.

12. A method for analyzing a region of interest, comprising:

acquiring ultrasound information associated with the region of interest;

storing a volumetric data set corresponding to at least a subset of said ultrasound information for at least a portion of the region of interest;

generating histogram information based on said volumetric data set;

generating an ultrasound image based on said volumetric data set;

formatting said histogram information and said ultrasound image to be co-displayed; and

simultaneously co-displaying said histogram information and said ultrasound image.

13. The method of claim 12, wherein said generating an ultrasound image further comprises generating at least one of a volume rendered image and a set of orthogonal image slices as said ultrasound image to be co-displayed with said histogram information.

14. The method of claim 12, wherein said volumetric data set comprises voxels of gray-scale values, said generating an ultrasound image further comprising generating said ultrasound image based on invert values of said gray-scale values.

15. The method of claim 12, wherein said volumetric data set comprises voxels of gray-scale values, said generating an ultrasound image further comprising generating said histogram based on invert values of said gray-scale values.

16. The method of claim 12, wherein said volumetric data set comprises voxels of gray-scale values, said histogram information and said ultrasound image representing invert of said gray-scale values.

17. The method of claim 12, said displaying including presenting said ultrasound image and said histogram information in first and second windows.

18. The method of claim 12, said displaying including presenting said ultrasound image and said histogram information in first and second windows that at least partially overlap one another.

19. The method of claim 12, further comprising storing an invert function and calculating invert data values based on said invert function and said volumetric data set, at least one of said histogram information and said ultrasound image being representative of said invert data values.

20. The method of claim 12, further comprising receiving a threshold parameter and updating said histogram information and said ultrasound image in real-time based on adjustment of said threshold parameter.

21. The method of claim 12, further comprising storing a threshold parameter and counting an amount of said volumetric data set above and below said threshold parameter to generate said histogram information.

22. The method of claim 12, further comprising storing a threshold parameter and shading pixels in said ultrasound image with one of first and second gray-scale levels depending on whether corresponding data values in said volumetric data set are above/below said threshold parameter.

23. The method of claim 12, further comprising generating volume information regarding the region of interest based on a number of voxels above and below said threshold parameter and a predetermined size of each voxel, said histogram information including said volume information.

* * * * *

patsnap

专利名称(译)	用于共显示逆模式超声图像和直方图信息的方法和装置		
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摘要(译)

提供了一种用于分析感兴趣区域的超声系统。超声系统包括用于获取与感兴趣区域相关联的超声信息的探针和用于存储对应于感兴趣区域的至少一部分的超声信息的至少一个子集的体数据集的存储器。该系统还包括至少一个处理器，用于基于体积数据集生成直方图信息，并基于体积数据集生成超声图像。处理器格式化直方图信息和要共同显示的超声图像。该系统还包括用于同时共同显示直方图信息和超声图像的显示器。