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(54) **METHOD AND SYSTEM FOR ORGANIC SPECIMEN FEATURE IDENTIFICATION IN ULTRASOUND IMAGE**

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A61B 8/13	(2006.01)
A61B 8/08	(2006.01)
A61B 8/00	(2006.01)

(52) **U.S. Cl.**

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USPC **702/56**; 702/19; 702/20; 600/437; 600/443; 382/128; 128/903; 128/904

(58) **Field of Classification Search**

CPC . A61N 1/368; A61N 1/3684; A61N 1/37264; A61N 7/00; A61N 2007/00; A61B 8/00; A61B 8/4245; A61B 8/464; A61B 8/5223; A61B 8/06; A61B 8/463; G06B 8/46; G06T 19/00; G06T 7/0012; G06F 19/30; G06F 19/321; G06F 19/3437; G01S 15/8913; G01S 15/8993

USPC 702/19, 20, 56; 128/898, 903, 904; 604/126; 600/437, 443, 407; 382/128, 382/132; 700/2, 9

See application file for complete search history.

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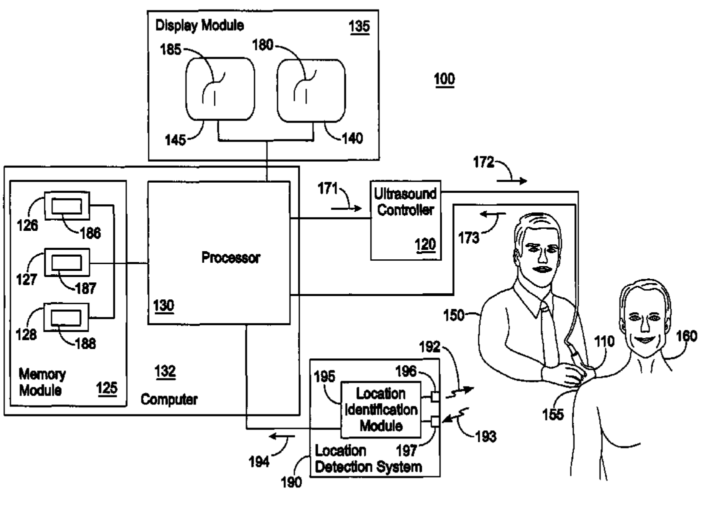
(57) **ABSTRACT**

A system, method, and computer program product. The system includes an ultrasound transducer configured for coupling ultrasound incident waves into selected regions of an organic specimen and transferring resultant ultrasound data from specimen features for selected ultrasound incident waves to a processor, a location detection unit configured for detecting locations of the ultrasound transducer and organic specimen and for transferring that data to the processor, a memory module configured for storing anatomic model data for at least part of the organic specimen, the processor configured for identifying the region associated with the selected ultrasound data, creating an ultrasound image from that data, obtaining model extracted data from the anatomic model data corresponding to the selected ultrasound data region, creating a model image from the model extracted data, and transferring the ultrasound and model images to a display module, and the display module configured for displaying the ultrasound and model images.

30 Claims, 13 Drawing Sheets



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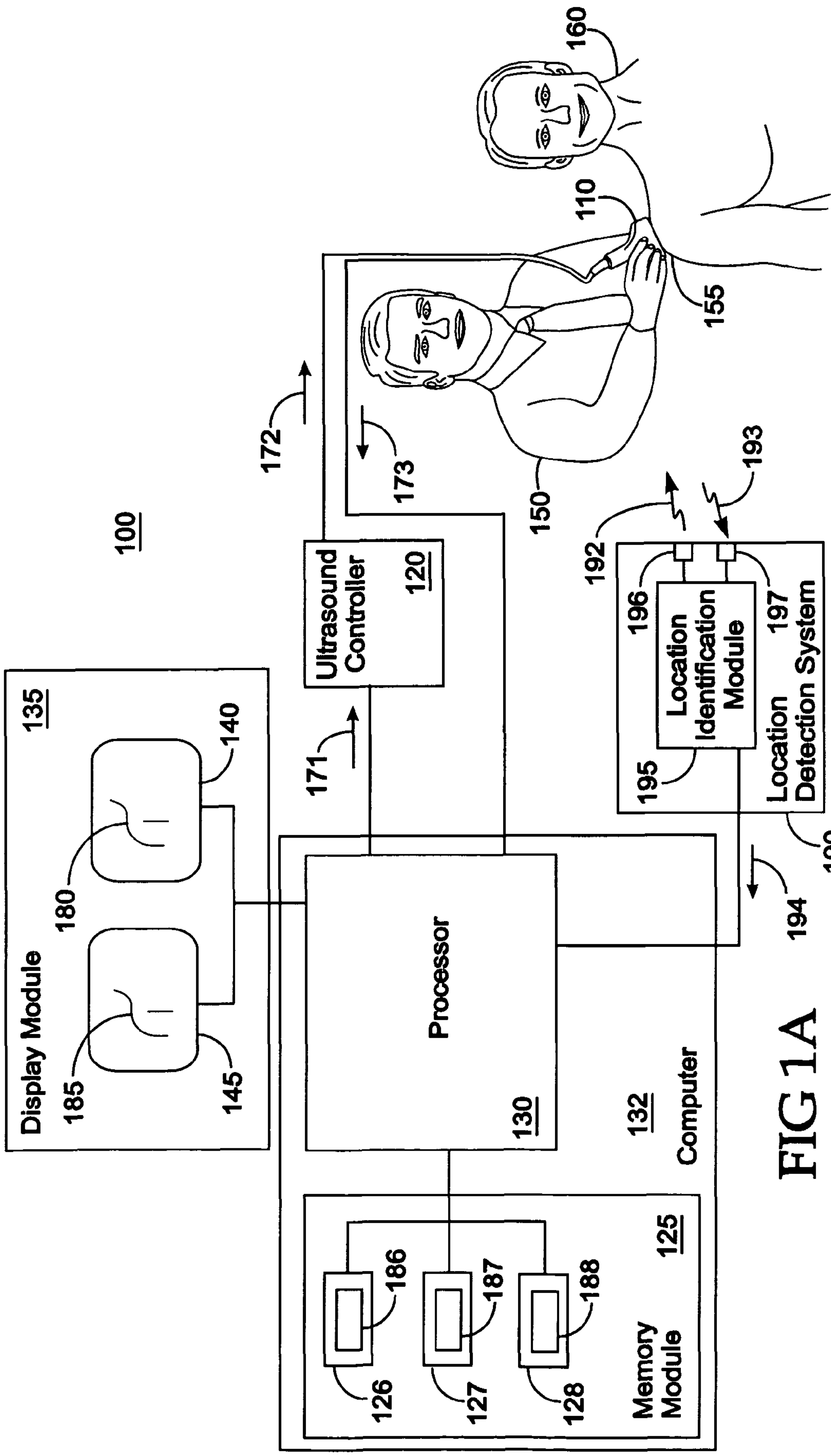
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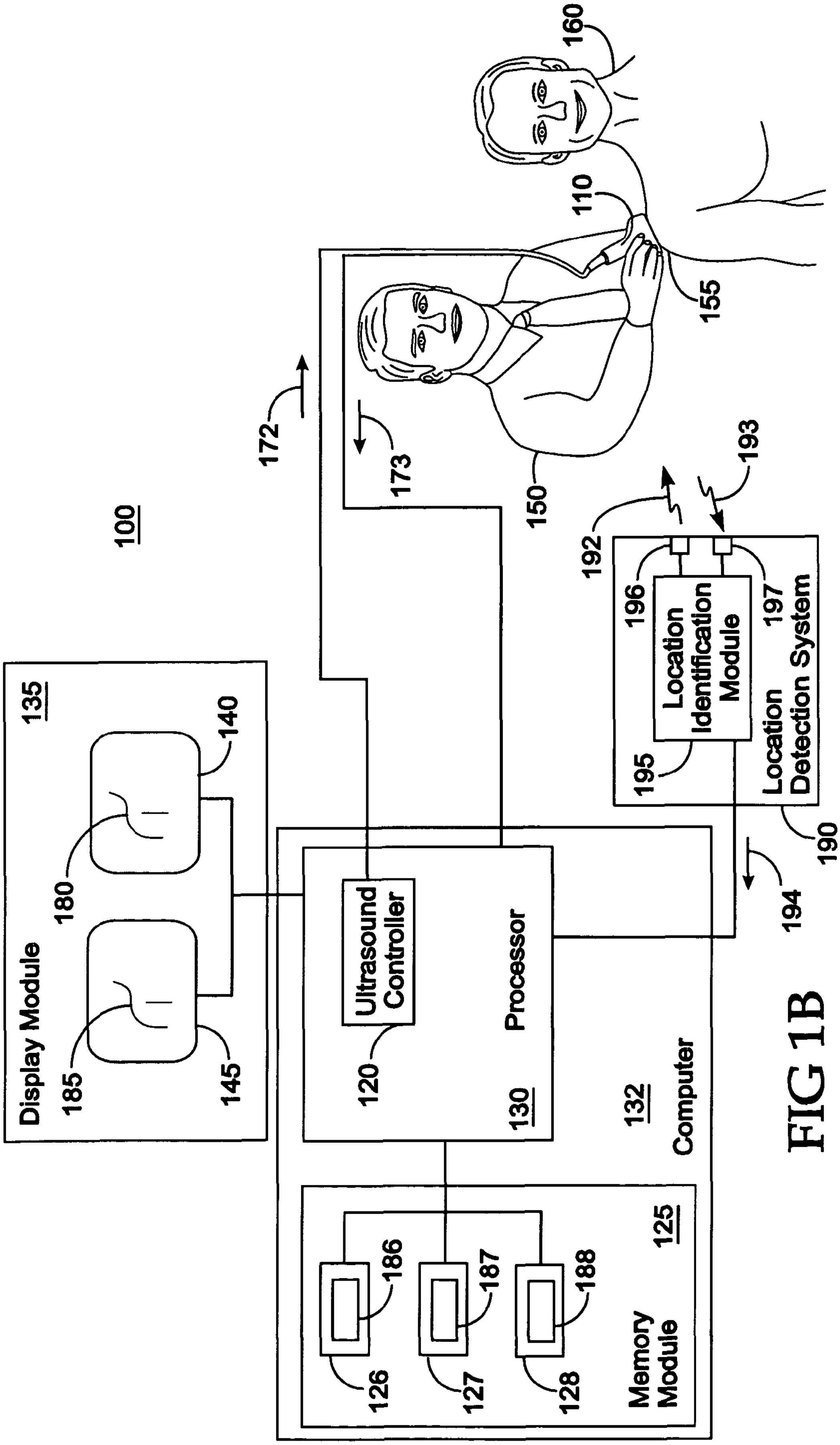
Display Module
135
140
180
185
145
Ultrasound Controller
120
171
172
173
110
155
150
160
Processor
130
Computer
132
Memory Module
125
126
127
128
186
187
188
Location Identification Module
Location Detection System
190
192
193
194
195
196
197

FIG 1A



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Display Module
135
140
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180
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Ultrasound Controller
120
Processor
130
Computer
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Memory Module
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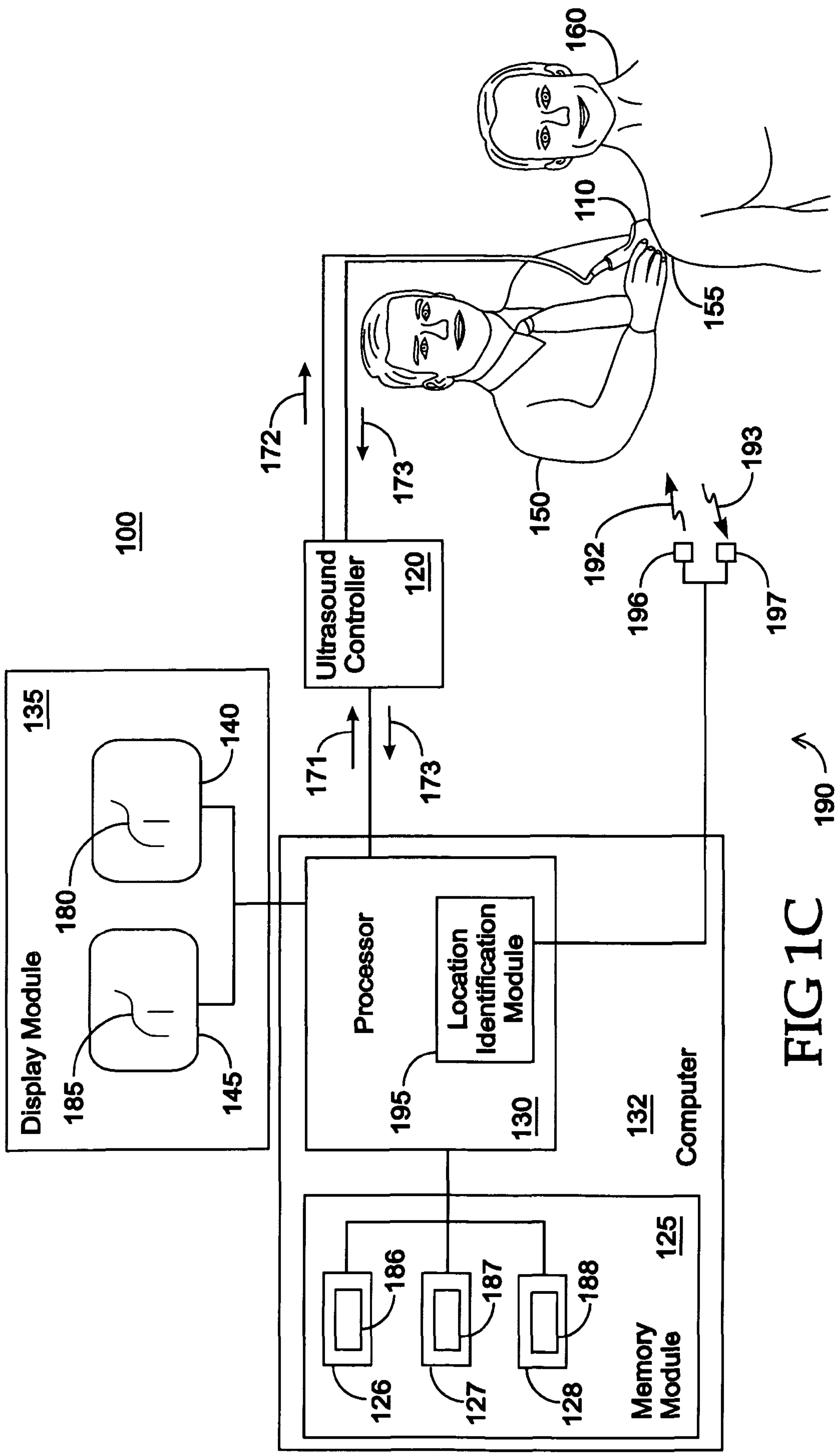
127
128
186
187
188
Location Identification Module
195
196
197
Location Detection System
190
192
193
194
172
173
150
155
110
160

FIG 1B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Ultrasound Controller
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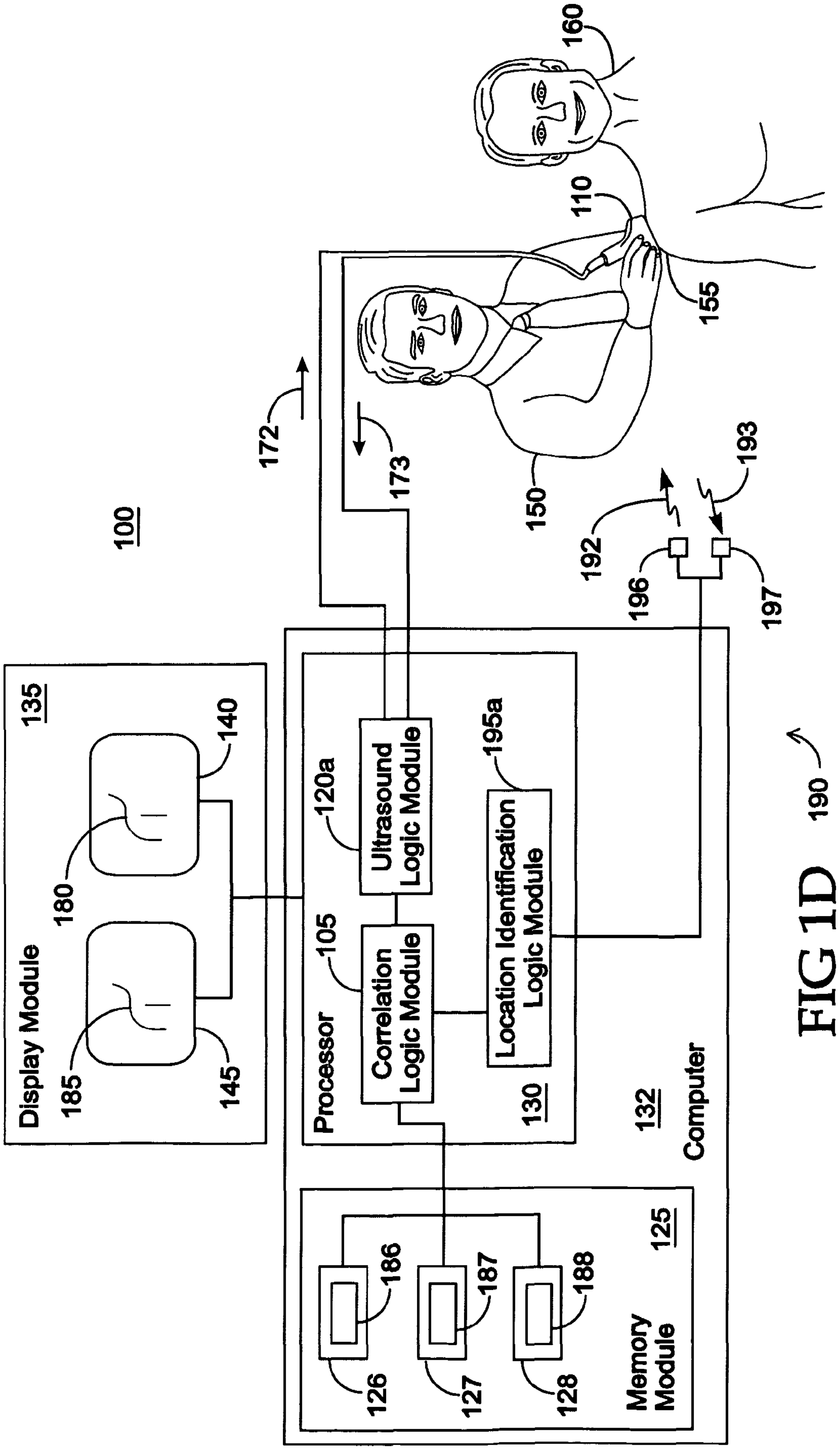
192
193
196
197
190
Processor
Location Identification Module
195
130
132
Computer
125
126
127
128
186
187
188
Memory Module

FIG 1C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Correlation Logic Module
105
Location Identification Logic Module
195a
Computer
132
Memory Module
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186
187
188
126
127
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110
150
155
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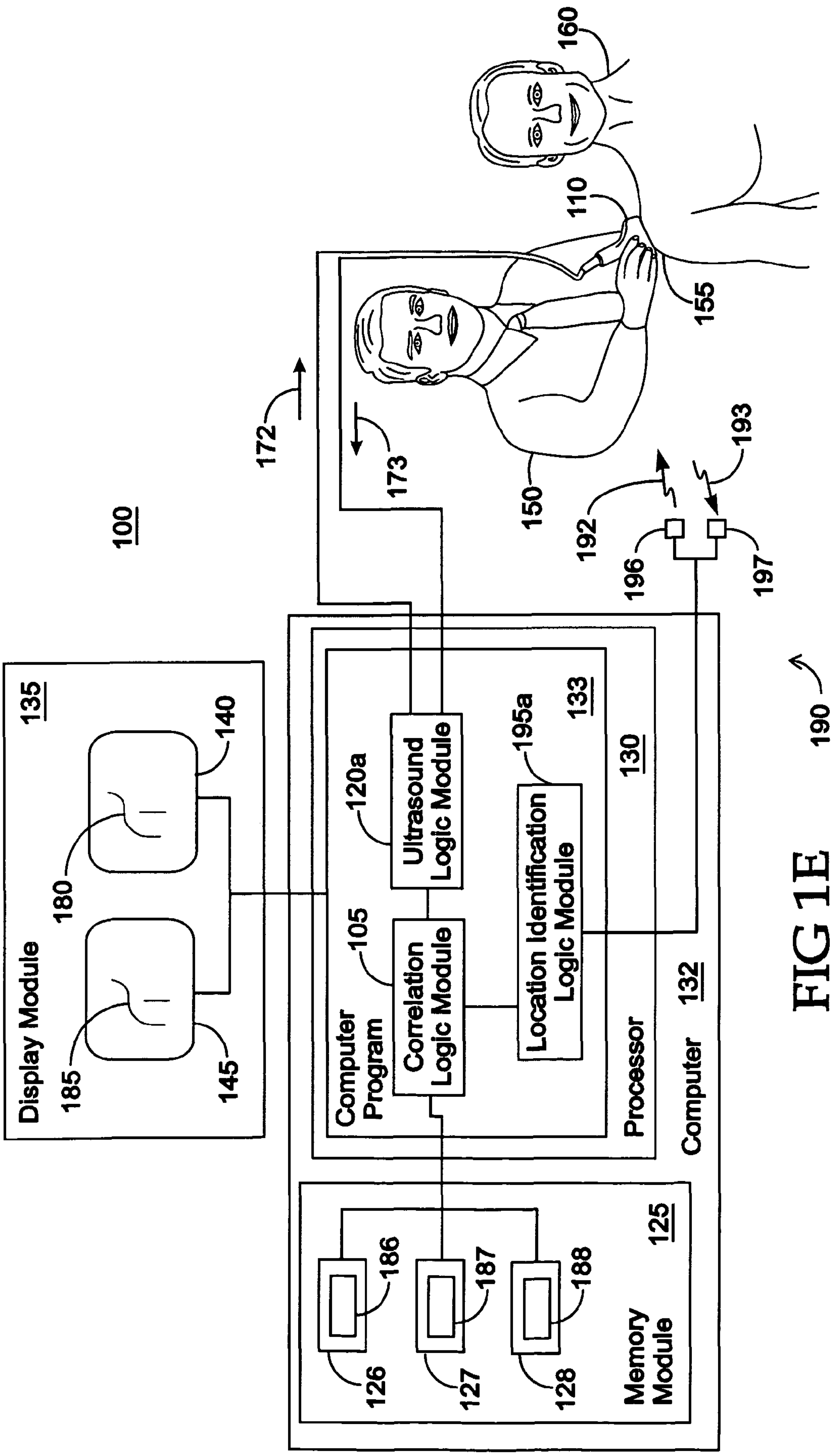
172
173
192
193
196
197
190

FIG 1D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Ultrasound Logic Module
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Location Identification Logic Module
195a
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Computer
132
Memory Module
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197
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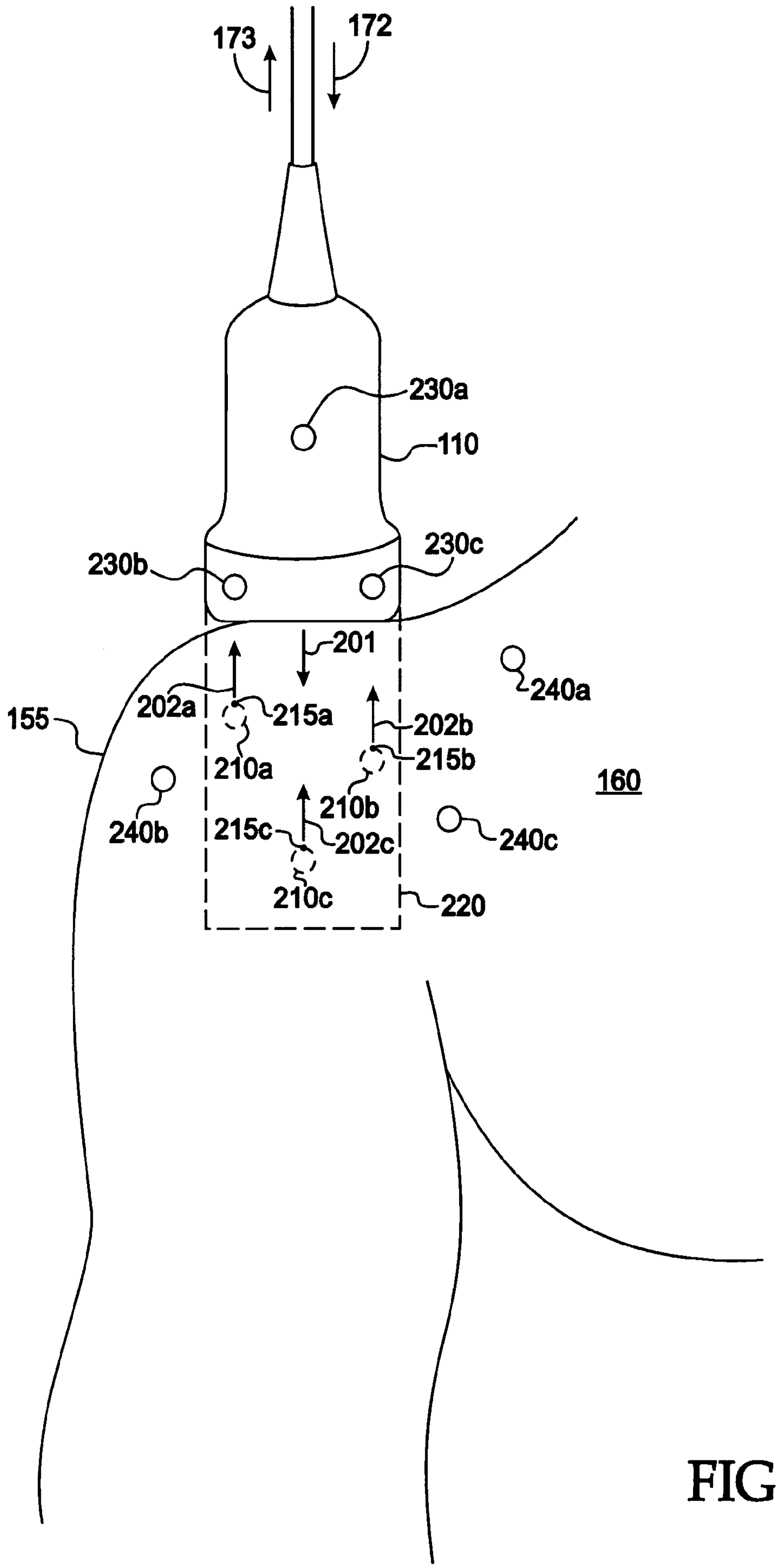
FIG 1E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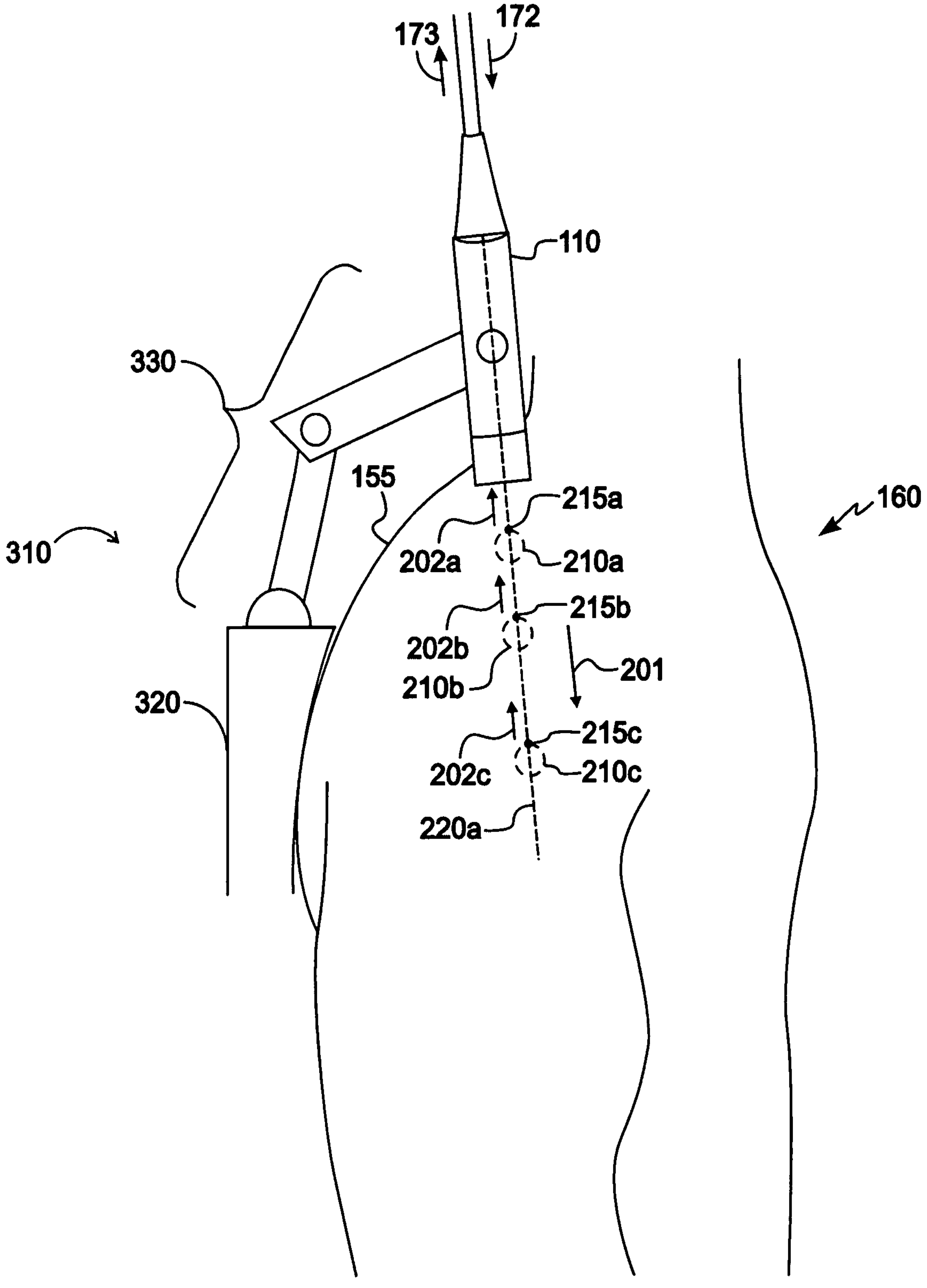
215c
202c
240c
210c
220

FIG 2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172
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320
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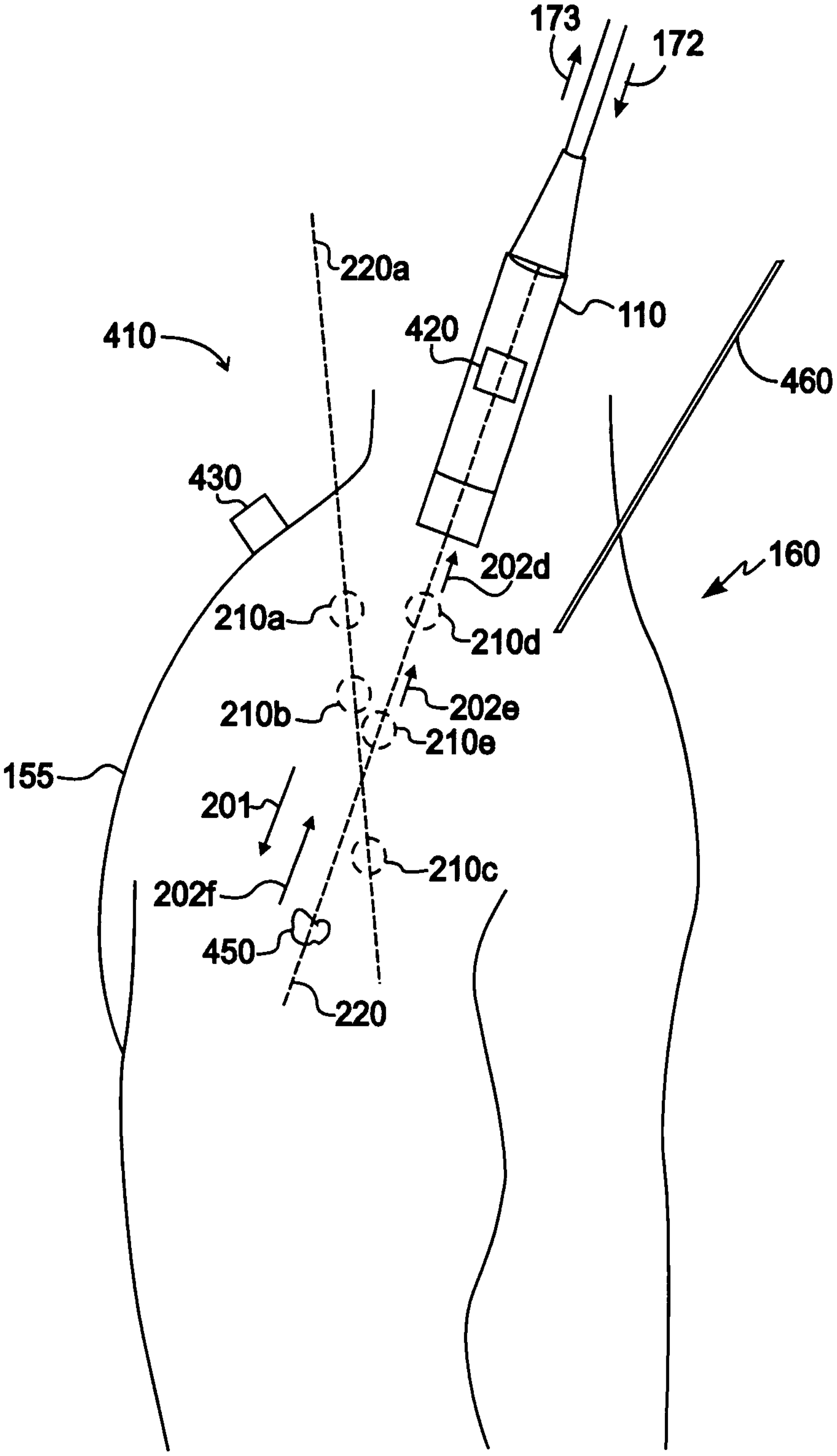
210c
220a

FIG 3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110
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210e
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201
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202f
450
220

FIG 4

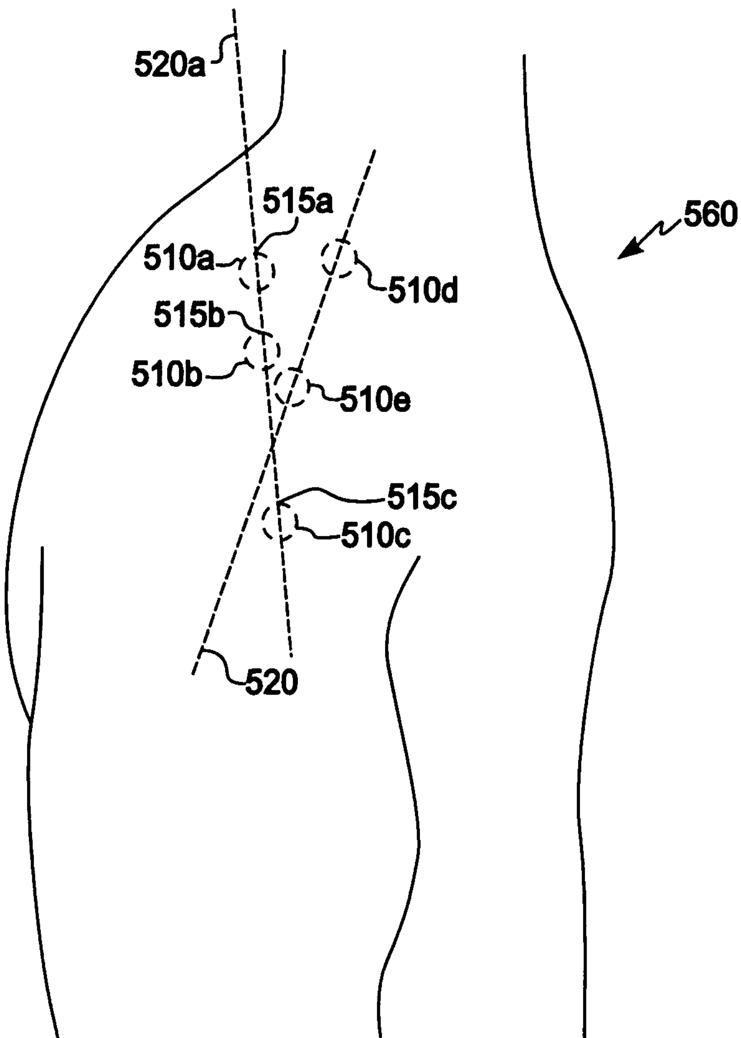

FIG 5

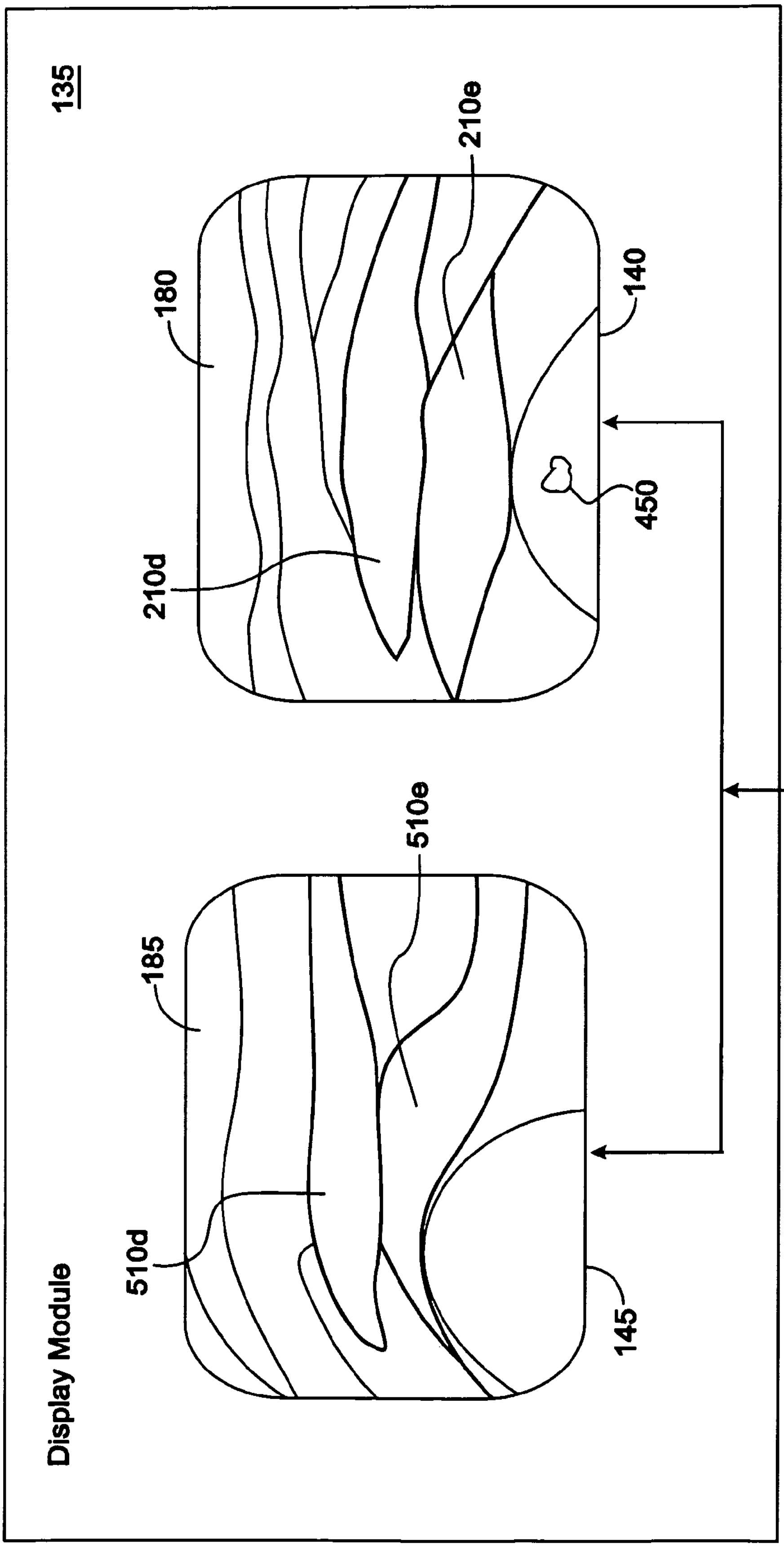

FIG 6

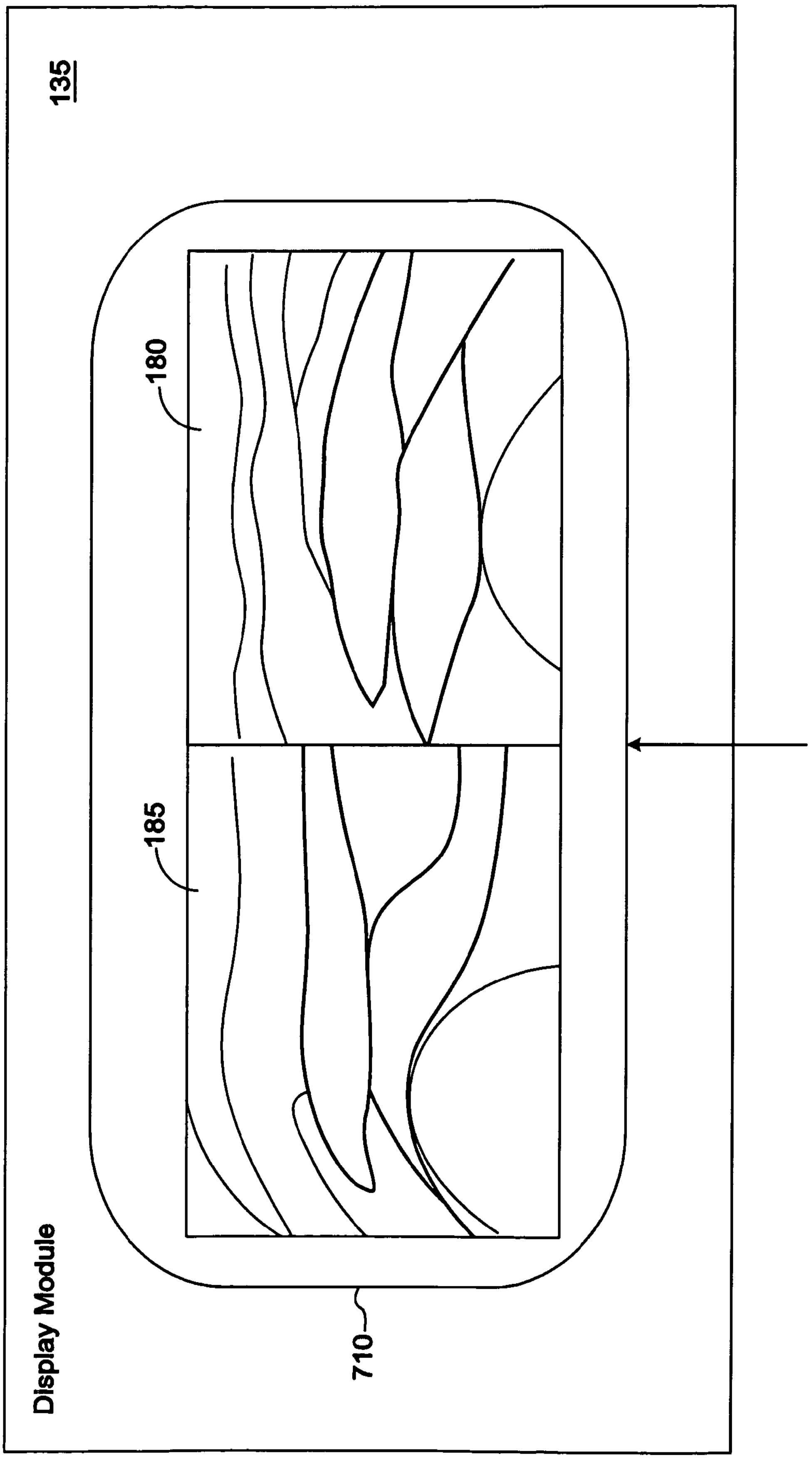

FIG 7

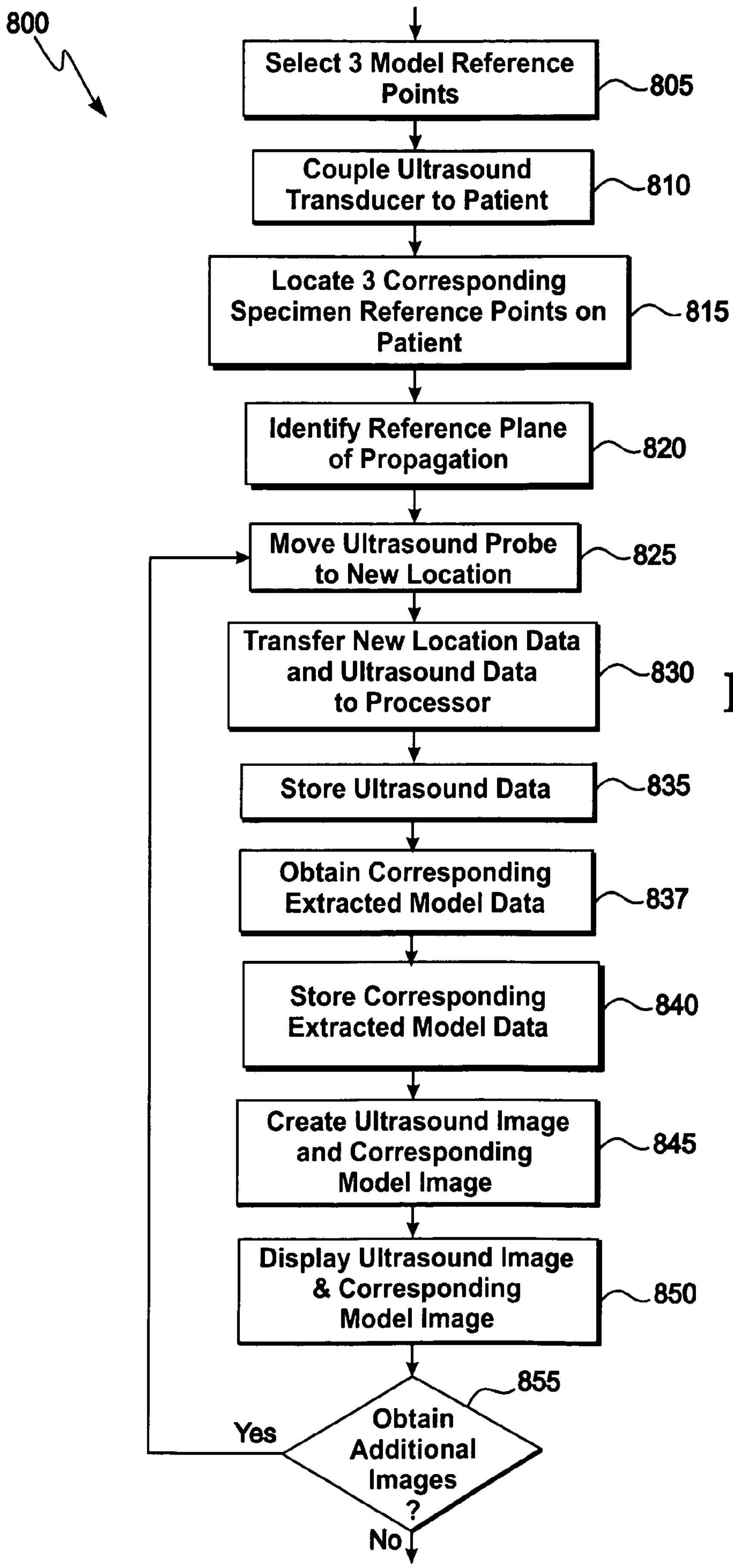
800
Select 3 Model Reference Points
805
Couple Ultrasound Transducer to Patient
810
Locate 3 Corresponding Specimen Reference Points on Patient
815
Identify Reference Plane of Propagation
820
Move Ultrasound Probe to New Location
825
Transfer New Location Data and Ultrasound Data to Processor
830
Store Ultrasound Data
835
Obtain Corresponding Extracted Model Data
837
Store Corresponding Extracted Model Data
840
Create Ultrasound Image and Corresponding Model Image
845
Display Ultrasound Image & Corresponding Model Image
850
Obtain Additional Images ?
855
Yes
No

FIG 8

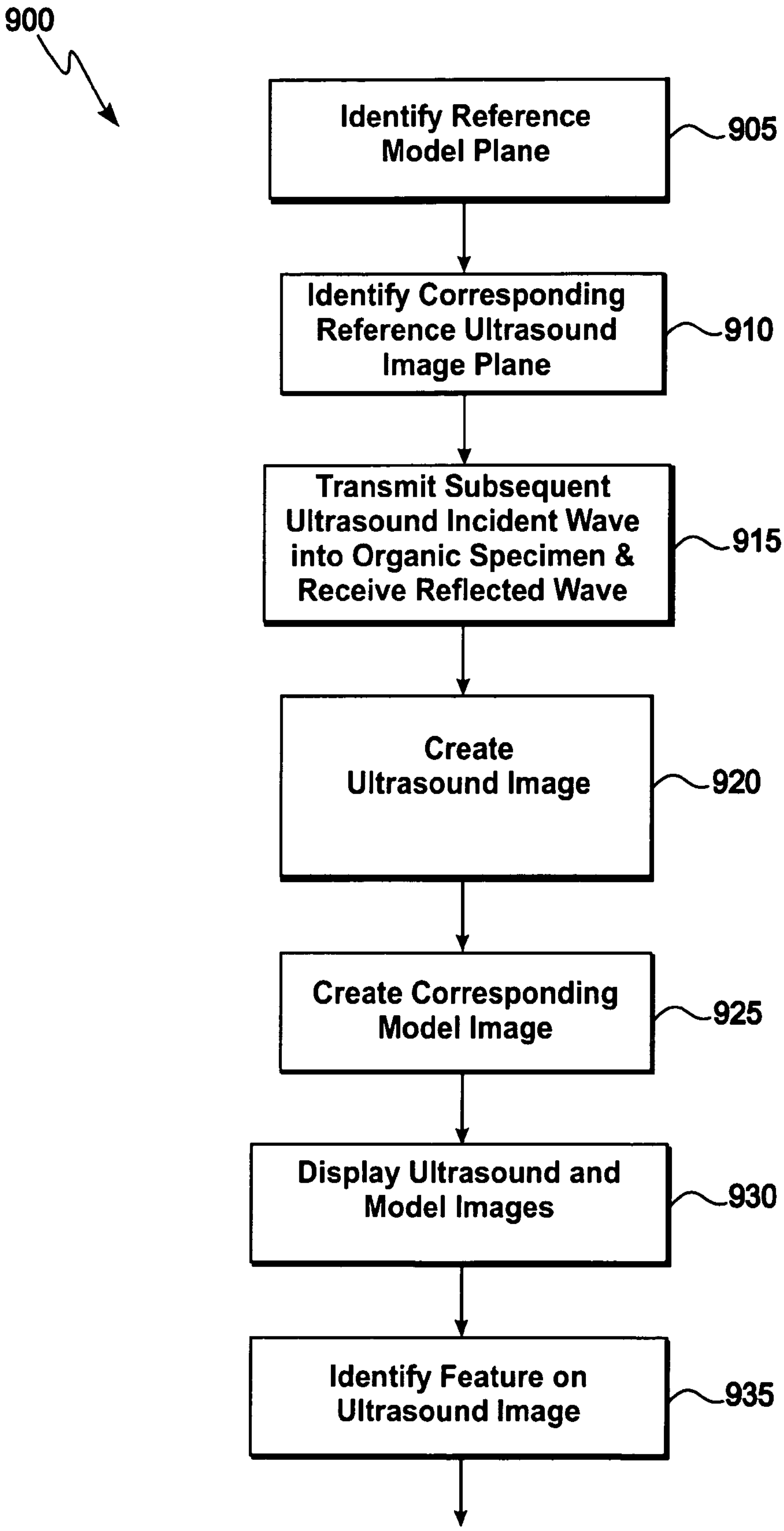
900
Identify Reference Model Plane
905
Identify Corresponding Reference Ultrasound Image Plane
910
Transmit Subsequent Ultrasound Incident Wave into Organic Specimen & Receive Reflected Wave
915
Create Ultrasound Image
920
Create Corresponding Model Image
925
Display Ultrasound and Model Images
930
Identify Feature on Ultrasound Image
935

FIG 9

METHOD AND SYSTEM FOR ORGANIC SPECIMEN FEATURE IDENTIFICATION IN ULTRASOUND IMAGE

BACKGROUND

Ultrasonic waves are used in various cleaning applications, in medical diagnostic and therapeutic applications, and for a number of research and investigative purposes. Ultrasound has become a widely used, medical diagnostic tool and is generally considered to be safe as well as non-invasive. One of the more well known medical applications is in the creation of visual images of fetuses in the human womb for diagnostic purposes. In other medical areas, however, ultrasound is now used as a diagnostic tool in the creation of visual images of muscles, tendons, and various internal organs. In such applications, the size, structure, and pathological lesions of bodily soft tissues can be captured via real time tomographic images.

Compared with other diagnostic technologies, such as magnetic resonance imaging (MRI) and computed tomography (CT), ultrasound machines are relatively inexpensive and portable. While X-rays are useful for medical purposes in obtaining images of bones, ultrasonic waves find their medical applications in the creation of soft tissue images. An advantage of ultrasonic waves is that they do not have the negative biological effects associated with X-rays or with other techniques involving radioactive materials.

SUMMARY

In a first representative embodiment, a system is disclosed. The system comprises an ultrasound transducer configured for transmitting ultrasound incident waves into selected regions of an organic specimen, detecting resultant ultrasound reflected waves from specimen features of the organic specimen, and transferring ultrasound data in the resultant ultrasound reflected waves for each of multiple selected ultrasound incident waves to a processor; a location detection unit configured for detecting locations of the ultrasound transducer and the organic specimen and for transferring that location data to the processor; a memory module configured for storing anatomic model data for at least part of the organic specimen; the processor configured for identifying the region associated with selected ultrasound data using location data and one or more sets of ultrasound data resultant from reflections of recognized specimen features, creating an ultrasound image from the selected ultrasound data, obtaining model extracted data from the anatomic model data corresponding to that of the selected ultrasound data region, creating a model image from that model extracted data, and transferring the ultrasound image and the model image to a display module; and the display module configured for displaying the ultrasound image and the model image.

In a second representative embodiment, a method is disclosed. The method comprises specifying a reference model image region in model extracted data obtained from anatomic model data of at least part of an organic specimen; transmitting ultrasound incident waves into the organic specimen and receiving thereby ultrasound data from ultrasound reflected waves from specimen features in the organic specimen, wherein positional awareness of each ultrasound reflected wave relative to the organic specimen is maintained; identifying a reference propagation region corresponding to the reference model image region from paired recognized specimen features in the ultrasound data and in the model extracted data; transmitting at least one subsequent ultrasound incident wave into the organic specimen and receiving thereby subsequent ultrasound data from ultrasound reflected waves from one or more specimen features, wherein positional awareness is maintained between the reference propagation region and the propagation region of the subsequent ultrasound data; and for the subsequent ultrasound data, creating an ultrasound image, creating a model image for a model image region from the anatomic model data corresponding to the propagation region of the subsequent ultrasound data, and displaying the ultrasound image and the model image on a display module.

In an optional aspect of the second representative embodiment, the method further comprises identifying at least one specimen feature on the ultrasound image from a corresponding model feature on the model image.

In a third representative embodiment, a means for identification of an organic specimen feature in an ultrasound image is disclosed. The means comprises an ultrasound means for transmitting ultrasound incident waves into selected regions of an organic specimen, detecting resultant ultrasound reflected waves from specimen features of the organic specimen, and transferring ultrasound data in the resultant ultrasound reflected waves for each of multiple selected ultrasound incident waves to a processor means; a location detection means for detecting locations of the ultrasound means and the organic specimen and for transferring that location data to the processor means; a memory means for storing anatomic model data for at least part of the organic specimen; the processor means for identifying a region of the organic specimen associated with selected ultrasound data using location data and one or more sets of ultrasound data resultant from reflections of recognized specimen features, creating an ultrasound image from the selected ultrasound data, obtaining model extracted data from the anatomic model data corresponding to that of the selected ultrasound data region, creating a model image from the model extracted data, and transferring the ultrasound image and the model image to a display means; and the display means configured for displaying the ultrasound image and the model image.

In a fourth representative embodiment, a computer program product stored on a computer readable storage medium for carrying out a method when executed on a computer is disclosed. The method comprises specifying a reference model image region in model extracted data obtained from anatomic model data of at least part of an organic specimen; instructing an ultrasound transducer to transmit ultrasound incident waves into the organic specimen and receiving thereby ultrasound data from ultrasound reflected waves from specimen features in the organic specimen, wherein positional awareness of each ultrasound reflected wave relative to the organic specimen is maintained; identifying a reference propagation region corresponding to the reference model image region from paired recognized specimen features in the ultrasound data and in the model extracted data; instructing an ultrasound transducer to transmit at least one subsequent ultrasound incident wave into the organic specimen and receiving thereby subsequent ultrasound data from ultrasound reflected waves from one or more specimen features, wherein positional awareness is maintained between the reference propagation region and the propagation region of the subsequent ultrasound data; and for the subsequent ultrasound data, creating an ultrasound image, creating a model image for a model image region from the anatomic model data corresponding to the propagation region of the subsequent ultrasound data, and instructing a display module to display the ultrasound image and the model image.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings provide visual representations which will be used to more fully describe various representative embodiments disclosed herein. They can be used by those skilled in the art to better understand the representative embodiments. In these drawings, like reference numerals identify corresponding elements.

FIG. **1**A is a block diagram of a system for identification of organic specimen features in ultrasound images as described in various representative embodiments.

FIG. **1**B is a block diagram of another system for identification of organic specimen features in ultrasound images as described in various representative embodiments.

FIG. **1**C is a block diagram of still another system for identification of organic specimen features in ultrasound images as described in various representative embodiments.

FIG. **1**D is a block diagram of yet another system for identification of organic specimen features in ultrasound images as described in various representative embodiments.

FIG. **1**E is a block diagram of yet still another system for identification of organic specimen feature's in ultrasound images as described in various representative embodiments.

FIG. **2** is a front view of the patient of FIGS. **1**A, **1**B, and **1**C with the ultrasound transducer coupled to the shoulder of the patient.

FIG. **3** is a side view of the arrangement whose front view is shown in FIG. **2**.

FIG. **4** is a side view of a modified arrangement of the side view shown in FIG. **3**.

FIG. **5** is a side view of a three-dimensional reconstructed model from the anatomic model data for the arrangement of FIG. **4**.

FIG. **6** is another drawing of the display module of FIGS. **1**A, **1**B, and **1**C with the ultrasound transducer placed as in FIG. **4**.

FIG. **7** is a drawing of an alternative embodiment of a display module for the systems of FIGS. **1**A, **1**B, and **1**C.

FIG. **8** is a flow chart of a method for the identification of organic specimen features in ultrasound images as described in various representative embodiments.

FIG. **9** is a flow chart of another method for the identification of organic specimen features in ultrasound images as described in various representative embodiments.

DETAILED DESCRIPTION

Novel techniques are disclosed herein of methods and systems for the identification of organic features in ultrasound images of organic specimens as shown in the drawings for purposes of illustration. An organic specimen is any living or deceased organism or a portion of a living or deceased organism. In particular, the organic specimen could be a human, another animal, a plant, or a portion of a human, another animal, or a plant. The human could be a baby, an infant, a child, an adolescent, a teenager, or an adult.

Ultrasound has been used to monitor fetus development in the womb and more recently for diagnosis in musculoskeletal applications. Musculoskeletal applications include the diagnosis of muscle tears, tendon tears such as rotator cuff tears, nerve problems, blood clots in the vascular system, and the like. Musculoskeletal ultrasound images differ from those obtained in monitoring fetus development in the womb in that the musculoskeletal ultrasound transducer transmits its signal in a straight line rather than a curve. As such, a straight tendon will be displayed as a straight line on the ultrasound monitor. Such ultrasound machines are being used more and more in outpatient settings. MRI, as well as ultrasound, can be used to create images of soft, internal body tissues, but MRIs are expensive. Nuclear methods can also be used but are less desirable than ultrasound as they expose the body to radiation. Another advantage of ultrasound is that it can be used to create dynamic pictures rather than the static pictures of MRI. Ultrasound diagnostic systems provide immediate images, are portable, are safe, and are economical.

However, current systems require extensive training to develop the skills necessary for interpreting ultrasound images. Even after extensive training, inaccurate diagnoses are not uncommon, and results are often inconsistent from one operator to another. Correctly identifying a patient's internal features in an ultrasound image has been strongly dependent upon the skill of the operator that is interpreting the image. The greatest barrier to the use of ultrasound is that it must be practiced over and over again which is time consuming and expensive. The operator must be able to correctly identify the tissue displayed in an ultrasound image which means that he/she must also know anatomy in great detail as there are a large number of different parts of the human anatomy that can be detected by ultrasound. The number of operators that have had an acceptable level of this skill has been very limited, and the cost of obtaining this skill has been expensive.

Conversely, the representative embodiments disclosed herein provide systems and methods that can significantly reduce operator training time and thereby training expense, can reduce the incidence of an inaccurate diagnosis by the correct identification of tissues, and can reduce the variation from operator to operator in a diagnosis.

While the present invention is susceptible to embodiment in many different forms, there is shown in the drawings and will herein be described in detail one or more specific embodiments, with the understanding that the present disclosure is to be considered as exemplary of the principles of the invention and is not intended to limit the invention to the specific embodiments shown and described. In the following description and in the several figures of the drawings, like reference numerals are used to describe the same, similar, or corresponding parts in the several views of the drawings.

In representative embodiments, an ultrasound image obtained from an organic specimen under study is correlated with data that represents or models all or part of that organic specimen. By first identifying certain features and anatomic patterns in the organic specimen that are relatively easy to identify and correlating that information with data from the model of the organic specimen, a reference position of an ultrasound transducer with respect to the organic specimen can be identified. Then while maintaining knowledge of any subsequent movement of the ultrasound transducer and/or any subsequent movement of the organic specimen relative to the reference locations of the ultrasound transducer and the organic specimen, subsequent ultrasound images of the organic specimen can be correlated with images created from the model. This correlation enables an operator to relatively easily identify features in the organic specimen on the ultrasound image. A software program could be used to automatically identify such features. To facilitate identification of features of the organic specimen, the ultrasound and model images can be displayed simultaneously either on two separate displays or together on a single display. In alternative embodiments, the two images could be overlaid, and certain features in one or the other images could be differentially colored, displayed with dashes, dots, or otherwise differentiated lines and areas, labeled and/or otherwise appropriately identified. Also, one or the other images could be faded in and out. A computer program could provide texted or auditory identification of a specific tissue upon request. In addition, the operator could preselect particular features of interest to be emphasized when found in an ultrasound image. Such emphasis can also be added by, for example, the addition of a preselected color to the feature of interest, a flashing indicator, displayed with dashes, dots, or otherwise differentiated lines and areas, labels and/or other appropriate means. Movement of the ultrasound transducer could be programmatically controlled so as to locate preselected features on the organic specimen with little or no operator assistance.

As the ultrasound transducer is moved, the location of the ultrasound transducer relative to its identified, reference location can be maintained by a mechanical fixture attached to the ultrasound transducer, by the detection of targets placed on the ultrasound transducer using mechanical, infrared, optical, radio frequency, inertial means, or by any other acceptable means. The location of the organic specimen relative to the identified, reference location of the ultrasound transducer can be maintained by holding the organic specimen immobilized, by a mechanical fixture attached to a non-moving surface and to the organic specimen, or by the detection of targets placed on the organic specimen using, mechanical coupling, infrared, optical, radio frequency, inertial means, or by any other acceptable means.

The Visible Human Project® (VHP) is an effort to create a detailed data set from cross-sectional photographs of the human body. The Visible Human Project® is a registered trademark of the National Library of Medicine. To obtain the data, successive layers of a male and a female cadaver were removed by grinding away the top surface at regular intervals. Each of the revealed planar surfaces was photographed and stored electronically. Image data for each pixel in the two-dimensional photographs are stored in digital format along with their associated three-dimensional coordinates. Pixel image and associated coordinate data can be used to create two-dimensional and three-dimensional images of a representative human body (male or female) at diverse selected depths and angular orientations.

In representative embodiments, anatomic model data which could be, for example, the VHP data are used in combination with ultrasound data and a three-dimensional location detection device to create correlated model and ultrasound images in a human patient as well as other organic entities. These correlated images can be used to facilitate the identification of specific features in the ultrasound images of the human patient or other organic specimen. A location detection unit could use a set of targets coupled to the organic specimen and another set of targets coupled to the ultrasound transducer to acquire the location and orientation of the ultrasound transducer relative to the organic specimen. These targets could be identified and located by mechanical coupling means, optical, infrared, radio frequency, inertial means, or other appropriate techniques or by a combination of such techniques. Once the reference location of the ultrasound transducer relative to the patient (the organic specimen) is set, the location detection unit monitors any subsequent motion of the ultrasound transducer and/or the patient, identifies the related subsequent location of the ultrasound transducer and patient, and identifies, thereby, the location and orientation of the ultrasound image and the associated model image. A split screen, dual screen, or other appropriate display module can be used to view the ultrasound and model images obtained. By correlating the ultrasound and model images and by identifying features on the model image by some means which could be, for example, by the use of tags, features on the ultrasound image can be readily identified by an operator. Using such embodiments, it is no longer necessary for the operator to receive the extensive training that has previously been required. Previously several years of expensive training typically have been needed for an operator to attain the needed skill level.

Due to the large amount of data that can be associated with any given model, it may be advantageous to divide the model into different specific areas of interest such as, for example, a shoulder, an elbow, a wrist, a hip, or other specific body part. Once the operator identifies a known feature of the patient, which could be, for example, the small notch in the bones of a shoulder in which the bicep tendon passes through or other readily identifiable feature, the operator could push a button or click a mouse button to select that feature as one used for setting a plane of reference. Once the reference frame is selected, the operator could select a feature on the ultrasound image by a mouse click or other means and a program could then identify that feature and notify the operator of its identity. In representative embodiments, systems and methods disclosed herein could be used as a diagnostic tool and/or as a teaching tool.

Pathology in the anatomic model data could be digitally repaired so that the model is in pristine condition prior to its use with ultrasound images. The human anatomic model data might have, for example, a rotator cuff tear or other damage. Repairing this tear in the anatomic model data would facilitate detecting similar damage in the patient. Based on the distances between features in the ultrasound image used to set the reference location of the ultrasound transducer relative to the patient (the organic specimen), the model image can be appropriately scaled to match the size of the patient. Alternatively, the anatomic model data could have previously been scaled to certain preset representative patient sizes such as, for example, small, medium, and large and adjusted to known anatomic variants.

While the representative embodiments disclosed herein are discussed in terms of static two-dimensional model and ultrasound images, the representative embodiments can also be implemented using time varying two-dimensional model and ultrasound images, static three-dimensional model and ultrasound images, and time varying three-dimensional model and ultrasound images. As appropriate, these images can be displayed on a two-dimensional display system as static or time varying two-dimensional images and on a three-dimensional display system as static or time varying three-dimensional images.

FIG. **1**A is a block diagram of a system **100** for identification of organic specimen **160** features in ultrasound images **180** as described in various representative embodiments. The system **100** comprises an ultrasound transducer **110**, an ultrasound controller **120**, a display module **135**, a location detection unit **190**, and a computer **132**. The computer **132** comprises a memory module **125** and a processor **130**. In FIG. **1**A, the display module **135** comprises an ultrasound display **140** also referred to herein as a first display **140** and a model display **145** also referred to herein as a second display **145**. The memory module **125** comprises an anatomic model memory **126**, an ultrasound memory **127**, and an extracted model memory **128**. The location detection unit **190** comprises an emitter device **196**, a receptor device **197**, and a location identification module **195**.

The ultrasound transducer **110** is separately coupled to the ultrasound controller **120** and to the processor **130**. The processor **130** is also coupled to the location detection unit **190** which transfers information regarding the relative locations of the ultrasound transducer **110** and the organic specimen **160** via location data **194** to the processor **130**, to the memory module **125** within which the processor **130** is coupled to the anatomic model memory **126**, the ultrasound memory **127**, and the extracted model memory **128**, to the display module **135** within which the processor **130** is coupled to the ultrasound display **140** and the model display **145**, and to the ultrasound controller **120**. Coupling between the various components of the system **100** could be via electronic cables, optical fibers, pairs of radio frequencies or infrared transmitter/receivers, or other appropriate means for transmitting or transferring signals.

The ultrasound memory **127** is configured to store sets of ultrasound data **187** obtained from the ultrasound transducer **110**. The anatomic model memory **126** is configured to store anatomic model data **186** which is a model of and representative of at least part **155** of an organic specimen **160**. The extracted model memory **128** is configured to store sets of model extracted data **188**. In representative embodiments, a set of model extracted data **188** can be obtained from the anatomic model data **186** for each set of ultrasound data **187** and can be associated with each set of ultrasound data **187**. Each associated set of ultrasound data **187** and model extracted data **188** can be used to create associated ultrasound and model images **180**,**185** wherein the model image **185** is a model of the region from which the ultrasound image **180** is obtained. The processor **130** is configured to obtain the appropriate set of model extracted data **188** and correlate it with its associated set of ultrasound data **187**. In an alternate representative embodiment, the model image **185** can be created from the set of model extracted data **188** without storage of the model extracted data **188**. And in another alternate representative embodiment, the set of ultrasound data **187** and the set of model extracted data **188** are stored jointly in a single memory which could be the ultrasound memory **127**. The ultrasound image **180** can be displayed on the ultrasound display **140**, and concurrently the model image **185** associated with the ultrasound image **180** can be displayed on the model display **145**.

The location identification module **195** is configured to instruct the emitter device **196** to transmit location interrogation signals **192** to transducer targets **230** (see FIG. **2** and discussion therewith) on the ultrasound transducer **110** and to specimen targets **240** (see FIG. **2** and discussion therewith) on an organic specimen **160** which could be a patient **160**. Upon reception of the location interrogation signals **192** by the transducer targets **230** and the specimen targets **240**, the transducer targets **230** and the specimen targets **240** separately respond with location information signals **193** which can be received by the receptor device **197**. Information from the location information signals **193** received by the receptor device **197** is transferred from the receptor device **197** to the location identification module **195**. The location identification module **195** is further configured to extract location information for the transducer targets **230** and the specimen targets **240** from the information in the location information signals **193** and/or from the location interrogation signals **192**. The extracted location information for the transducer targets **230** and the specimen targets **240** is transferred to the processor **130** as location data **194**. The location data **194** can be used by the processor **130** to associate a specific set of ultrasound data **187** with the relative locations and orientations of the ultrasound transducer **110** and the organic specimen **160** for which that set of ultrasound data **187** was obtained. The location data **194** can also be used by the processor **130** to obtain a set of model extracted data **188** from the anatomic model data **186** for the region from which the set of ultrasound data **187** is obtained. This set of model extracted data **188** is thereby associated with that set of ultrasound data **187**.

In representative embodiments, an operator **150** holds the ultrasound transducer **110** against, for example, a shoulder **155** of a patient **160**. The patient **160** shown in FIG. **1**A could more generally be any organic specimen **160** and more particularly could be a person **160**, a baby **160**, another animal **160**, a plant **160** or the like. However, the term organic specimen **160** as used herein more generally means any living or deceased organism or any portion of a living or deceased organism. In particular, the organic specimen could be a human, another animal, a plant, a portion of a human, a portion of another animal, or a portion of a plant. The shoulder **155** shown in FIG. **1**A could more generally be a part **155** of any organic specimen **160**. The initiation signal **171**, the activation signal **172** and reflected data signal **173** will be more completely described with the description of FIG. **2**. The anatomic model data **186** stored in the memory module **125** could be anatomic model data **186** of at least part **155** of the organic specimen **160**. In representative embodiments, the anatomic model data **186** could be obtained, for example, from the Visible Human Project® (VHP) or other appropriate data which can be used, for example, to create two-dimensional model images **185** of a representative human body (male or female) at diverse selected depths and angular orientations. The VHP data and other model data sources could be used to create static two-dimensional, static three-dimensional, time varying two-dimensional, and/or time varying three-dimensional model images **185**. Various components of FIG. **1**A will be more completely described with the description of subsequent figures.

While the representative embodiments disclosed herein are discussed in terms of static two-dimensional model and ultrasound images **185**,**180**, the representative embodiments can also be implemented using time varying two-dimensional model and ultrasound images **185**,**180**, static three-dimensional model and ultrasound images **185**,**180**, and time varying three-dimensional model and ultrasound images **185**,**180**. As appropriate, these images can be displayed, for example, on a two-dimensional display system as static or time varying two-dimensional images and on a three-dimensional display system as static or time varying three-dimensional images.

FIG. **1**B is a block diagram of another system **100** for identification of organic specimen **160** features in ultrasound images **180** as described in various representative embodiments. The system **100** of FIG. **1**B differs from that of FIG. **1**A by the inclusion of the functions of the ultrasound controller **120** in the processor **130**. In this embodiment, the processor **130** comprises the ultrasound controller **120** which creates the activation signal **172** directly and then transfers the activation signal **172** to the ultrasound transducer **110**. Again, the activation signal **172** and the reflected data signal **173** will be more completely described with the description of FIG. **2**, and various other components of FIG. **1**B will be more completely described with the description of subsequent figures.

FIG. **1**C is a block diagram of still another system **100** for identification of organic specimen **160** features in ultrasound images **180** as described in various representative embodiments. The system **100** of FIG. **1**C differs from that of FIG. **1**A in that the ultrasound controller **120** receives the reflected data signal **173** from the ultrasound transducer **110** and then transfers the reflected data signal **173** to the processor **130** either as received or as appropriately modified. The system **100** of FIG. **1**C also differs from that of FIG. **1**A in that the functions of the location identification module **195** are included in the processor **130** with the emitter device **196** and the receptor device **197** located external to the processor **130**. The location detection unit **190** comprises the emitter device

196, the receptor device **197**, and the location identification module **195**. Again, the activation signal **172** and the reflected data signal **173** will be more completely described with the description of FIG. **2**, and various other components of FIG. **1**C will be more completely described with the description of subsequent figures.

In alternative embodiments, the location detection unit **190** of FIG. **1**A could replace the location detection unit **190** of FIG. **1**C in the configuration of FIG. **1**C, the location detection unit **190** of FIG. **1**C could replace the location detection unit **190** of FIG. **1**A in the configuration of FIG. **1**A, and the location detection unit **190** of FIG. **1**C could replace the location detection unit **190** of FIG. **1**B in the configuration of FIG. **1**B.

FIG. **1**D is a block diagram of yet another system for identification of organic specimen **160** features in ultrasound images **180** as described in various representative embodiments. The system **100** of FIG. **1**D differs from that of FIG. **1**A in that the processor **130** comprises an ultrasound logic module **120***a*, a location identification logic module **195***a*, and a correlation logic module **105**.

The ultrasound logic module **120***a* can be configured to perform the functions associated with the ultrasound controller **120** of FIGS. **1**A, **1**B, and/or **1**C and is operatively coupled to the ultrasound transducer **110** and to the correlation logic module **105**. upon instructions from the processor **130**, the ultrasound logic module **120***a* initiates transmission of the activation signal **172** to the ultrasound transducer **110** and receives the subsequent reflected data signal **173**. The ultrasound logic module **120***a* then transfers ultrasound data **187** from the reflected data signal **173** to the correlation logic module **105**.

FIG. **1**E is a block diagram of yet still another system for identification of organic specimen features in ultrasound images as described in various representative embodiments. The system **100** of FIG. **1**E differs from that of FIG. **1**D in that the processor **130** comprises a computer program **133** which is also referred to herein as a computer program product **133**.

The computer program product **133** comprises instructions for carrying out a method **900** when executed by the processor **130** on the computer **132**. The computer program product **133** is stored on a computer readable storage medium which could be the memory module **125** and/or the memory of the processor **130**. The computer readable storage medium could be the hard drive of a computer, a floppy disk, a CD, a DVD, a RAM memory, or other acceptable storage medium. In a representative embodiment, the computer program product **133** comprises an ultrasound logic module **120***a*, a location identification logic module **195***a*, and a correlation logic module **105**. These logic modules comprise instructions for performing a method **900**, wherein the method **900** comprises: specifying a reference model image region **520***a* in model extracted data **188** obtained from anatomic model data **186** of at least part **155** of an organic specimen **160**; instructing an ultrasound transducer **110** to transmit ultrasound incident waves **201** into the organic specimen **160** and receiving thereby ultrasound data **187** from ultrasound reflected waves **202** from specimen features **210** in the organic specimen **160**, wherein positional awareness **194** of each ultrasound reflected wave **202** relative to the organic specimen **160** is maintained; identifying a reference propagation region **220***a* corresponding to the reference model image region **520***a* from paired recognized specimen features **210** in the ultrasound data **202** and in the model extracted data **188**; instructing the ultrasound transducer **110** to transmit at least one subsequent ultrasound incident wave **201** into the organic specimen **160** and receiving thereby subsequent ultrasound data **187** from ultrasound reflected waves **202** from one or more specimen features **210**, wherein positional awareness is maintained between the reference propagation region **220***a* and the propagation region **220** of the subsequent ultrasound data **187**; and for the subsequent ultrasound data **187**, creating an ultrasound image **180**, creating a model image **185** for a model image region **520** from the anatomic model data **186** corresponding to the propagation region **220** of the subsequent ultrasound data **187**, and instructing a display module **135** to display the ultrasound image **180** and the model image **185**.

The location identification logic module **195***a* is configured to instruct the emitter device **196** to transmit location interrogation signals **192** to transducer targets **230** (see FIG. **2** and discussion therewith) on the ultrasound transducer **110** and to specimen targets **240** (see FIG. **2** and discussion therewith) on an organic specimen **160** which could be a patient **160** and to receive location information from subsequent location information signals **193** received by the receptor device **197**. The location identification logic module **195***a* is further configured to extract location information for the transducer targets **230** and/or the specimen targets **240** from the information in the location information signals **193** and/or from the location interrogation signals **192**. This location information is then transferred to the correlation logic module **105**. In FIG. **1**D, the location detection unit **190** comprises the emitter device **196**, the receptor device **197**, and the location identification logic module **195***a*.

The correlation logic module **105** is configured to receive ultrasound data **187** from the ultrasound logic module **120***a* and location information from the location identification logic module **195***a*, to obtain model extracted data **188** from the anatomic model data **186** in the memory module **125**, to identify a reference model image plane **520***a* in the model extracted data **188**, to identify a corresponding reference propagation plane **220***a* from recognized specimen features **210** in the ultrasound data **187** and associated location information from the location identification logic module **195***a*, to receive ultrasound data **187** from subsequent ultrasound reflected waves **202** from one or more specimen features **210** wherein positional awareness is maintained between the reference propagation plane **220***a* and the propagation plane **220** of the subsequent ultrasound data **187**, and for the subsequent ultrasound data **187** to create an ultrasound image **180**, to create a model image **185** for a model image plane **520** from the anatomic model data **186** corresponding to the propagation plane **220** of the subsequent ultrasound data **187**, and to transfer the ultrasound image **180** and the model image **185** to the display module **135**. As appropriate, the correlation logic module **105** can be further configured to store the ultrasound data **187**, the model extracted data **188**, the ultrasound images **180**, and/or the model images **185**.

In alternative representative embodiments, the ultrasound logic module **120***a*, the location identification logic module **195***a*, and/or the correlation logic module **105** can be implemented in hardware, as a software program, or in firmware either external to or internal to the processor **130**. The software program and/or the firmware could be configured to provide instructions to the computer **105** to perform various method steps and/or functions disclosed herein. In other alternative embodiments, the ultrasound logic module **120***a*, the location identification logic module **195***a*, and/or the correlation logic module **105** can be replaced respectively by the ultrasound controller **120**, the location identification module **195**, and or the functions of the processor **130** as in the configurations of FIGS. **1**A, **1**B, and/or **1**C.

FIG. **2** is a front view of the patient **160** of FIGS. **1**A, **1**B, and **1**C with the ultrasound transducer **110** coupled to the shoulder **155** of the patient **160**. In the embodiment of FIG. **2**, the activation signal **172** is transferred to the ultrasound transducer **110** which converts it to an ultrasound incident wave **201** and then transmits the ultrasound incident wave **201** into the shoulder **155** of the patient **160** in a propagation plane **220**. The propagation plane **220** is considered in an ideal sense to extend to infinity in two dimensions. However, only that part of the propagation plane **220** into which the ultrasound incident wave **201** is transmitted is shown in FIG. **2**. The ultrasound incident wave **201** is reflected by various specimen features **210**, as well as patient unique features **450** (see FIG. **4** and discussion therewith), in the patient's shoulder **155** as ultrasound reflected waves **202**. A patient unique feature **450** could be a pathologic feature **450** such as a muscle tear, a tendon tear such as a rotator cuff tear, a nerve problem, a blood clot in the vascular system, or the like, or it could be a foreign object **450** such as a metallic pin affixed to a broken bone in the patient **160** or the like. The ultrasound reflected waves **202** are detected by the ultrasound transducer **110** and converted into a reflected data signal **173** which is in turn transferred back to the processor **130**. The plane of the ultrasound image **180** created from the reflected data signal **173** is from features in the propagation plane **220** and, thus, the propagation plane **220** is also the plane of the ultrasound image **180** and is also referred to as the ultrasound image plane **220**.

The three specimen features **210***a*,**210***b*,**210***c* (first specimen feature **210***a*, second specimen feature **210***b*, and third specimen feature **210***c*) separately reflect that part of the ultrasound incident wave **201** incident on them as associated ultrasound reflected waves **202***a*,**202***b*,**202***c* (first ultrasound reflected wave **202***a*, second ultrasound reflected wave **202***b*, and third ultrasound reflected wave **202***c*). In the representative embodiment of FIG. **2**, these three specimen features **210***a*,**210***b*,**210***c* have separately identifiable specimen reference points **215** (first specimen reference point **215***a*, second specimen reference point **215***b*, and third specimen reference point **215***c*) that together specify a reference propagation plane **220***a* which is used for specifying the location of and identification of additional, detected specimen features **210**. The three specimen features **210***a*,**210***b*,**210***c* and their associated specimen reference points **215***a*,**215***b*,**215***c* in the representative embodiment of FIG. **2** are shown for illustrative purposes only and are not intended to represent any physical feature of the shoulder **155** or any other part **155** of the patient **160**.

In locating the specimen reference points **215***a*,**215***b*,**215***c* which are typically selected previously for locating, the operator **150** moves the ultrasound transducer **110** to different locations on the shoulder **155** of the patient **160** until the three specimen reference points **215***a*,**215***b*,**215***c* are found. For ease of illustration and discussion, all three specimen reference points **215***a*,**215***b*,**215***c* are shown in FIG. **2** as being detected with the ultrasound transducer **110** in a single location, i.e., with the three specimen reference points **215***a*,**215***b*, **215***c* in a single reference propagation plane **220***a*. In the more general case, however, as long as current locations of the ultrasound transducer **110** are known relative to a previous location, detection of the three specimen reference points **215***a*,**215***b*,**215***c* in separate propagation planes **220**, i.e., with the ultrasound transducer **110** in separate locations relative to the patient **160** can be used to specify the reference propagation plane **220***a*.

Also shown in FIG. **2** are three transducer targets **230** (first transducer target **230***a*, second transducer target **230***b*, and third transducer target **230***c*) and three specimen targets **240** (first specimen target **240***a*, second specimen target **240***b*, and third specimen target **240***c*). In representative embodiments, the emitter device **196** of the location detection unit **190** transmits one or more location interrogation signals **192** which are received by the transducer targets **230** and the specimen targets **240**. In response to the location interrogation signals **192**, the transducer targets **230** and the specimen targets **240** return location information signals **193** which are received by the receptor device **197**. The location identification module **195** monitors any movement of the ultrasound transducer **110** and of the patient **160**. The location identification module **195** transfers information regarding the locations of the ultrasound transducer **110** and the organic specimen **160** via location data **194** to the processor **130**. The transducer and specimen targets **230**,**240** could transmit location information signals **193** in response to location interrogation signals **192**, actively transmit location information signals **193** automatically without initiation from the location interrogation signals **192**, or passively reflect the location interrogation signals **192** as location information signals **193**. The location interrogation signals **192** and location information signals **193** could be infrared, optical, radio frequency or any other acceptable signal types. In addition, information regarding the relative locations of the ultrasound transducer **110** and the organic specimen **160** can be maintained as the ultrasound transducer **110** and/or the organic specimen **160** are/is moved by a mechanical fixture (see FIG. **3**) attached to the ultrasound transducer **110** or by an inertial reference device (see FIG. **4**) attached to the ultrasound transducer **110**.

FIG. **3** is a side view of the arrangement whose front view is shown in FIG. **2**. As indicated in the discussion of FIG. **2**, the three specimen features **210***a*,**210***b*,**210***c* separately reflect that part of the ultrasound incident wave **201** incident on them as associated ultrasound reflected waves **202***a*,**202***b*, **202***c* (first ultrasound reflected wave **202***a*, second ultrasound reflected wave **202***b*, and third ultrasound reflected wave **202***c*). In the representative embodiment of FIGS. **2** and **3**, these three specimen features **210***a*,**210***b*,**210***c* have separately identifiable specimen reference points **215***a*,**215***b*,**215***c* that together specify a reference propagation plane **220***a* that will be used for specifying the location of and identification of additional, detected specimen features **210**. The reference propagation plane **220***a* of the ultrasound incident wave **201** is shown edge on in FIG. **3** and therefore appears as a line in that figure. As previously indicated, all three specimen reference points **215***a*,**215***b*,**215***c* may be detected with the ultrasound transducer **110** in a single location as shown in FIGS. **2** and **3**. However, as long as any current location of the ultrasound transducer **110** is known relative to a previous location, the three specimen reference points **215***a*,**215***b*,**215***c* can be detected in separate propagation planes **220**, i.e., with the ultrasound transducer **110** in separate locations.

Also, shown in FIG. **3** is a representative embodiment wherein the emitter device **196** and the receptor device **197** of the location detection unit **190** are replaced by a mechanical coupling device **310** which can be used to maintain a reference between the location of the ultrasound transducer **110** and the location of the patient **160**. The mechanical coupling device **310** comprises a mechanical fixture **320** and a mechanical coupler **330**. In order to reduce or eliminate movement by the patient **160**, the mechanical fixture **320** is placed adjacent to the patient **160**. The mechanical coupler **330** is located between the mechanical fixture **320** and the ultrasound transducer **110**. Measurements of various angular rotations of components in the mechanical coupling device **310** relative to the reference propagation plane **220***a* can be used to compute the new propagation plane **220** following any movement of the ultrasound transducer **110**.

FIG. **4** is a side view of a modified arrangement of the side view shown in FIG. **3**. In FIG. **4**, the ultrasound transducer **110** is again coupled to the shoulder **155** of the patient **160**. However, the ultrasound transducer **110** has been moved to another location on the shoulder **155** of the patient **160**.

Also, shown in FIG. **4** is a representative embodiment wherein the emitter device **196** and the receptor device **197** of the location detection unit **190** of FIGS. **1**A, **1**B, and **1**C are replaced by an inertial reference device **410** which can be used to maintain a reference between the location of the ultrasound transducer **110** and the location of the patient **160**. The inertial reference device **410** comprises a first inertial module **420** and a second inertial module **430**. The first inertial module **420** is coupled to the ultrasound transducer **110** and a second inertial module **430** is coupled to the patient **160**. Communication between the first and the second inertial modules **420**,**430** and the processor **130** can be effected by infrared, optical, radio frequency, or any other acceptable communication technology. A combination of the mechanical fixture **320** in FIG. **3** coupled to the patient **160** and the first inertial module **420** coupled to the ultrasound transducer **110** can also be used to maintain information regarding the location of the ultrasound transducer **110** relative to the patient **160**.

As previously discussed, the ultrasound transducer **110** converts the activation signal **172** to an ultrasound incident wave **201** and transmits it into the shoulder **155** of the patient **160** in the propagation plane **220**. The ultrasound incident wave **201** in FIG. **4** is reflected in the patient's shoulder **155** by two additional specimen features **210***d*,**210***e* (fourth specimen feature **210***d* and fifth specimen feature **210***e*) and the patient unique feature **450** as additional ultrasound reflected waves **202***d*,**202***e*,**202***f* (fourth ultrasound reflected wave **202***d*, fifth ultrasound reflected wave **202***e*, and sixth ultrasound reflected wave **202***f*). The ultrasound reflected waves **202***d*,**202***e*,**202***f* are detected by the ultrasound transducer **110** and converted into the reflected data signal **173**. However, the three specimen features **210***a*,**210***b*,**210***c* and their associated specimen reference points **215***a*,**215***b*,**215***c* are not detectable by the ultrasound transducer **110** with the ultrasound transducer **110** positioned as in FIG. **4** as these specimen features **210***a*,**210***b*,**210***c* do not lie in the current propagation plane **220**.

Also in FIG. **4** is an instrument **460** shown inserted into the patient's **160** shoulder **155**. The placement of the instrument **460** within the patient's **160** shoulder **155** can be adjusted using appropriate ultrasound transducer **110** positions and the resultant displayed ultrasound and model images **180**,**185**. The instrument **460** can be configured for providing medical treatment to the patient **160** or for obtaining diagnostic information regarding the patient **160** such as obtaining a biopsy.

FIG. **5** is a side view of a three-dimensional reconstructed model **560** from the anatomic model data **186** for the arrangement of FIG. **4**. In FIG. **5** are shown a first, a second, a third, a fourth, and a fifth model features **510***a*,**510***b*,**510***c*,**510***d*, **510***e* that in order correspond to the first, the second, the third, the fourth, and the fifth specimen features **210***a*,**210***b*,**210***c*, **210***d*,**210***e* and a first, a second, and a third model reference points **515***a*,**515***b*,**515***c* that in order correspond to the first, the second, and the third specimen reference points **215***a*, **215***b*,**215***c* shown in FIG. **4**. Also shown in FIG. **5** is a model image plane **520** that corresponds to the propagation plane **220** (the ultrasound image plane **220**) of FIG. **4**. Note that the first, the second, and the third model features **510***a*,**510***b*,**510***c* and their associated first, second, and third model reference points **515***a*,**515***b*,**515***c* lie in another model image plane **520***a* referred to herein as the reference model image plane **520***a*. The reference model image plane **520***a* for the model image **185** that includes the first, second, and third model reference points **515***a*,**515***b*,**515***c* corresponds to the reference ultrasound image plane **220***a* for the ultrasound image **180** that includes the first, second, and third specimen reference points **215***a*,**215***b*,**215***c*. Note also, that FIG. **5** does not include a model feature **510** that corresponds to the patient unique feature **450** as such items are not a part of the anatomic model data **186**.

FIG. **6** is another drawing of the display module **135** of FIGS. **1**A, **1**B, and **1**C with the ultrasound transducer **110** placed as in FIG. **4**. In FIG. **6**, as in FIGS. **1**A, **1**B, and **1**C, the ultrasound image **180** is displayed on the ultrasound display **140** and a corresponding model image **185** is preferably displayed concurrently on the model display **145**. The model image **185** is a display of a two-dimensional slice through a representative model of the patient **160** for a plane that corresponds to the propagation plane **220** of the ultrasound incident wave **201** shown in FIG. **4**. The ultrasound reflection of the fourth and the fifth specimen features **210***d*,**210***e* and the patient unique feature **450** of the ultrasound image **180** of the patient's shoulder **155** are indicated on the ultrasound display **140**, and the corresponding model features **510** (fourth model feature **510***d* and fifth model feature **510***ec*) are shown on the model image **185** displayed on the model display **145**.

Other locations of the ultrasound transducer **110** will result in displayed ultrasound and model images **180**,**185** for other propagation planes **220**. A set of ultrasound data **187** for the ultrasound image **180** can be stored for future reference and future creation of ultrasound images **180** in the ultrasound memory **127** of the memory module **125**. The stored set of ultrasound data **187** can be keyed to or stored with a set of model extracted data **188** obtained from the anatomic model data **186** for the region of that part **155** of the patient **160** from which the ultrasound data **187** was obtained.

The two specimen features **210***d*,**210***e*, the patient unique feature **450**, and the two model features **510***d*,**510***e* in FIG. **6** are shown for illustrative purposes only and are not intended to represent any particular feature **210** or patient unique feature **450** in the shoulder **155** or any other part **155** of the patient **160**.

FIG. **7** is a drawing of an alternative embodiment of a display module **135** for the systems **100** of FIGS. **1**A, **1**B, and **1**C. The display module **135** of FIG. **7** comprises a single display **710** in a split screen mode for the combined display of the ultrasound image **180** and the model image **185**. For ease and clarity of illustration, the two specimen features **210***d*, **210***e* and the patient unique feature **450** as well as the corresponding two model features **510***d*,**510***e* are not labeled in FIG. **7** as they were in FIG. **6**.

As in FIG. **6**, other locations of the ultrasound transducer **110** will result in displayed ultrasound and model images **180**,**185** for other propagation planes **220**. A set of ultrasound data **187** for the ultrasound image **180** can be stored for future reference and future creation of ultrasound images **180** in the ultrasound memory **127** of the memory module **125**. The stored set of ultrasound data **187** can be keyed to or stored with a set of model extracted data **188** obtained from the anatomic model data **186** for the region of that part **155** of the patient **160** from which the ultrasound data **187** was obtained.

FIG. **8** is a flow chart of a method **800** for the identification of organic specimen **160** features **210** in ultrasound images **180** as described in various representative embodiments. In block **805** of FIG. **8**, three model reference points **515** (first, second, and third model reference points **515**a,**515**b,**515**c) are selected. Block **805** then transfers control to block **810**.

In block **810**, the ultrasound transducer **110** is coupled to the organic specimen **160** which could be, for example, the patient **160**. Block **810** then transfers control to block **815**.

In block **815**, the ultrasound transducer **110** is moved until the three specimen reference points **215** (first, second, and third specimen reference points **215**a,**215**b,**215**c) on the patient **160** that correspond to the three model reference points **515** (first, second, and third model reference points **515**a,**515**b,**515**c) are located and marked on the ultrasound data **187**. Block **815** then transfers control to block **820**.

In block **820**, the reference propagation plane **220**a is identified based on the first, the second, and the third specimen reference points **215**a,**215**b,**215**c. Block **820** then transfers control to block **825**.

In block **825**, the ultrasound transducer **110** is moved to a new location on the patient **160**. Block **825** then transfers control to block **830**.

In block **830**, data specifying the new location of the ultrasound transducer **110** is transferred by the location detection unit **190** to the processor **130**, and the reflected data signal **173** is transferred to the processor **130** from which a set of ultrasound data **187** is obtained. Block **830** then transfers control to block **835**.

In block **835**, the set of ultrasound data **187** is stored in the ultrasound memory **127**. Block **835** then transfers control to block **837**.

In block **837**, a set of model extracted data **188** is obtained from the anatomic model data **186** in the anatomic model memory **126** for the region from which the set of ultrasound data **187** is obtained. Block **837** then transfers control to block **840**.

In block **840**, the corresponding set of model extracted data **188** is stored in the extracted model memory **128**. Block **840** then transfers control to block **845**.

In block **845**, an ultrasound image **180** is created from the set of ultrasound data **187**, and a corresponding model image **185** is created from the associated set of model extracted data **188**. Block **845** then transfers control to block **850**.

In block **850**, the ultrasound image **180** and the corresponding model image **185** are displayed on the display module **135**. Block **850** then transfers control to block **855**.

In block **855**, if an additional ultrasound image **180** and corresponding model image **185** are to be obtained, block **855** transfers control back to block **825**. Otherwise, block **855** terminates the process.

FIG. **9** is a flow chart of another method **900** for the identification of organic specimen **160** features **210** in ultrasound images **180** as described in various representative embodiments. In block **905** of FIG. **9**, a reference model image plane **520**a in anatomic model data **186** of at least a part **155** of an organic specimen **160** is identified. Block **905** then transfers control to block **910**.

In block **910**, a corresponding reference ultrasound image plane **220**a is identified by transmitting one or more ultrasound incident waves **201** into the organic specimen **160** and receiving corresponding one or more ultrasound reflected waves **202**. Positional awareness is maintained between the one or more ultrasound reflected waves **202**. Block **910** then transfers control to block **915**.

In block **915**, at least one subsequent ultrasound incident wave **201** is transmitted into the organic specimen **160** and at least one corresponding subsequent ultrasound reflected wave **202** reflected from one or more specimen features **210** in the organic specimen **160** is received. Positional awareness is maintained between the reference ultrasound plane **220**a and a propagation plane **220** of the at least one subsequent ultrasound incident wave **201**. Block **915** then transfers control to block **920**.

In block **920**, for at least one subsequent ultrasound reflected wave **202**, an ultrasound image **180**, is created therefrom. Block **920** then transfers control to block **925**.

In block **925**, for the at least one subsequent ultrasound reflected wave **202**, a corresponding model image **185** from the anatomic model data **186** for the model image plane **520** that corresponds to the ultrasound image plane **220** for the at least one subsequent ultrasound reflected wave **202** is created. Block **925** then transfers control to block **930**.

In block **930**, for the at least one subsequent ultrasound reflected wave **202**, the ultrasound image **180** and the model image **185** are displayed on a display module **135**. Block **930** then transfers control to block **935**.

In block **935**, for the at least one subsequent ultrasound reflected wave **202**, a specimen feature **210** on the ultrasound image **180** is identified from a corresponding model feature **510** on the model image **185**. Block **935** then terminates the process.

While the representative embodiments disclosed herein have been discussed in terms of the ultrasound transducer **110** coupled to the shoulder **155** of a human patient **160**, it will be understood by one of ordinary skill in the art that other representative embodiments can be implemented for use with other parts **155** of any organic specimen **160**. As stated above, an organic specimen **160** is any living or deceased organism or any portion of a living or deceased organism. In particular, the organic specimen could be a human, another animal, a plant, or a portion of a human, another animal, or a plant.

In representative embodiments, the ultrasound images **180** and/or the model images **185** could be stored in the memory module **125**.

In alternative representative embodiments, the ultrasound controller **120** could be implemented in hardware, as a software program, or in firmware either external to or internal to the processor **130**. In alternative representative embodiments, the location identification module **195** could be implemented in hardware, as a software program, or in firmware either external to or internal to the processor **130**.

In other representative embodiments, the propagation plane **220** could be adjusted electronically rather than by a physical movement of the ultrasound transducer **110** relative to the organic specimen **160**.

The term region as used herein refers to a plane or slice for two-dimensional embodiments and to a volume for three-dimensional embodiments. Generally for both two-dimensional and three-dimensional embodiments, the propagation plane **220** is referred to as the propagation region **220**, the ultrasound image plane **220** is referred to as the ultrasound image region **220**, the reference propagation plane **220**a is referred to as the reference propagation region **220**a, and the reference ultrasound image plane **220**a is referred to as the reference ultrasound image region **220**a. Also generally for both two-dimensional and three-dimensional embodiments, the model image plane **520** and the reference model image plane **520**a are referred to respectively as the model image region **520** and the reference model region **520**a.

The anatomic model data **186** could be obtained from data sets such as or similar to the Visible Human Project® (VHP) which can be used to create model images **185** of a representative human body (male or female) at diverse selected depths and angular orientations. The anatomic model data **186** could also be based on a theoretical model of an organic specimen **160**. The anatomic model data **186** stored in the memory module **125** can be anatomic model data **186** of at least part

155 of the organic specimen **160**. The processor **130** could be a central processing unit (CPU) **130** and could be located in a computer. The memory module **125** could be a computer memory **125**.

In addition, while representative embodiments herein have been discussed in terms of creating and displaying static, two-dimensional ultrasound images **180**, the ultrasound images **180** could also be static, three-dimensional ultrasound images **180**, time varying, two-dimensional ultrasound images **180**, and time varying, three-dimensional ultrasound images **180**. Further, while representative embodiments herein have been discussed in terms of creating and displaying corresponding static, two-dimensional model images **185**, the corresponding model images **185** could also be static, three-dimensional model images **185**, time varying, two-dimensional model images **185**, and time varying, three-dimensional model images **185**.

Also, while representative embodiments disclosed herein have been discussed in terms of the various modules, components, and functions being located on or operatively coupled to a single processor **130**, multiple processors **130** can instead be employed. And further, while representative embodiments disclosed herein have been discussed in terms of the various modules, components, and functions being located locally, at least one of these can instead be distributed.

In a first representative embodiment, a system is disclosed. The system comprises an ultrasound transducer **110** configured for transmitting ultrasound incident waves **201** into selected regions **220** of an organic specimen **160**, detecting resultant ultrasound reflected waves **202** from specimen features **210** of the organic specimen **160**, and transferring ultrasound data **187** in the resultant ultrasound reflected waves **202** for each of multiple selected ultrasound incident waves **201** to a processor **130**; a location detection unit **190** configured for detecting locations of the ultrasound transducer **110** and the organic specimen **160** and for transferring that location data **194** to the processor **130**; a memory module **125** configured for storing anatomic model data **186** for at least part **155** of the organic specimen **160**; the processor **130** configured for identifying the region **220** associated with selected ultrasound data **187** using location data **194** and one or more sets of ultrasound data **187** resultant from reflections of recognized specimen features **210**, creating an ultrasound image **180** from the selected ultrasound data **187**, obtaining model extracted data **188** from the anatomic model data **186** corresponding to that of the selected ultrasound data **187** region **220**, creating a model image **185** from that model extracted data **188**, and transferring the ultrasound image **180** and the model image **185** to a display module **135**; and the display module **135** configured for displaying the ultrasound image **180** and the model image **185**.

In an optional aspect of the first representative embodiment, wherein the memory module **125** is further configured for storing the model extracted data **188**.

In an optional aspect of the first representative embodiment, wherein the memory module **125** is further configured for storing the ultrasound data **187**.

In an optional aspect of the first representative embodiment, wherein the processor **130** is configured for creating and the display module **135** is configured for displaying at least one static, two-dimensional ultrasound image **180** and its associated static, two-dimensional model image **185**, and/or at least one static, three-dimensional ultrasound image **180** and its associated static, three-dimensional model image **185**, and/or at least one set of time varying, two-dimensional ultrasound images **180** and its associated set of time varying, two-dimensional model images **185**, and/or at least one set of time varying, three-dimensional ultrasound images **180** and its associated set of time varying, three-dimensional model images **185**.

In an optional aspect of the first representative embodiment, wherein the processor **130** is a central processing unit **130**.

In an optional aspect of the first representative embodiment, wherein the display module **135** comprises a first display **140** and a second display **145** and wherein the ultrasound image **180** is displayed on the first display **140** and the model image **185** is displayed on the second display **145**.

In an optional aspect of the first representative embodiment, wherein the ultrasound image **180** and the model image **185** are overlaid on the display module **135** or wherein the ultrasound image **180** and the model image **185** are displayed side-by-side on the display module **135**.

In an optional aspect of the first representative embodiment, wherein the model image **185** and the ultrasound image **180** are scaled to each other.

In an optional aspect of the first representative embodiment, wherein the anatomic model data **186** is obtained from the Visible Human Project data **186** for a representative human male or a representative human female.

In an optional aspect of the first representative embodiment, wherein the anatomic model data **186** is of a representative human male or a representative human female.

In an optional aspect of the first representative embodiment, wherein the resultant ultrasound reflected wave **202** further comprises reflections from a patient unique feature **450** in the organic specimen **160**.

In an optional aspect of the first representative embodiment, wherein the resultant ultrasound reflected wave **202** further comprises reflections from an instrument **460** inserted into the organic specimen **160** when the ultrasound transducer **110** is appropriately located.

In an optional aspect of the first representative embodiment, wherein the resultant ultrasound reflected wave **202** further comprises reflections from an instrument **460** inserted into the organic specimen **160** when the ultrasound transducer **110** is appropriately located and wherein the instrument **460** is configured for providing medical treatment to the organic specimen **160** or is configured for providing diagnostic information regarding the organic specimen **160**.

In a second representative embodiment, a method is disclosed. The method comprises specifying a reference model image region **520***a* in model extracted data **188** obtained from anatomic model data **186** of at least part **155** of an organic specimen **160**; transmitting ultrasound incident waves **201** into the organic specimen **160** and receiving thereby ultrasound data **187** from ultrasound reflected waves **202** from specimen features **210** in the organic specimen **160**, wherein positional awareness **194** of each ultrasound reflected wave **202** relative to the organic specimen **160** is maintained; identifying a reference propagation region **220***a* corresponding to the reference model image region **520***a* from paired recognized specimen features **210** in the ultrasound data **202** and in the model extracted data **188**; transmitting at least one subsequent ultrasound incident wave **201** into the organic specimen **160** and receiving thereby subsequent ultrasound data **187** from ultrasound reflected waves **202** from one or more specimen features **210**, wherein positional awareness is maintained between the reference propagation region **220***a* and the propagation region **220** of the subsequent ultrasound data **187**; and for the subsequent ultrasound data **187**, creating an ultrasound image **180**, creating a model image **185** for a model image region **520** from the anatomic model data **186** corresponding to the propagation region **220** of the subsequent ultrasound data **187**, and displaying the ultrasound image **180** and the model image **185** on a display module **135**.

In an optional aspect of the second representative embodiment, the method **900** further comprises identifying at least one specimen feature **210** on the ultrasound image **180** from a corresponding model feature **510** on the model image **185**.

In an optional aspect of the second representative embodiment, wherein the reference model image region **520***a* is a plane **520***a* and is specified by three non-collinear model reference points **515***a*,**515***b*,**515***c* in the anatomic model data **186** of at least part **155** of the organic specimen **160**.

In an optional aspect of the second representative embodiment, wherein the reference model image region **520***a* is a plane **520***a* and is specified by three non-collinear model reference points **515***a*,**515***b*,**515***c* in the anatomic model data **186** of at least part **155** of the organic specimen **160** and wherein the reference propagation region **220***a* in the organic specimen **160** is a plane **220***a* corresponding to the reference model image plane **520***a* and is identified when one or more ultrasound incident waves **201** are reflected separately or in combination from three specimen reference points **215***a*, **215***b*,**215***c* corresponding to the three model reference points **515***a*,**515***b*,**515***c*.

In an optional aspect of the second representative embodiment, wherein the model extracted data **188** is stored in a memory module **125**.

In an optional aspect of the second representative embodiment, wherein the ultrasound data **187** is stored in a memory module **125**.

In an optional aspect of the second representative embodiment, wherein displaying the ultrasound image **180** and the model image **185** on the display module **135** comprises: displaying at least one static, two-dimensional ultrasound image **180** and its associated static, two-dimensional model image **185**, and/or displaying at least one static, three-dimensional ultrasound image **180** and its associated static, three-dimensional model image **185**, and/or displaying at least one set of time varying, two-dimensional ultrasound images **180** and its associated set of time varying, two-dimensional model images **185**, and/or displaying at least one set of time varying, three-dimensional ultrasound images **180** and its associated set of time varying, three-dimensional model images **185**.

In an optional aspect of the second representative embodiment, wherein the anatomic model data **186** is stored in a memory module **125**.

In an optional aspect of the second representative embodiment, wherein the display module **135** comprises a first display **140** and a second display **145** and wherein the ultrasound image **180** is displayed on the first display **140** and the model image **185** is displayed on the second display **145**.

In an optional aspect of the second representative embodiment, wherein the ultrasound image **180** and the model image **185** are overlaid on the display module **135** or wherein the ultrasound image **180** and the model image **185** are displayed side-by-side on the display module **135**.

In an optional aspect of the second representative embodiment, wherein the model image **185** and the ultrasound image **180** are scaled to each other.

In an optional aspect of the second representative embodiment, wherein the anatomic model data **186** is obtained from the Visible Human Project data **186** for a representative human male or a representative human female.

In an optional aspect of the second representative embodiment, wherein the anatomic model data **186** is for a representative human male or a representative human female.

In an optional aspect of the second representative embodiment, further comprising: detecting a patient unique feature **450** in the organic specimen **160**.

In an optional aspect of the second representative embodiment, further comprising: inserting an instrument **460** into the organic specimen **160**; and adjusting the instrument **460** position within the organic specimen **160** using the displayed ultrasound image **180** and displayed model image **185**.

In an optional aspect of the second representative embodiment, further comprising: inserting an instrument **460** into the organic specimen **160**; and adjusting the instrument **460** position within the organic specimen **160** using the displayed ultrasound image **180** and displayed model image **185**, wherein the instrument **460** is configured for providing medical treatment to the organic specimen **160** or is configured for providing diagnostic information regarding the organic specimen **160**.

In a third representative embodiment, a means **100** for identification of an organic specimen **160** feature **210** in an ultrasound image **180** is disclosed. The means comprises an ultrasound means **110** for transmitting ultrasound incident waves **201** into selected regions **210** of an organic specimen **160**, detecting resultant ultrasound reflected waves **202** from specimen features **210** of the organic specimen **160**, and transferring ultrasound data **187** in the resultant ultrasound reflected waves **202** for each of multiple selected ultrasound incident waves **201** to a processor means **130**; a location detection means **190** for detecting locations of the ultrasound means **110** and the organic specimen **160** and for transferring that location data **194** to the processor means **130**; a memory means **125** for storing anatomic model data **186** for at least part **155** of the organic specimen **160**; the processor means **130** for identifying a region **220** of the organic specimen **160** associated with selected ultrasound data **187** using location data **194** and one or more sets of ultrasound data **187** resultant from reflections of recognized specimen features **210**, creating an ultrasound image **180** from the selected ultrasound data **187**, obtaining model extracted data **188** from the anatomic model data **186** corresponding to that of the selected ultrasound data **187** region **220**, creating a model image **185** from the model extracted data **188**, and transferring the ultrasound image **180** and the model image **185** to a display means **135**; and the display means **135** configured for displaying the ultrasound image **180** and the model image **185**.

In a fourth representative embodiment, a computer program product **133** stored on a computer readable storage medium for carrying out a method **900** when executed on a computer **132** is disclosed. The method **900** comprises specifying a reference model image region **520***a* in model extracted data **188** obtained from anatomic model data **186** of at least part **155** of an organic specimen **160**; instructing an ultrasound transducer **110** to transmit ultrasound incident waves **201** into the organic specimen **160** and receiving thereby ultrasound data **187** from ultrasound reflected waves **202** from specimen features **210** in the organic specimen **160**, wherein positional awareness **194** of each ultrasound reflected wave **202** relative to the organic specimen **160** is maintained; identifying a reference propagation region **220***a* corresponding to the reference model image region **520***a* from paired recognized specimen features **210** in the ultrasound data **202** and in the model extracted data **188**; instructing an ultrasound transducer **110** to transmit at least one subsequent ultrasound incident wave **201** into the organic specimen **160** and receiving thereby subsequent ultrasound data **187** from ultrasound reflected waves **202** from one or more specimen features **210**, wherein positional awareness is maintained between the reference propagation region **220***a* and the propagation region **220** of the subsequent ultrasound data **187**; and for the subsequent ultrasound data **187**, creating an ultrasound image **180**, creating a model image **185** for a model image region **520** from the anatomic model data **186** corresponding to the propagation region **220** of the subsequent ultrasound data **187**, and instructing a display module **135** to display the ultrasound image **180** and the model image **185**.

In an optional aspect of the fourth representative embodiment, the method **900** further comprising: identifying at least one specimen feature **210** on the ultrasound image **180** from a corresponding model feature **510** on the model image **185**.

In an optional aspect of the fourth representative embodiment, wherein the reference model image region **520***a* is a plane **520***a* and is specified by three non-collinear model reference points **515***a*,**515***b*,**515***c* in the anatomic model data **186** of at least part **155** of the organic specimen **160**.

In an optional aspect of the fourth representative embodiment, wherein the reference model image region **520***a* is a plane **520***a* and is specified by three non-collinear model reference points **515***a*,**515***b*,**515***c* in the anatomic model data **186** of at least part **155** of the organic specimen **160** and wherein the reference propagation region **220***a* in the organic specimen **160** is a plane **220***a* corresponding to the reference model image plane **520***a* and is identified when one or more ultrasound incident waves **201** are reflected separately or in combination from three specimen reference points **215***a*, **215***b*,**215***c* corresponding to the three model reference points **515***a*,**515***b*,**515***c*.

In an optional aspect of the fourth representative embodiment, wherein the model extracted data **188** is stored in a memory module **125**.

In an optional aspect of the fourth representative embodiment, wherein the ultrasound data **187** is stored in a memory module **125**.

In an optional aspect of the fourth representative embodiment, wherein instructing the display module **135** to display the ultrasound image **180** and the model image **185** comprises: an instruction to display at least one static, two-dimensional ultrasound image **180** and its associated static, two-dimensional model image **185**, and/or an instruction to display at least one static, three-dimensional ultrasound image **180** and its associated static, three-dimensional model image **185**, and/or an instruction to display at least one set of time varying, two-dimensional ultrasound images **180** and its associated set of time varying, two-dimensional model images **185**, and/or an instruction to display at least one set of time varying, three-dimensional ultrasound images **180** and its associated set of time varying, three-dimensional model images **185**.

In an optional aspect of the fourth representative embodiment, wherein the anatomic model data **186** is stored in a memory module **125**.

In an optional aspect of the fourth representative embodiment, wherein the display module **135** comprises a first display **140** and a second display **145** and wherein the ultrasound image **180** is displayed on the first display **140** and the model image **185** is displayed on the second display **145**.

In an optional aspect of the fourth representative embodiment, wherein the ultrasound image **180** and the model image **185** are overlaid on the display module **135** or wherein the ultrasound image **180** and the model image **185** are displayed side-by-side on the display module **135**.

In an optional aspect of the fourth representative embodiment, wherein the model image **185** and the ultrasound image **180** are scaled to each other.

In an optional aspect of the fourth representative embodiment, wherein the anatomic model data **186** is obtained from the Visible Human Project data **186** for a representative human male or a representative human female.

In an optional aspect of the fourth representative embodiment, wherein the anatomic model data **186** is for a representative human male or a representative human female.

In an optional aspect of the fourth representative embodiment, the method **900** further comprising: detecting a patient unique feature **450** in the organic specimen **160**.

The representative embodiments, which have been described in detail herein, have been presented by way of example and not by way of limitation. It will be understood by those skilled in the art that various changes may be made in the form and details of the described embodiments resulting in equivalent embodiments that remain within the scope of the appended claims.

What is claimed is:

1. A method, comprising:

identifying a reference model image region in anatomic model data and a corresponding reference propagation region in an organic specimen, wherein the anatomic model data correspond to at least part of the organic specimen;

transmitting at least one reference ultrasound incident wave into the organic specimen and receiving thereby reference ultrasound data from resultant ultrasound reflected waves from specimen features in the organic specimen,

wherein positional awareness of each ultrasound reflected wave relative to the organic specimen is maintained and

wherein the reference model image region in the anatomic model data and the corresponding reference propagation region in the organic specimen are identified using paired equivalent specimen features in the anatomic model data and in the reference ultrasound data;

transmitting at least one additional ultrasound incident wave into the organic specimen and receiving thereby additional ultrasound data from resultant ultrasound reflected waves from one or more specimen features, wherein positional awareness is maintained between the reference propagation region and a propagation region of the additional ultrasound data;

creating an ultrasound image using the additional ultrasound data; and

creating a model image for a model image region corresponding to the propagation region of the additional ultrasound data using the anatomic model data.

2. The method as recited in claim **1**, wherein the anatomic model data are obtained from at least part of data for a representative human male or a representative human female.

3. The method as recited in claim **1**, wherein the anatomic model data are for at least part of a representative organic specimen that is other than the organic specimen from which the ultrasound data are obtained.

4. The method as recited in claim **1**, further comprising:

identifying at least one specimen feature in the ultrasound image from a corresponding model feature in the model image.

5. The method as recited in claim **1**, further comprising:

displaying the ultrasound image and the model image on a display module.

6. The method as recited in claim **5**, wherein displaying the ultrasound image and the model image on the display module comprises:

displaying at least one static, two-dimensional ultrasound image and associated at least one static, two-dimensional model image, and/or

displaying at least one static, three-dimensional ultrasound image and associated at least one static, three-dimensional model image, and/or

displaying at least one set of time varying, two-dimensional ultrasound images and associated at least one set of time varying, two-dimensional model images, and/or

displaying at least one set of time varying, three-dimensional ultrasound images and associated at least one set of time varying, three-dimensional model images.

7. The method as recited in claim **5**, wherein the display module comprises a first display and a second display and wherein the ultrasound image is displayed on the first display and the model image is displayed on the second display.

8. The method as recited in claim **5**, wherein the ultrasound image and the model image are overlaid on the display module or wherein the ultrasound image and the model image are displayed side-by-side on the display module.

9. The method as recited in claim **1**, further comprising: detecting an aberrant feature in the organic specimen.

10. The method as recited in claim **1**, wherein the anatomic model data are obtained from photographs and/or visual images of physical cross-sections of a representative organic specimen.

11. A system, comprising:

a processor configured

to identify a reference model image region in anatomic model data and a corresponding reference propagation region in an organic specimen, wherein the anatomic model data correspond to at least part of the organic specimen;

to issue an instruction for an ultrasound transducer to transmit at least one reference ultrasound incident wave into the organic specimen and to receive thereby reference ultrasound data from resultant ultrasound reflected waves from specimen features in the organic specimen,

wherein positional awareness of each ultrasound reflected wave relative to the organic specimen is maintained and

wherein the reference model image region in the anatomic model data and the corresponding reference propagation region in the organic specimen are identified using paired equivalent specimen features in the anatomic model data and in the reference ultrasound data;

to issue an instruction for the ultrasound transducer to transmit at least one additional ultrasound incident wave into the organic specimen and to receive thereby additional ultrasound data from resultant ultrasound reflected waves from one or more specimen features, wherein positional awareness is maintained between the reference propagation region and a propagation region of the additional ultrasound data;

to create an ultrasound image using the additional ultrasound data; and

to create a model image for a model image region corresponding to the propagation region of the additional ultrasound data using the anatomic model data.

12. The system as recited in claim **11**, wherein the anatomic model data are obtained from at least part of data for a representative human male or a representative human female.

13. The system as recited in claim **11**, wherein the anatomic model data are obtained from photographs and/or visual images of physical cross-sections of a representative organic specimen.

14. The system as recited in claim **11**, further comprising:

a location detection unit configured to detect locations of the ultrasound transducer and the organic specimen and to transfer that location data to the processor.

15. The system as recited in claim **11**, further comprising:

a memory module configured to store the ultrasound data and/or to store the anatomic model data for at least part of the organic specimen.

16. The system as recited in claim **11**, further comprising:

a display module configured to display the ultrasound image and the model image.

17. The system as recited in claim **16**, wherein the processor is configured to create and the display module is configured to display at least one static, two-dimensional ultrasound image and associated at least one static, two-dimensional model image, and/or at least one static, three-dimensional ultrasound image and associated at least one static, three-dimensional model image, and/or at least one set of time varying, two-dimensional ultrasound images and associated at least one set of time varying, two-dimensional model images, and/or at least one set of time varying, three-dimensional ultrasound images and associated at least one set of time varying, three-dimensional model images.

18. The system as recited in claim **16**, wherein the display module comprises a first display and a second display, wherein the first display is configured to display the ultrasound image, and wherein the second display is configured to display the model image.

19. The system as recited in claim **16**, wherein the ultrasound image and the model image are overlaid on the display module or wherein the ultrasound image and the model image are displayed side-by-side on the display module.

20. The system as recited in claim **11**, wherein the processor is further configured to detect one or more aberrant features in the organic specimen.

21. A non-transitory computer-readable medium having computer-executable instructions for causing a computer comprising a processor and associated memory to carry out a method, the method comprising:

identifying a reference model image region in anatomic model data and a corresponding reference propagation region in an organic specimen, wherein the anatomic model data correspond to at least part of the organic specimen;

instructing an ultrasound transducer to transmit at least one reference ultrasound incident wave into the organic specimen and receiving thereby reference ultrasound data from resultant ultrasound reflected waves from specimen features in the organic specimen,

wherein positional awareness of each ultrasound reflected wave relative to the organic specimen is maintained and

wherein the reference model image region in the anatomic model data and the corresponding reference propagation region in the organic specimen are identified using paired equivalent specimen features in the anatomic model data and in the reference ultrasound data;

instructing the ultrasound transducer to transmit at least one additional ultrasound incident wave into the organic specimen and receiving thereby additional ultrasound data from resultant ultrasound reflected waves from one or more specimen features, wherein positional awareness is maintained between the reference propagation region and a propagation region of the additional ultrasound data;

creating an ultrasound image using the additional ultrasound data; and

creating a model image for a model image region corresponding to the propagation region of the additional ultrasound data using the anatomic model data.

22. The non-transitory computer-readable medium as recited in claim **21**, wherein the anatomic model data are obtained from at least part of data for a representative human male or a representative human female.

23. The non-transitory computer-readable medium as recited in claim **21**, wherein the anatomic model data are for at least part of a representative organic specimen that is other than the organic specimen from which the ultrasound data are obtained.

24. The non-transitory computer-readable medium as recited in claim **21**, the method further comprising:

identifying at least one specimen feature in the ultrasound image from a corresponding model feature in the model image.

25. The non-transitory computer-readable medium as recited in claim **21**, the method further comprising:

instructing a display module to display the ultrasound image and the model image.

26. The non-transitory computer-readable medium as recited in claim **25**, wherein instructing the display module to display the ultrasound image and the model image comprises:

instructing the display module to display at least one static, two-dimensional ultrasound image and associated at least one static, two-dimensional model image, and/or

instructing the display module to display at least one static, three-dimensional ultrasound image and associated at least one static, three-dimensional model image, and/or

instructing the display module to display at least one set of time varying, two-dimensional ultrasound images and associated at least one set of time varying, two-dimensional model images, and/or

instructing the display module to display at least one set of time varying, three-dimensional ultrasound images and associated at least one set of time varying, three-dimensional model images.

27. The non-transitory computer-readable medium as recited in claim **25**, wherein the display module comprises a first display and a second display and wherein the ultrasound image is displayed on the first display and the model image is displayed on the second display.

28. The non-transitory computer-readable medium as recited in claim **25**, wherein the ultrasound image and the model image are overlaid on the display module or wherein the ultrasound image and the model image are displayed side-by-side on the display module.

29. The non-transitory computer-readable medium as recited in claim **21**, the method further comprising:

detecting an aberrant feature in the organic specimen.

30. The non-transitory computer-readable medium as recited in claim **21**, wherein the anatomic model data are obtained from photographs and/or visual images of physical cross-sections of a representative organic specimen.

* * * * *

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摘要(译)

一种系统，方法和计算机程序产品。该系统包括超声换能器，其配置用于将超声入射波耦合到有机样本的选定区域中，并将得到的超声数据从用于所选超声入射波的样本特征传送到处理器，位置检测单元被配置用于检测超声换能器和有机物的位置。样本并用于将该数据传送到处理器，存储器模块被配置用于存储至少部分有机样本的解剖模型数据，该处理器被配置用于识别与所选择的超声数据相关联的区域，从该数据创建超声图像，从对应于所选择的超声数据区域的解剖模型数据获得模型提取数据，从模型提取数据创建模型图像，并将超声和模型图像传送到显示模块，并且显示模块被配置用于显示超声和模型图片。