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

VERFAHREN UND VORRICHTUNG ZUR MERKMALSIDENTIFIZIERUNG ORGANISCHER PROBEN IN ULTRASCHALLBILDERN

PROCÉDÉ ET APPAREIL D'IDENTIFICATION DE CARACTÉRISTIQUES D'UN OBJET ORGANIQUE DANS UNE IMAGE ULTRASONORE

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Description

BACKGROUND

[0001] 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.

[0002] 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.

[0003] In US 2009/0036775 A1 a medical guiding system is disclosed that comprises a position and orientation calculation apparatus for detecting and outputting a position and an orientation of an ultrasound transducer and of body surface detection coils attached to a subject, a reference image storage portion for storing reference image data having anatomical positional information of an organ of a human body, and a guide image creation portion, which is based on the output from the position and orientation calculation apparatus and the reference image data, for creating a guide image, wherein the guide image comprises an anatomical model image of the organ of the human body. A display apparatus displays the guide image adjacent to an ultrasound tomographic image.

SUMMARY

[0004] In a representative embodiment, a method according to claim 1 is disclosed.

[0005] In another representative embodiment, a non-transitory computer-readable according to claim 8 is disclosed.

[0006] In yet still another representative embodiment, an apparatus according to claim 9 is disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] 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.

Figure 1A is a block diagram of an apparatus for identification of organic specimen features in ultrasound images as described in various representative embodiments.

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

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

Figure ID is a block diagram of yet another apparatus for identification of organic specimen features in ultrasound images as described in various representative embodiments.

Figure IE is a block diagram of yet still another apparatus for identification of organic specimen features in ultrasound images as described in various representative embodiments.

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

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

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

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

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

Figure 7 is a drawing of an alternative embodiment of a display module for the apparatuses of Figures 1A, 1B, and 1C.

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

Figure 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

[0008] Novel techniques are disclosed herein of methods and apparatuses 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, an animal, a mammal, a plant, a portion of a human, a portion of an animal, a portion of a mammal, or a portion of a plant. The human could be a baby, an infant, a child, an adolescent, a teenager, or an adult. The human could be further referred to as the human subject, the animal as the animal subject, the mammal as the mammal subject, and the plant as the plant subject.

[0009] 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 devices provide immediate images, are portable, are safe, and are economical.

[0010] However, current ultrasound devices 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.

[0011] Conversely, the representative embodiments disclosed herein provide apparatuses 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.

[0012] 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.

[0013] 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.

[0014] 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.

[0015] 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.

[0016] 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.

[0017] 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, apparatuses and methods disclosed herein could be used as a diagnostic tool and/or as a teaching tool.

[0018] 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.

[0019] 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 as static or time varying two-dimensional images and on a three-dimensional display as static or time varying three-dimensional images.

[0020] Figure 1A is a block diagram of an apparatus **100** for identification of organic specimen **160** features in ultrasound images **180** as described in various representative embodiments. The apparatus **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 Figure 1A, 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.**

[0021] 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 apparatus **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.

[0022] 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.**

[0023] The location identification module **195** is configured to instruct the emitter device **196** to transmit location interrogation signals **192** to transducer targets **230** (see Figure 2 and discussion therewith) on the ultrasound transducer **110** and to specimen targets **240** (see Figure 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.**

[0024] 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 Figure 1A 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 Figure 1A 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 Figure 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 Figure 1A will be more completely described with the description of subsequent figures.

[0025] 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 as static or time varying two-dimensional images and on a three-dimensional display as static or time varying three-dimensional images.

[0026] Figure 1B is a block diagram of another apparatus **100** for identification of organic specimen **160** features in ultrasound images **180** as described in various representative embodiments. The apparatus **100** of Figure 1B differs from that of Figure 1A 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 Figure 2, and various other components of Figure 1B will be more completely described with the description of subsequent figures.

[0027] Figure 1C is a block diagram of still another apparatus **100** for identification of organic specimen **160** features in ultrasound images **180** as described in various representative embodiments. The apparatus **100** of Figure 1C differs from that of Figure 1A 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 apparatus **100** of Figure 1C also differs from that of Figure 1A 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 Figure 2, and various other components of Figure 1C will be more completely described with the description of subsequent figures.

[0028] In alternative embodiments, the location detection unit **190** of Figure 1A could replace the location detection unit **190** of Figure 1C in the configuration of Figure 1C, the location detection unit **190** of Figure 1C could replace the location detection unit **190** of Figure 1A in the configuration of Figure 1A, and the location detection unit **190** of Figure 1C could replace the location detection unit **190** of Figure 1B in the configuration of Figure 1B.

[0029] Figure 1D is a block diagram of yet another apparatus **100** for identification of organic specimen **160** features in ultrasound images **180** as described in various representative embodiments. The apparatus **100** of Figure ID differs from that of Figure 1A in that the processor **130** comprises an ultrasound logic module **120a,** a location identification logic module **195a,** and a correlation logic module **105.**

[0030] The ultrasound logic module **120a** can be configured to perform the functions associated with the ultrasound controller **120** of Figures 1A, 1B, and/or 1C 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 **120a** initiates transmission of the activation signal **172** to the ultrasound transducer **110** and receives the subsequent reflected data signal **173.** The ultrasound logic module **120a** then transfers ultrasound data **187** from the reflected data signal **173** to the correlation logic module **105.**

[0031] Figure 1E is a block diagram of yet still another apparatus **100** for identification of organic specimen features in ultrasound images as described in various representative embodiments. The apparatus **100** of Figure IE differs from that of Figure 1D in that the processor **130** comprises a computer program **133** which is also referred to herein as a computer program product **133.**

[0032] 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 **120a,** a location identification logic module **195a,** 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 **520a** 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 **220a** corresponding to the reference model image region **520a** 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 **220a** 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.**

[0033] The location identification logic module **195a** is configured to instruct the emitter device **196** to transmit location interrogation signals **192** to transducer targets **230** (see Figure 2 and discussion therewith) on the ultrasound transducer **110** and to specimen targets **240** (see Figure 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 **195a** 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 Figure ID, the location detection unit **190** comprises the emitter device **196,** the receptor device **197,** and the location identification logic module **195a.**

[0034] The correlation logic module **105** is configured to receive ultrasound data **187** from the ultrasound logic module **120a** and location information from the location identification logic module **195a,** to obtain model extracted data **188** from the anatomic model data **186** in the memory module **125,** to identify a reference model image plane **520a** in the model extracted data **188,** to identify a corresponding reference propagation plane **220a** from recognized specimen features **210** in the ultrasound data **187** and associated location information from the location identification logic module **195a,** 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 **220a** 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.**

[0035] In alternative representative embodiments, the ultrasound logic module **120a,** the location identification logic module **195a,** 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 **120a,** the location identification logic module **195a,** 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 Figures 1A, 1B, and/or 1C.

[0036] Figure 2 is a front view of the patient **160** of Figures 1A, 1B, and 1C with the ultrasound transducer **110** coupled to the shoulder **155** of the patient **160.** In the embodiment of Figure 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 Figure 2. The ultrasound incident wave **201** is reflected by various specimen features **210,** as well as patient unique features **450** (see Figure 4 and discussion therewith) which are also referred to herein as organic specimen unique features **450,** 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.**

[0037] The three specimen features **210a,210b,210c** (first specimen feature **210a,** second specimen feature **210b,** and third specimen feature **210c**) separately reflect that part of the ultrasound incident wave **201** incident on them as associated ultrasound reflected waves **202a,202b,202c** (first ultrasound reflected wave **202a,** second ultrasound reflected wave **202b,** and third ultrasound reflected wave **202c**). In the representative embodiment of Figure 2, these three specimen features **210a,210b,210c** have separately identifiable specimen reference points **215** (first specimen reference point **215a,** second specimen reference point **215b,** and third specimen reference point **215c**) that together specify a reference propagation plane **220a** which is used for specifying the location of and identification of additional, detected specimen features **210.** The three specimen features **210a,210b,210c** and their associated specimen reference points **215a,215b,215c** in the representative embodiment of Figure 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.**

[0038] In locating the specimen reference points **215a,215b,215c** 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 **215a,215b,215c** are found. For ease of illustration and discussion, all three specimen reference points **215a,215b,215c** are shown in Figure 2 as being detected with the ultrasound transducer **110** in a single location, i.e., with the three specimen reference points **215a,215b,215c** in a single reference propagation plane **220a.** 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 **215a,215b,215c** 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 **220a.**

[0039] Also shown in Figure 2 are three transducer targets **230** (first transducer target **230a,** second transducer target **230b,** and third transducer target **230c**) and three specimen targets **240** (first specimen target **240a,** second specimen target **240b,** and third specimen target **240c**). 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 Figure 3) attached to the ultrasound transducer **110** or by an inertial reference device (see Figure 4) attached to the ultrasound transducer **110.**

[0040] Figure 3 is a side view of the arrangement whose front view is shown in Figure 2. As indicated in the discussion of Figure 2, the three specimen features **210a,210b,210c** separately reflect that part of the ultrasound incident wave **201** incident on them as associated ultrasound reflected waves **202a,202b,202c** (first ultrasound reflected wave **202a,** second ultrasound reflected wave **202b,** and third ultrasound reflected wave **202c**). In the representative embodiment of Figures 2 and 3, these three specimen features **210a,210b,210c** have separately identifiable specimen reference points **215a,215b,215c** that together specify a reference propagation plane **220a** that will be used for specifying the location of and identification of additional, detected specimen features **210.** The reference propagation plane **220a** of the ultrasound incident wave **201** is shown edge on in Figure 3 and therefore appears as a line in that figure. As previously indicated, all three specimen reference points **215a,215b,215c** may be detected with the ultrasound transducer **110** in a single location as shown in Figures 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 **215a,215b,215c** can be detected in separate propagation planes **220,** i.e., with the ultrasound transducer **110** in separate locations.

[0041] Also, shown in Figure 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 **220a** can be used to compute the new propagation plane **220** following any movement of the ultrasound transducer **110.**

[0042] Figure 4 is a side view of a modified arrangement of the side view shown in Figure 3. In Figure 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.**

[0043] Also, shown in Figure 4 is a representative embodiment wherein the emitter device **196** and the receptor device **197** of the location detection unit **190** of Figures 1A, 1B, and 1C 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 Figure 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.**

[0044] 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 Figure 4 is reflected in the patient's shoulder **155** by two additional specimen features **210d,210e** (fourth specimen feature **210d** and fifth specimen feature **210e**) and the patient unique feature **450** as additional ultrasound reflected waves **202d,202e,202f** (fourth ultrasound reflected wave **202d,** fifth ultrasound reflected wave **202e,** and sixth ultrasound reflected wave **202f**). The ultrasound reflected waves **202d,202e,202f** are detected by the ultrasound transducer **110** and converted into the reflected data signal **173.** However, the three specimen features **210a,210b,210c** and their associated specimen reference points **215a,215b,215c** are not detectable by the ultrasound transducer **110** with the ultrasound transducer **110** positioned as in Figure 4 as these specimen features **210a,210b,210c** do not lie in the current propagation plane **220.**

[0045] Also in Figure 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.

[0046] Figure 5 is a side view of a three-dimensional reconstructed model **560** from the anatomic model data **186** for the arrangement of Figure 4. In Figure 5 are shown a first, a second, a third, a fourth, and a fifth model features **510a,510b,510c,510d,510e** that in order correspond to the first, the second, the third, the fourth, and the fifth specimen features **210a,210b,210c,210d,210e** and a first, a second, and a third model reference points **515a,515b,515c** that in order correspond to the first, the second, and the third specimen reference points **215a,215b,215c** shown in Figure 4. Also shown in Figure 5 is a model image plane **520** that corresponds to the propagation plane **220** (the ultrasound image plane **220**) of Figure 4. Note that the first, the second, and the third model features **510a,510b,510c** and their associated first, second, and third model reference points **515a,515b,515c** lie in another model image plane **520a** referred to herein as the reference model image plane **520a.** The reference model image plane **520a** for the model image **185** that includes the first, second, and third model reference points **515a,515b,515c** corresponds to the reference ultrasound image plane **220a** for the ultrasound image **180** that includes the first, second, and third specimen reference points **215a,215b,215c.** Note also, that Figure 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.**

[0047] Figure 6 is another drawing of the display module **135** of Figures 1A, 1B, and 1C with the ultrasound transducer **110** placed as in Figure 4. In Figure 6, as in Figures 1A, 1B, and 1C, 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 Figure 4. The ultrasound reflection of the fourth and the fifth specimen features **210d,210e** 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 **510d** and fifth model feature **510ec**) are shown on the model image **185** displayed on the model display **145.**

[0048] 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.

[0049] The two specimen features **210d,210e,** the patient unique feature **450,** and the two model features **510d,510e** in Figure 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.

[0050] Figure 7 is a drawing of an alternative embodiment of a display module **135** for the apparatuses **100** of Figures 1A, 1B, and 1C. The display module **135** of Figure 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 **210d,210e** and the patient unique feature **450** as well as the corresponding two model features **510d,510e** are not labeled in Figure 7 as they were in Figure 6.

[0051] As in Figure 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.

[0052] Figure 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 Figure 8, three model reference points **515** (first, second, and third model reference points **515a,515b,515c**) are selected. Block **805** then transfers control to block **810.**

[0053] 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.**

[0054] In block **815,** the ultrasound transducer **110** is moved until the three specimen reference points **215** (first, second, and third specimen reference points **215a,215b,215c**) on the patient **160** that correspond to the three model reference points **515** (first, second, and third model reference points **515a,515b,515c**) are located and marked on the ultrasound data **187.** Block **815** then transfers control to block **820.**

[0055] In block **820,** the reference propagation plane **220a** is identified based on the first, the second, and the third specimen reference points **215a,215b,215c.** Block **820** then transfers control to block **825.**

[0056] 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.**

[0057] 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.**

[0058] In block **835,** the set of ultrasound data **187** is stored in the ultrasound memory **127.** Block **835** then transfers control to block **837.**

[0059] 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.**

[0060] 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.**

[0061] 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.**

[0062] 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.**

[0063] 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.

[0064] Figure 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 Figure 9, a reference model image plane **520a** 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.**

[0065] In block **910,** a corresponding reference ultrasound image plane **220a** 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.**

[0066] 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 **220a** and a propagation plane **220** of the at least one subsequent ultrasound incident wave **201.** Block **915** then transfers control to block **920.**

[0067] 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.**

[0068] 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.**

[0069] 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.**

[0070] 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.

[0071] 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.

[0072] In representative embodiments, the ultrasound images **180** and/or the model images **185** could be stored in the memory module **125.**

[0073] 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.**

[0074] 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.**

[0075] 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 **220a** is referred to as the reference propagation region **220a,** and the reference ultrasound image plane **220a** is referred to as the reference ultrasound image region **220a.** Also generally for both two-dimensional and three-dimensional embodiments, the model image plane **520** and the reference model image plane **520a** are referred to respectively as the model image region **520** and the reference model region **520a.**

[0076] 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.**

[0077] 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.**

[0078] 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.

[0079] In a first representative embodiment, an apparatus **100** is disclosed. The apparatus **100** 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.**

[0080] In an optional aspect of the first representative embodiment, wherein the memory module **125** is further configured for storing the model extracted data **188.**

[0081] In an optional aspect of the first representative embodiment, wherein the memory module **125** is further configured for storing the ultrasound data **187.**

[0082] 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.**

[0083] In an optional aspect of the first representative embodiment, wherein the processor **130** is a central processing unit **130.**

[0084] 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.**

[0085] 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.**

[0086] In an optional aspect of the first representative embodiment, wherein the model image **185** and the ultrasound image **180** are scaled to each other.

[0087] 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.

[0088] 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.

[0089] 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.**

[0090] 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.

[0091] 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.**

[0092] In a second representative embodiment, a method is disclosed. The method comprises specifying a reference model image region **520a** 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 **220a** corresponding to the reference model image region **520a** 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 **220a** 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.**

[0093] 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.**

[0094] In an optional aspect of the second representative embodiment, wherein the reference model image region **520a** is a plane **520a** and is specified by three non-collinear model reference points **515a,515b,515c** in the anatomic model data **186** of at least part **155** of the organic specimen **160.**

[0095] In an optional aspect of the second representative embodiment, wherein the reference model image region **520a** is a plane **520a** and is specified by three non-collinear model reference points **515a,515b,515c** in the anatomic model data **186** of at least part **155** of the organic specimen **160** and wherein the reference propagation region **220a** in the organic specimen **160** is a plane **220a** corresponding to the reference model image plane **520a** and is identified when one or more ultrasound incident waves **201** are reflected separately or in combination from three specimen reference points **215a,215b,215c** corresponding to the three model reference points **515a,515b,515c.**

[0096] In an optional aspect of the second representative embodiment, wherein the model extracted data **188** is stored in a memory module **125.**

[0097] In an optional aspect of the second representative embodiment, wherein the ultrasound data **187** is stored in a memory module **125.**

[0098] 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.**

[0099] In an optional aspect of the second representative embodiment, wherein the anatomic model data **186** is stored in a memory module **125.**

[0100] 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.**

[0101] 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.**

[0102] In an optional aspect of the second representative embodiment, wherein the model image **185** and the ultrasound image **180** are scaled to each other.

[0103] 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.

[0104] 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.

[0105] In an optional aspect of the second representative embodiment, further comprising: detecting a patient unique feature **450** in the organic specimen **160.**

[0106] 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.**

[0107] 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.**

[0108] 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.**

[0109] In a fourth representative embodiment, a computer program product **133** stored on a non-transitory 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 **520a** 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 **220a** corresponding to the reference model image region **520a** 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 **220a** 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.**

[0110] 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.**

[0111] In an optional aspect of the fourth representative embodiment, wherein the reference model image region **520a** is a plane **520a** and is specified by three non-collinear model reference points **515a,515b,515c** in the anatomic model data **186** of at least part **155** of the organic specimen **160.**

[0112] In an optional aspect of the fourth representative embodiment, wherein the reference model image region **520a** is a plane **520a** and is specified by three non-collinear model reference points **515a,515b,515c** in the anatomic model data **186** of at least part **155** of the organic specimen **160** and wherein the reference propagation region **220a** in the organic specimen **160** is a plane **220a** corresponding to the reference model image plane **520a** and is identified when one or more ultrasound incident waves **201** are reflected separately or in combination from three specimen reference points **215a,215b,215c** corresponding to the three model reference points **515a,515b,515c.**

[0113] In an optional aspect of the fourth representative embodiment, wherein the model extracted data **188** is stored in a memory module **125.**

[0114] In an optional aspect of the fourth representative embodiment, wherein the ultrasound data **187** is stored in a memory module **125.**

[0115] 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.**

[0116] In an optional aspect of the fourth representative embodiment, wherein the anatomic model data **186** is stored in a memory module **125.**

[0117] 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.**

[0118] 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.**

[0119] In an optional aspect of the fourth representative embodiment, wherein the model image **185** and the ultrasound image **180** are scaled to each other.

[0120] 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.

[0121] 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.

[0122] 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.**

[0123] In a fifth representative embodiment, a non-transitory computer-readable medium **125** having computer-executable instructions for causing a computer **132** comprising a processor **130** and associated memory **125** to carry out a method **900** is disclosed. The method **900** comprises specifying a reference model image region **520a** 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 **220a** corresponding to the reference model image region **520a** 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 **220a** 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.**

[0124] In representative embodiments, the anatomic model data **186** for at least part of the organic specimen **160** can be for a representative organic specimen, a representative human male, and/or a representative human female that is other than the organic specimen **160** or patient **160** from which ultrasound data **187** is obtained.

[0125] In representative embodiments, various technical steps do not require the presence of a human subject **160** or any other organic specimen **160.** These technical steps include, among others, obtaining anatomic model data **186** corresponding to at least part **155** of a human subject **160,** specifying a reference model image region **520a** in the anatomic model data **186,** using equivalent specimen features **210** in the anatomic model data **186** to identify a reference propagation region **220a** corresponding to the reference model image region **520a,** creating a model image **185** for a model image region **520** from the anatomic model data **186,** displaying the model image **185,** creating an ultrasound image **180,** and displaying the ultrasound image **180.**

[0126] It will be appreciated that any module or component disclosed herein that executes instructions may include or otherwise have access to non-transient and tangible computer readable media such as storage media, computer storage media, or data storage devices (removable or non-removable) such as, for example, magnetic disks, optical disks, or tape data storage. Computer storage media may include volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information, such as computer readable instructions, data structures, program modules, or other data. Examples of computer storage media include RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by an application, module, or both. Any such computer storage media may be part of the server, any component of or related to the network, backend, etc., or accessible or connectable thereto. Any application or module herein described may be implemented using computer readable/executable instructions that may be stored or otherwise held by such computer readable media.

[0127] Certain embodiments described herein are or may be implemented using a programmed processor executing programming instructions that are broadly described above in flow chart form that can be stored on any suitable electronic or computer readable storage medium including non-transitory storage media. The term "non-transitory" is intended herein only to preclude propagating waves and not storage that can be rewritten or storage that loses its stored information when power is removed.

[0128] 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.

Claims

1. A method (900), comprising:

obtaining anatomic model data (186) corresponding to at least part (155) of an organic specimen (160);
specifying a reference model image region (520a) in the anatomic model data (186);
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 of each ultrasound reflected wave (202) relative to the organic specimen (160) is maintained;
identifying a reference propagation region (220a) corresponding to the reference model image region (520a) using paired equivalent specimen features (210) in the ultrasound data (187) and in the anatomic model data (186);
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 (220a) and a propagation region (220) of the subsequent ultrasound data (187); and
for the subsequent ultrasound data (187), creating an ultrasound image (180) and 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).

2. The method (900) as recited in claim 1, wherein the anatomic model data (186) are for at least part (155) of a representative organic specimen (160) that is other than the organic specimen (160) from which the ultrasound data (187) are obtained.

3. The method (900) as recited in claim 1, further comprising:
identifying at least one specimen feature (210) in the ultrasound image (180) from a corresponding model feature (510) in the model image (185).

4. The method (900) as recited in claim 1, further comprising:
displaying the ultrasound image (180) and the model image (185) on a display module (135).

5. The method (900) as recited in claim 4, 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).

6. The method (900) as recited in claim 4, 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).

7. The method (900) as recited in claim 4, 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).

8. A non-transitory computer-readable medium (125) having computer-executable instructions for causing a computer (132) comprising a processor (130) and associated memory (125) to carry out a method (900) according to any one of the claims 1 to 7.

9. An apparatus (100), comprising:

a processor (130) configured for

receiving ultrasound data (187) from ultrasound reflected waves (202),

wherein the ultrasound reflected waves (202) result from reflections of ultrasound incident waves (201) by specimen features (210) in an organic specimen (160) and
wherein positional awareness of each ultrasound reflected wave (202) relative to the organic specimen (160) is maintained;

obtaining anatomic model data (186) corresponding to at least part (155) of the organic specimen (160); and
identifying a reference model image region (520a) in the anatomic model data (186) and a corresponding reference propagation region (220a) in the organic specimen (160) using paired equivalent specimen features (210) in the anatomic model data (186) and in the ultrasound data (187),

said apparatus (100) further comprising:
a location detection unit (190) configured for detecting locations of an ultrasound transducer (110) and the organic specimen (160) and for transferring that location data (194) to the processor (130);

wherein the processor (130) is further 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 equivalent 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), and
creating a model image (185) from that model extracted data (188).

10. The apparatus (100) as recited in claim 9, wherein the anatomic model data (186) are obtained from at least part of data (186) for a representative human male or a representative human female.

11. The apparatus (100) as recited in claim 9, wherein the anatomic model data (186) are for at least part (155) of a representative organic specimen (160) that is other than the organic specimen (160) from which the ultrasound data (187) are obtained.

12. The apparatus (100) as recited in claim 9, further comprising:
a display module (135) configured to display the ultrasound image (180) and the model image (185).

13. The apparatus (100) as recited in claim 12, 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).

14. The apparatus (100) as recited in claim 12, 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).

15. The apparatus (100) as recited in claim 12, 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).

Patentansprüche

1. Verfahren (900), das Folgendes umfasst:

Erhalten anatomischer Modelldaten (186), die mindestens einem Teil (155) einer organischen Probe (160) entsprechen;
Festlegen eines Referenzmodellbildbereichs (520a) in den anatomischen Modelldaten (186);
Senden bzw. übertragen einfallender Ultraschallwellen (201) in die organische Probe (160) und dadurch Empfangen von Ultraschalldaten (187) von reflektierten Ultraschallwellen (202) von Probenmerkmalen (210) in der organischen Probe (160),
wobei die Positionskenntnis von jeder reflektierten Ultraschallwelle (202) relativ zu der organischen Probe (160) aufrechterhalten wird;
Identifizieren eines Referenzausbreitungsbereichs (220a), der dem Referenzmodellbildbereich (520a) entspricht, unter Verwendung paarweiser äquivalenter Probenmerkmale (210) in den Ultraschalldaten (187) und in den anatomischen Modelldaten (186);
Senden bzw. übertragen mindestens einer nachfolgenden einfallenden Ultraschallwelle (201) in die organische Probe (160) und dadurch Empfangen nachfolgender Ultraschalldaten (187) von reflektierten Ultraschallwellen (202) von einem oder mehreren Probenmerkmalen (210),
wobei die Positionskenntnis zwischen dem Referenzausbreitungsbereich (220a) und einem Ausbreitungsbereich (220) der nachfolgenden Ultraschalldaten (187) aufrechterhalten wird; und
Erzeugen eines Ultraschallbildes (180) und Erzeugen eines Modellbildes (185) für einen Modellbildbereich (520) aus den anatomischen Modelldaten (186), die dem Ausbreitungsbereich (220) der nachfolgenden Ultraschalldaten entsprechen, für die nachfolgenden Ultraschalldaten (187) .

2. Verfahren (900) nach Anspruch 1, wobei die anatomischen Modelldaten (186) mindestens ein Teil (155) einer repräsentativen organischen Probe (160) sind, der von der organischen Probe (160), von der die Ultraschalldaten (187) erhalten wurden, verschieden ist.

3. Verfahren (900) nach Anspruch 1, das ferner Folgendes umfasst:
Identifizieren mindestens eines Probenmerkmals (210) in dem Ultraschallbild (180) von einem entsprechenden Modellmerkmal (510) in dem Modellbild (185).

4. Verfahren (900) nach Anspruch 1, das ferner Folgendes umfasst:
Anzeigen des Ultraschallbildes (180) und des Modellbildes (185) auf einem Anzeigemodul.

5. Verfahren (900) nach Anspruch 4, wobei das Anzeigen des Ultraschallbildes (180) und des Modellbildes (185) auf dem Anzeigemodul (135) Folgendes umfasst:

Anzeigen mindestens eines statischen, zweidimensionalen Ultraschallbildes (180) und seines zugeordneten statischen zweidimensionalen Modellbildes (185) und/oder
Anzeigen mindestens eines statischen, dreidimensionalen Ultraschallbildes (180) und seines zugeordneten statischen dreidimensionalen Modellbildes (185) und/oder
Anzeigen mindestens einer Gruppe von zeitlich veränderlichen zweidimensionalen Ultraschallbildern (180) und ihrer zugeordneten Gruppe von zeitlich veränderlichen zweidimensionalen Modellbildern (185) und/oder
Anzeigen mindestens einer Gruppe von zeitlich veränderlichen dreidimensionalen Ultraschallbildern (180) und ihrer zugeordneten Gruppe von zeitlich veränderlichen dreidimensionalen Modellbildern (185).

6. Verfahren (900) nach Anspruch 4, wobei das Anzeigemodul (135) eine erste Anzeigevorrichtung (140) und eine zweite Anzeigevorrichtung (145) umfasst und wobei das Ultraschallbild (180) auf der ersten Anzeigevorrichtung (140) angezeigt wird und das Modellbild (185) auf der zweiten Anzeigevorrichtung (145) angezeigt wird.

7. Verfahren (900) nach Anspruch 4, wobei das Ultraschallbild (180) und das Modellbild (185) auf dem Anzeigemodul (135) überlagert werden oder wobei das Ultraschallbild (180) und das Modellbild (185) auf dem Anzeigemodul (135) nebeneinander angezeigt werden.

8. Nichttransitorisches computerlesbares Medium (125), das computerlesbare Anweisungen enthält, um zu bewirken, dass ein Computer (132), der einen Prozessor (130) und einen zugeordneten Speicher (125) enthält, ein Verfahren (900) nach einem der Ansprüche 1 bis 7 ausführt.

9. Vorrichtung (100), die Folgendes enthält:

einen Prozessor (130), der konfiguriert ist zum Empfangen von Ultraschalldaten (187) von reflektierten Ultraschallwellen (202), wobei
die reflektierten Ultraschallwellen (202) aus Reflektionen von einfallenden Ultraschallwellen (201) an Probenmerkmalen (210) in einer organischen Probe (160) resultieren und
die Positionskenntnis von jeder reflektierten Ultraschallwelle (202) relativ zu der organischen Probe (160) aufrechterhalten wird;
Erhalten anatomischer Modelldaten (186), die mindestens einem Teil (155) der organischen Probe (160) entsprechen; und
Identifizieren eines Referenzmodellbildbereichs (520a) in den anatomischen Modelldaten (186) und eines entsprechenden Referenzausbreitungsbereichs (220a) in der organischen Probe (160) unter Verwendung paarweise äquivalenter Probenmerkmale (210) in den anatomischen Modelldaten (186) und in den Ultraschalldaten (187),
wobei die Vorrichtung (100) ferner Folgendes enthält:

eine Ortsdetektionseinheit (190), die konfiguriert ist, Orte eines Ultraschallwandlers (110) und der organischen Probe (160) zu detektieren und diese Ortsdaten (194) zu dem Prozessor (130) zu übertragen;
wobei der Prozessor (130) ferner konfiguriert ist, den Bereich (220), der den ausgewählten Ultraschalldaten (187) zugeordnet ist, unter Verwendung von Ortsdaten (194) und einer oder mehreren Gruppen von Ultraschalldaten (187), die aus Reflektionen von äquivalenten Probenmerkmalen (210) resultieren, zu identifizieren,
Erzeugen eines Ultraschallbildes (180) aus den ausgewählten Ultraschalldaten (187),
Erhalten von extrahierten Modelldaten (188) aus den anatomischen Modelldaten (186), die denen des ausgewählten Bereichs (220) von Ultraschalldaten (187) entsprechen, und
Erzeugen eines Modellbildes (185) aus den extrahierten Modelldaten (188).

10. Vorrichtung (100) nach Anspruch 9, wobei die anatomischen Modelldaten (186) von mindestens einem Teil von Daten (186) für einen repräsentativen menschlichen Mann oder eine repräsentative menschliche Frau erhalten werden.

11. Vorrichtung (100) nach Anspruch 9, wobei die anatomischen Modelldaten (186) mindestens ein Teil (155) einer repräsentativen organischen Probe (160) sind, der von der organischen Probe (160), von der die Ultraschalldaten (187) erhalten wurden, verschieden ist.

12. Vorrichtung (100) nach Anspruch 9, die ferner Folgendes enthält:
ein Anzeigemodul (135), das konfiguriert ist, das Ultraschallbild (180) und das Modellbild (185) anzuzeigen.

13. Vorrichtung (100) nach Anspruch 12, wobei der Prozessor (130) zum Erzeugen und das Anzeigemodul (135) zum Anzeigen von Folgendem konfiguriert sind: mindestens eines statischen, zweidimensionalen Ultraschallbildes (180) und seines zugeordneten statischen zweidimensionalen Modellbildes (185) und/oder mindestens eines statischen, dreidimensionalen Ultraschallbildes (180) und seines zugeordneten statischen dreidimensionalen Modellbildes (185) und/oder mindestens einer Gruppe von zeitlich veränderlichen zweidimensionalen Ultraschallbildern (180) und ihrer zugeordneten Gruppe von zeitlich veränderlichen zweidimensionalen Modellbildern (185) und/oder mindestens einer Gruppe von zeitlich veränderlichen dreidimensionalen Ultraschallbildern (180) und ihrer zugeordneten Gruppe von zeitlich veränderlichen dreidimensionalen Modellbildern (185) .

14. Vorrichtung (100) nach Anspruch 12, wobei das Anzeigemodul (135) eine erste Anzeigevorrichtung (140) und eine zweite Anzeigevorrichtung (145) umfasst und wobei das Ultraschallbild (180) auf der ersten Anzeigevorrichtung (140) angezeigt wird und das Modellbild (185) auf der zweiten Anzeigevorrichtung (145) angezeigt wird.

15. Vorrichtung (100) nach Anspruch 12, wobei das Ultraschallbild (180) und das Modellbild (185) auf dem Anzeigemodul (135) überlagert werden oder wobei das Ultraschallbild (180) und das Modellbild (185) nebeneinander auf dem Anzeigemodul (135) angezeigt werden.

Revendications

1. Procédé (900) comportant les étapes consistant à :

obtenir des données de modèle anatomique (186) correspondant à au moins une partie (155)

d'un échantillon organique (160) ;
spécifier une région d'image de modèle de référence (520a) dans les données de modèle anatomique (186) ;
transmettre des ondes ultrasonores incidentes (201) dans l'échantillon organique (160) et recevoir ainsi des données ultrasonores (187) provenant d'ondes ultrasonores réfléchies (202) par des caractéristiques d'échantillon (210) dans l'échantillon organique (160),
dans lequel la mémorisation de la position de chaque onde ultrasonore réfléchie (202) par rapport à l'échantillon organique (160) est maintenue ;
identifier une région de propagation de référence (220a) correspondant à la région d'image de modèle de référence (520a) en utilisant des paires de caractéristiques d'échantillon équivalentes (210) dans les données ultrasonores (187) et dans les données de modèle anatomique (186) ;
transmettre au moins une onde ultrasonore incidente subséquente (201) dans l'échantillon organique (160) et recevoir ainsi des données ultrasonores subséquentes (187) provenant d'ondes ultrasonores réfléchies (202) par une ou plusieurs caractéristiques d'échantillon (210),
dans lequel la mémorisation de la position est maintenue entre la région de propagation de référence (220a) et une région de propagation (220) des données ultrasonores subséquentes (187) ; et
pour les données ultrasonores subséquentes (187), créer une image ultrasonore (180) et créer une image de modèle (185) pour une région d'image de modèle (520) à partir des données de modèle anatomique (186) correspondant à la région de propagation (220) des données ultrasonores subséquentes (187) .

2. Procédé (900) selon la revendication 1, dans lequel les données de modèle anatomique (186) sont destinées à au moins une partie (155) d'un échantillon organique représentatif (160) qui est différent de l'échantillon organique (160) à partir duquel les données ultrasonores (187) sont obtenues.

3. Procédé (900) selon la revendication 1, comportant en outre l'étape consistant à :
identifier au moins une caractéristique d'échantillon (210) dans l'image ultrasonore (180) à partir d'une caractéristique de modèle (510) correspondante dans l'image de modèle (185) .

4. Procédé (900) selon la revendication 1, comportant en outre l'étape consistant à :
afficher l'image ultrasonore (180) et l'image de modèle (185) sur un module d'affichage (135).

5. Procédé (900) selon la revendication 4, dans lequel l'affichage de l'image ultrasonore (180) et de l'image de modèle (185) sur le module d'affichage (135) comporte les étapes consistant à :

afficher au moins une image ultrasonore bidimensionnelle, statique (180) et son image de modèle bidimensionnelle, statique associée (185), et/ou
afficher au moins une image ultrasonore tridimensionnelle, statique (180) et son image de modèle tridimensionnelle, statique (185), et/ou
afficher au moins un ensemble d'images ultrasonores bidimensionnelles, variables dans le temps (180) et son ensemble associé d'images de modèle bidimensionnelles, variables dans le temps (185), et/ou
afficher au moins un ensemble d'images ultrasonores tridimensionnelles, variables dans le temps (180) et son ensemble associé d'images de modèle tridimensionnelles, variables dans le temps (185).

6. Procédé (900) selon la revendication 4, dans lequel le module d'affichage (135) comporte un premier affichage (140) et un second affichage (145), et dans lequel l'image ultrasonore (180) est affichée sur le premier affichage (140) et le modèle d'image (185) est affiché sur le second affichage (145).

7. Procédé (900) selon la revendication 4, dans lequel l'image ultrasonore (180) et l'image de modèle (185) sont superposées sur le module d'affichage (135), ou dans lequel l'image ultrasonore (180) et l'image de modèle (185) sont affichés côte à côte sur le module d'affichage (135).

8. Support non transitoire lisible par ordinateur (125) ayant des instructions exécutables par ordinateur pour amener un ordinateur (132) comportant un processeur (130) et une mémoire (125) associée à exécuter un procédé (900) selon l'une quelconque des revendications 1 à 7.

9. Appareil (100) comportant :

un processeur (130) configuré pour
recevoir des données ultrasonores (187) provenant d'ondes ultrasonores réfléchies (202), dans lequel les ondes ultrasonores réfléchies (202) résultent de réflexions d'ondes ultrasonores incidentes (201) par des caractéristiques d'échantillon (210) dans un échantillon organique (160) et dans lequel la mémorisation de la position de chaque onde ultrasonore réfléchie (202) par rapport à l'échantillon organique (160) est maintenue ;
obtenir des données de modèle anatomique

(186) correspondant à au moins une partie (155) de l'échantillon organique (160) ; et
identifier une région d'image de modèle de référence (520a) dans les données de modèle anatomique (186) et une région de propagation de référence (220a) correspondante dans l'échantillon organique (160) en utilisant des paires de caractéristiques d'échantillon équivalentes (210) dans les données de modèle anatomique (186) et dans les données ultrasonores (187),
ledit appareil (100) comportant en outre :

une unité de détection d'emplacement (190) configurée pour détecter des emplacements d'un transducteur ultrasonore (110) et de l'échantillon organique (160) et pour transférer ces données d'emplacement (194) vers le processeur (130) ;
dans lequel le processeur (130) est en outre configuré pour identifier la région (220) associée aux données ultrasonores (187) sélectionnées en utilisant les données d'emplacement (194) et un ou plusieurs ensembles de données ultrasonores (187) résultant de réflexions de caractéristiques d'échantillon équivalentes (210),
créer une image ultrasonore (180) à partir des données ultrasonores sélectionnées (187),
obtenir des données extraites de modèle (188) à partir des données de modèle anatomique (186) correspondant à celles des données ultrasonores sélectionnées (187) de la région (220), et
créer une image de modèle (186) à partir de ces données extraites de modèle (188).

10. Appareil (100) selon la revendication 9, dans lequel les données de modèle anatomique (186) sont obtenues à partir d'au moins d'une partie des données (186) pour un sujet humain mâle représentatif ou un sujet humain femelle représentatif.

11. Appareil (100) selon la revendication 9, dans lequel les données de modèle anatomique (186) sont destinées à au moins une partie (155) d'un échantillon organique représentatif (160) qui est différent de l'échantillon organique (160) à partir duquel les données ultrasonores (187) sont obtenues.

12. Appareil (100) selon la revendication 9, comportant en outre :
un module d'affichage (135) configuré pour afficher l'image ultrasonore (180) et l'image de modèle (185).

13. Appareil (100) selon la revendication 12, dans lequel le processeur (130) est configuré pour créer et le module d'affichage (135) est configuré pour afficher au moins une image ultrasonore bidimensionnelle, statique (180) et son image de modèle bidimensionnelle, statique (185), et/ou au moins une image ultrasonore tridimensionnelle, statique (180) et son image de modèle tridimensionnelle, statique (185), et/ou au moins un ensemble d'images ultrasonores bidimensionnelles, variant dans le temps (180) et son ensemble associé d'images de modèle bidimensionnelles, variant dans le temps (185), et/ou au moins un ensemble d'images ultrasonores tridimensionnelles, variant dans le temps (180) et son ensemble associé d'images de modèle tridimensionnelles, variant dans le temps (185).

14. Appareil (100) selon la revendication 12, dans lequel le module d'affichage (135) comporte un premier affichage (140) et un second affichage (145), et dans lequel l'image ultrasonore (180) est affichée sur le premier affichage (140) et le modèle d'image (185) est affiché sur le second affichage (145).

15. Appareil (100) selon la revendication 12, dans lequel l'image ultrasonore (180) et l'image de modèle (185) sont superposées sur le module d'affichage (135) ou dans lequel l'image ultrasonore (180) et l'image de modèle (185) sont affichées côte à côte sur le module d'affichage (135).

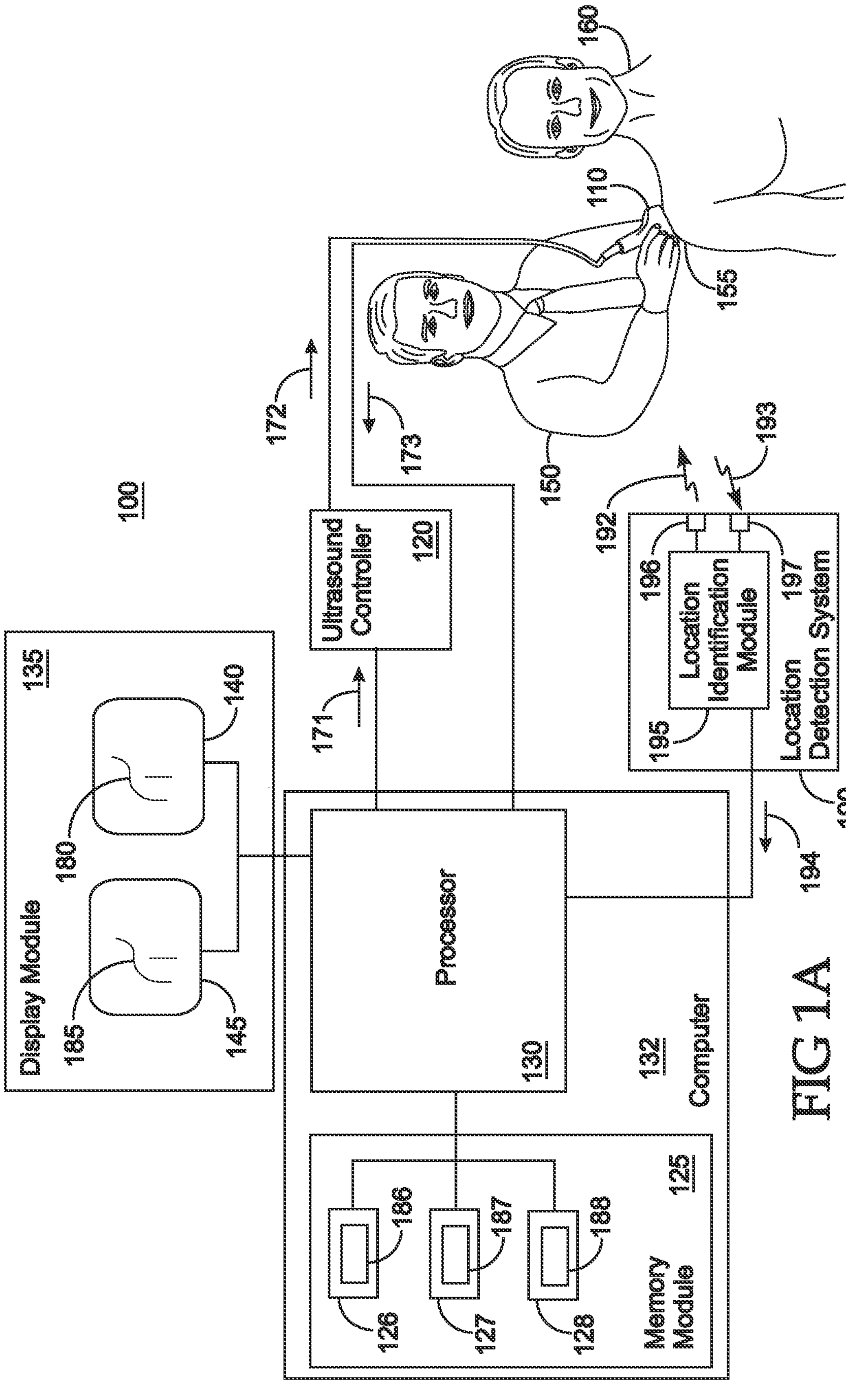
100
Display Module
135
185
145
180
140
Processor
130
132
Computer
Memory Module
125
126
127
128
186
187
188
Ultrasound Controller
120
171
172
173
150
155
110
160
Location Identification Module
195
196
197
Location Detection System
190
192
193
194

FIG 1A

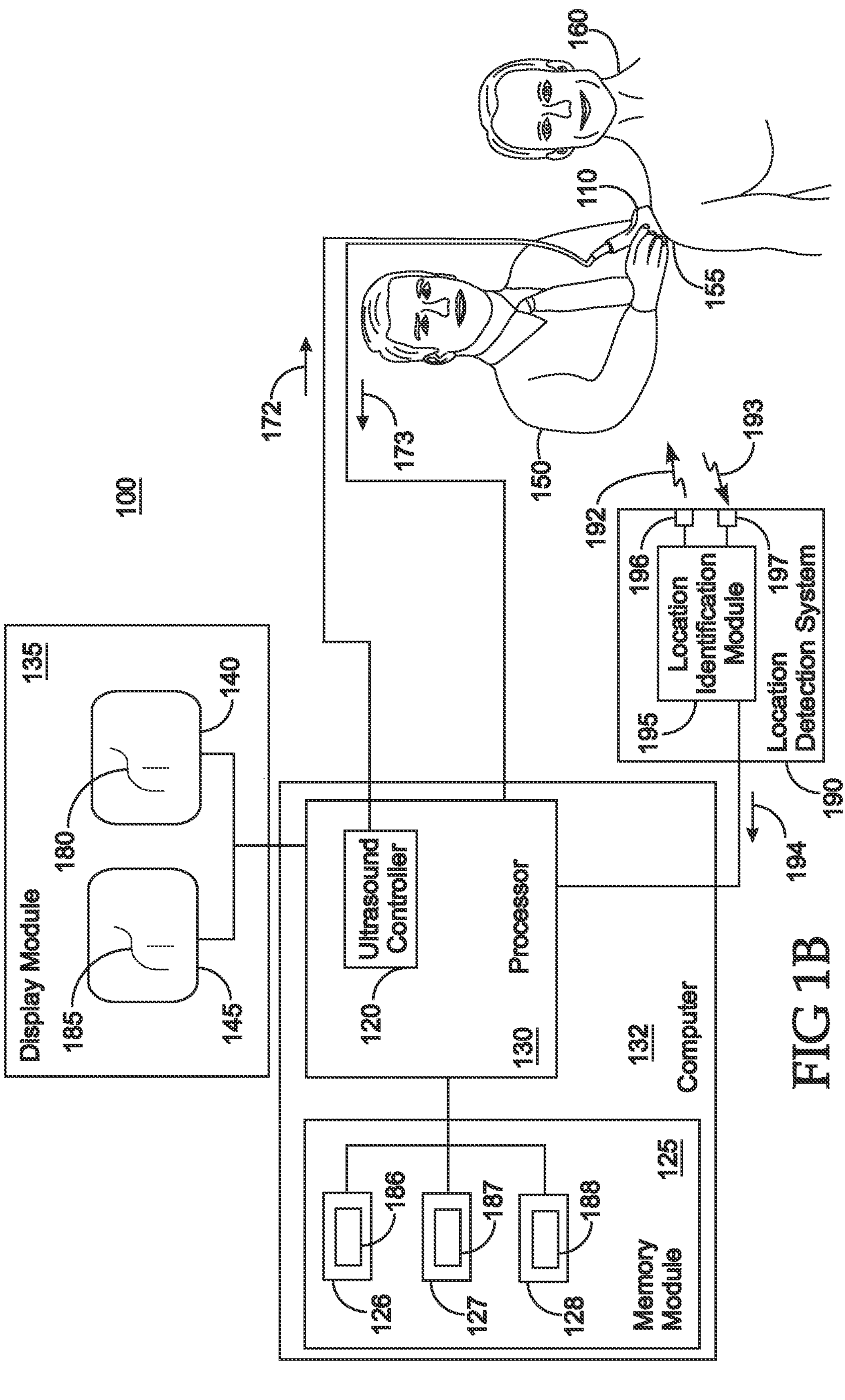
100
Display Module
135
185
145
180
140
Ultrasound Controller
120
Processor
130
132
Computer
Memory Module
125
186
187
188
126
127
128
172
173
150
155
110
160
Location Identification Module
195
196
197
192
193
Location Detection System
190
194

FIG 1B

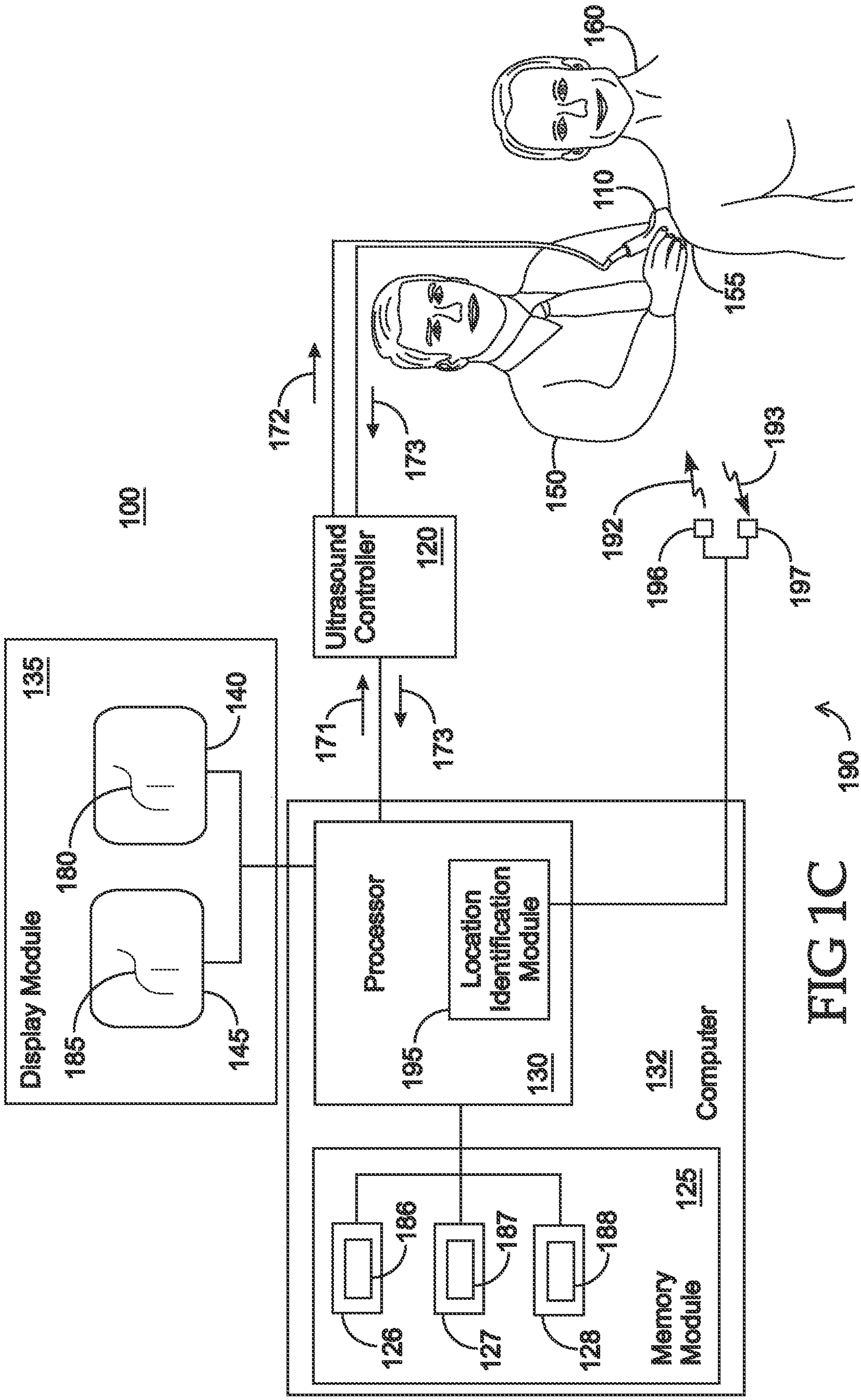
100
Display Module
135
185
145
180
140
Ultrasound Controller
120
171
172
173
173
Processor
Location Identification Module
195
130
132
Computer
Memory Module
125
126
127
128
186
187
188
150
155
110
160
192
193
196
197
190

FIG 1C

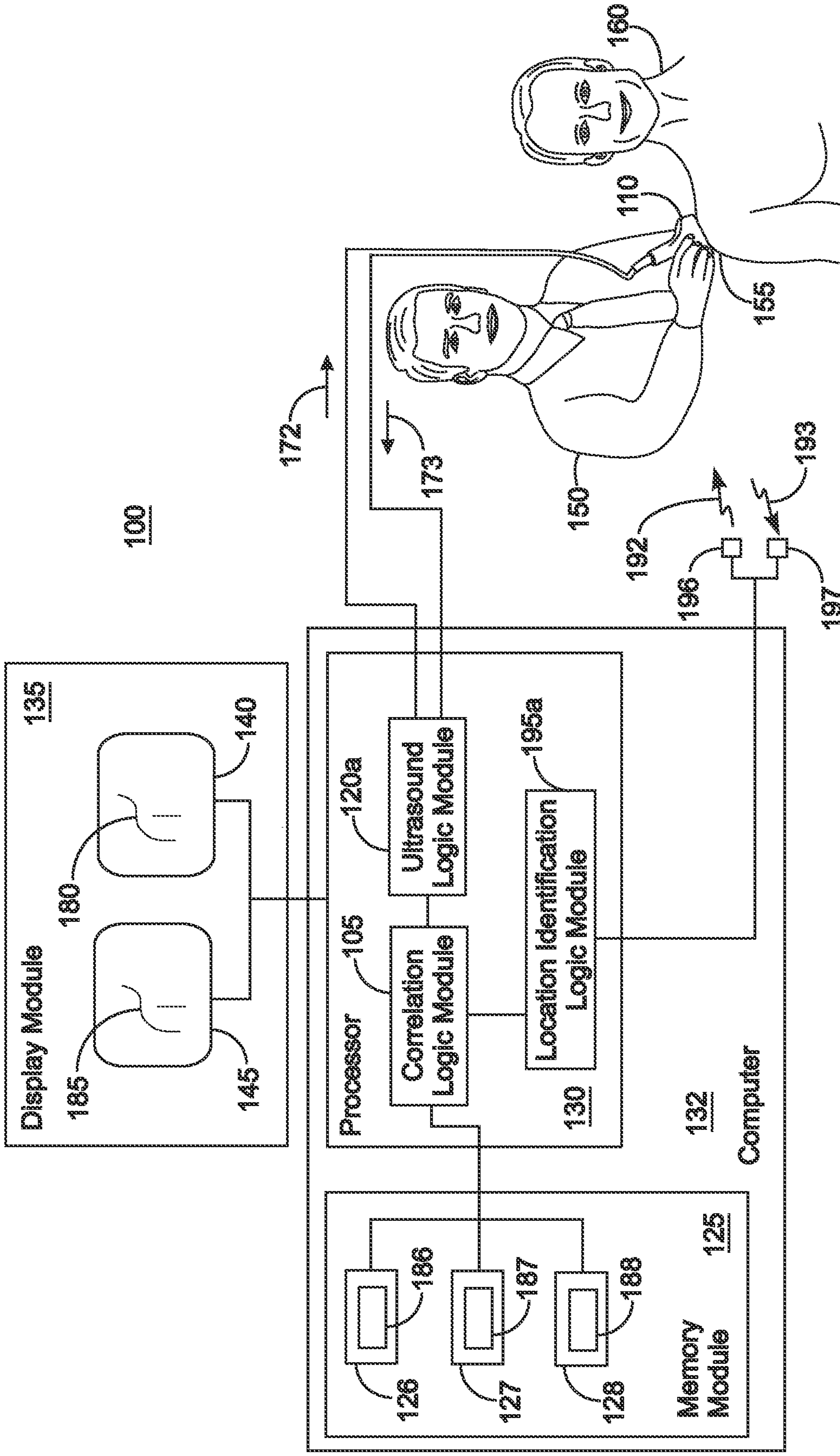
100
Display Module
135
185
145
180
140
Processor
130
Correlation Logic Module
105
Ultrasound Logic Module
120a
Location Identification Logic Module
195a
132
Computer
Memory Module
125
126
127
128
186
187
188
172
173
150
155
110
160
192
193
196
197
190

FIG 1D

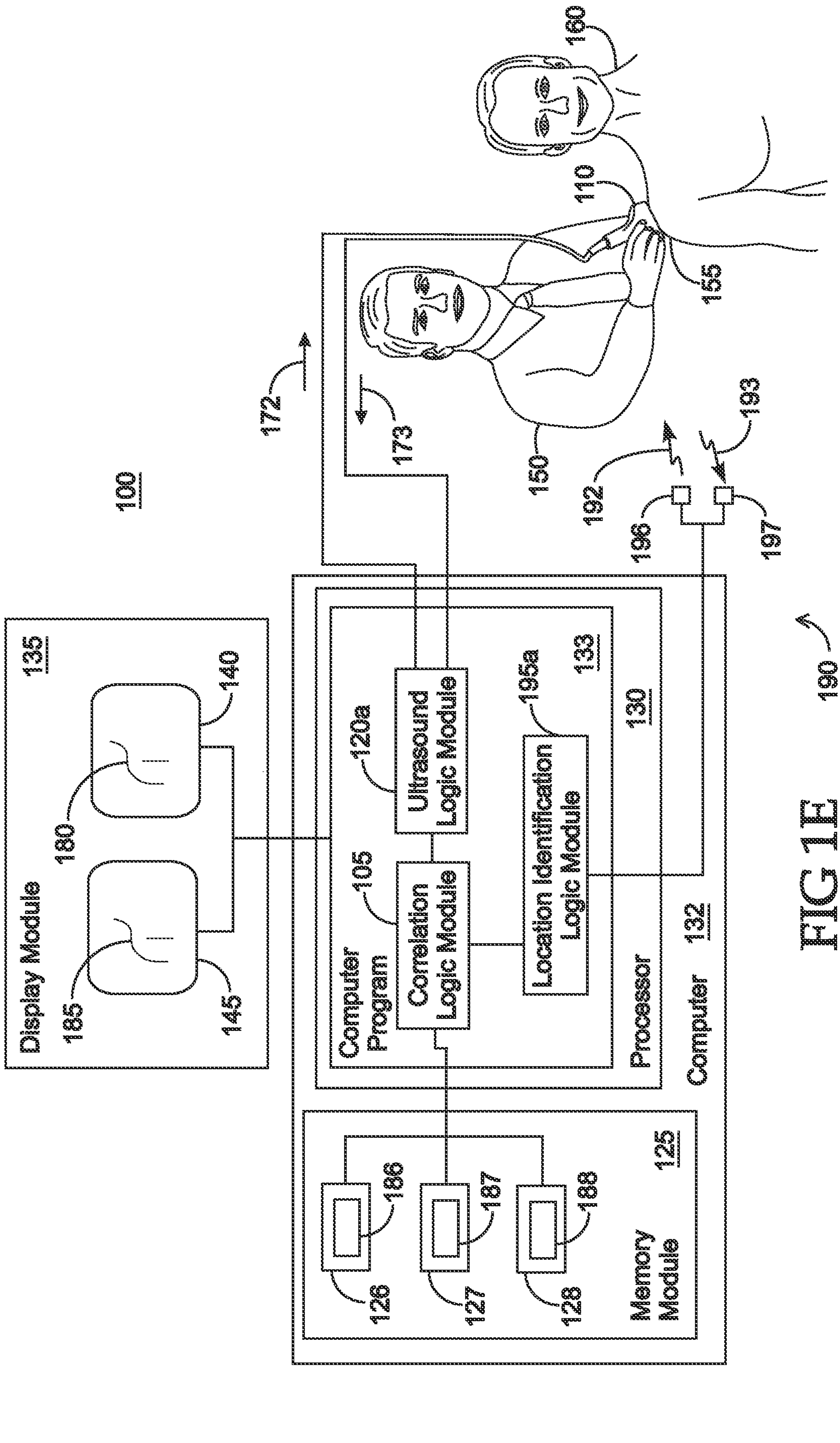
100
Display Module
135
185
145
180
140
Computer Program
Correlation Logic Module
105
Ultrasound Logic Module
120a
Location Identification Logic Module
195a
133
130
Processor
Computer
132
Memory Module
125
126
127
128
186
187
188
172
173
150
155
110
160
192
193
196
197
190

FIG 1E

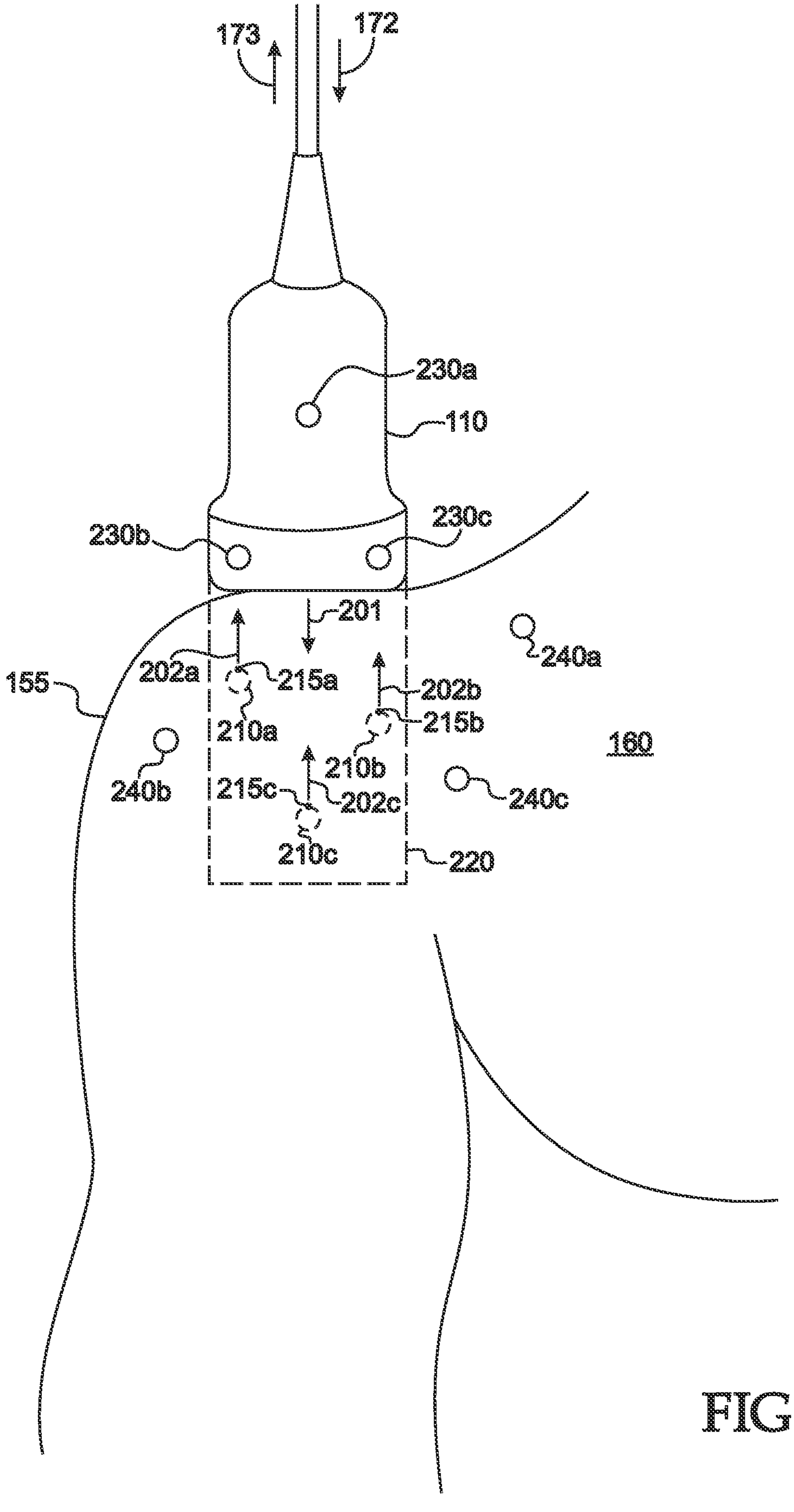
173
172
230a
110
230b
230c
201
240a
202a
215a
155
202b
215b
210a
160
210b
240b
215c
202c
240c
210c
220

FIG 2

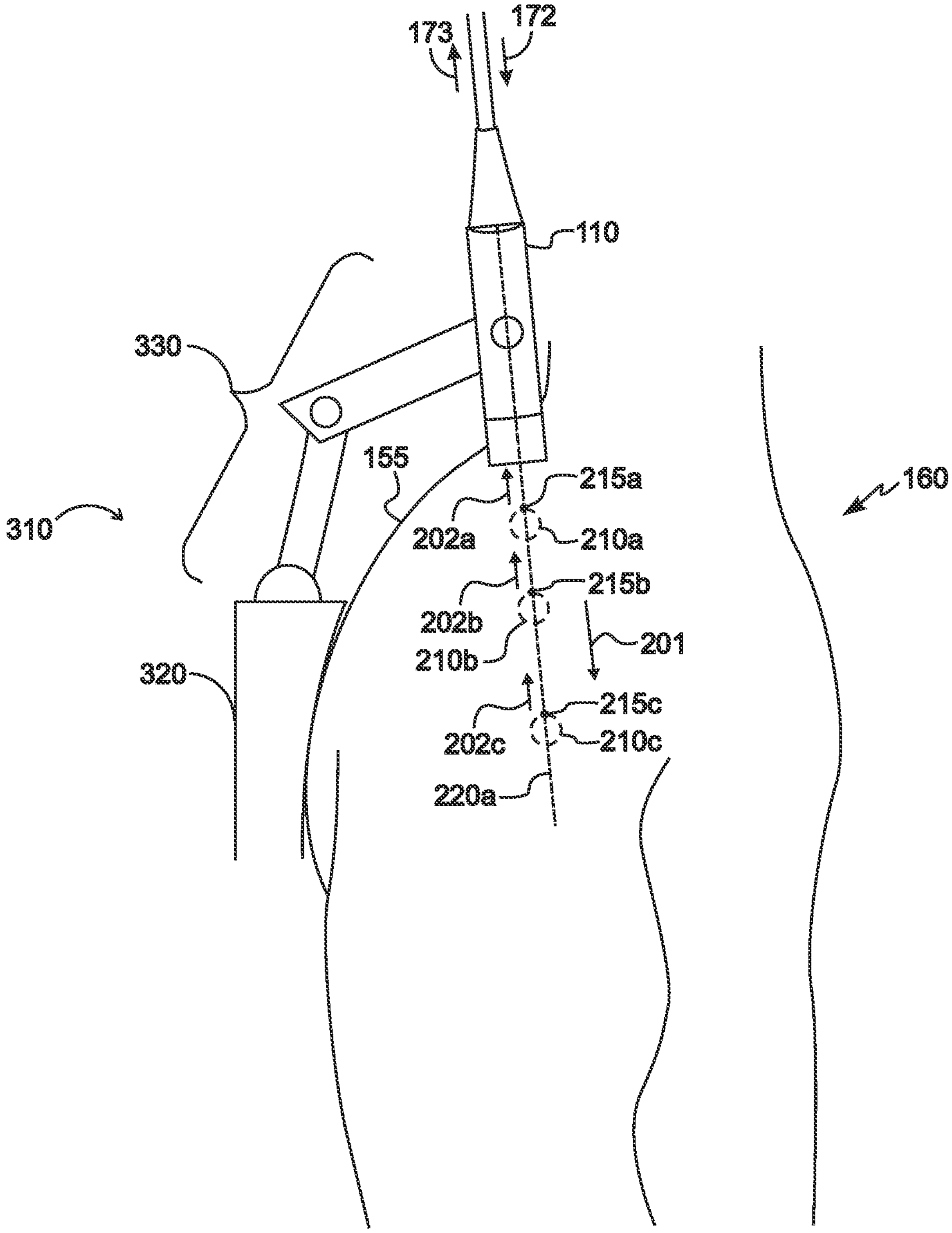
173
172
110
330
155
215a
160
310
202a
210a
202b
215b
210b
201
320
202c
215c
210c
220a

FIG 3

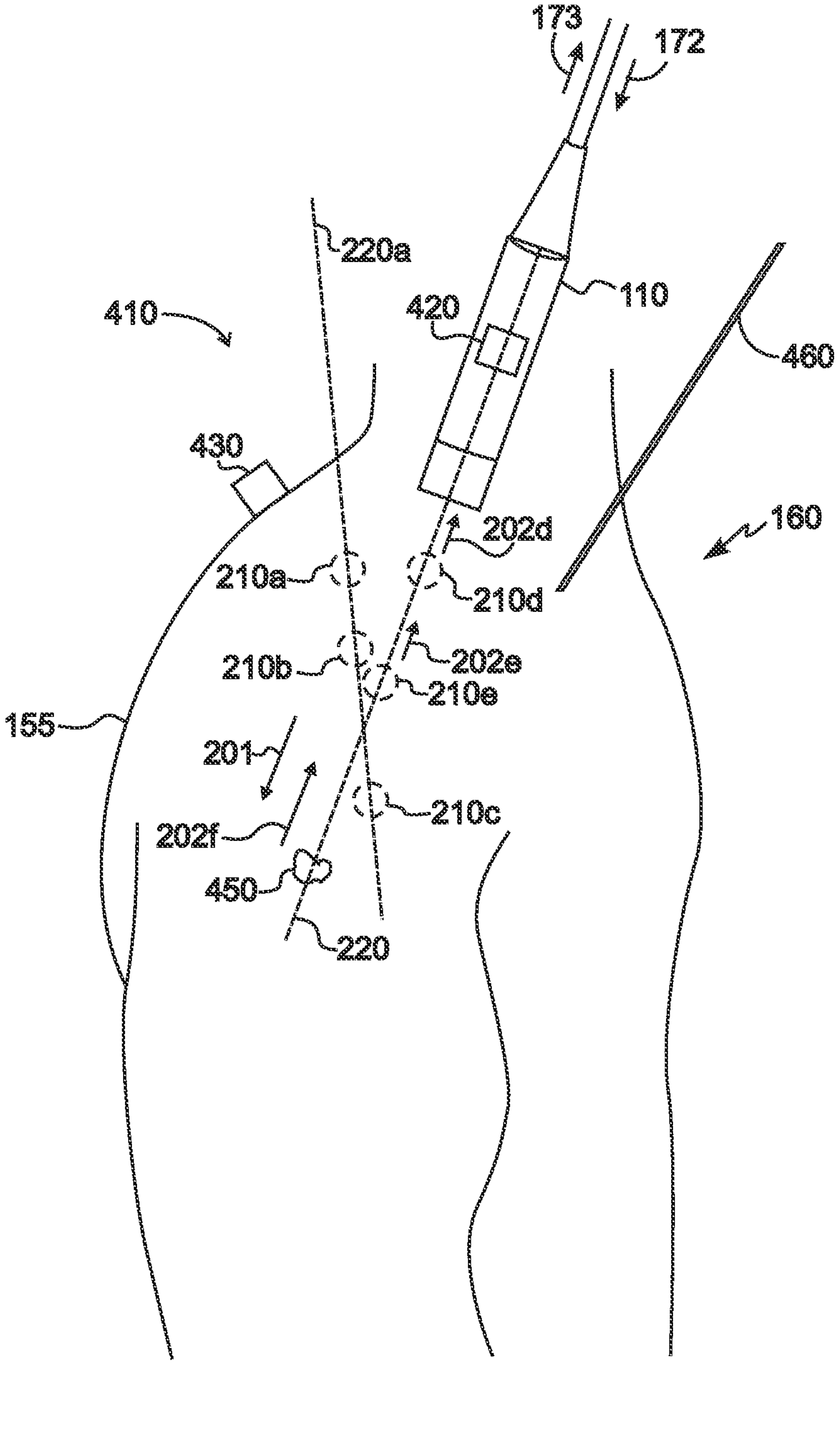
173
172
220a
110
410
420
460
430
202d
160
210a
210d
210b
202e
210e
155
201
210c
202f
450
220

FIG 4

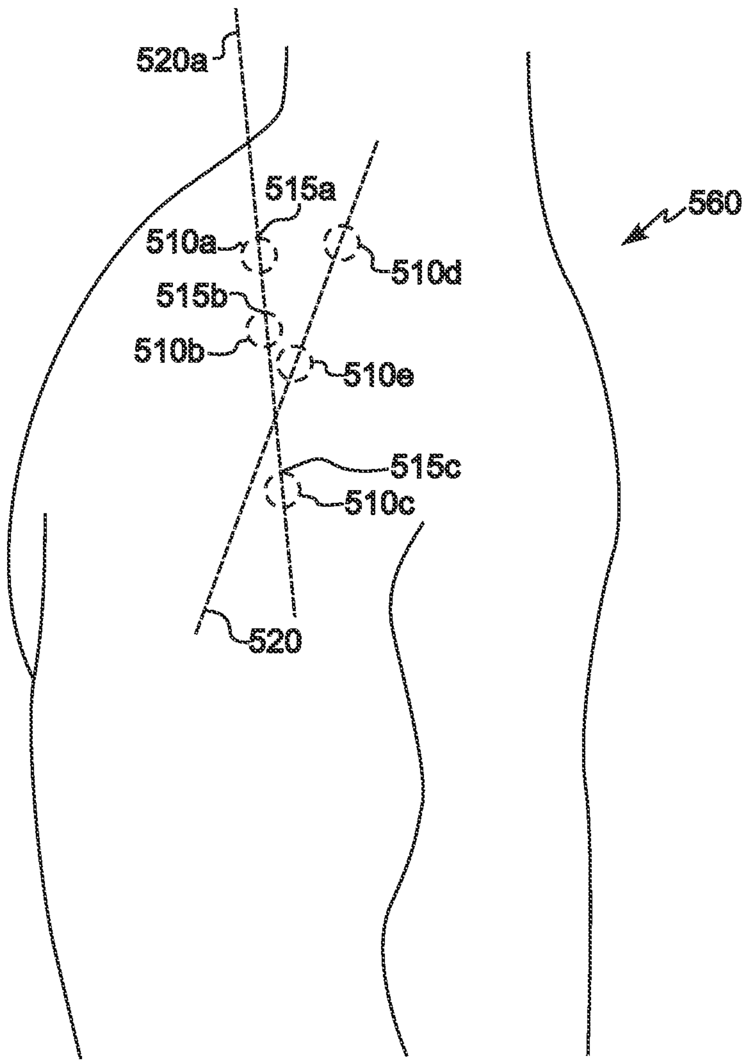

FIG 5

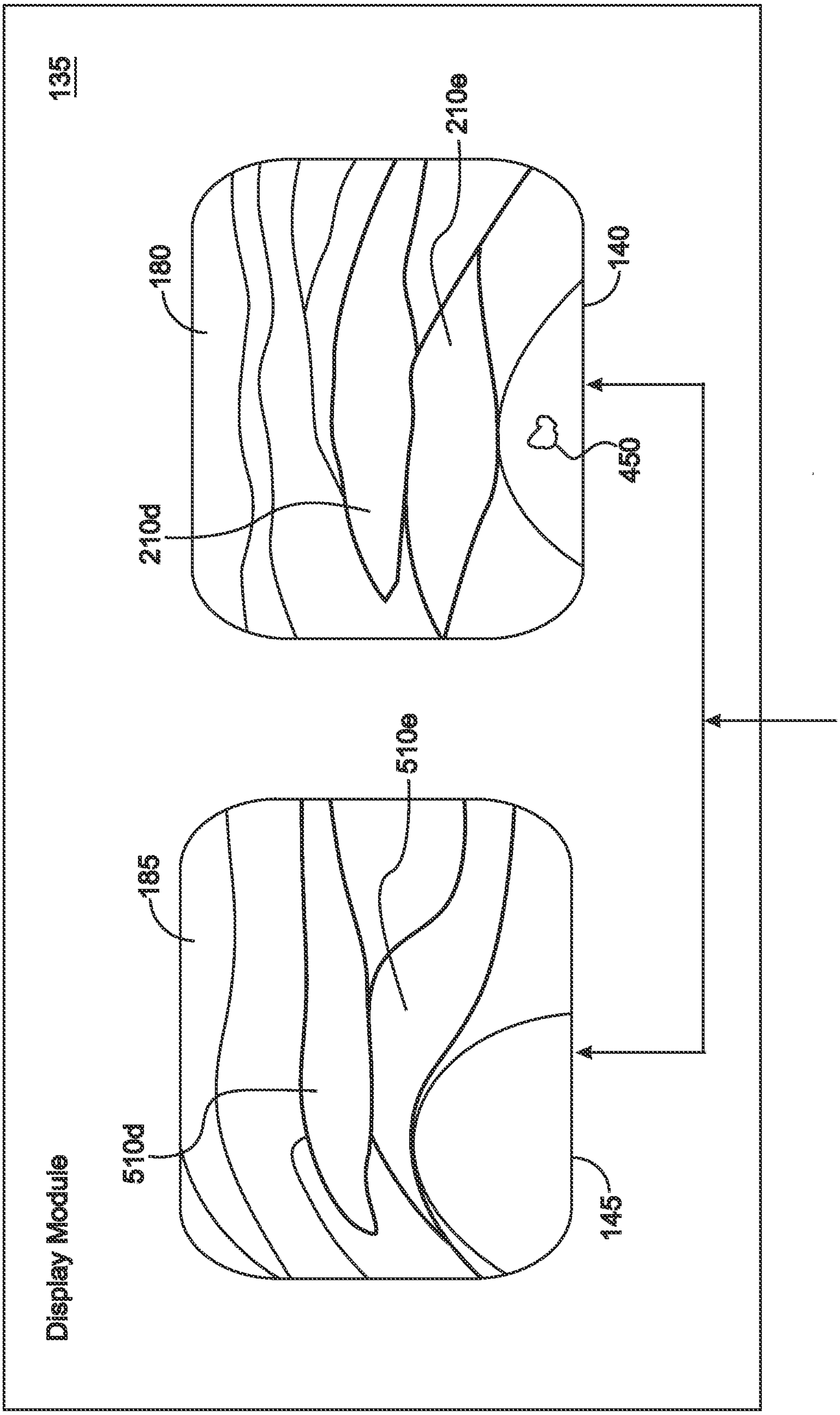

FIG 6

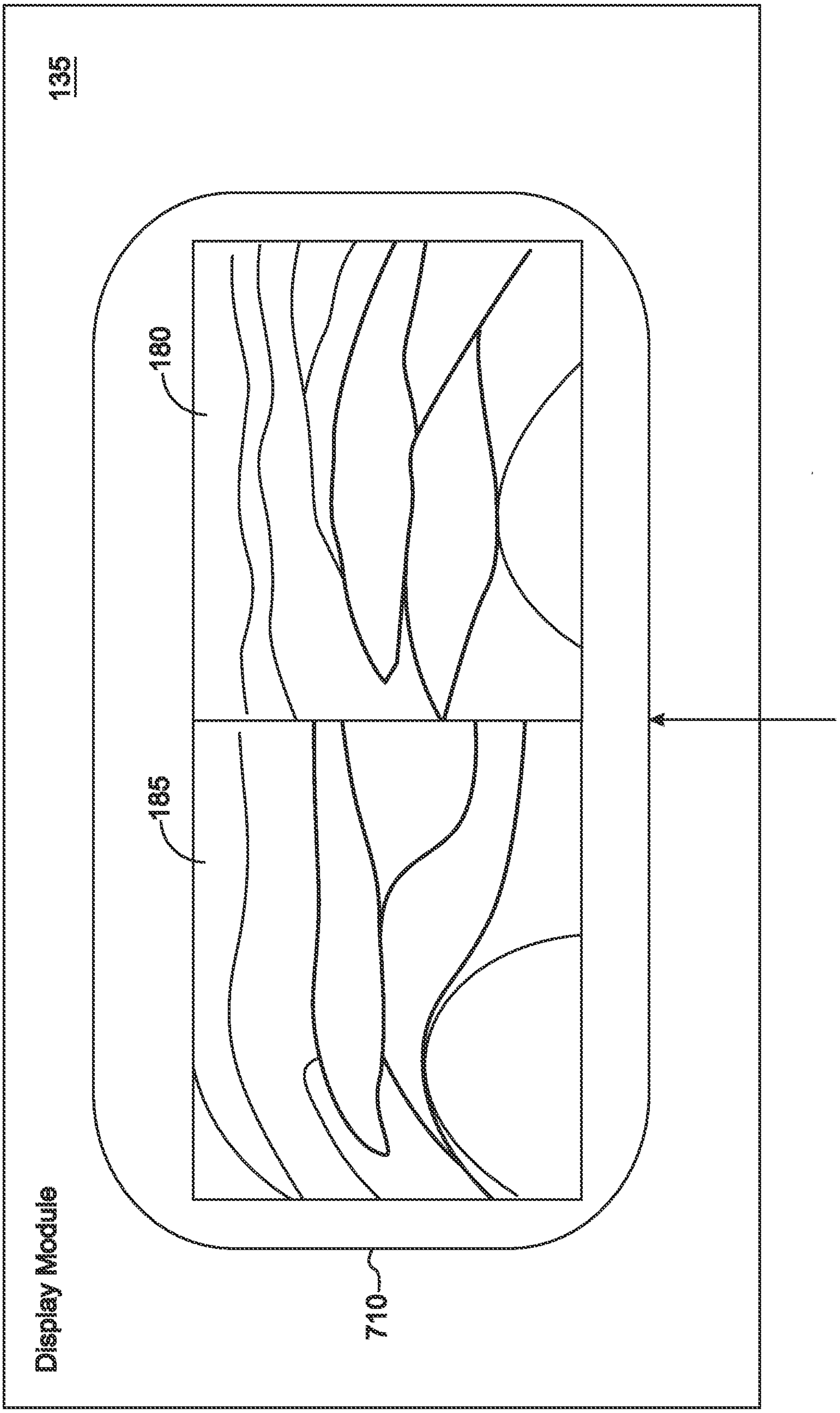

FIG 7

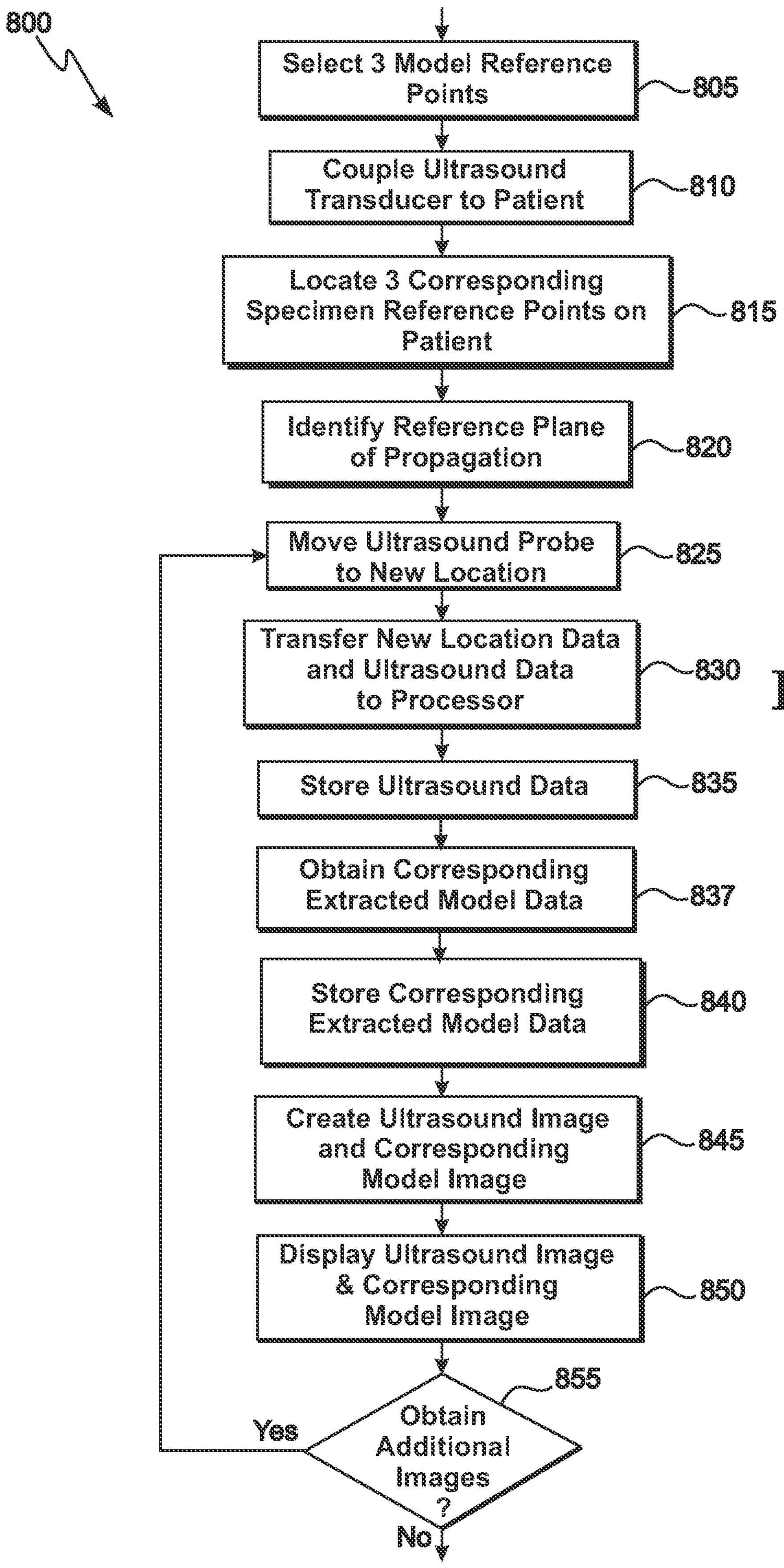
800
Select 3 Model Reference Points
805
Couple Ultrasound Transducer to Patient
810
Locate 3 Corresponding Specimen Reference Points on Patient
815
Identify Reference Plane of Propagation
820
Move Ultrasound Probe to New Location
825
Transfer New Location Data and Ultrasound Data to Processor
830
Store 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

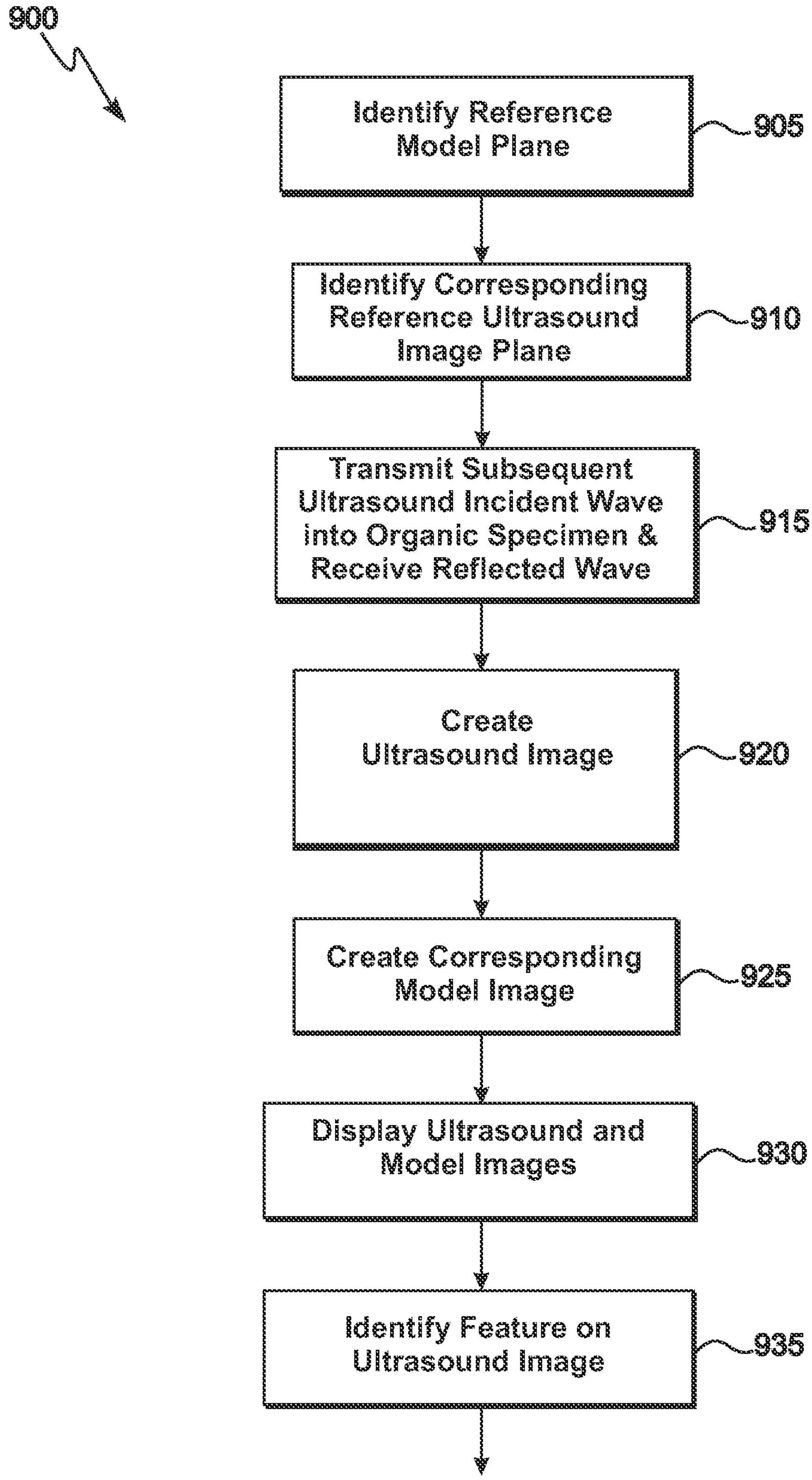
900
Identify Reference Model Plane
905
Identify Corresponding Reference Ultrasound Image Plane
910
Transmit Subsequent Ultrasound Incident Wave into Organic Specimen & Receive Reflected Wave
915
Create Ultrasound Image
920
Create Corresponding Model Image
925
Display Ultrasound and Model Images
930
Identify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

FIG 9

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20090036775 A1 **[0003]**

专利名称(译)	超声图像中有机标本特征识别的方法和装置		
公开(公告)号	EP2725982B1	公开(公告)日	2018-08-15
申请号	EP2012807572	申请日	2012-06-15
[标]申请(专利权)人(译)	GRONSETH悬崖 托比John发		
申请(专利权)人(译)	GRONSETH，悬崖，A. 托比，约翰E.		
当前申请(专利权)人(译)	GRONSETH，悬崖，A. 托比，约翰E.		
[标]发明人	GRONSETH CLIFF A TOBEY JOHN E		
发明人	GRONSETH, CLIFF, A. TOBEY, JOHN, E.		
IPC分类号	A61B8/00 G06T7/00 G06T19/00		
CPC分类号	A61B8/4263 A61B8/13 A61B8/4209 A61B8/4218 A61B8/4245 A61B8/463 A61B8/464 A61B8/466 A61B8/483 A61B8/5223 A61B8/5238 Y10S128/903 Y10S128/904		
优先权	13/135350 2011-07-01 US 13/270120 2011-10-10 US		
其他公开文献	EP2725982A4 EP2725982A2		
外部链接	Espacenet		

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。

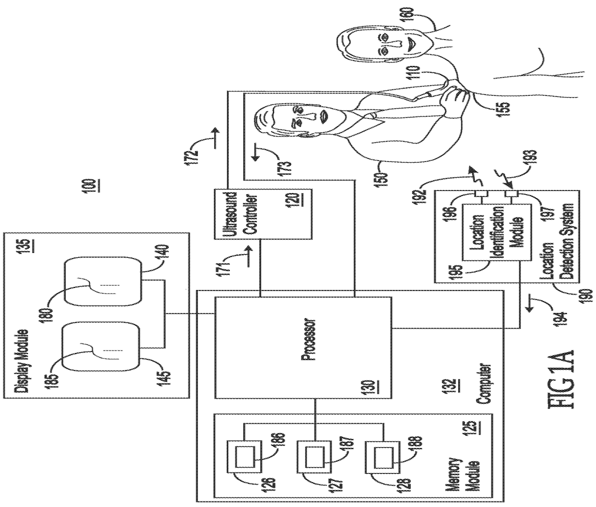

FIG 1A