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(54) **System for superimposing an electrically mapped location of an electrode onto a corresponding ultrasound image**

System zur Überlagerung der elektrisch bestimmten Position einer Elektrode auf einem entsprechenden Ultraschallbild

Système de superposition d’un emplacement électriquement cartographié d’une électrode sur une image échographique correspondante

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(73) Proprietor: **Medtronic, Inc.**
Minneapolis, MN 55432-5604 (US)

(72) Inventor: **FEREK-PETRIC, Bozidar**
10000 Fagreb (HR)

(74) Representative: **Hughes, Andrea Michelle**
Dehns
St Bride’s House
10 Salisbury Square
London EC4Y 8JD (GB)

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Description

[0001] The present invention relates generally to systems for mapping an electrode position within a body, and more specifically to a system for superimposing an electrically mapped location of one or more electrodes onto a corresponding ultrasound image.

BACKGROUND OF THE INVENTION

[0002] The following background describes one context in which embodiments of the present invention may be practiced and should not be viewed as limiting the scope of the present invention as set forth in the appended claims.

[0003] Tachycardia is the condition of an accelerated pulse rate. Natural tachycardia occurs in physical exercise and emotional stress because of the sympathetic nervous tone and increase of the circulatory catecholamine concentration. The most important quality of natural tachycardia is the resultant increase in cardiac output. Pathologic tachycardia results in impaired hemodynamics, i.e. decreased cardiac output. The electrophysiology discriminates two major classes of tachycardia: supra-ventricular and ventricular, as well as two major classes of etiology: ectopic focuses and reentry phenomena. The therapy of tachycardia is in principle either the suppression of ectopic focuses or interruption of the reentry pathway. The first approach is always the pharmacotherapy. Despite of the recent advances in electropharmacology, every antiarrhythmic drug is not effective in every patient. Drugs also provoke side effects, which can be hazardous to the patient. Therefore more invasive modes of therapy must be considered like surgical treatment and permanent implantation of an electrotherapy device. One therapy of choice is cardiac ablation, which is a semi-invasive interventional method.

[0004] Transvenous catheter ablation of cardiac conduction tissue is a low risk alternative to surgical ablation to treat refractory supra-ventricular tachyarrhythmias. Some positive results have also been achieved in the treatment of ventricular tachycardia. The principal energy source for catheter ablations is a DC energy pulse from a standard defibrillator. In order to minimize the energy for the purpose of safety, numerous modifications in design of the energy source as well as of the catheter have been realized. In order to achieve the controllability of the lesion size as well as to avoid hazardous shock wave, the radiofrequency energy source has been introduced. For the same reason, laser ablation fiber optic catheters have been developed. The application of microwave energy is an alternative method, as well as ablation by means of chemical agents.

[0005] One of the challenges to a clinician in performing an ablation procedure is the exact positioning of the ablation electrode within the heart. The positioning is normally observed under of radiographic imaging. Limitations of X-ray methods, however, include poor imaging of soft tissues, i.e. papillary muscle, interventricular septa, and so forth. As an alternative, ultrasonic imaging is well suited for imaging of soft tissues. Ultrasonically marked catheters and cardiac pacing leads have been described in U.S. Pat. No. 4,697,595 (Breyer, et al.) and in U.S. Pat. No. 4,706,681 (Breyer, et al.) respectively. Such systems enable the echocardiography guidance of the procedure for deploying a lead as well as the exact localization of the lead tip. If an ultrasonic transducer marks an ablation electrode, the exact position of the ablation electrode can be identified. A system having an ultrasonically marked cardiac ablation electrode wherein the ultrasonic sensitivity characteristics may be either in the same direction as the ablation field or in some other direction is disclosed in U.S. Pat. No. 5,840,030 (Ferek-Petric et al.). The system allows radial orientation of the ultrasonically marked catheter as wells as directional field ablation.

[0006] Electrophysiologists usually monitor the intracardiac potentials to confirm the proper position as well as the proper contact of the electrode with the endocardium. However, the intracardiac potential is discontinuous being characterized with intrinsic deflection, which is repetitive at the frequency of the heartbeats. Distinct ST elevation caused by the injury current confirms the pressure of the electrode to the cardiac muscle. However, dislodgement may also occur anywhere within the cardiac cycle while there is no intracardiac signal. Ultrasonic imaging of the cardiac tissues and an ultrasonically marked ablation catheter allow the distance between the tissue and the ablation electrode to be measured as disclosed in the above-referenced Ferek-Petric patent.

[0007] Although three-dimensional ultrasonic imaging is available, the currently high cost of three-dimensional systems generally prohibits widespread use. Therefore, even with the assistance of ultrasonically marked catheter, the catheter position is generally displayed in two dimensions. The clinician is required to envision the catheter position in three-dimensions, which makes exact positioning of the catheter a challenge. Three dimensional mapping systems have been proposed including the mapping system and method disclosed in U.S. Pat. No. 5,697,377 (Wittkampf et al.). In this system, a catheter is provided with at least one measuring electrode. A voltage is measured between the measuring electrode and a reference electrode, which voltage signal has components corresponding to three orthogonal current signals applied to the patient substantially in the area to be mapped, such as the heart. The three-dimensional location of the catheter within the patient's body may be determined from the measured voltage signal components. This three-dimensional location may be represented relative to reference points on a graphic user interface. Without an anatomical image, however, the clinician must still envision the three-dimensional location of the catheter with respect to the patient's anatomy.

[0008] The present invention provides a system as defined in claim 1.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The following drawings are illustrative of particular embodiments of the invention and therefore do not limit its scope, but are presented to assist in providing a proper understanding of the invention. The drawings are not to scale (unless so stated) and are intended for use in conjunction with the explanations in the following detailed description. The present invention will hereinafter be described in conjunction with the appended drawings, wherein like numerals denote like elements; and

Figure 1 is a schematic diagram of a system in accordance with one embodiment of the present invention;
Figure 2 is a flow chart summarizing the salient steps included in a method of using the described system;
Figure 3 is an schematic of a display of mapped catheter points superimposed on a 2-D ultrasound image according to one embodiment of the present invention;
Figure 4 is a flow chart providing an overview of steps included in a calibration method; and
Figures 5A-C are schematics of two-dimensional four-chamber echocardiogram views of a patient's heart in which two ultrasonically-marked reference catheters have been placed.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] The following detailed description is exemplary in nature and is not intended to limit the scope, applicability, or configuration of the invention in any way. Rather, the following description provides a practical illustration for implementing exemplary embodiments of the invention.

[0011] Figure 1 is a schematic diagram of a mapping system in accordance with an embodiment of the present invention. The mapping system includes a measuring catheter 10 which may be mapped in three dimensions and used for delivering a medical therapy; a reference catheter 36 used in a calibration procedure for aligning ultrasound views and location mapping views; orthogonally-arranged electrodes 30, 31, 32, 33, 34, and 35 defining a local coordinate system of a mapping volume 8; and an ultrasound scanning probe 24. The measuring catheter 10, one or more reference catheters 36, orthogonally-arranged electrodes 30 through 35, and ultrasound scanning probe are coupled to appropriate components included in the mapping system, specifically a location mapping unit 16, an ultrasound imaging unit 18, an optional electrophysiological mapping unit 20, an optional therapy delivery unit 26, and an image display 22.

[0012] The anatomical volume of interest in a patient is indicated as mapping volume 8, which may correspond to a patient's heart. Mapping volume 8 illustrated in Figure 1 is defined by orthogonal coordinates, X, Y, and Z wherein pairs of electrodes, 30 and 31, at locations X and X', 32 and 33, at locations Y and Y', and 34 and 35, at locations Z and Z', such that signal sources included in catheter location mapping circuitry 16 transmit a signal in each of the three orthogonal directions through mapping volume 8. Signal sources and measurement circuitry included in location mapping unit 16 may correspond to the mapping system disclosed in the previously-referenced '377 patent (Wittkampf).

[0013] Figure 1 illustrates catheter 10, having an elongated body, advanced into mapping volume 8. Catheter 10 may be a transvenous cardiac ablation catheter, the system and methods described herein expected to be particularly beneficial in cardiac ablation applications wherein precise positioning of the ablation catheter is critical to therapy success. However, the system and methods described herein may be beneficial in a number of other applications, particularly medical applications wherein a catheter- or lead-based therapy, such as an electrical therapy, a chemical or pharmacological therapy, or a genetic or other biological therapy, requires precise positioning of the catheter or lead delivering the therapy.

[0014] As illustrated in Figure 1, catheter 10 includes a measuring electrode 12 positioned at or near a distal catheter tip 11 and a calibration electrode 14 spaced apart, proximally, from electrode 12. Calibration electrode 14, positioned at a known distance from measuring electrode 12, is used in a calibration procedure for determining coefficients in equations which define measured voltage signal components in the x, y and z directions as functions of the x, y, and z coordinate values for the location of measuring electrode 12. Details regarding the location mapping calibration procedure are provided in the aforementioned '377 Wittkampf patent.

[0015] Although just two electrodes 12 and 14 are shown for the sake of illustration, catheter 10 may further include three, four or more electrodes, i.e. further including electrodes 42, 44 and 46 illustrated in Figure 3, so long as at least one electrode, i.e. measuring electrode 12, is included, preferably at or near the catheter tip 11, and a pair of electrodes, i.e. electrodes 12 and 14, separated by a known distance is included for location mapping calibration purposes. Measuring electrode 12 serves as a mapping electrode for mapping the three dimensional location of catheter tip 11 within mapping volume 8 by measuring a signal between measuring electrode 12 and a reference electrode 15. Figure 1 illustrates reference catheter 36 including reference electrode 15, which is preferably anchored at a fixed location within mapping volume 8.

[0016] Three electrical signals are applied at slightly different frequencies or phases to respective orthogonal electrode pairs 30 and 31, 32 and 33, and 34 and 35 by location mapping unit 16. By adjusting a distinguishing characteristic, such as phase or frequency, for each of the three signals, a voltage signal measured between measuring electrode 12 and reference electrode 15 can be separated out as respective x, y, and z signals. Knowing the calibration coefficients obtained previously in the location mapping calibration procedure, the location of measuring electrode 12 may be derived from the measured voltage signal in orthogonal coordinates. Other two- or three-dimensional mapping techniques may be used to derive the location of one or more electrodes or other mapping elements located on catheter 10. Systems employing electrical signal measurements, such as current, voltage, impedance, or the like, electromagnetic, acoustic or other energy signal measurements from mapping elements positioned on a catheter may be substituted. For example, locating or positioning techniques that may be adapted for use with the present invention are disclosed in U.S. Pat. No. 5,944,022 issued to Nardella et al., U.S. Pat. No. 5,042,486 issued to Pfeiler et al., U.S. Pat. No. 6,104,944 issued to Martinelli, U.S. Pat. No. 5,879,297 issued to Haynor et al., or U.S. Pat. 6,226,543 issued to Gilboa et al.

[0017] Measuring electrode 12 may additionally be used to measure cardiac depolarization signals for electrophysiological mapping purposes. As such, catheter 10 may be further coupled to electrophysiological (EP) mapping unit 20 to allow three-dimensional EP mapping to be performed using any of the catheter electrodes 12 and 14. Electrophysiological mapping apparatus and methods are known in the art.

[0018] When measuring catheter 10 is positioned as desired, an ablation electric field may be generated via electrode 12 to perform cardiac ablation under the control of therapy delivery unit 26. Alternatively, separate ablation and measuring electrodes for location and/or EP mapping may be provided on catheter 10. As noted previously, in alternative embodiments therapy delivery unit 26 may be used to control the delivery of other types of electrical or chemical therapies. Measuring catheter 10 thus serves as a therapy delivery catheter but is referred to herein as the "measuring" catheter in contrast to the "reference" catheter used for making location mapping measurements.

[0019] Figure 1 further illustrates measuring catheter 10 including an ultrasonic marking transducer 13, located in close proximity to electrode 12, and reference catheter 36 including a reference ultrasonic marking transducer 37 located in close proximity to reference electrode 15. Ultrasound markers 13 and 37 may take the form of the transducer assembly disclosed in the '030 Ferek-Petric patent. Measuring catheter 10 and reference catheter 36 each generate an ultrasonic field via ultrasound markers 13 and 37 respectively. As such, measuring catheter 10 and reference catheter 36 are additionally coupled to ultrasound unit 8 to allow an ultrasound field to be generated in a desired direction. Ultrasound scans of a two-dimensional plane within mapping volume 8 may be acquired using an ultrasound probe 24, such as a trans-esophageal probe, to obtain a two dimensional image of the anatomy. An ultrasound scanning plane within mapping volume 8 is defined relative to a location mapping plane by means of ultrasound markers 13 and 37; arming of ultrasound scanning planes with the location mapping coordinate system, by alignment of an initial scanning plane with a location mapping reference plane, is performed in a calibration procedure to be described herein below.

[0020] The present invention may be practiced with the use of three-dimensional ultrasound scanning equipment as it becomes more widely used, however, the benefits of the present invention may be realized with the use of a less costly two-dimensional ultrasound system, which provides a two-dimensional anatomical view allowing an operator to determine a distance between electrode 12 and a cardiac structure. Display 22, i.e. a GUI, illustrated in Figure 1, merges the location mapping, anatomical ultrasound image, and, optionally, EP mapping information into a single visual image, preferably a video image, to assist the operator in ascertaining a position of electrode 12 relative to anatomical structures. Display 22 receives output from location mapping unit 16, ultrasound unit 18, and optionally EP mapping unit 20. Display 22 preferably displays a three-dimensional image of catheter 10 as derived from location mapping measurements performed by location mapping unit 16 superimposed on a two- or three-dimensional anatomical image obtained from ultrasound unit 18. The 3-D location mapping image and 2-D or 3-D anatomical image may also be superimposed on a three-dimensional EP mapping image obtained from EP mapping unit 20.

[0021] Figure 2 is a flow chart summarizing the salient steps included in a method using the system according to the invention. At step 105, a calibration procedure is performed during which an ultrasound scanning plane and a location mapping reference plane are aligned. The reference plane coordinates within the local coordinate system of the location mapping system are then determined so that a relative position between new ultrasound scanning planes and the reference plane are known. These reference plane coordinates are stored at step 115. A calibration method performed at step 105 for arming the ultrasound and location mapping planes will be described in greater detail below.

[0022] At step 120, the position of measuring catheter 10 is adjusted, and then an ultrasound scan repeated at step 125; a resulting ultrasound image is displayed on the associated GUI or display 22 with a designated marker, e.g. a flashing signal, indicating the location of ultrasound marker 13 when it is in the ultrasound scanning plane. For each new ultrasound scan, the relative spatial position of the location mapping reference plane is calculated based on the stored relative coordinate system determined during calibration (step130). At step 135, a perspective grid, i.e. grid 48 illustrated in Figure 3, representing the location mapping reference plane is displayed, superimposed on the new two-dimensional ultrasound image to indicate a spatial angle between the ultrasound scanning plane and the location mapping reference plane. Then, at step 138, measuring catheter electrode locations, i.e. for electrodes 12, 42, 44, and 46 illustrated in Figure 3, are mapped by the location mapping unit and marked relative to the reference plane coordinates on the GUI using designated markers, e.g. color-coded points. Steps 120 through 138 may be repeated until no further adjustments of the measuring catheter position are required. Ablation energy or another therapy may then be delivered at a selected site or sites.

[0023] Figure 3 is a schematic of a display of mapped catheter points superimposed on a 2-D ultrasound image. The display shows measuring catheter 10 having been advanced into the left ventricle (LV) of the heart; an ascending aorta (Ao) and a right ventricle (RV) are also indicated. A flashing signal induced by ultrasound marker 13 indicates the location of measuring electrode 12 and unique symbol shape or color is used to mark locations of additional mapping electrodes 42, 44 and 46 included on measuring catheter 10. Grid 48 provides visualization of the location mapping reference plane, determined during the calibration procedure, with respect to the current ultrasound scanning plane; solid lines extending between the measuring electrode symbols and the reference plane grid 48 provide 3-D perspective visualization of locations of measuring electrodes 12, 42, 44, and 46 with respect to the reference mapping plane, while a dashed line joining the symbols indicates the approximate position of the catheter within the LV.

[0024] As measuring catheter 10 is advanced, ultrasound scans are repeated and, with each new ultrasound scan, the location mapping reference plane may be visualized by displaying reference plane grid 48 relative to the scanning plane. The relative angle between the ultrasound scan and the location mapping reference plane is calculated based on calibration results obtained previously, as will be described below. The electrode locations are then mapped and displayed relative to the reference plane grid 48, superimposed on the ultrasound image.

[0025] Figure 4 is a flow chart providing an overview of steps included in a calibration method 200 for aligning three-dimensional location mapping catheter views with two-dimensional ultrasound views in a super-imposed image. Steps included in calibration method 200 are shown generally divided between steps performed by an operator, steps performed by an ultrasound unit included in the mapping system, and steps performed using the location mapping unit included in the mapping system. Method 200 begins at step 215 wherein a reference catheter and a measuring catheter are positioned in a mapping volume of interest. A three-dimensional view of the measuring and reference electrodes is displayed at step 260 using location mapping techniques. As described in conjunction with Figure 1, each of the reference catheter and measuring catheter include at least one ultrasound marker located adjacent to the reference electrode and measuring electrode, respectively, used for performing location mapping measurements. According to an alternate embodiment, a single catheter is equipped with the measuring electrode and the reference electrode along with associated ultrasound markers to define a common plane between the location mapping world and the ultrasound imaging world.

[0026] In order to align a three-dimensional mapping image and a two-dimensional ultrasound image, the two electrodes and two ultrasound markers are positioned in the mapping volume to thereby define a common plane that may be identified by both the location mapping unit and the ultrasound imaging unit. At step 220, the operator performs an ultrasound scan of a plane within the mapping volume of interest, e.g. the heart. A two-dimensional ultrasound image is displayed at step 225 by image processing circuitry included in the ultrasound unit. The image processing circuitry determines if the at least two ultrasound markers are present in the ultrasound image at decision step 230. If not, the operator adjusts the ultrasound probe position at step 235 and returns to step 220 to perform a new scan. This process (steps 220 through 235) is repeated until both ultrasound markers are displayed in a single ultrasound image plane. Once the scanning plane defined by the two ultrasound markers is found, a signal is generated at step 240 notifying the operator so that he/she may maintain the ultrasound probe position at step 245. An audible or visual signal may be generated by the ultrasound unit to notify the operator that both ultrasound markers are within the imaging plane.

[0027] At step 250, the scanning view is displayed including a display of the two ultrasound markers, which may be visualized by a flashing light or other distinguishing icon. The scanning plane and the plane defined by the measuring and reference electrodes are now aligned. A small but expectedly acceptable error will be inherent in the alignment of the two planes since the ultrasound markers are not located in the exact same position as the measuring and reference electrodes. To minimize the calibration error, the ultrasound markers are preferably located as close as possible to the reference and measuring electrodes on the reference and measuring catheters, respectively.

[0028] Reference points defined by the reference and measuring electrodes and ultrasound markers may thus be registered in the separate two-dimensional ultrasound image and in the three-dimensional mapping image. As such, at step 265, the ultrasound scanning plane and the location mapping plane are armed together. The location of the ultrasound makers, which approximately coincide with the adjacent reference and measuring electrodes, are registered within the location mapping image. An updated three-dimensional image may be displayed at step 270 including individually identifiable markers indicating the reference and measuring electrode and ultrasound marker locations. At step 275, the coordinates of the aligned scanning plane and location mapping reference plane are calculated relative to the three-dimensional location mapping coordinate world and stored within the operating memory of the system. The ultrasound image and the three-dimensional mapping image are then superimposed at step 280 to provide an integrated display at step 295.

[0029] The calibration procedures are now complete and the measuring catheter may be advanced within the mapping volume as indicated by step 290. New ultrasound scans (298) and location mapping images (290) are superimposed in the integrated display (295) as the catheter is advanced to a desired location. As described above in conjunction with Figure 3, each updated display includes a reference grid indicating the angular position of the location mapping reference plane relative to the new ultrasound scanning plane and the measuring electrode locations are indicated by distinctive symbols or icons.

[0030] Figures 5A-C are schematics of two-dimensional four-chamber echocardiogram views of a patient's heart in which two ultrasonically-marked reference catheters have been placed. In Figure 5A, the left ventricle 304, right ventricle 306, left atrium 305 and right atrium 307 are shown in a two-dimensional echocardiography scanning plane. A motor 301 is used to rotate the ultrasonic scanner probe 302. In the view shown in Figure 5A, the ultrasound marker 13 located on measuring catheter 10 is visible as indicated by a flashing signal or other symbol or icon displayed in right ventricle 306. An operator can tilt the scanning probe 302 in order to change the angular orientation of scanning plane 303 relative to the patient's body surface. At a certain angular and polar position of scanner probe 302, both ultrasound markers 13 and 37 will appear in scanning plane 303 as shown in Figure 5C. In a preferred configuration, the ultrasound unit includes processing methods within image processing circuitry for detecting the appearance of two ultrasound markers within the image. When both ultrasound markers are detected, a signal is generated to alert the operator to maintain the probe 302 position and commence with mapping of relevant points, corresponding to the catheter electrodes, by the location mapping unit as described above in conjunction with method 200 shown in Figure 4.

[0031] The calibration method 200 shown in Figure 4 may also be applied in mapping systems including three-dimensional ultrasound imaging of the mapping volume. To obtain a three-dimensional image, the scanning plane 303 (Figures 5A through 5C) is rotated 180 degrees on the probe 302 axis. By arming the ultrasound scanning plane and location mapping image plane together at one ultrasound scanning plane that includes at least two ultrasound markers, the ultrasound and location mapping images may be integrated. The superimposed display of the three-dimensional ultrasound image and the location mapping image can be updated as new three-dimensional ultrasound views are obtained and/or the measuring catheter is advanced. The three-dimensional location mapping image including the distinctive symbols for each measuring electrode present may be observed moving through the three-dimensional ultrasound image. Display of a reference plane grid, as shown in Figure 3, is not necessary for indicating the relative position of the ultrasound scanning plane to the reference plane since both the mapping image and the ultrasound image are displayed in three dimensions.

[0032] Thus, a mapping system has been described wherein a mapped location of one or more electrodes within an electrical mapping volume is superimposed on an ultrasound image corresponding to the mapping volume. The detailed descriptions provided herein are intended to be illustrative, not limiting, with regard to the following claims.

Claims

1. A medical system for superimposing an electrically mapped location of one or more electrodes onto a corresponding ultrasound image, comprising:

    a measuring electrode (12);
    an ultrasound marking transducer (13) located in close proximity to the measuring electrode;
    a calibration electrode (14) spaced apart from the measuring electrode;
    a reference electrode (15) spaced apart from the measuring electrode and the calibration electrode;
    a reference ultrasound marking transducer (37) located in close proximity to the reference electrode;
    a plurality of orthogonally-arranged electrodes (30-35) for defining a local coordinate system of the mapping volume;
    a location mapping unit (16) adapted to define the mapping volume and to locate the measuring electrode within the mapping volume; and
    an ultrasound unit (18) adapted to generate an image of a patient's anatomy; and
    a display unit (22) adapted to receive data from the location mapping unit and from the ultrasound unit and to superimpose the location of the measuring electrode onto the ultrasound image;
    wherein, during use of the system, the relative location of a reference plane in the mapping volume with respect to the ultrasound image is established by aligning an initial ultrasound scanning plane with the location mapping reference plane by means of the ultrasound marking transducer and the reference ultrasound marking transducer.

2. The mapping system of claim 1, wherein the measuring electrode (12), the ultrasound marking transducer (13) and the calibration electrode (14) are all included on a single elongated medical device (10).

3. The mapping system of claim 1 or 2, wherein the measuring electrode (12) is further adapted for delivering ablation energy.

4. The mapping system of claim, 1, 2 or 3, further comprising one or more additional measuring electrodes.

5. The mapping system of claim 1, wherein the measuring electrode (12) and the ultrasound marking transducer (13) are both included on a single elongated medical device (10) and the measuring electrode and the transducer are aligned with one another along a longitudinal axis of the said medical device.

Patentansprüche

1. Medizinisches System zum Überlagern eines elektrisch abgebildeten Ortes einer oder mehrerer Elektroden mit einem entsprechenden Ultraschallbild, das enthält:

eine Messelektrode (12);
einen Ultraschallmarkierungswandler (13), der sich sehr nahe bei der Messelektrode befindet;
eine Kalibrierungselektrode (14), die von der Messelektrode beabstandet ist;
eine Referenzelektrode (15), die von der Messelektrode und der Kalibrierungselektrode beabstandet ist;
einen Referenz-Ultraschallmarkierungswandler (37), der sich sehr nahe bei der Referenzelektrode befindet;
mehrere zueinander senkrecht angeordnete Elektroden (30-35), um ein lokales Koordinatensystem des Abbildungsvolumens zu definieren;
eine Ortsabbildungseinheit (16), die dafür ausgelegt ist, das Abbildungsvolumen zu definieren und die Messelektrode in dem Abbildungsvolumen zu lokalisieren; und
eine Ultraschalleinheit (18), die dafür ausgelegt ist, ein Bild der Anatomie eines Patienten zu erzeugen; und
eine Anzeigeeinheit (22), die dafür ausgelegt ist, Daten von der Ortsabbildungseinheit und von der Ultraschalleinheit zu empfangen und den Ort der Messelektrode mit dem Ultraschallbild zu überlagern;
wobei während der Verwendung des Systems der relative Ort einer Referenzebene in dem Abbildungsvolumen in Bezug auf das Ultraschallbild durch Ausrichten einer anfänglichen Ultraschallabtastebene auf die Ortsabbildungsreferenzebene mittels des Ultraschallmarkierungswandlers und des Referenz-Ultraschallmarkierungswandlers gebildet wird.

2. Abbildungssystem nach Anspruch 1, wobei die Messelektrode (12), der Ultraschallmarkierungswandler (13) und die Kalibrierungselektrode (14) sämtlich in einer einzigen lang gestreckten medizinischen Vorrichtung (10) enthalten sind.

3. Abbildungssystem nach Anspruch 1 oder 2, wobei die Messelektrode (12) ferner dafür ausgelegt ist, Ablationsenergie zu liefern.

4. Abbildungssystem nach Anspruch 1, 2 oder 3, das ferner eine oder mehrere zusätzliche Messelektroden enthält.

5. Abbildungssystem nach Anspruch 1, wobei sowohl die Messelektrode (12) als auch der Ultraschallmarkierungswandler (13) in einer einzigen lang gestreckten medizinischen Vorrichtung (10) enthalten sind und die Messelektrode und der Wandler längs einer Längsachse dieser medizinischen Vorrichtung aufeinander ausgerichtet sind.

Revendications

1. Système médical pour superposer un emplacement mappé électriquement d'une ou plusieurs électrodes sur une image à ultrasons correspondante comportant :

un transducteur de marquage à ultrasons (13) positionné à proximité étroite de l'électrode de mesure ;
une électrode d'étalonnage (14) espacée de l'électrode de mesure ;
une électrode de référence (15) espacée de l'électrode de mesure et de l'électrode d'étalonnage ;
un transducteur de marquage à ultrasons de référence (37) positionné à proximité étroite de l'électrode de référence ;
une pluralité d'électrodes agencées orthogonalement (30-35) pour définir un système de coordonnées locales du volume de mappage ;
une unité de mappage d'emplacement (16) adaptée pour définir le volume de mappage et pour localiser l'électrode de mesure dans le volume de mappage ; et
une unité à ultrasons (18) adaptée pour générer une image d'une anatomie d'un patient ; et
une unité d'affichage (22) adaptée pour recevoir des données en provenance de l'unité de mappage d'emplacement et en provenance de l'unité à ultrasons et pour superposer l'emplacement de l'électrode de mesure sur l'image à ultrasons ;
dans lequel, pendant l'utilisation du système, l'emplacement relatif d'un plan de référence

dans le volume de mappage par rapport à l'image à ultrasons est établi en alignant un plan de balayage à ultrasons initial avec le plan de référence de mappage d'emplacement par l'intermédiaire du transducteur de marquage à ultrasons et du transducteur de marquage à ultrasons de référence.

2. Système de mappage selon la revendication 1, dans lequel l'électrode de mesure (12), le transducteur de marquage à ultrasons (13) et l'électrode étalonnage (14) sont tous inclus sur un dispositif médical allongé unique (10).

3. Système de mappage selon la revendication 1 ou 2, dans lequel l'électrode de mesure (12) est en outre adaptée pour délivrer une énergie d'ablation.

4. Système de mappage selon la revendication 1, 2 ou 3, comportant en outre une ou plusieurs électrodes de mesure supplémentaires.

5. Système de mappage selon la revendication 1, dans lequel l'électrode de mesure (12) et le transducteur de marquage à ultrasons (13) sont tous les deux inclus sur un dispositif médical allongé unique (10) et l'électrode de mesure et le transducteur sont alignés l'un sur l'autre le long d'un axe longitudinal dudit dispositif médical.

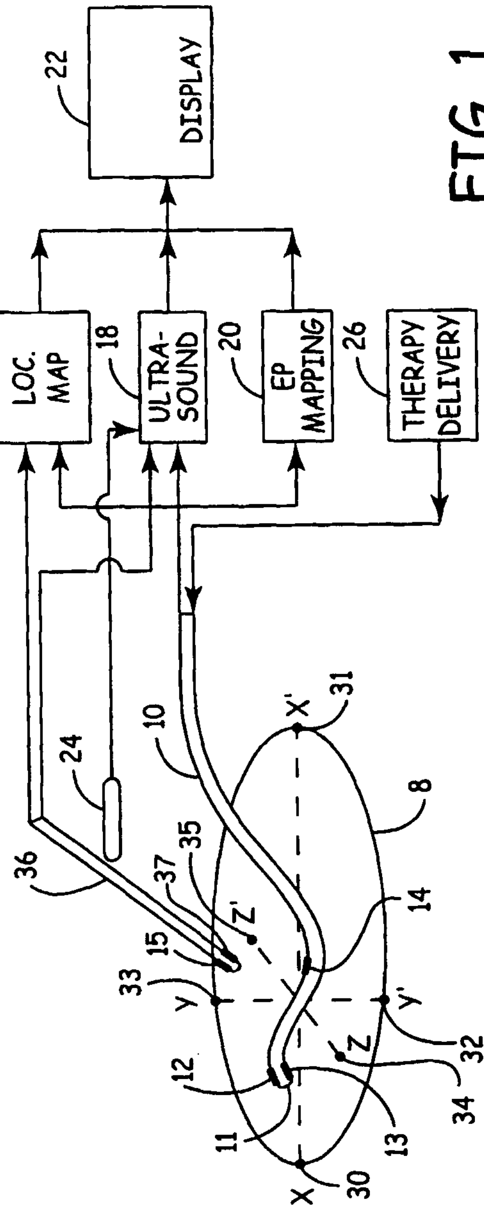

FIG. 1

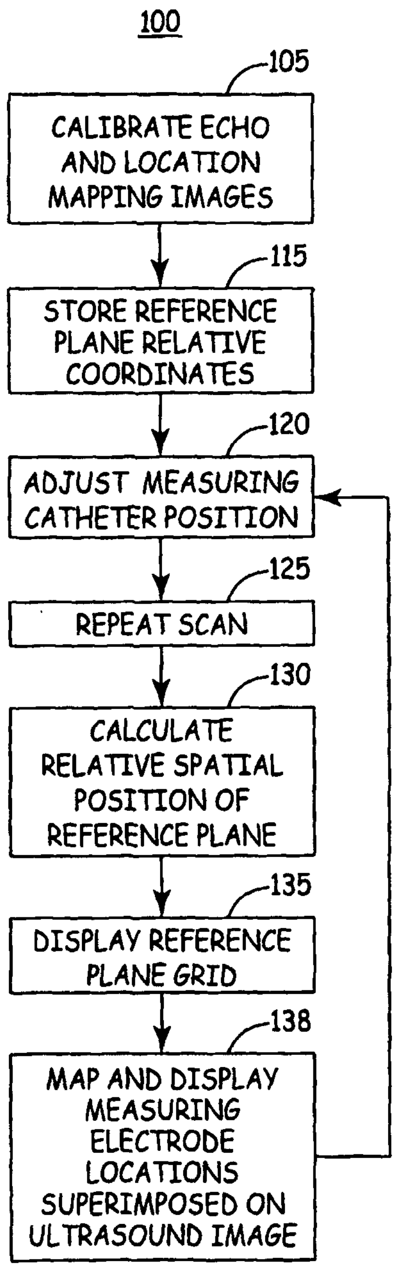
100
105
CALIBRATE ECHO AND LOCATION MAPPING IMAGES
115
STORE REFERENCE PLANE RELATIVE COORDINATES
120
ADJUST MEASURING CATHETER POSITION
125
REPEAT SCAN
130
CALCULATE RELATIVE SPATIAL POSITION OF REFERENCE PLANE
135
DISPLAY REFERENCE PLANE GRID
138
MAP AND DISPLAY MEASURING ELECTRODE LOCATIONS SUPERIMPOSED ON ULTRASOUND IMAGE

FIG. 2

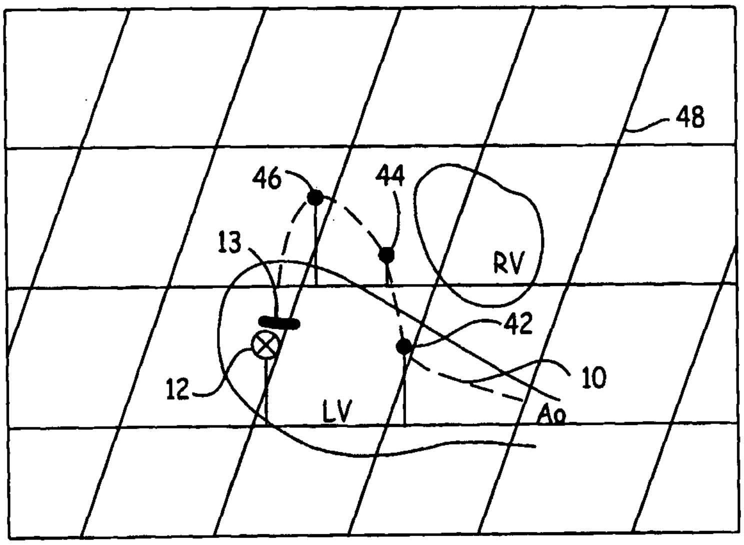

FIG. 3

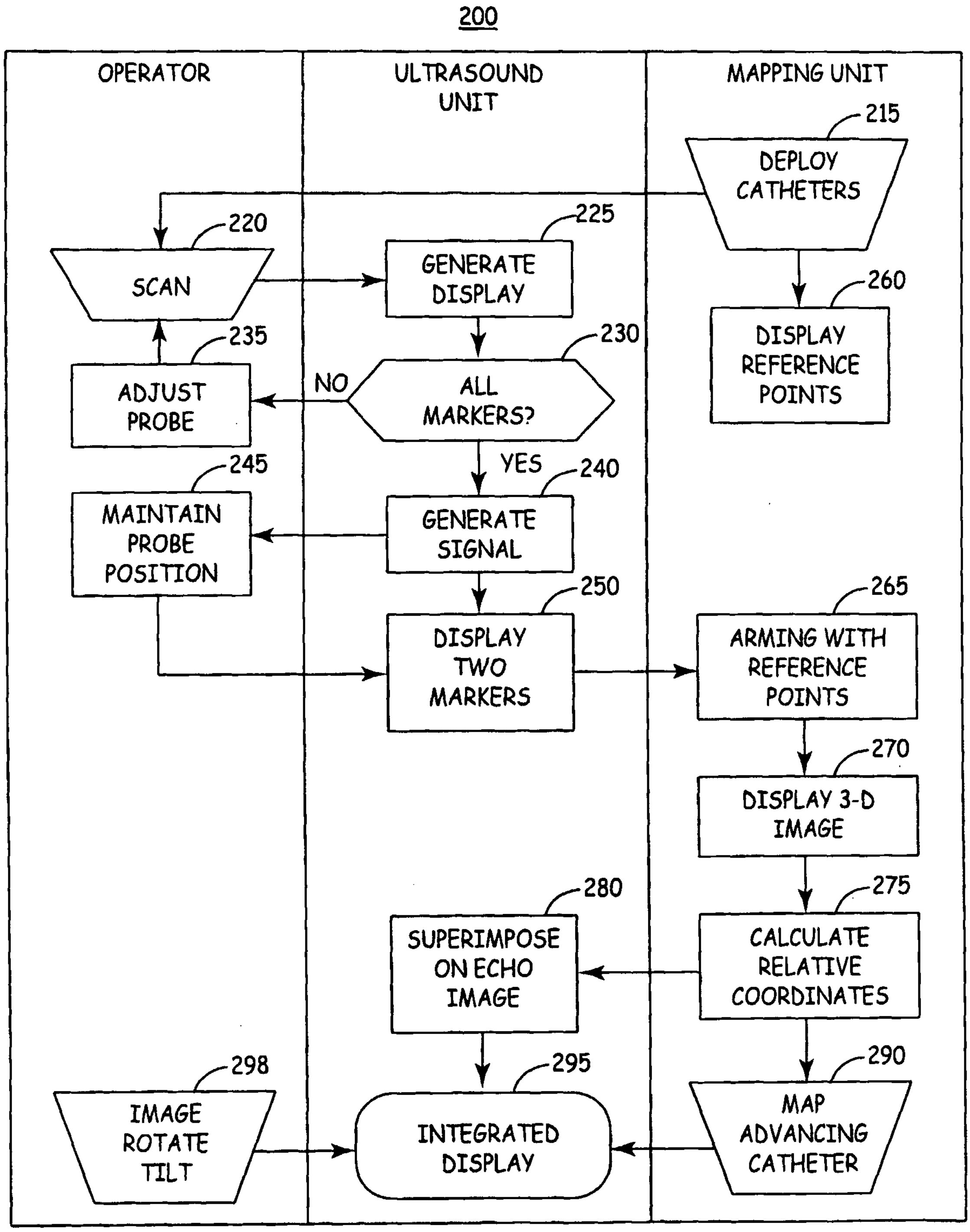
200
OPERATOR
ULTRASOUND UNIT
MAPPING UNIT
215
DEPLOY CATHETERS
220
SCAN
225
GENERATE DISPLAY
260
DISPLAY REFERENCE POINTS
235
ADJUST PROBE
NO
230
ALL MARKERS?
YES
240
245
MAINTAIN PROBE POSITION
GENERATE SIGNAL
250
DISPLAY TWO MARKERS
265
ARMING WITH REFERENCE POINTS
270
DISPLAY 3-D IMAGE
280
SUPERIMPOSE ON ECHO IMAGE
275
CALCULATE RELATIVE COORDINATES
298
IMAGE ROTATE TILT
295
INTEGRATED DISPLAY
290
MAP ADVANCING CATHETER

FIG. 4

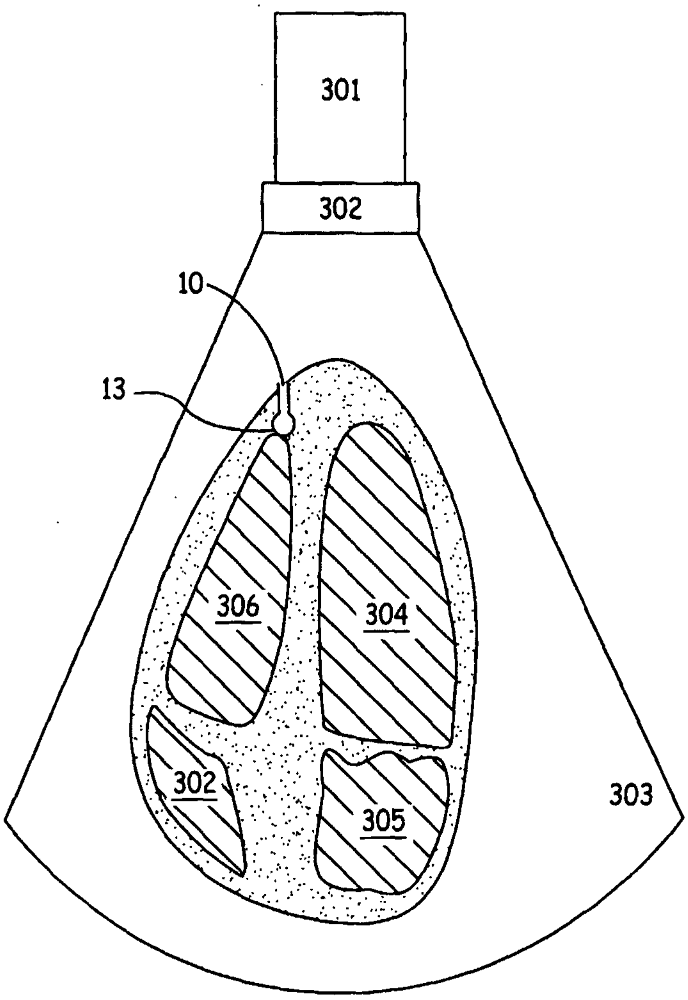

FIG. 5A

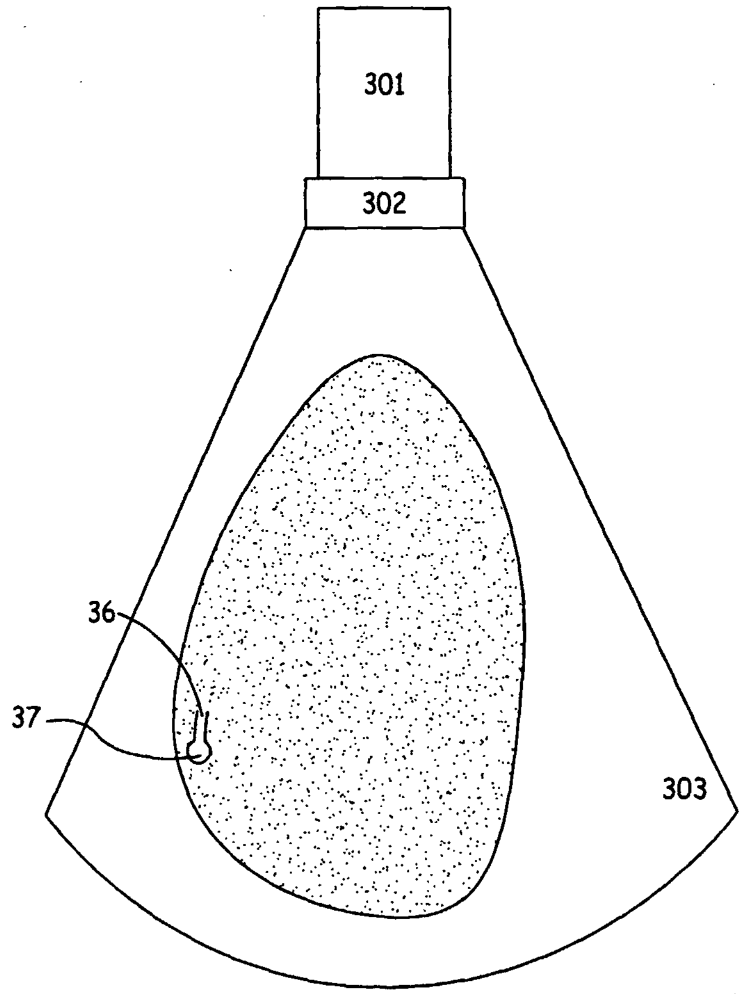

FIG. 5B

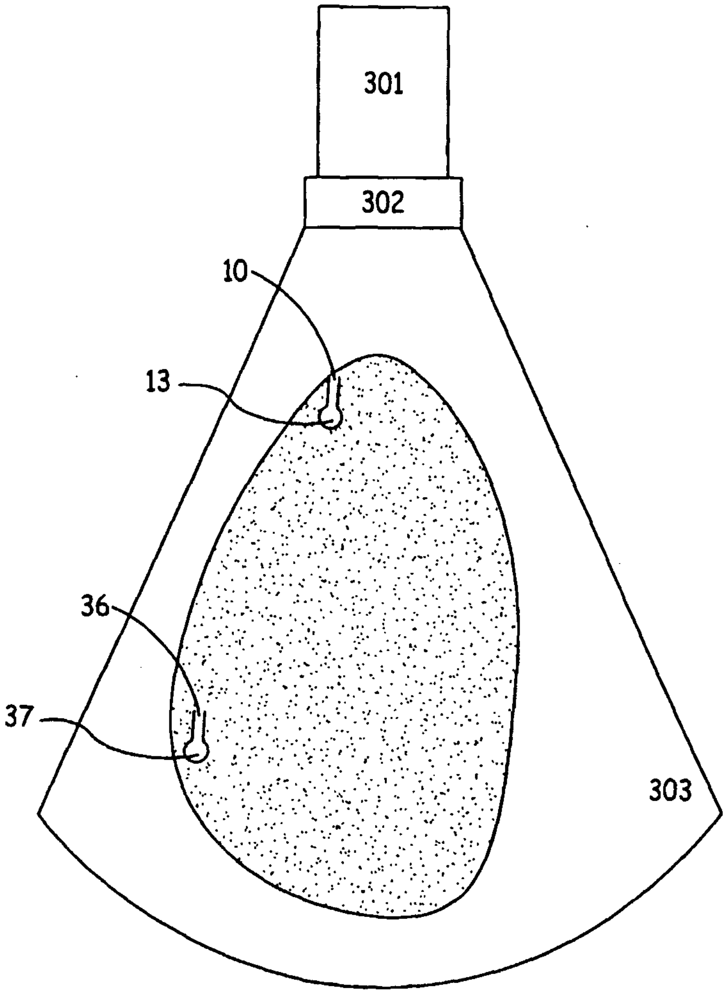

FIG. 5C

REFERENCES CITED IN THE DESCRIPTION

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专利名称(译)	用于将电极的电映射位置叠加到相应的超声图像上的系统		
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[标]申请(专利权)人(译)	美敦力公司		
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当前申请(专利权)人(译)	美敦力公司，INC.		
[标]发明人	FEREK PETRIC BOZIDAR		
发明人	FEREK-PETRIC, BOZIDAR		
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外部链接	Espacenet		

摘要(译)

电映射体积内的一个或多个电极的映射位置被叠加到对应于电气映射体积的超声图像上。