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(54) AUTOMATED BIPLANE-PW WORKFLOW FOR ULTRASONIC STENOSIS ASSESSMENT

AUTOMATISIERTER ZWEI-EBENEN-WORKFLOW ZUR ULTRASCHALL-STENOSEUNTERSUCHUNG

FLUX DE TRAVAIL BIPLANAIRE/ONDES PULSÉES AUTOMATISÉ POUR L'ÉVALUATION D'UNE STÉNOSE PAR ULTRASONS

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EP 2 900 143 B1

Description

[0001] This invention relates to medical diagnostic systems and, in particular, to diagnostic ultrasound systems for assessing blood flow through stenotic blood vessels or at other points in the cardiovascular system.

[0002] A significant procedure in many standard vascular ultrasound exams is to obtain an assessment of a stenosis, or narrowing, of an artery. This is typically assessed using Color Doppler to find the stenosis and PW-Doppler to measure the peak flow velocity, which is correlated with the degree of stenosis. Although this is a well established workflow for assessing a vascular stenosis, it is subject to a number of limitations well known to clinical users. First, there are many manual steps involved that require an experienced user in order to perform them successfully and also can require a significant amount of time. Also, since the user can only visualize the vessel flow by means of the color Doppler display in one two dimensional (2D) image plane, the procedure requires repositioning the ultrasound probe by manually tilting it to precisely visualize the location of peak velocity blood flow. It is difficult for the user to be sure that she is actually aligned with the peak velocity flow. Experienced users utilize the Doppler audio to blindly locate the highest stenotic site in the perpendicular plane of the image. This takes time and can also result in inaccurate peak velocity measurements when the alignment is not precise. Finally, it is also difficult to be sure that the angle correction, which attempts to set the optimal angle between the flow direction and the Doppler line (and is required to determine the actual flow velocity), is correct when the vessel is only seen in one plane. Inaccurate angle correction can lead to the possibility of incorrect peak velocity measurements, and inconsistent results between repeat measurements, different users and different labs. Accordingly it is desirable to provide an ultrasound workflow for a vascular procedure which overcomes these sources of error, inaccuracy, and procedural difficulty.

[0003] This object is solved by the independent claim. Advantageous embodiments are defined in the dependent claims. Document US 2008/0242996 A1 can be considered as closest prior art document. It discloses a method for operating an ultrasonic diagnostic imaging system having a matrix array probe operable in the biplane mode for the conduct of blood flow assessment comprising:

1. imaging a blood vessel in biplane mode and simultaneously displaying first and second biplane images of first and second image planes;
2. locating a Doppler sample volume in the first image;
3. locating the Doppler sample volume in the second image;
4. acquiring a spectral Doppler display of the flow velocities at the Doppler sample volume location; and
5. measuring velocity characteristics using the acquired spectral Doppler display. In accordance with the principles of the present invention a diagnostic ultrasound system and workflow are described in which two imaging planes at different orientations are acquired and displayed simultaneously. The two planes are intersecting image planes in the body which enable visualization of the stenosis or site under investigation and angle correction in one plane and independent Doppler sample volume (SV) placement in both planes. A semi-automated implementation is described in which the two image planes automatically adjust their relative orientation to maintain visualization of the sample volume in both planes. In an automated implementation optimization of a number of steps of the workflow are performed automatically.

[0004] In the drawings:

FIGURE 1 illustrates in block diagram form an ultrasonic diagnostic imaging system constructed in accordance with the present invention.

FIGURE 2 illustrates an ultrasound display screen for a conventional ultrasound stenosis assessment exam.

FIGURE 3 illustrates the workflow of a typical ultrasound stenosis assessment exam.

FIGURE 4 illustrates an ultrasound display screen for an ultrasound stenosis assessment exam in accordance with the present invention.

FIGURE 5 illustrates the workflow of an ultrasound stenosis assessment exam in accordance with the principles of the present invention.

FIGURE 6 illustrates the workflow of a highly automated ultrasound stenosis assessment exam in accordance with the principles of the present invention.

[0005] Referring first to FIGURE 1, an ultrasound system constructed in accordance with the principles of the present invention is shown in block diagram form. An ultrasound probe 10 contains a transducer array 12 of transducer elements which transmit ultrasound waves into the body and receive returning echo signals. The transmitted waves are directed in beams or scanlines to interrogate a region of interest in the body. A one-dimensional array can be used to transmit beams over a single plane for two dimensional imaging. For a stenosis assessment exam in accordance with the present invention, the probe 10 is a matrix array probe having a two-dimensional array of transducer elements 500 coupled to a probe microbeamformer 502. A matrix array probe can be used to transmit beams over a volumetric region of the body for three dimensional imaging. The beams can be steered and focused in different directions by the probe to interrogate tissue in specific locations or blood flow in specific directions as explained more fully below. For a workflow of the present invention the matrix array probe is operable in a biplane mode as described in US

Pat. 6,709,394 (Frisa et al.) in which two intersecting planes in a three dimensional region are scanned and imaged simultaneously. Control and processing of beams on transmit and receive is provided by a beamformer controller 16, which controls the microbeamformer 502 and a system beamformer 14 to transmit properly formed beams and beamform the received signals through delay and summation into coherent echo signals. In a two-stage beamforming system as shown in FIGURE 1, partial beamforming of received signals is performed by the microbeamformer and completion of the beamforming process is performed by the system beamformer. The beamformers can control the transducer array to scan beams over a desired image plane, for example, and to repetitively scan beams over an area of the image plane in which blood flow is to be assessed at a pulse repetition frequency (PRF) appropriate for the velocities of blood flow present in that region of the body.

[0006] A quadrature bandpass filter 18 processes the echo signals into quadrature I and Q components. The separate components are used by a Doppler angle estimator 20 to estimate the phase or frequency shift of a Doppler signal at points where Doppler interrogation is to be performed. A B mode detector 22 uses the I and Q components to perform B mode detection for tissues images by taking the square root of the sum of the squares of the I and Q components. The detected echo intensities are processed by a B mode image processor 24 on a spatial basis to form a two or three dimensional image of the tissue in the body, which is processed for display by display processor 36 and displayed on display screen 52.

[0007] The Doppler frequencies at locations in the image plane which are produced by the Doppler angle estimator 20 can be mapped directly to velocity values of flow at those locations. This Doppler data is coupled to a colorflow processor 30 which spatially processes the data into a two or three dimensional image format, in which the velocity values are color-coded. This Doppler color map is overlaid over the spatially corresponding B mode image by the display processor 36 to illustrate the locations in the anatomy where flow is taking place and the velocity and direction of that flow by the color coding. Doppler data from a particular point in the image, selected by placement of a sample volume SV over that location in the image, is coupled to a spectral Doppler processor 32 which produces a spectral display of the variation and distribution of flow velocities at that point with time. The spectral Doppler display is forwarded to the display processor 36 for processing and display of the spectral Doppler display on the display screen 52.

[0008] For a stenosis exam workflow of the present invention, colorflow data from the colorflow processor 30 and, preferably, spatially corresponding B mode data from the B mode processor 24, is coupled to a color box position and steering angle processor 40. The color box position and steering angle processor controls the automation of settings and features of the colorflow image, including properly positioning the color box, setting the Doppler angle of the Doppler beams, locating the sample volume SV in the image, and proper positioning of the flow angle cursor for Doppler angle correction. For control of the Doppler angle the color box position and steering angle processor is coupled to the beamformer controller 16 to control the Doppler beam directions. Setup and control of the color box position and steering angle processor is provided by the setting of controls on a user control panel 50. Graphical display of functions controlled by the color box position and steering angle processor, such as the outline of the color box, the sample volume graphic, and the flow angle cursor, is provided through a graphics processor 34 which is coupled to the display processor 36 to overlay the graphics over the ultrasound images. The operation of the color box position and steering angle processor 40 is more fully described in US patent application serial number 61/541,353, entitled ULTRASOUND SYSTEM WITH AUTOMATED DOPPLER FLOW SETTINGS, and filed September 30, 2011, on which the later application US 2014/0221838 A1 is based. FIGURE 2 shows an ultrasound system display of a typical colorflow/spectral Doppler duplex image for conduct of a stenosis assessment exam in accordance with the current standard of practice. A two dimensional (2D) anatomical ultrasound image 60 is at the top of the screen and a spectral Doppler display 62 is at the bottom of the screen. Doppler interrogation is done inside the color box 70, and a colorflow image is displayed inside this box. The surrounding portion of the image outside the color box 70 is shown in B mode grayscale without the color Doppler overlay. The use of a color box delineates the region where Doppler is to be performed, and repeated Doppler transmission for Doppler ensemble acquisition is not performed outside of the color box. Restricting the Doppler transmission to only the color box eliminates the need for repeated line interrogation outside the box and hence limits the total number of transmit-receive cycles needed to produce the image, thereby reducing the time needed to acquire the image which improves the real time frame rate of display. The Doppler beams for the spectral Doppler data are transmitted and received along the beam direction line 68 and the data used for the spectral Doppler display are acquired from echoes returning from the sample volume SV on the beam direction line. The Doppler flow direction cursor 66, used for angle correction, is aligned with the longitudinal orientation of the blood vessel 64 and is thus substantially parallel with the flow direction in the vessel, and the Doppler steering angle is the vertical angle of the color box 70 and the beam direction line 68, which are generally parallel to each other. In this example the Doppler steering angle is set to approximately a 60° angle with the longitudinal direction of the blood vessel 64.

[0009] With the aid of a duplex Doppler display as shown in FIGURE 2, a typical ultrasound stenosis exam proceeds as shown by the workflow of FIGURE 3. First, the ultrasound system is set to the color Doppler mode to image the site of the stenosis in a blood vessel 64 in a color Doppler image 60 as indicated at step 80. The color Doppler image is optimized in step 81 by positioning the sample volume SV over the vessel 64 and adjusting the color Doppler steering angle, the longitudinal angle of the color box 70. The clinician then examines the image to search for the highest velocity flow in the vessel 64 as represented by colors associated with the higher velocities on the color Doppler scale 61, in step 82. In step 83 the clinician tilts the probe 10 while continuing to observe the color Doppler image in an effort to ensure that the scan plane of the image intersects the vessel 64 at the location of the peak flow velocity. This is essentially a blind search because each change of the scan plane presents new Doppler values in a new image which must be examined carefully in comparison with colors previously seen in other planes to assure that the peak velocity color is present in the image. Once the clinician is confident she is imaging the peak velocity location, the PW (pulse wave) Doppler mode is activated to display the PW Doppler beam direction line 68 and the line is positioned and the Doppler sample volume SV placed on it at the peak velocity location in the image as indicated in step 84. Since a new image plane is being imaged, optimization of the color Doppler image (step 81) may have to be repeated. The scrolling display of the PW Doppler spectrum is now started (step 85), producing the spectral Doppler display 62 of flow velocities at the SV location as shown at the bottom of the screen. The PW Doppler display is optimized in step 86 by adjusting settings such as that for the Doppler scale, Doppler angle, sample volume size, and angle correction. The probe is now tilted again as indicated in step 87 to maximize the PW Doppler signal strength and/or velocity, to ensure that the maximum flow velocities are being recorded in the spectral display. The scrolling spectral Doppler display is captured (stopped on the screen; saved) in step 88, at which time the peak velocities and other parameters of the blood flow may be measured from the display.

[0010] As can be appreciated from the foregoing, this procedure entails a great deal of probe manipulation and ultrasound system setting adjustment, all of which benefit from extensive experience and expertise from the clinician. These difficulties are addressed in accordance with the present invention by conducting the stenosis exam with a matrix array probe operating in the biplane mode as illustrated by the ultrasound system screen display of FIGURE 4 in conjunction with the workflow diagram of FIGURE 5. FIGURE 4 shows a duplex ultrasound display but with two biplane images 42 and 44. In the biplane mode a two dimensional array transducer 500 alternately scans two different planes in the body, producing the two images 42 and 44. Generally one of the images such as the left image in FIGURE 4 is that of a reference plane projecting normal to the center of the transducer array. The second image, image 44 in this example, is then rotated and/or tilted about the plane of the reference image. In a preferred implementation of the present invention, both image planes can be repositioned with respect to each other. So that both left and right planes make sense and their orientation can be easily understood by the user, the planes intersect at the location of the center of the SV and along a vector defined by the PW Doppler beam line 68. This means that, if the left image 42 is in the plane of the drawing, the right image plane 44 is tilted out of the plane of the drawing when Color/PW is steered in the left plane. Lateral movement by the user of the SV in the left plane will cause the right plane to translate laterally so that the right image 44 always shows where the SV is in that image plane. Moving the SV in the right plane 44 will likewise translate the plane of the left image, this time in elevation (in or out of the plane of the drawing). For a trapezoidal biplane format the planes (and the PW Doppler line 68) will originate from a common origin, and so all the planes will tilt instead of translate.

[0011] With the duplex display of FIGURE 4, an ultrasound stenosis exam can proceed as shown by the workflow of FIGURE 5. The stenotic blood vessel 64 is imaged in biplane in the color Doppler mode as indicated at step 90. In step 91 the color Doppler image is optimized by positioning the sample volume SV over the vessel 64 and selecting an optimal color Doppler steering angle, the angle of the color box 70a. The clinician examines the left biplane image 60a to search for the highest velocity flow in the vessel 64 as represented by colors associated with the higher velocities on the color Doppler scale 61, in step 92. In step 93 the PW Doppler mode is activated, the PW Doppler beam line 68 is displayed over the left image 60a, and the clinician adjust the positions of the line 68 and the sample volume SV along the line. In this example the plane of the right biplane image 60b is aligned with the PW Doppler beam line 68. In step 94 the SV shown in the right image 60b is adjusted to center it on the peak color velocity in the cross-sectional view of the vessel 64 in this image plane. The clinician can preferably adjust the position of the SV in the right image plane both laterally and axially onto the peak flow velocity in the right image. No color angle adjustment is needed for this image. When the SV is repositioned laterally, the left image plane may change slightly in elevation to keep both planes aligned along the PW beam line 68. In a simplified implementation the SV is restricted to only axial (depth) adjustment and lateral adjustment is done by moving or rocking the probe in elevation so that the line 68 is over the peak velocity location in the right image. Again, the left image plane plane may move in correspondence with the adjustment.

[0012] The scrolling of the PW Doppler spectral display 62 is started in step 95 and the spectral display is optimized as needed, as described above, in step 96. The scrolling spectral Doppler display is captured in step 97, and the peak velocities and other parameters of the blood flow measured from the display.

[0013] The procedure of the workflow of FIGURE 5 can be automated to even further relieve user manipulation and increase precision as illustrated by the automated stenosis assessment workflow of FIGURE 6, in which steps previously described in FIGURE 5 are given the same reference numerals. In step 193 the positioning of the sample volume SV and the setting of the optimal Doppler steering angle in the left image plane are done automatically for the user. Apparatus and techniques for automating these adjustments are described in the aforementioned US patent application serial number 61/541,353. This application also describes the automatic setting of the angle correction cursor 66, as well as automated centering of the sample volume location in the color box 70a. The automated adjustment of the sample volume location in the left image plane 60a will cause a tilt or translation of the position of the plane of the right image 60b. In step 194 the processor 40 in a similar manner automatically positions the sample volume SV at the peak velocity location in the plane of the right image. Again, this will cause a translation or tilt effect on the left image plane. In step 195 the scrolling of the PW Doppler spectral display starts automatically after the previous adjustments are made, and in step 196 the spectral display is optimized automatically to set the Doppler scale, baseline, and gain as described in international patent publication WO 2003/019227 (Christopher et al.) entitled "AUTOMATIC OPTIMIZATION OF DOPPLER DISPLAY PARAMETERS." The clinician is thus quickly and accurately brought to the point where the Doppler spectrum of the stenotic blood flow can be captures and its characteristics measured.

[0014] While the method of the present invention is ideally suited for assessing the flow characteristics of a stenosis, it will be appreciated that the inventive method is useful in other cardiovascular procedures where the peak velocity of blood flow is to be measured, such as an investigation of the hemodynamics within the chambers of the heart and of blood flow through valves.

Claims

1. A method for operating an ultrasonic diagnostic imaging system having a matrix array probe operable in the biplane mode for the conduct of blood flow assessment comprising:

   imaging a blood vessel (64) in biplane color Doppler mode (90) and simultaneously displaying first (42) and second (44) biplane images of first and second image planes, the first biplane image being a longitudinal cross-sectional view of the blood vessel and the second biplane image being a transverse cross-sectional view of the blood vessel, wherein at least one of the first and second biplane images has a Doppler beam line (68) intersecting the blood vessel in the image, wherein the first and second image planes intersect along the Doppler beam line;
   locating (93) a Doppler sample volume (SV) at a peak velocity location in the first biplane image, wherein the orientation of the second image plane is automatically adjusted relative to the first image plane in response to the first locating step, so that the first and second image planes intersect at the location of the center of the Doppler sample volume and along the Doppler beam line; locating (94) the Doppler sample volume at the peak velocity location in the second biplane image, wherein the orientation of the first image plane is automatically adjusted relative to the second image plane in response to the second locating step, so that the first and second image planes intersect at the location of the center of the Doppler sample volume and along the Doppler beam line;
   acquiring (95) a spectral Doppler display of the flow velocities at the Doppler sample volume location; and
   measuring (97) velocity characteristics using the acquired spectral Doppler display.

2. The method of Claim 1, wherein locating (93) a Doppler sample volume at a peak velocity location in the first biplane image (42) further comprises positioning a Doppler sample volume graphic along a Doppler beam line (68) in the first biplane image.

3. The method of Claim 1, wherein locating(94) a Doppler sample volume at a peak velocity location in the second biplane image (44) further comprises positioning a Doppler sample volume graphic along a Doppler beam line (68) in the second biplane image.

4. The method of Claim 1, wherein acquiring (95) a spectral Doppler display further comprises acquiring a Doppler spectral display by means of PW Doppler acquisition.

5. The method of Claim 4, wherein the PW Doppler acquisition is in the direction of the Doppler beam line.

6. The method of Claim 1, wherein locating (93, 94) a Doppler sample volume at a peak velocity location in the first or second biplane image further comprises automatically positioning a sample volume graphic in an image.

7. The method of Claim 1, wherein acquiring (95) a spectral Doppler display further comprises automatically starting (195) the scrolling of a spectral Doppler display.

8. The method of Claim 1, wherein imaging a blood vessel in biplane color Doppler mode (90) further comprises automatically optimizing (91) a biplane color Doppler image.

9. The method of Claim 1, wherein acquiring (95) a spectral Doppler display further comprises automatically optimizing (196) a spectral Doppler display.

10. An ultrasonic diagnostic imaging system constructed to carry out the method of any of the claims 1-9.

Patentansprüche

1. Verfahren zum Betreiben eines Ultraschallsystems zur diagnostischen Bildgebung mit einer Matrixarraysonde, die in dem Zwei-Ebenen-Modus betrieben werden kann, um eine Blutflussbeurteilung durchzuführen, umfassend:

bildgebendes Darstellen eines Blutgefäßes (64) im Zwei-Ebenen-Farbdopplermodus (90) und gleichzeitiges Anzeigen von ersten (42) und zweiten (44) Zwei-Ebenen-Bildern von ersten und zweiten Bildebenen, wobei das erste Zwei-Ebenen-Bild eine longitudinale Querschnittsansicht des Blutgefäßes ist und das zweite Zwei-Ebenen-Bild eine transversale Querschnittsansicht des Blutgefäßes ist, wobei mindestens eines von den ersten und den zweiten Zwei-Ebenen-Bildern eine Dopplerstrahllinie (68) hat, die das Blutgefäß in dem Bild schneidet, wobei sich die erste und die zweite Bildebene entlang der Dopplerstrahllinie schneiden;
Lokalisieren (93) eines Dopplerprobenvolumens (SV) an einem Spitzengeschwindigkeitsort in dem ersten Zwei-Ebenen-Bild, wobei die Orientierung der zweiten Bildebene in Reaktion auf den ersten Lokalisierungsschritt automatisch in Bezug auf die erste Bildebene angepasst wird, sodass sich die erste und die zweite Bildebene an dem Ort der Mitte des Dopplerprobenvolumens und entlang der Dopplerstrahllinie schneiden;
Lokalisieren (94) des Dopplerprobenvolumens an dem Spitzengeschwindigkeitsort in dem zweiten Zwei-Ebenen-Bild, wobei die Orientierung der ersten Bildebene in Reaktion auf den zweiten Lokalisierungsschritt automatisch in Bezug auf die zweite Bildebene angepasst wird, sodass sich die erste und die zweite Bildebene an dem Ort der Mitte des Dopplerprobenvolumens und entlang der Dopplerstrahllinie schneiden;
Erfassen (95) einer spektralen Doppleranzeige der Flussgeschwindigkeiten an dem Dopplerprobenvolumenort; und
Messen (97) von Geschwindigkeitseigenschaften unter Verwendung der erfassten spektralen Doppleranzeige.

2. Verfahren nach Anspruch 1, wobei das Lokalisieren (93) eines Dopplerprobenvolumens an einem Spitzengeschwindigkeitsort in dem ersten Zwei-Ebenen-Bild (42) weiterhin das Positionieren einer Dopplerprobenvolumengrafik entlang einer Dopplerstrahllinie (68) in dem ersten Zwei-Ebenen-Bild umfasst.

3. Verfahren nach Anspruch 1, wobei das Lokalisieren (94) eines Dopplerprobenvolumens an einem Spitzengeschwindigkeitsort in dem zweiten Zwei-Ebenen-Bild (44) weiterhin das Positionieren einer Dopplerprobenvolumengrafik entlang einer Dopplerstrahllinie (68) in dem zweiten Zwei-Ebenen-Bild umfasst.

4. Verfahren nach Anspruch 1, wobei das Erfassen (95) einer spektralen Doppleranzeige weiterhin das Erfassen einer spektralen Doppleranzeige mithilfe von PW-Dopplererfassung umfasst.

5. Verfahren nach Anspruch 4, wobei die PW-Dopplererfassung in der Richtung der Dopplerstrahllinie erfolgt.

6. Verfahren nach Anspruch 1, wobei das Lokalisieren (93, 94) eines Dopplerprobenvolumens an einem Spitzengeschwindigkeitsort in dem ersten oder dem zweiten Zwei-Ebenen-Bild weiterhin das automatische Positionieren einer Probenvolumengrafik in einem Bild umfasst.

7. Verfahren nach Anspruch 1, wobei das Erfassen (95) einer spektralen Doppleranzeige weiterhin das automatische Starten (195) des Scrollens einer spektralen Doppleranzeige umfasst.

8. Verfahren nach Anspruch 1, wobei das bildgebende Darstellen eines Blutgefäßes im Zwei-Ebenen-Farbdopplermodus (90) weiterhin das automatische Optimieren (91) eines Zwei-Ebenen-Farbdopplerbilds umfasst.

9. Verfahren nach Anspruch 1, wobei das Erfassen (95) einer spektralen Doppleranzeige weiterhin das automatische Optimieren (196) einer spektralen Doppleranzeige umfasst.

10. Ultraschallsystem zur diagnostischen Bildgebung, das konstruiert ist, um das Verfahren nach einem der Ansprüche 1 bis 9 durchzuführen.

Revendications

1. Procédé pour actionner un système d’imagerie diagnostique à ultrasons ayant une sonde matricielle actionnable en mode biplanaire pour la réalisation d’une évaluation du flux sanguin comprenant :

l'imagerie d'un vaisseau sanguin (64) en mode Doppler en couleur biplanaire (90) et l'affichage simultané d'une première (42) et d'une seconde (44) images biplanaires d'un premier et d'un second plans d'image, la première image biplanaire étant une vue en coupe transversale longitudinale du vaisseau sanguin et la seconde image biplanaire étant une vue en coupe transversale du vaisseau sanguin, dans lequel au moins une parmi les première et seconde images biplanaires a une ligne de faisceau Doppler (68) coupant le vaisseau sanguin dans l'image, dans lequel le premier et le second plans de l'image se coupent le long de la ligne de faisceau Doppler ;
la localisation (93) d'un volume d'échantillon Doppler (SV) à un emplacement de la vitesse de pic dans la première image biplanaire, dans laquelle l'orientation du second plan d'image est automatiquement ajustée relativement au premier plan d'image en réponse à la première étape de localisation, de sorte que les premier et second plans d'image se coupent à l'endroit du centre du volume d'échantillon Doppler et le long de la ligne de faisceau Doppler ;
la localisation (94) du volume d'échantillon Doppler à l'emplacement de la vitesse de pic dans la seconde image biplanaire, dans laquelle l'orientation du premier plan d'image est automatiquement ajustée relativement au second plan d'image, en réponse à la seconde étape de localisation, de sorte que les premier et second plans d'image se coupent à l'endroit du centre du volume d'échantillon Doppler et le long de la ligne de faisceau Doppler ;
l'acquisition (95) d'un affichage Doppler spectral des vitesses de flux à l'emplacement du volume d'échantillon Doppler ; et
la mesure (97) des caractéristiques de vitesse en utilisant l'affichage Doppler spectral acquis.

2. Procédé selon la revendication 1, dans lequel la localisation (93) d'un volume d'échantillon Doppler à un emplacement de vitesse de pic dans la première image biplanaire (42) comprend en outre le positionnement d'un graphique de volume d'échantillon Doppler le long d'une ligne de faisceau Doppler (68) dans la première image biplanaire.

3. Procédé selon la revendication 1, dans lequel la localisation (94) d'un volume d'échantillon Doppler à un emplacement de vitesse de pic dans la seconde image biplanaire (44) comprend en outre le positionnement d'un graphique de volume d'échantillon Doppler le long d'une ligne de faisceau Doppler (68) dans la seconde image biplanaire.

4. Procédé selon la revendication 1, dans lequel l'acquisition (95) d'un affichage Doppler spectral comprend en outre l'acquisition d'un affichage spectral Doppler au moyen d'une acquisition Doppler PW.

5. Procédé selon la revendication 4, dans lequel l'acquisition Doppler PW est dans la direction de la ligne de faisceau Doppler.

6. Procédé selon la revendication 1, dans lequel la localisation (93, 94) d'un volume d'échantillon Doppler à un emplacement de vitesse de pic dans la première ou la seconde image biplanaire comprend en outre automatiquement le positionnement d'un graphique de volume échantillon dans une image.

7. Procédé selon la revendication 1, dans lequel l'acquisition (95) d'un affichage Doppler spectral comprend en outre le démarrage automatique (195) du défilement d'un affichage Doppler spectral.

8. Procédé selon la revendication 1, dans lequel l'imagerie d'un vaisseau sanguin en mode Doppler en couleur biplanaire (90) comprend en outre l'optimisation automatique (91) d'une image Doppler en couleur biplanaire.

9. Procédé selon la revendication 1, dans lequel l'acquisition (95) d'un affichage Doppler spectral comprend en outre l'optimisation automatique (196) d'un affichage Doppler spectral.

10. Système d'imagerie diagnostique à ultrasons construit de manière à réaliser le procédé selon l'une quelconque des revendications 1 à 9.

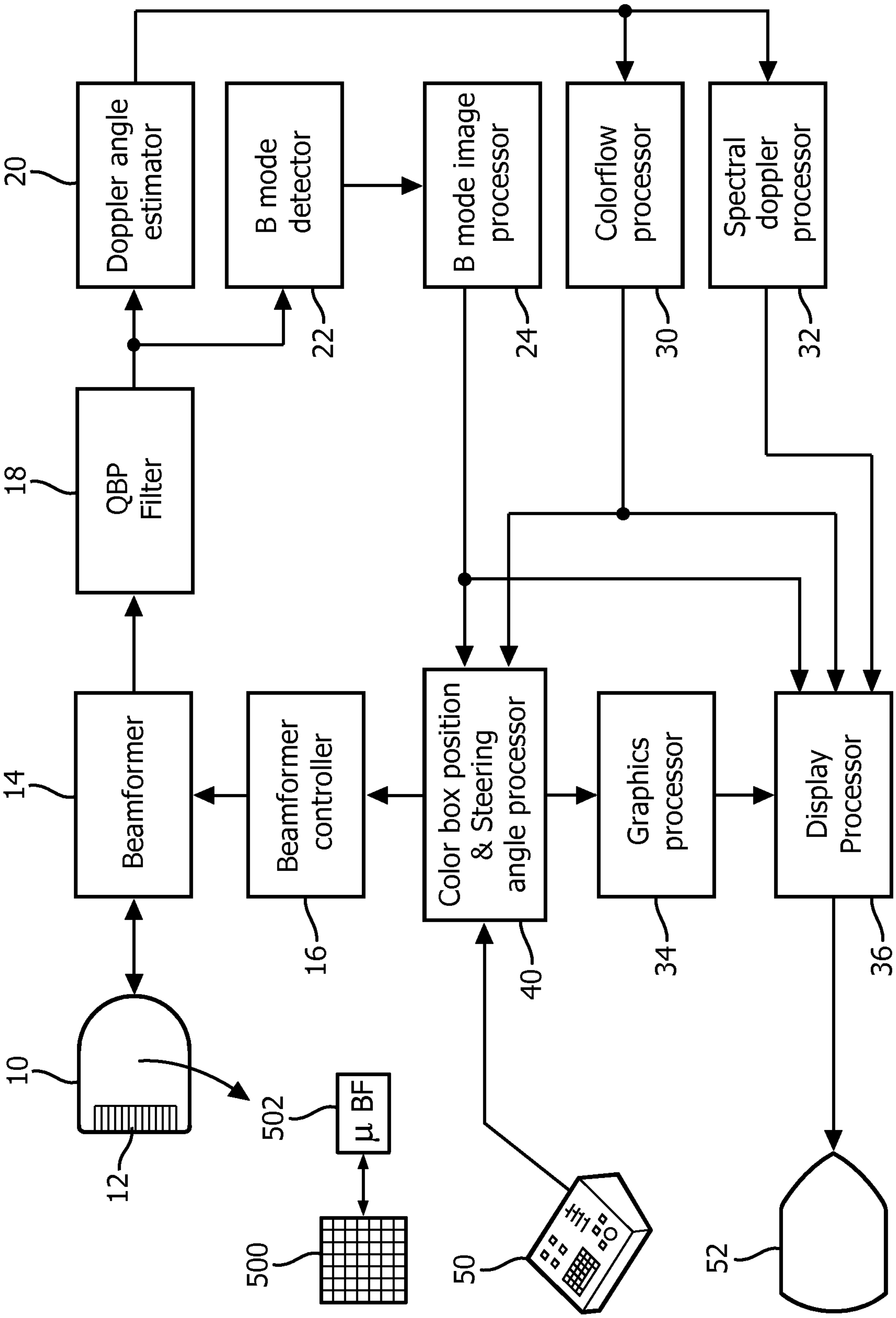
Doppler angle estimator
20
B mode detector
22
B mode image processor
24
Colorflow processor
30
Spectral doppler processor
32
QBP Filter
18
Beamformer
14
Beamformer controller
16
Color box position & Steering angle processor
40
Graphics processor
34
Display Processor
36
10
12
502
μ BF
500
50
52

FIG. 1

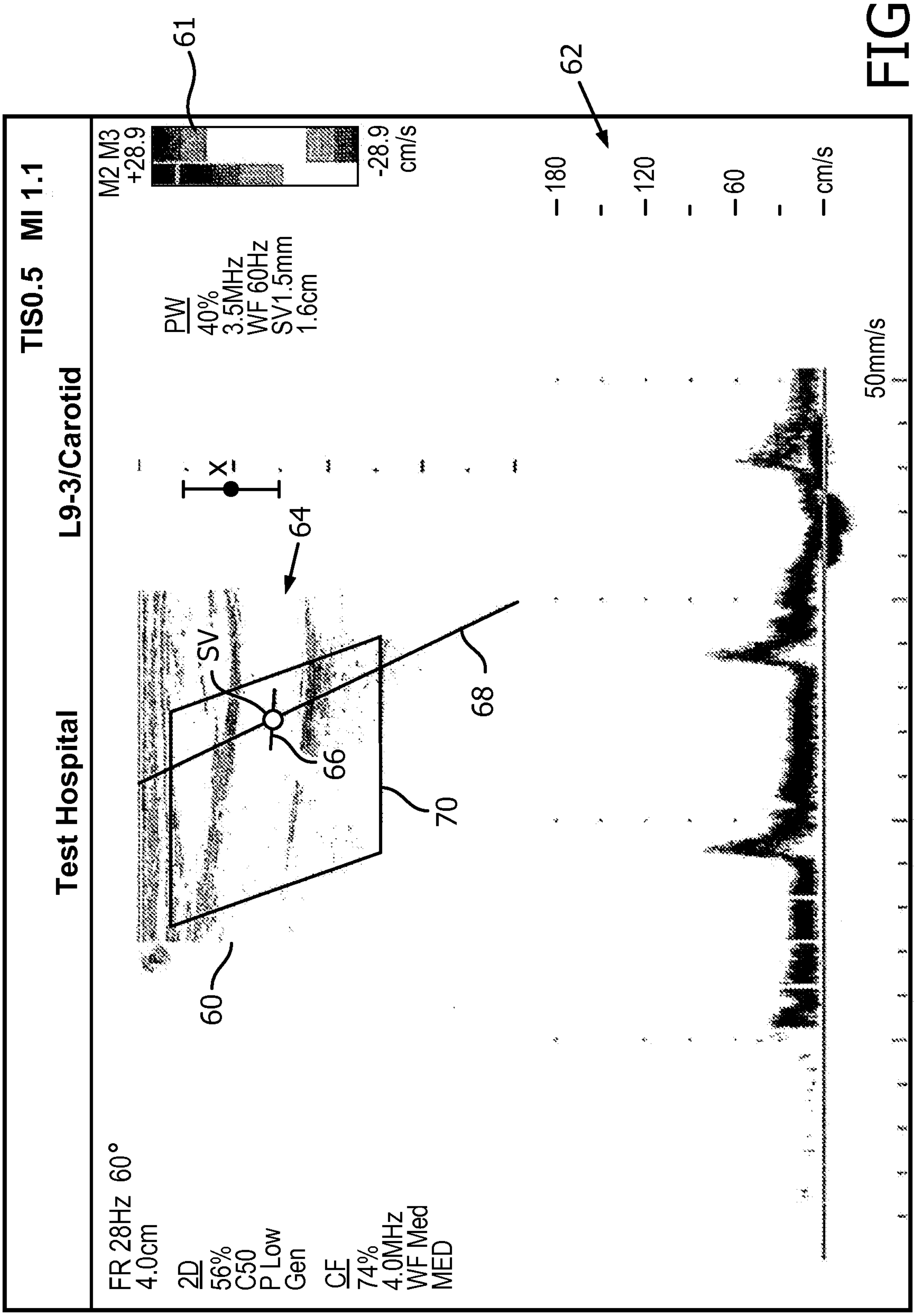
Test Hospital
L9-3/Carotid
TIS0.5 MI 1.1
FR 28Hz 60°
4.0cm
2D
56%
C50
P Low
Gen
CF
74%
4.0MHz
WF Med
MED
PW
40%
3.5MHz
WF 60Hz
SV1.5mm
1.6cm
M2 M3
+28.9
-28.9
cm/s
-180
-120
-60
cm/s
50mm/s
SV
60
61
62
64
66
68
70

FIG. 2

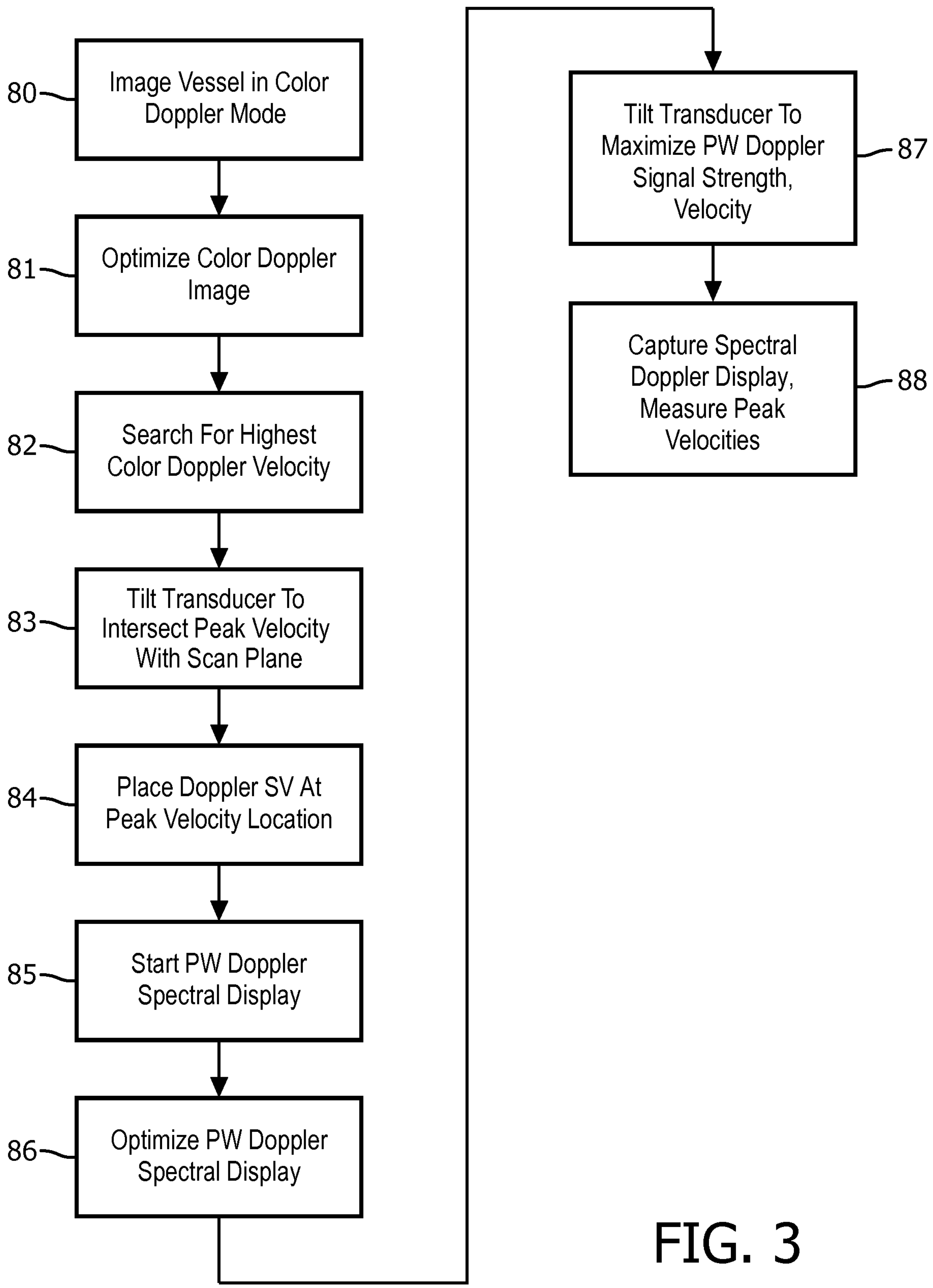
80
Image Vessel in Color Doppler Mode
81
Optimize Color Doppler Image
82
Search For Highest Color Doppler Velocity
83
Tilt Transducer To Intersect Peak Velocity With Scan Plane
84
Place Doppler SV At Peak Velocity Location
85
Start PW Doppler Spectral Display
86
Optimize PW Doppler Spectral Display
87
Tilt Transducer To Maximize PW Doppler Signal Strength, Velocity
88
Capture Spectral Doppler Display, Measure Peak Velocities

FIG. 3

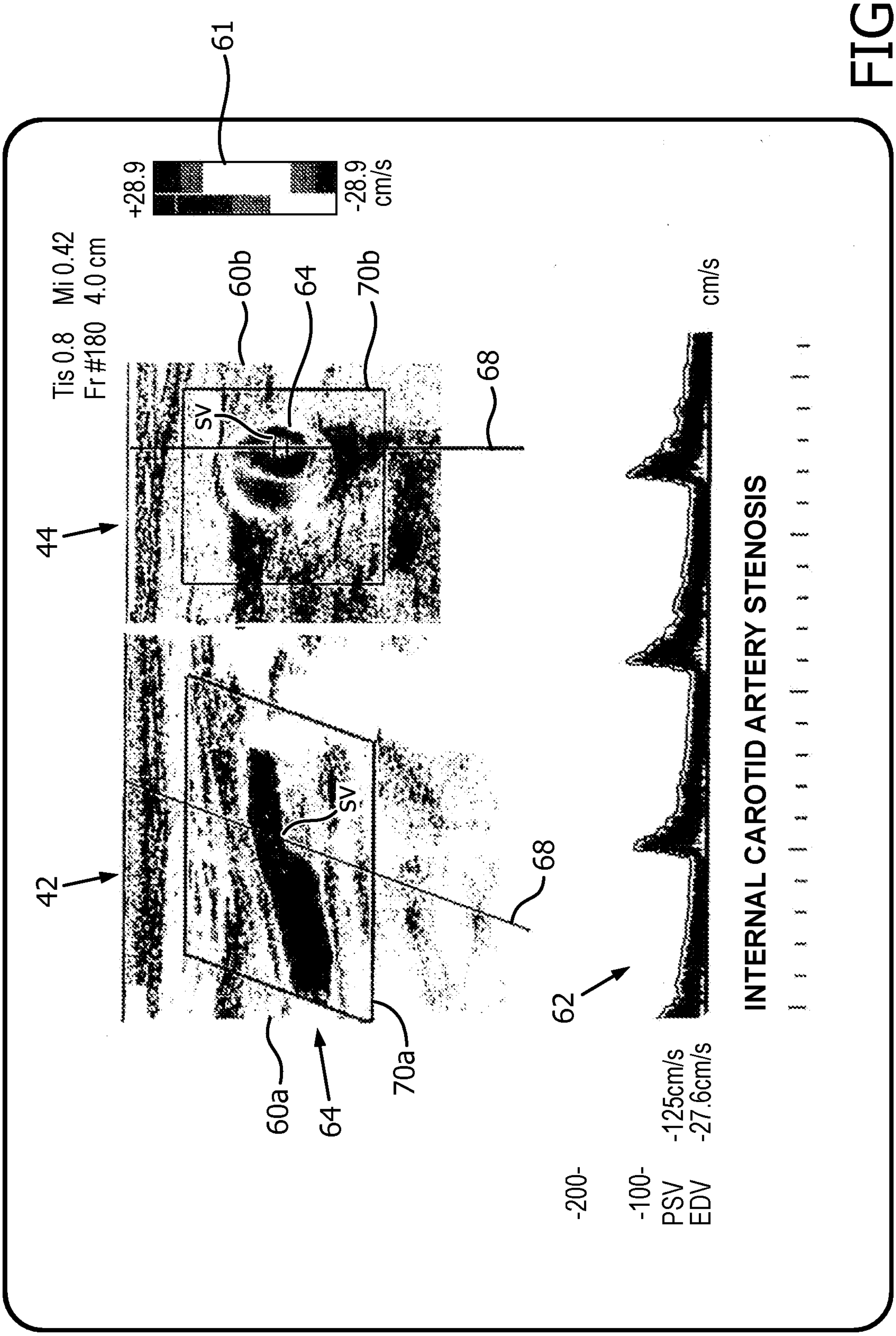
61
+28.9
-28.9
cm/s
Tis 0.8 Mi 0.42
Fr #180 4.0 cm
42
44
60a
60b
64
64
68
68
70a
70b
SV
SV
62
cm/s
-200-
-100-
PSV -125cm/s
EDV -27.6cm/s
INTERNAL CAROTID ARTERY STENOSIS

FIG. 4

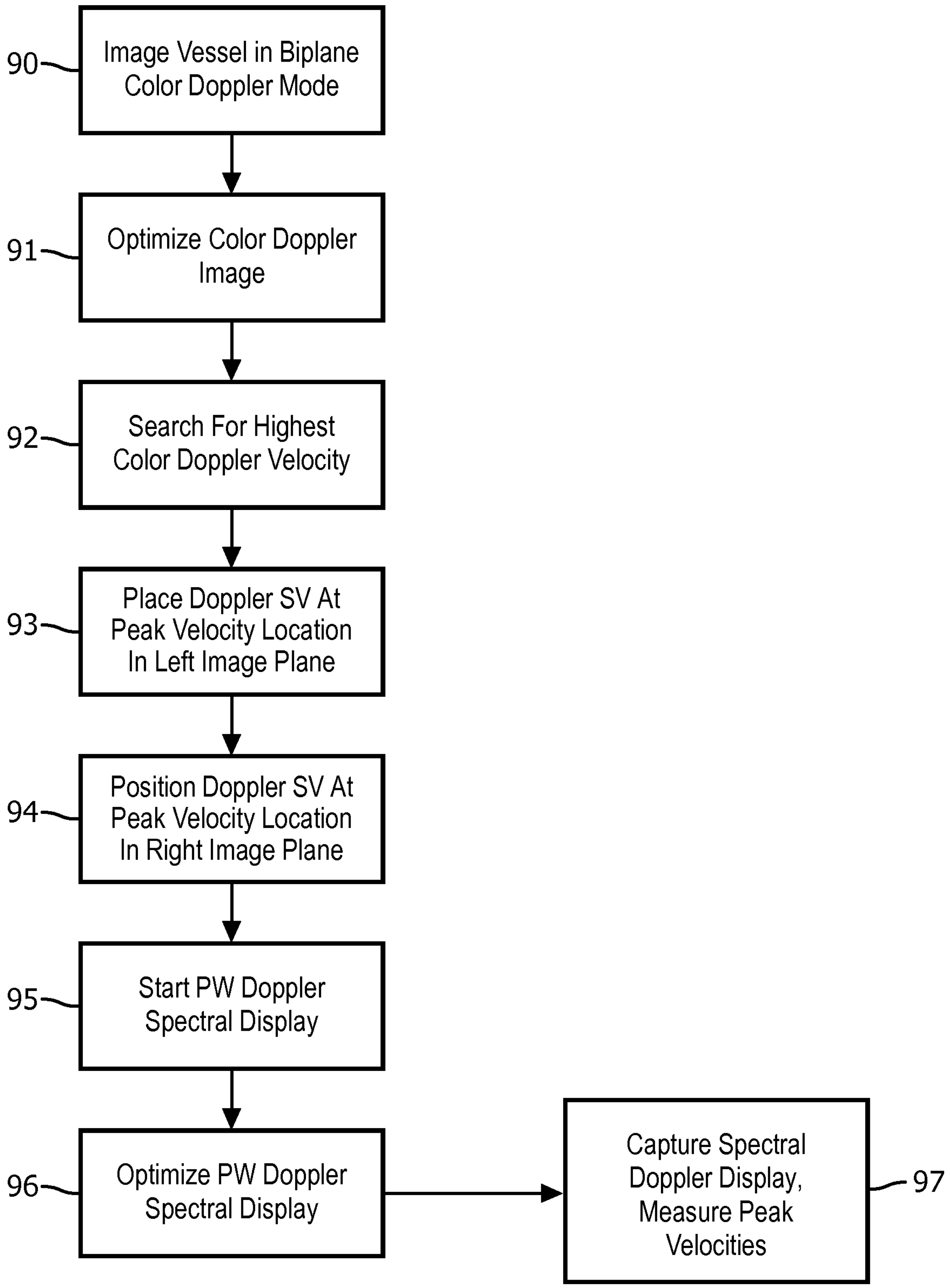
90
Image Vessel in Biplane Color Doppler Mode
91
Optimize Color Doppler Image
92
Search For Highest Color Doppler Velocity
93
Place Doppler SV At Peak Velocity Location In Left Image Plane
94
Position Doppler SV At Peak Velocity Location In Right Image Plane
95
Start PW Doppler Spectral Display
96
Optimize PW Doppler Spectral Display
Capture Spectral Doppler Display, Measure Peak Velocities
97

FIG. 5

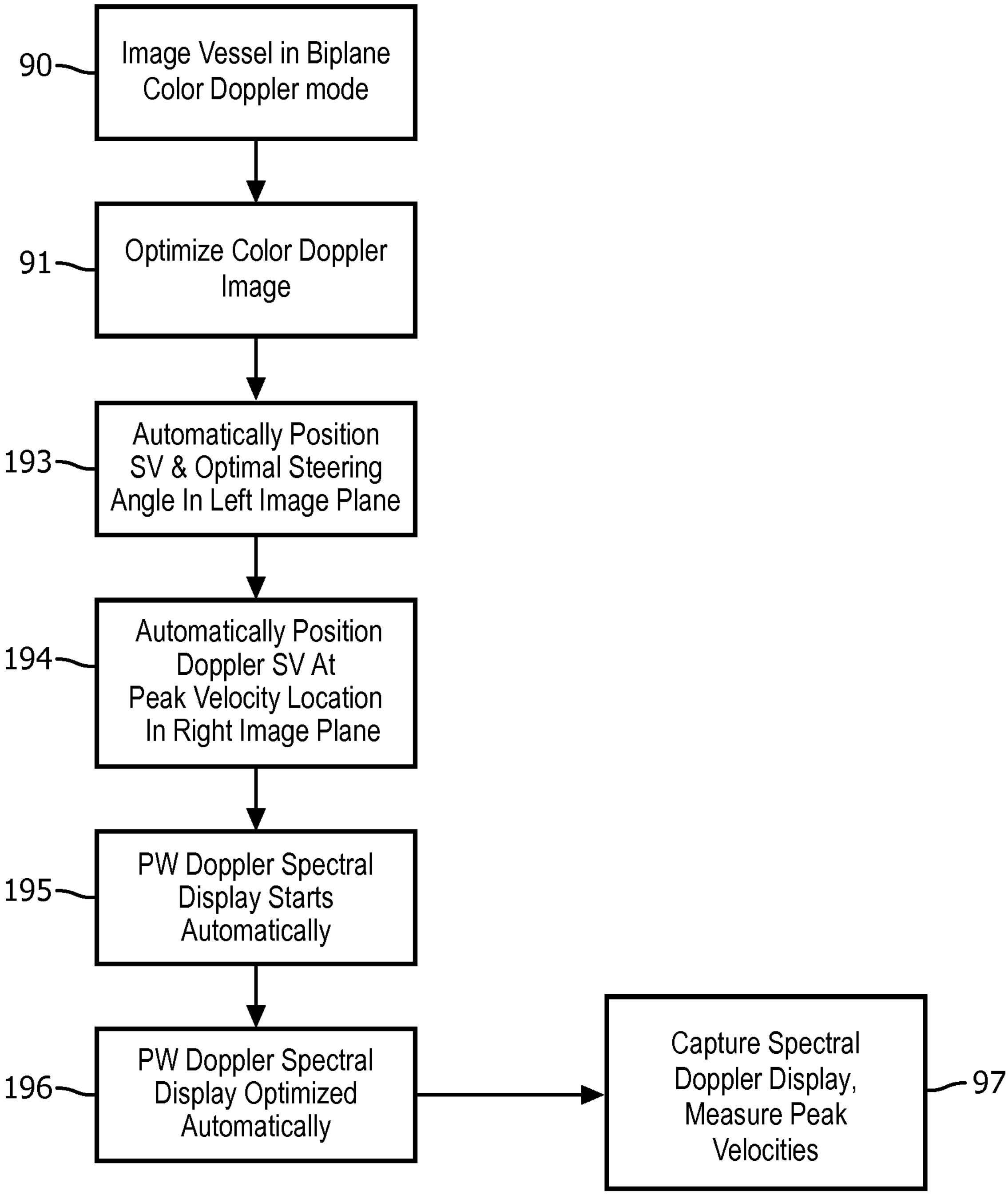
90
Image Vessel in Biplane Color Doppler mode
91
Optimize Color Doppler Image
193
Automatically Position SV & Optimal Steering Angle In Left Image Plane
194
Automatically Position Doppler SV At Peak Velocity Location In Right Image Plane
195
PW Doppler Spectral Display Starts Automatically
196
PW Doppler Spectral Display Optimized Automatically
Capture Spectral Doppler Display, Measure Peak Velocities
97

FIG. 6

REFERENCES CITED IN THE DESCRIPTION

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- US 6709394 B, Frisa **[0005]**
- US 61541353 A **[0008] [0013]**
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- WO 2003019227 A, Christopher **[0013]**

专利名称(译)	用于超声波狭窄评估的自动双平面PW工作流程		
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[标]申请(专利权)人(译)	皇家飞利浦电子股份有限公司		
申请(专利权)人(译)	皇家飞利浦N.V.		
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代理机构(译)	STEFFEN , THOMAS		
优先权	61/706165 2012-09-27 US		
其他公开文献	EP2900143B1		
外部链接	Espacenet		

摘要(译)

具有可在双平面模式下操作的矩阵阵列(500)探针(10)的超声系统用于通过同时显示血管的两个彩色多普勒双平面图像(60a,60b)来评估血管的狭窄,一个纵向交叉。截面图(60a)和另一个横截面图(60b)。两个图像平面沿着用于PW多普勒的多普勒波束线(68)相交。样本体积图形(SV)在一个图像中的峰值速度位置处定位在血管上方,然后在另一图像中的峰值速度位置处定位在血管上方。当样本体积位置在一个图像中移动时,相应地调整另一图像的平面和/或样本体积位置。然后从样本体积位置获取并显示频谱多普勒数据(62)。