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(54) Clutter signal filtering using eigenvectors in an ultrasound system

Störechofilterung mit Eigenvektoren in einem Ultraschallsystem

Filtrage de signal d'écho parasite utilisant des vecteurs propres dans un système ultrasonore

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Description

TECHNICAL FIELD

5 **[0001]** The present disclosure relates to ultrasound signal processing, and more particularly to clutter signal filtering upon Doppler signals using eigenvectors in an ultrasound system.

BACKGROUND

10 **[0002]** Recently, an ultrasound system has been extensively used in the medical field due to its non-invasive and non-destructive nature. Modern high-performance ultrasound imaging diagnostic systems and techniques are commonly used to produce two- or three-dimensional ultrasound images of internal features of patients. In order to provide the ultrasound images, the ultrasound system operates in various image modes such as a brightness mode, a Doppler mode and the like to acquire ultrasound images for diagnosis.

15 **[0003]** In the Doppler mode, the ultrasound system provides a color flow image visualizing velocities of moving objects such as blood flow, heart, etc. The color flow image may be formed based on Doppler signals obtained by alternately transmitting and receiving ultrasound signals to and from a target object at a pulse repetition frequency (PRF). The Doppler signals may include low frequency signals (the so-called clutter signals) due to the motion of a cardiac wall or valve of a heart. The clutter signals may have amplitudes, which are over 100 times than those of pure Doppler signals indicative of velocities of the blood flow. The clutter signals may be an obstacle to accurately detecting velocities of the blood flow. Thus, it is required to remove the clutter signals from the Doppler signals for accurate velocity detection of the blood flow. Since the eigenvector-based clutter filtering is carried out by reflecting characteristics of the Doppler signals, the performance of the eigenvector-based clutter filtering may exceed that of the IIR filtering. Thus, it has been required to appropriately set eigenvectors for the enhanced eigenvector-based clutter filtering.

20 **[0004]** XP007913995 "Nonparametric clutter rejection in Doppler ultrasound using principal component analysis" by Ahmed Elnokrashy et al. describes an ultrasound system according to the preamble of claim 1. Furthermore, this document discloses a method of setting eigenvectors suitable for providing a color flow image in which ultrasound signals are transmitted to and received from a target object to acquire first Doppler signals.

30 SUMMARY

[0005] Embodiments for setting eigenvectors for clutter signal filtering are disclosed herein. The invention is defined in claims 1 and 4.

35 **[0006]** The Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used in determining the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

40 **[0007]**

FIG 1 is a block diagram showing an illustrative embodiment of an ultrasound system

FIG 2 is a block diagram showing an illustrative embodiment of a Doppler signal acquisition unit shown in FIG 1.

45 FIG 3 is a block diagram showing an illustrative embodiment of a processing unit shown in FIG 2.

FIG 4 shows graphs indicative of component values of the Doppler signals.

50 FIG 5 is a graph showing Doppler frequency estimates of the Doppler signals.

FIG 6 is a graph showing a trajectory of the phase differences computed from the third Doppler signals, which are clutter signals filtered by using two eigenvectors.

55 FIG 7 is a graph showing a trajectory of the phase differences computed from the third Doppler signals, which are clutter signals filtered by using three eigenvectors.

DETAILED DESCRIPTION

5 [0008] A detailed description may be provided with reference to the accompanying drawings. One of ordinary skill in the art may realize that the following description is illustrative only and is not in any way limiting. Other embodiments of the present invention may readily suggest themselves to such skilled persons having the benefit of this disclosure.

10 [0009] Referring to FIG 1, an illustrative embodiment of an ultrasound system 100 is shown. As depicted therein, the ultrasound system 100 may include a user input unit 110. The user input unit 110 may allow a user to input a user instruction. The user instruction may include information on the position and size of a region of interest (ROI) (e.g., a color box), which the user wants to set on a brightness mode (B-mode) image. The user input unit 110 may include at least one of a control panel, a mouse, a keyboard, a touch screen, etc.

15 [0010] The ultrasound system 100 may further include a Doppler signal acquisition unit 120. The Doppler signal acquisition unit 120 may be operable to alternately transmit and receive ultrasound signals to and from a target object (e.g., heart, blood flow, etc) in synchronization with a pulse repetition frequency (PRF). The Doppler signal acquisition unit 120 may acquire Doppler signals corresponding to the ROI based on the received ultrasound signals. The acquisition of the Doppler signals will be described in detail by referring to FIG 2.

20 [0011] FIG 2 is a block diagram showing an illustrative embodiment of the Doppler signal acquisition unit 120. Referring to FIG 2, the Doppler signal acquisition unit 120 may include a transmit (Tx) signal generating section 121. The Tx signal generating section 121 may be operable to generate a plurality of Tx signals. The generation of the Tx signals may be controlled by whether the current image mode is a B-mode, a C-mode, a D-mode, etc. In one embodiment, the Tx signal generating section 121 may generate Tx signals for forming a color flow image within the ROI consisting of a plurality of scan lines in the C-mode. The Tx signal generating section 121 may repeatedly generate the Tx signals based on a predetermined ensemble number.

25 [0012] The Doppler signal acquisition unit 120 may further include an ultrasound probe 122 containing a plurality of elements for reciprocally converting ultrasound signals and electrical signals. The ultrasound probe 122 may be operable to transmit ultrasound signals into a target object in response to the Tx signals. The ultrasound probe 122 may be further operable to receive echo signals reflected from the target object to thereby output electrical receive signals, which are analog signals. The transmission and reception of the ultrasound signals are alternately carried out to output a plurality of electrical receive signals.

30 [0013] The Doppler signal acquisition unit 120 may further include a beam forming section 123. The beam forming section 123 may be operable to convert the electrical receive signals into digital signals. The beam forming section 123 may be further operable to apply delays to the digital signals in consideration of distances between the elements and focal points, thereby outputting digital receive-focused signals.

35 [0014] The Doppler signal acquisition unit 120 may further include a Doppler signal forming section 124 that may be operable to form Doppler signals based on the digital receive-focused signals. In one embodiment, the Doppler signals may include in-phase Doppler signals and quadrature phase signals. The Doppler signals may also include clutter signals. Hereinafter, these Doppler signals may be referred to as "first Doppler signals." " The Doppler signal acquisition unit 120 may form the first Doppler signals as many as the predetermined ensemble number for each of the scan lines within the ROI.

40 [0015] The ultrasound system 100 may further include a processing unit 130 coupled to the Doppler signal acquisition unit 120. The processing unit 130 may be operable to set at least one eigenvector based on the first Doppler signals. The processing unit 130 may be further operable to perform clutter signal filtering upon the first Doppler signals by using eigenvectors thereof to remove the clutter signals. The processing unit 130 may be operable to form a color flow image by using the Doppler signals from which the clutter signals are filtered out. The operation of the processing unit 130 will be described in detail by referring to FIG 3.

45 [0016] FIG 3 is a block diagram showing an illustrative embodiment of the processing unit 130. Referring to FIG 3, the processing unit 130 may include a covariance matrix computing section 131. The covariance matrix computing section 131 may be operable to compute a covariance matrix by using the plurality of first Doppler signals provided from the Doppler signal acquisition unit 120. In one embodiment, the covariance matrix computing section 131 may be operable to select one of the scan lines, which are included in the ROI, and compute the covariance matrix by using the first Doppler signals corresponding to the entire pixels on the selected scan line. In another embodiment, the covariance matrix computing section 131 may be operable to select one of the scan lines, and compute the covariance matrix by using the first Doppler signals corresponding to a predetermined number of pixels on the selected scan line. In yet another embodiment, the covariance matrix computing section 131 may be operable to compute the covariance matrix by using the first Doppler signals corresponding to the entire pixels of the scan lines on the ROI. The covariance matrix may be computed by using various well-known methods. Thus, the detailed descriptions thereof will be omitted herein.

55 [0017] For the sake of convenience, a method of computing the covariance matrix by using the first Doppler signals corresponding to the entire pixels on the selected one scan line will be described. The processing unit 130 may further include an eigenvector computing section 132. The eigenvector computing section 132 may be operable to compute a

plurality of eigenvalues by using the computed covariance matrix and eigenvectors corresponding to the respective eigenvalues. The eigenvalues and eigenvectors may be computed by using various well-known methods. As such, the detailed explanations thereof will be omitted herein.

[0018] The processing unit 130 may further include an eigenvector setting section 133. The eigenvector setting section 133 may be operable to set at least one eigenvector for performing clutter signal filtering upon the first Doppler signals by using the plurality of eigenvectors (or both eigenvalues and eigenvectors). In one embodiment, the eigenvector setting section 133 may project the first Doppler signals corresponding to the respective pixels on the selected scan line along the respective eigenvectors. Hereinafter, the projected first Doppler signals will be referred to as "second Doppler signals." The second Doppler signals may be obtained as many as the number of the eigenvectors. The eigenvector setting section 133 may be operable to compute component values from the second Doppler signals for the respective pixels. In one embodiment, the component values may be projected values of the second Doppler signals along the respective eigenvectors. The component values (C_{ij}) may be computed by using the following equation.

$$C_{ij} = S_i^* e_j \quad (1)$$

wherein S_i represents a first Doppler signal corresponding to an i^{th} pixel and e_j represents j^{th} eigenvector.

[0019] For example, the eigenvector setting section 133 may be operable to compute an inner product through the equation (1) for the first Doppler signals corresponding to the respective pixels on the selected scan line and eigenvectors e_1 - e_{10} computed in the eigenvector computing section 132, thereby computing the component values of the second Doppler signals for the respective pixels. The eigenvector setting section 133 may be further operable to compute correlation values between the component values of the first Doppler signals and the component values of the second Doppler signals (i.e., amplitudes of the first and second Doppler signals). The eigenvector setting section 133 may compare the computed correlation values with a predetermined threshold to detect the component values of the second Doppler signals greater than the predetermined threshold. The eigenvector setting section 133 may be operable to set the eigenvectors corresponding to the detected component values as eigenvectors for clutter signal filtering.

[0020] FIG 4 shows graphs indicative of component values of the Doppler signals. In FIG 4, reference numerals "211-220" show graphs indicative of component values of the second Doppler signals (hereinafter, referred to as "first component graphs"). Further, reference numeral "230" shows a graph indicative of component values of the first Doppler signals (hereinafter, referred to as "second component graph"). In FIG 4, a horizontal direction (X-axis) represents positions of the pixels (i.e., depths) and a vertical direction (Y-axis) represents the component values (i.e., amplitudes) of the Doppler signals. The portions of relatively large component values may correspond to blood vessels, which may be a possible source of the clutter signals.

[0021] As such, in one embodiment, the eigenvector setting section 133 may be operable to detect the component values of the second Doppler signals whose correlation values are greater than the predetermined threshold (e.g., the component values corresponding to first graphs 219 and 220 in FIG 4). The eigenvector setting section 133 may be further operable to set eigenvectors corresponding to the component values e_9 - e_{10} of the detected second Doppler signals as the eigenvectors for the clutter signal filtering.

[0022] FIG 5 is a graph showing Doppler frequency estimates of the Doppler signals. In FIG 5, reference numeral "310" represents Doppler frequencies of original Doppler signals obtained at a vessel portion (i.e., first Doppler signals). Further, reference numeral "320" represents Doppler frequencies of the Doppler signals resulting from the clutter signal filtering upon the first Doppler signals using the eigenvectors e_9 and e_{10} , which are set in the eigenvector setting section 133. Reference numeral "330" represents Doppler frequencies of the Doppler signals resulting from the clutter signal filtering upon the first Doppler signals using the eigenvector e_{10} , which has been set in the eigenvector setting section 133. As shown in FIG 5, the clutter signal filtering using the eigenvectors e_9 and e_{10} has a better performance than the clutter signal filtering using the eigenvector e_{10} .

[0023] In another embodiment, the eigenvector setting section 133 may be operable to perform the clutter signal filtering upon the first Doppler signals by sequentially using the eigenvectors computed in the eigenvector computing section 132 to thereby form clutter signal filtered Doppler signals (hereinafter, referred to as "third Doppler signals"). In this case, the first Doppler signals may be filtered in an order determined by the magnitudes of the eigenvalues of the respective eigenvectors. The eigenvector setting section 133 may be further operable to compute component values of the third Doppler signals for each of the pixels. In one embodiment, by way of non-limiting example, the component values may be a phase difference between third Doppler signals corresponding to an n^{th} sample (or ensemble) and a $(n-1)^{\text{th}}$ sample (or ensemble) at each of the pixels, wherein n is a positive integer equal to or greater than 2. The eigenvector setting section 133 may be further operable to set eigenvectors for clutter signal filtering by using the computed component values. The eigenvector setting section 133 may be operable to set an eigenvector, which makes the phase difference kept to have the same sign, as the eigenvector for the clutter signal filtering.

[0024] For example, assuming that a blood flows at a constant velocity during a scanning time, the phase differences of the Doppler signals may not be changed. That is, the phase differences may be maintained to have the same sign. The eigenvector setting section 133 may be operable to perform the clutter signal filtering upon the first Doppler signals by using the eigenvector having the largest eigenvalue (e.g., eigenvector e_{10}) among the plurality of eigenvectors e_1 to e_{10} to form the third Doppler signals. The eigenvector setting section 133 may be further operable to compute phase differences between the third Doppler signals corresponding to an n^{th} sample (or ensemble) and a $(n+1)^{\text{th}}$ sample (or ensemble) for each of the pixels. The eigenvector setting section 133 may be operable to detect a sign change of the detected phase differences. If the detected sign change is not maintained in the same sign, i.e., the sign is changed from plus (+) to minus (-) or vice versa, then the clutter signal filtering may be performed upon the first Doppler signals by using the eigenvectors having the first and second largest eigenvalues, e.g., eigenvectors e_{10} and e_9 to form the third Doppler signals. Thereafter, the eigenvector setting section 133 may be operable to detect a sign change of the phase differences for the third Doppler signals in the same manner described above.

[0025] FIG 6 is a graph showing a trajectory of the phase differences of the third Doppler signals, in which the clutter signals are filtered by using two eigenvectors e_9 and e_{10} . If the sign change of the detected phase differences is not maintained in the same sign, as shown in TABLE 1, then the eigenvector setting section 133 may be operable to perform the clutter signal filtering upon the first Doppler signals by using the eigenvectors having the first to third largest eigenvalues, e.g., eigenvectors e_8 - e_{10} , to form the third Doppler signals. Thereafter, the eigenvector setting section 133 may detect a sign change of the phase differences for the third Doppler signals.

[TABLE 1]

Sign change of phase differences																		
Filtering with eigenvectors e_9 and e_{10}									Filtering with eigenvectors e_8 to e_{10}									
-	-	+	-	-	...	-	-	-	-	-	-	-	-	-	...	-	-	-

[0026] FIG 7 is a graph showing a trajectory of phase differences of the third Doppler signals, in which the clutter signals are filtered by using the three eigenvectors e_8 to e_{10} . If it is determined that the sign change of the detected phase differences is maintained in the same sign, i.e., the sign of the phase differences is not changed, then the eigenvector setting section 133 may set the eigenvectors of the eigenvectors e_8 to e_{10} as the eigenvectors for the clutter signal filtering. In FIGS. 6 and 7, PCA represents an abbreviation of Principal Component Analysis.

[0027] In one embodiment, although it is described above that the eigenvectors for the clutter signal filtering are set by using the eigenvectors in a magnitude order of the eigenvalues of the entire eigenvectors in order to detect the sign change of the phase differences, the setting of the eigenvectors for the clutter signal filtering may not be limited thereto. In another embodiment, the eigenvectors for the clutter signal filtering may be set by using the eigenvectors in a magnitude order of the eigenvalues of the eigenvectors corresponding to the component values e_9 - e_{10} of the detected second Doppler signals in FIG 4.

[0028] The processing unit 130 may further include a filtering section 134. The filtering section may be operable to perform the clutter signal filtering upon the first Doppler signals by using the eigenvectors set in the eigenvector setting section 133. The processing unit 130 may further include an image forming section 135. The image forming section 135 may be operable to form a color flow image by using the Doppler signals with the clutter signals filtered.

[0029] The ultrasound system 100 may further include a display unit 140. The display unit 140 may be embodied with any display capable of displaying the ultrasound images such as a B-mode image, a color flow image and the like. In one embodiment, the display unit 140 may include at least one of a CRT monitor, a LCD monitor and the like.

[0030] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the scope of the principles of this disclosure. More particularly, numerous variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

Claims

1. An ultrasound system (100), comprising:

a Doppler signal acquisition unit (120) configured to transmit and receive ultrasound signals to and from a target object to acquire first Doppler signals; and

a processing unit (130) configured to compute a plurality of eigenvectors by using the first Doppler signals and to form second Doppler signals corresponding to directions of the computed eigenvectors, **characterized in that** the processing unit (130) is configured to compute phase differences between n^{th} samples and $(n+1)^{\text{th}}$ samples of the second Doppler signals, wherein n is a positive integer equal to or greater than 1, and detect a sign change of the computed phase differences to set the eigenvectors of which the sign of the phase differences is not changed as the eigenvectors for the clutter signal filtering among the plurality of eigenvectors.

2. The ultrasound system (100) of Claim 1, wherein the processing unit (130) includes:

an eigenvector setting section (133) configured to perform the clutter signal filtering upon the first Doppler signals by using the plurality of eigenvectors in an order determined by magnitudes of eigenvalues of the respective eigenvectors to form the second Doppler signals and set the eigenvectors for the clutter signal filtering among the plurality of eigenvectors based on the phase differences computed from the second Doppler signals; and an image forming section (135) configured to form a color flow image based on the clutter signal filtered Doppler signals.

3. The ultrasound system (100) of Claim 2, wherein the processing unit (130) further includes:

a covariance matrix computing section (131) configured to compute a covariance matrix by using the first Doppler signals; and an eigenvector computing section (132) configured to compute the plurality of eigenvectors based on the computed covariance matrix.

4. A method of setting eigenvectors to provide a color flow image, comprising:

- a) transmitting and receiving ultrasound signals to and from a target object to acquire first Doppler signals;
- b) computing a plurality of eigenvectors by using the first Doppler signals; **characterized by** comprising:
- c) forming second Doppler signals corresponding to directions of the computed eigenvectors;
- d) computing phase differences between n^{th} samples and $(n+1)^{\text{th}}$ samples of the second Doppler signals, wherein n is a positive integer equal to or greater than 1; and
- e) detecting a sign change of the computed phase differences;
- f) setting the eigenvectors of which the sign of the phase differences uniformly maintains as the eigenvectors for the clutter signal filtering among the plurality of eigenvectors.

5. The method of Claim 4, wherein the step c) includes performing clutter signal filtering upon the first Doppler signals by sequentially using the plurality of eigenvectors to form the second Doppler signals.

6. The method of Claim 5, wherein the clutter signal filtering is performed in an order determined by magnitudes of eigenvalues of the respective eigenvectors.

7. The method of Claim 4, wherein the step b) includes:

computing covariance matrixes by using the first Doppler signals; and computing the plurality of eigenvectors by using the covariance matrixes.

8. The method of one of Claim 4, further comprising:

performing the clutter signal filtering upon the plurality of first Doppler signals by using the eigenvectors for the clutter signal filtering; forming a color flow image based on the clutter signal filtered Doppler signals; and displaying the color flow image.

Patentansprüche

1. Ultraschallsystem (100), welches Folgendes aufweist:

eine Doppler-Signalerlangungseinheit (120), welche dafür vorgesehen ist, Ultraschallsignale zu einem Zielobjekt zu übertragen und von demselben zu empfangen, um erste Doppler-Signale zu erlangen; und
eine Verarbeitungseinheit (130), welche dafür vorgesehen ist, eine Vielzahl von Eigenvektoren durch Verwenden der ersten Doppler-Signale zu berechnen und zweite Doppler-Signale zu bilden, welche den Richtungen der berechneten Eigenvektoren entsprechen,

dadurch gekennzeichnet, dass

die Verarbeitungseinheit (130) dafür vorgesehen ist, Phasenverschiebungen zwischen n^{th} -Samples und $(n+1)^{\text{th}}$ -Samples der zweiten Doppler-Signale zu berechnen, wobei n eine positive ganze Zahl gleich oder größer als 1 ist, und einen Vorzeichenwechsel der berechneten Phasenverschiebungen zu detektieren, um die Eigenvektoren, von denen das Vorzeichen der Phasendifferenz sich nicht geändert hat, als die Eigenvektoren für ein Filtern von Stördatensignalen unter der Vielzahl von Eigenvektoren festzulegen.

2. Ultraschallsystem (100) nach Anspruch 1, wobei die Verarbeitungseinheit (130) Folgendes aufweist:

einen Eigenvektor-Festlegungsabschnitt (133), welcher dafür vorgesehen ist, die Filterung von Stördatensignalen an den ersten Doppler-Signalen durch Verwenden der Vielzahl von Eigenvektoren in einer durch die Größe von Eigenwerten der jeweiligen Eigenvektoren festgelegten Reihenfolge durchzuführen, um die zweiten Doppler-Signale zu bilden, und die Eigenvektoren für das Filtern der Stördatensignale unter der Vielzahl von Eigenvektoren basierend auf den Phasenverschiebungen, die aus den zweiten Doppler-Signalen berechnet wurden, festzulegen; und

einen Bilderzeugungsabschnitt (135), der dafür vorgesehen ist, ein Farbströmungsbild basierend auf den Stördatensignal gefilterten Doppler-Signalen zu erzeugen.

3. Ultraschallsystem (100) nach Anspruch 2, wobei die Verarbeitungseinheit (130) des Weiteren Folgendes aufweist:

einen Kovarianz-Matrix-Berechnungsabschnitt (131), welcher dafür vorgesehen ist, eine Kovarianz-Matrix unter Verwendung der ersten Doppler-Signale zu berechnen; und

einen Eigenvektor-Berechnungsabschnitt (132), welcher dafür vorgesehen ist, die Vielzahl von Eigenvektoren auf der berechneten Kovarianz-Matrix zu berechnen.

4. Verfahren zum Festlegen von Eigenvektoren, um ein Farbströmungsbild zu schaffen, welches Folgendes aufweist:

a) Übertragen von Ultraschallsignalen zu einem Zielobjekt und Empfangen derselben, um erste Doppler-Signale zu erlangen;

b) Berechnen einer Vielzahl von Eigenvektoren durch Verwenden der ersten Doppler-Signale;

gekennzeichnet durch die folgenden Schritte:

c) Bilden von zweiten Doppler-Signalen, welche den Richtungen der berechneten Eigenvektoren entsprechen;

d) Berechnen von Phasenverschiebungen zwischen n^{th} -Samples und $(n+1)^{\text{th}}$ -Samples der zweiten Doppler-Signale, wobei n eine positive ganze Zahl größer oder gleich 1 ist; und

e) Detektieren eines Vorzeichenwechsels der berechneten Phasenverschiebungen;

f) Festlegen der Eigenvektoren, von denen das Vorzeichen der Phasenverschiebung gleichbleibt, als die Eigenvektoren für ein Filtern von Stördatensignalen unter der Vielzahl von Eigenvektoren.

5. Verfahren nach Anspruch 4, wobei der Schritt c) das Durchführen eines Filterns der Stördatensignale an den ersten Doppler-Signalen durch sequentielles Verwenden der Vielzahl von Eigenvektoren beinhaltet, um die zweiten Doppler-Signale zu bilden.

6. Verfahren nach Anspruch 5, wobei das Filtern von Stördatensignalen in einer durch die Größe von Eigenwerten der jeweiligen Eigenvektoren festgelegten Reihenfolge durchgeführt wird.

7. Verfahren nach Anspruch 4, wobei der Schritt b) Folgendes aufweist:

Berechnen von Kovarianz-Matrizen unter Verwendung der ersten Doppler-Signale; und

Berechnen der Vielzahl von Eigenvektoren unter Verwendung der Kovarianz-Matrizen.

8. Verfahren nach Anspruch 4, welches des Weiteren Folgendes aufweist:

Durchführen des Filterns der Stördatensignale an der Vielzahl von ersten Doppler-Signalen unter Verwendung

der Eigenvektoren für das Filtern von Stördatensignalen;
Erzeugen eines Farbströmungsbilds basierend auf den Stördaten gefilterten Doppler-Signalen; und
Anzeigen des Farbströmungsbilds.

5

Revendications

1. Système ultrasonique (100) comportant :

10 une unité Doppler (120) d'acquisition de signal configurée pour transmettre et acquérir des signaux ultrasoniques vers et provenant d'un objet cible; pour acquérir des premiers signaux Doppler ; et
une unité de traitement (130) configurée pour traiter une pluralité de vecteurs propres en utilisant les premiers signaux Doppler ; et pour former des seconds signaux Doppler correspondant à des directions des vecteurs propres enregistrés,

15 **caractérisé en ce que** l'unité de traitement (130) est configurée pour traiter des différences de phase entre les (n)ïèmes échantillons et les (n+1)ïèmes échantillons des seconds signaux Doppler, dans lequel n est un nombre entier positif égal ou supérieur à 1, et détecter un changement de signe des différences de phase enregistrées pour fixer les vecteurs propres dont les signes des différences de phase ne changent pas comme les vecteurs propres pour le filtrage du signal parasite parmi la pluralité des vecteurs propres.

20

2. Système ultrasonique (100) selon la revendication 1, dans lequel l'unité de traitement (130) comprend :

25 une section (133) de détermination des vecteurs propres configurée pour effectuer le filtrage des signaux parasites parmi les premiers signaux Doppler en utilisant la pluralité de vecteurs propres dans un ordre déterminé par l'amplitude des valeurs propres des vecteurs propres respectifs, pour constituer les seconds signaux Doppler et pour déterminer les vecteurs propres pour le filtrage des signaux parasites parmi la pluralité de vecteurs propres basés sur les différences de phase enregistrées à partir des seconds signaux Doppler ; et
une unité de formation d'image (135) configurée pour former un flux d'images en couleurs basées sur les signaux Doppler parasites filtrés.

30

3. Système ultrasonique (100) selon la revendication 2, dans lequel l'unité de traitement (130) comprend en outre:

35 une section de traitement à matrice de covariance (131) configurée pour traiter une matrice de covariance en utilisant les premiers signaux Doppler ; et
une section de traitement des vecteurs propres (132) configurée pour traiter la pluralité des vecteurs propres basée sur la matrice de covariance enregistrée.

4. Procédé de détermination de vecteurs propres pour réaliser un flux d'images en couleurs, comportant :

40 a) la transmission et la réception de signaux ultrasoniques vers et provenant d'une cible objet pour acquérir des premiers signaux Doppler ;
b) le traitement d'une pluralité de vecteurs propres en utilisant les premiers signaux Doppler ;
caractérisé en ce qu'il comprend :
c) la formation de seconds signaux Doppler correspondant à des directions des vecteurs propres enregistrés,
45 d) le traitement des différences de phase entre les (n)ïèmes échantillons et les (n+1)ïèmes échantillons des seconds signaux Doppler, dans lequel n est un nombre entier positif égal à ou supérieur à 1, et
e) la détection d'un changement de signe des différences de phase enregistrées ;
f) la fixation des vecteurs propres dont les signes des différences de phase ne changent pas comme les vecteurs propres pour le filtrage du signal parasite parmi la pluralité de vecteurs propres.

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5. Procédé selon la revendication 4, dans lequel la phase c) comprend le filtrage des signaux parasites parmi les premiers signaux Doppler en utilisant séquentiellement la pluralité de vecteurs propres pour constituer les seconds signaux Doppler.

55 6. Procédé selon la revendication 5, dans lequel le filtrage des signaux parasites est effectué dans un ordre déterminé par l'amplitude des valeurs propres des vecteurs propres correspondants.

7. Procédé selon la revendication 4, dans laquelle l'étape b) comprend :

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le traitement de matrices de covariance en utilisant les premiers signaux Doppler ; et
le traitement de la pluralité de vecteurs propres en utilisant les matrices de covariance.

8. Procédé selon la revendication 4, comprenant en outre :

- 5
- le filtrage des signaux parasites sur la pluralité des premiers signaux Doppler utilisant les vecteurs propres pour le filtrage des signaux parasites ;
 - 10 la formation d'un flux d'images en couleurs à partir des signaux Doppler parasites filtrés ; et
 - l'affichage du flux d'images en couleurs.
- 15
- 20
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- 55

FIG. 1

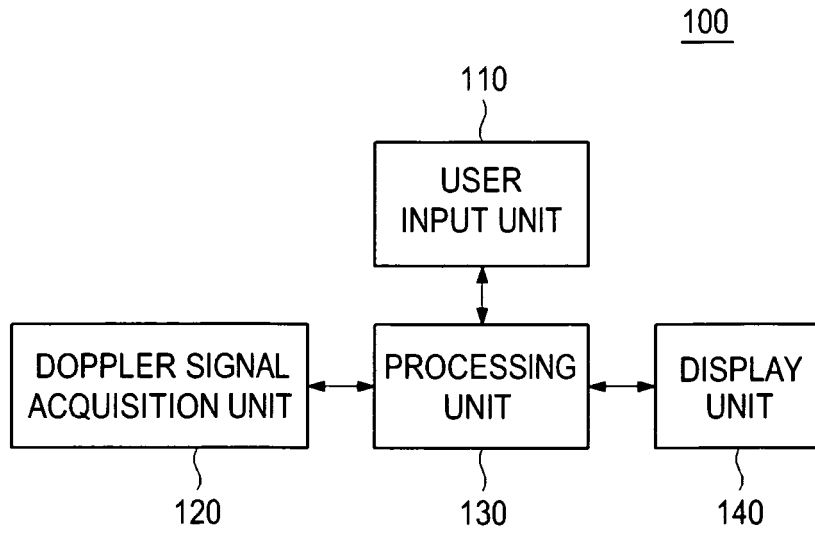


FIG. 2

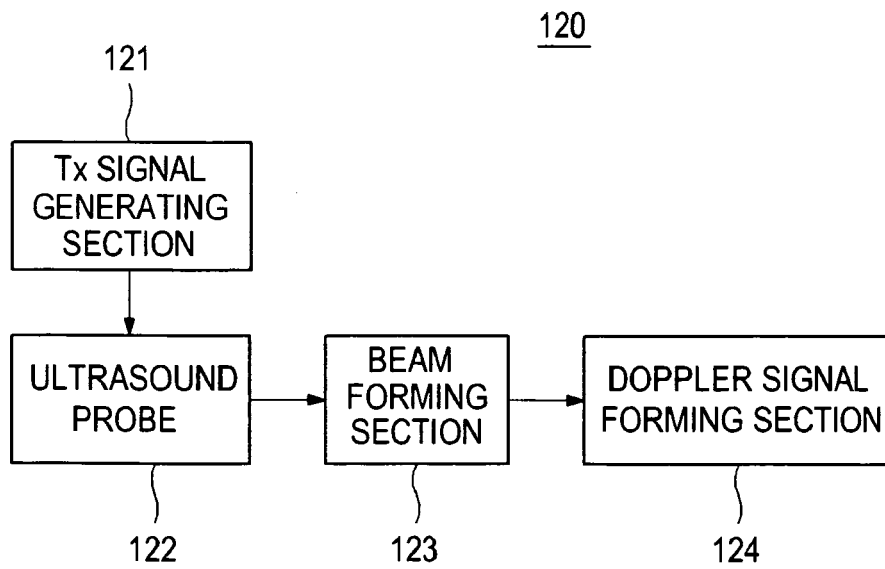


FIG. 3

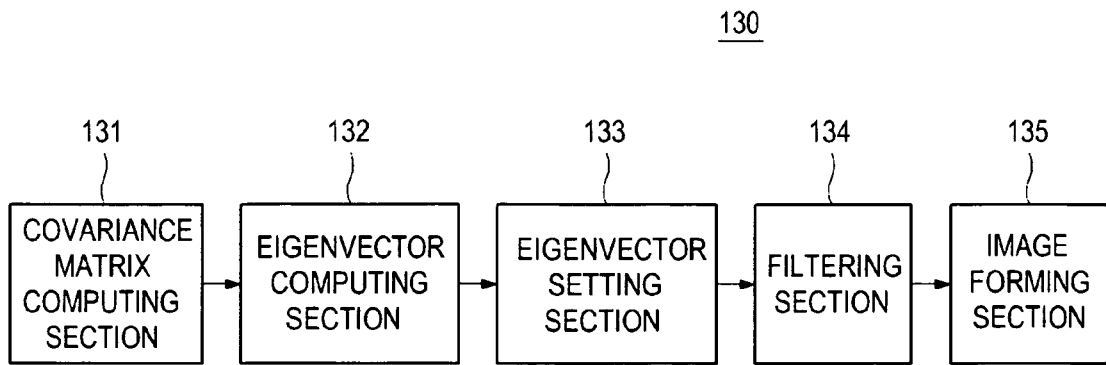


FIG. 4

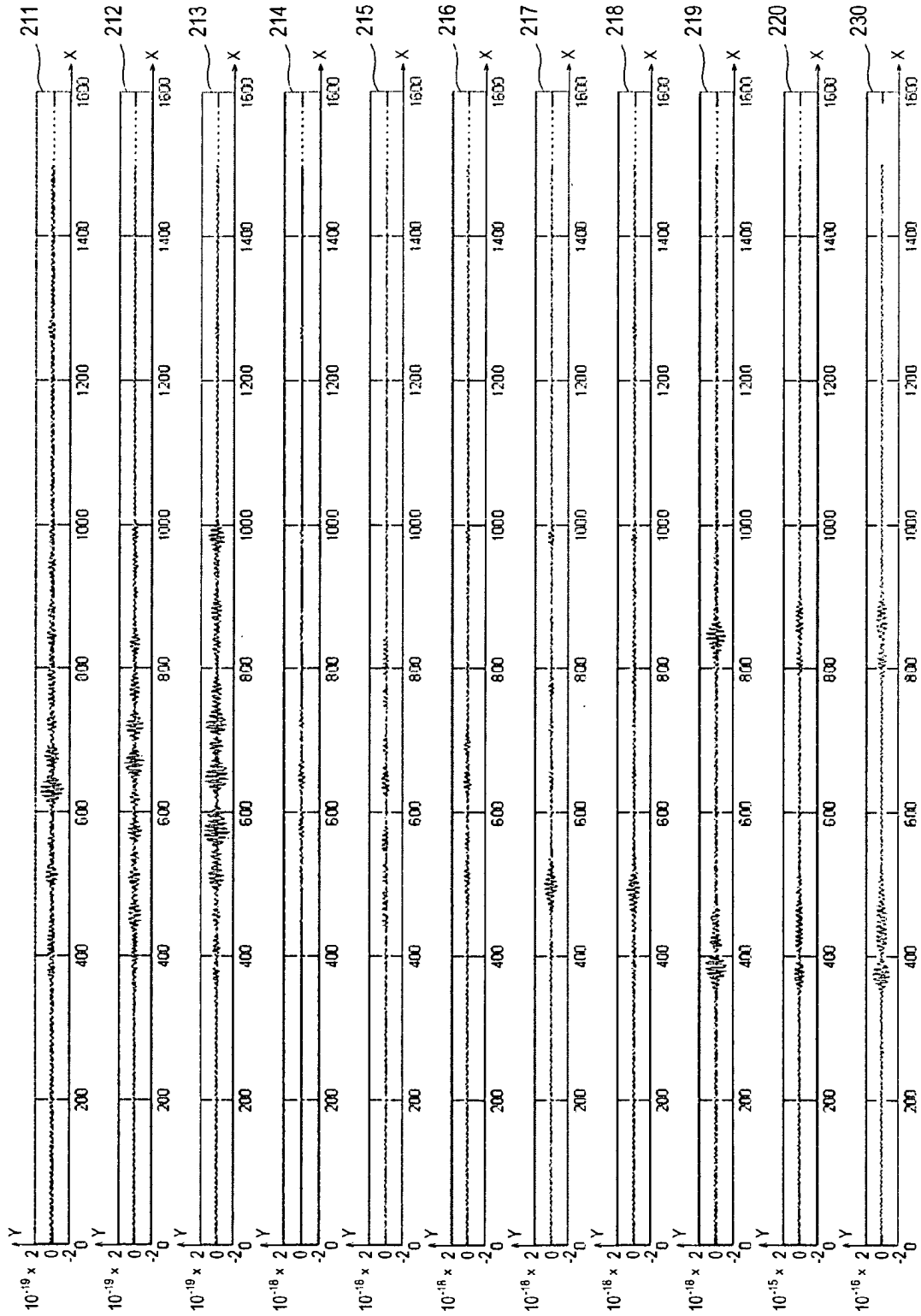


FIG. 5

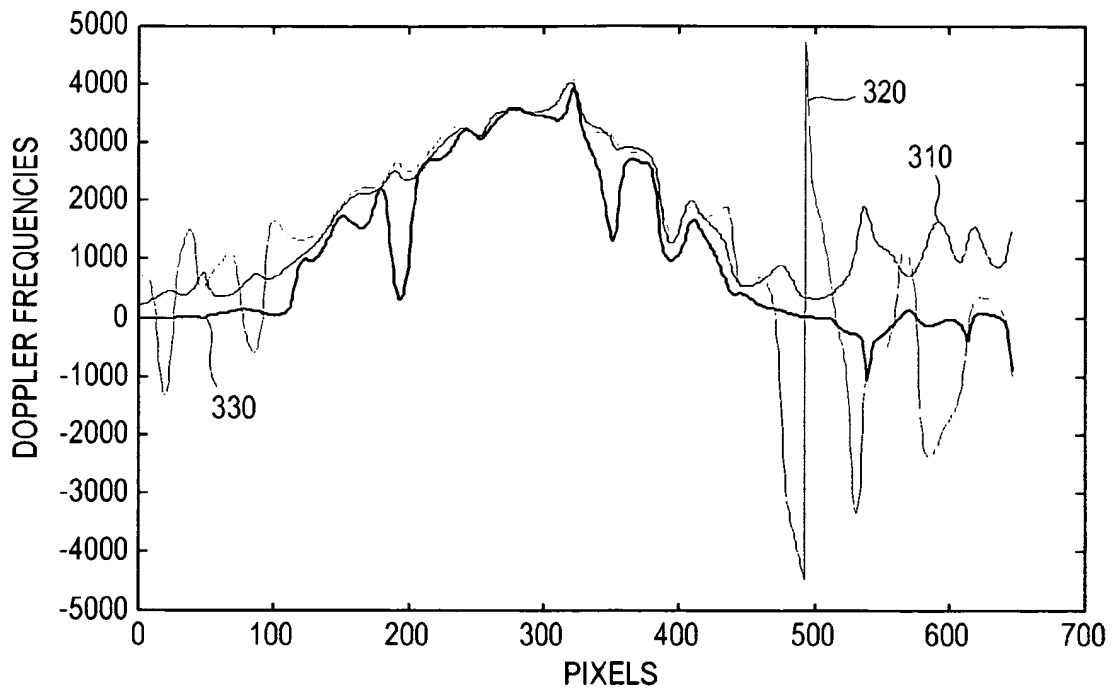
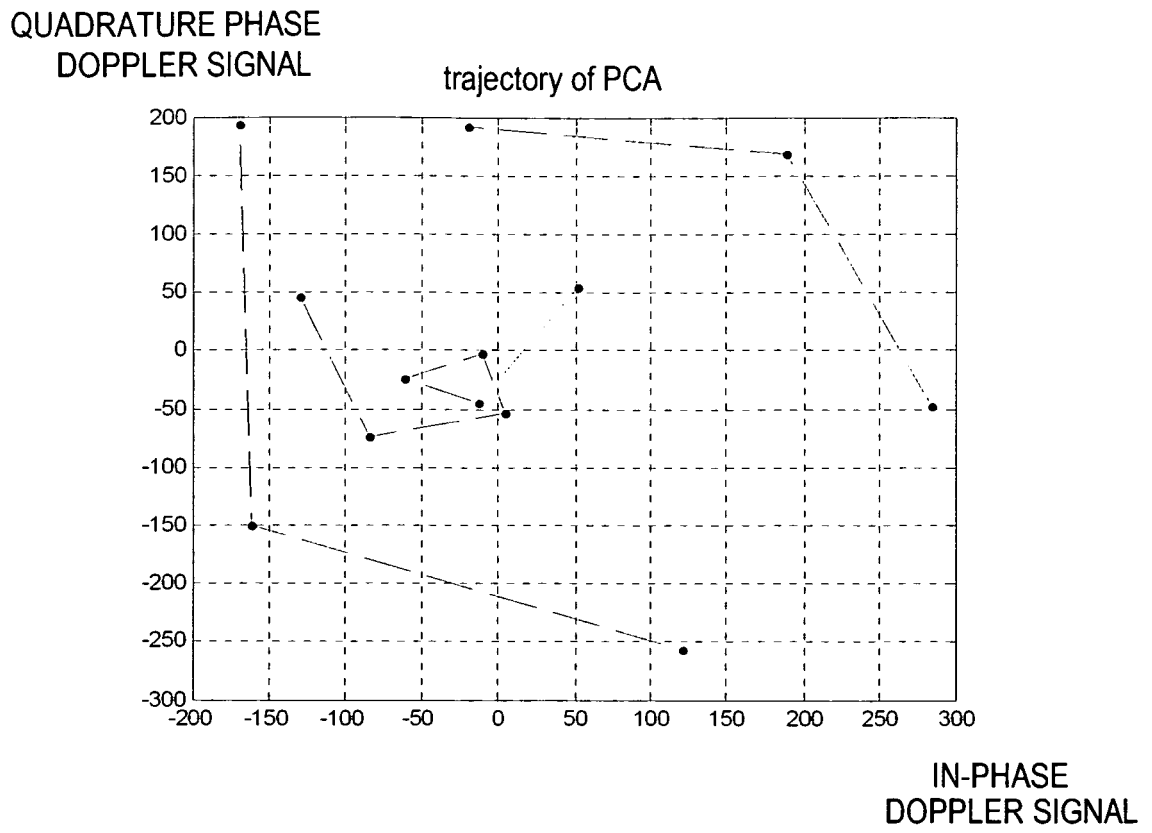


FIG. 6



REFERENCES CITED IN THE DESCRIPTION

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Non-patent literature cited in the description

- **AHMED ELNOKRASHY.** *Nonparametric clutter rejection in Doppler ultrasound using principal component analysis* **[0004]**

专利名称(译)	在超声系统中使用特征向量的杂波信号滤波		
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外部链接	Espacenet		

摘要(译)

公开了用于在超声系统中从多普勒信号设置用于杂波信号滤波的特征向量的实施例。在一个实施例中，超声系统包括：多普勒信号获取单元，被配置为向目标对象发送超声信号和从目标对象接收超声信号以获取第一多普勒信号；处理单元，用于通过所述第一多普勒信号计算多个特征向量，并形成与所计算的特征向量的方向对应的第二多普勒信号，所述处理单元还用于计算所述第二多普勒信号的分量值，并设置特征向量用于杂波通过使用计算的分量值在多个特征向量之间进行信号滤波。

