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(71) Applicant: **Samsung Medison Co., Ltd.**
Nam-myun
Hongchun-gun
Kangwon do 250-875 (KR)

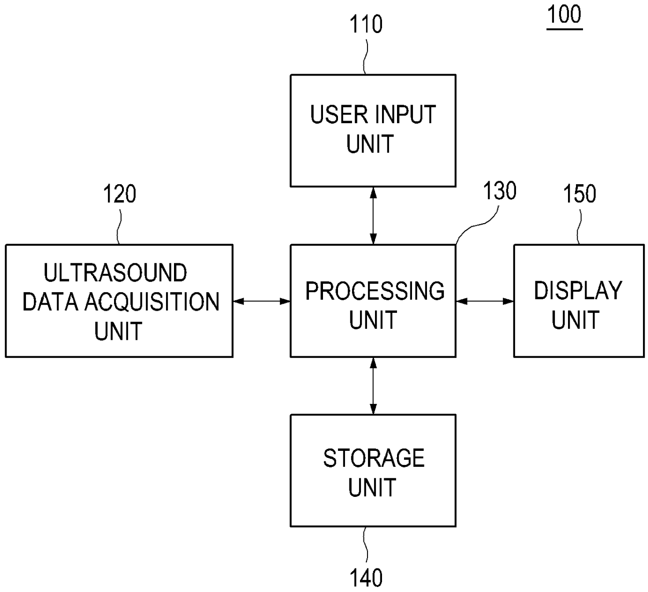
(72) Inventors:
- **Bae, Moo Ho**
  138-240, Seoul (KR)
- **Lee, Young Seok**
  200-760, Gangwon-do (KR)
- **Park, Sung Bae**
  200-060, Gangwon-Do (KR)
- **Lee, Kyoung Bo**
  465-816, Gyeonggi-do (KR)

(74) Representative: **Schmid, Wolfgang**
Lorenz & Kollegen
Patentanwälte Partnerschaftsgesellschaft
Alte Ulmer Strasse 2
89522 Heidenheim (DE)

(54) **Adaptive clutter filtering in an ultrasound system**

(57) Embodiments for performing clutter filtering in an ultrasound system are disclosed. In one embodiment, an ultrasound data acquisition unit acquires ultrasound data from a target object for color Doppler imaging, and a processing unit extracts a plurality of frequency components of the ultrasound data using an autoregressive model and computes a mean frequency component of the plurality of frequency components. The processing unit detects frequency components corresponding to a clutter signal based on the plurality of frequency components and the mean frequency component and performs clutter filtering upon the ultrasound data by using the frequency components corresponding to the clutter signal.

FIG. 1



EP 2 380 498 A1

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority from Korean Patent Application Nos. 10-2010-0038422 and 10-2011-0018707 filed on April 26, 2010 and March 3, 2011, the entire subject matter of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure generally relates to strain imaging, and more particularly to adaptive clutter filtering in an ultrasound system.

BACKGROUND

[0003] An ultrasound system has become an important and popular diagnostic tool since it has a wide range of applications. Specifically, due to its non-invasive and non-destructive nature, the ultrasound system has been extensively used in the medical profession. Modem high-performance ultrasound systems and techniques are commonly used to produce two or three-dimensional images of internal features of an object (e.g., human organs).

[0004] Generally, the ultrasound system may operate in a Brightness-mode (B-mode) visualizing reflectivity of an ultrasound signal reflected from a target object as a 2-dimensional image, a Doppler mode visualizing a velocity of a moving object as spectral Doppler by using the Doppler effect, a color Doppler mode visualizing velocity and direction of a moving object with colors by using the Doppler effect and an elasticity mode visualizing mechanical characteristics of tissues such as the elasticity of the same.

[0005] In the color Doppler mode, the ultrasound system may transmit an ultrasound signal to the target object and receive the ultrasound echoes to thereby form a Doppler signal. The ultrasound system may form a color Doppler image based on the Doppler signal. The Doppler signal may include a low frequency signal (the so-called clutter signal) due to the motion of a cardiac wall or valve of a heart and a noise in addition to a signal caused by a blood flow (referred to as "blood flow signal"). The clutter signal may have amplitude, which is over 100 times than that of the blood flow signal. The clutter signal may be an obstacle to accurately detect a velocity of the blood flow. Thus, it is required to remove the clutter signal from the Doppler signal to accurately detect the velocities of the blood flow.

[0006] A frequency down mixing method has been used to remove the clutter signal. According to the frequency down mixing method, frequency components corresponding to the clutter signal are estimated and then down mixing, i.e., frequency shifting is performed upon the Doppler signal such that a center frequency of the clutter signal becomes zero. Thereafter, the clutter filtering is performed to remove the clutter signal.

[0007] Generally, the ultrasound system may acquire an amount of the ultrasound data by the ensemble number and estimate the frequency components corresponding to the clutter signal by using the acquired ultrasound data. However, it may be difficult to accurately estimate the frequency components corresponding to the clutter signal and frequency components corresponding to the blood flow signal by using the ultrasound data corresponding to the limited ensemble number.

[0008] To cope with the above problem, the conventional clutter filtering has been performed by setting a high cutoff frequency of a high pass filter. When the cutoff frequency is set high, a Doppler signal (i.e., blood flow signal) corresponding to a blood flow of a relatively low speed may be removed and a clutter signal of a relatively high frequency may not be removed. Thus, the motion of the blood flow may not be accurately indicated on a color Doppler image.

SUMMARY

[0009] Embodiments for adaptively performing clutter filtering in an ultrasound system are disclosed herein. In one embodiment, by way of non-limiting example, an ultrasound system comprises: an ultrasound data acquisition unit configured to perform a transmit/receive operation including transmitting ultrasound signals to a target object and receiving ultrasound echoes reflected from the target object to thereby acquire ultrasound data for color Doppler imaging; and a processing unit configured to extract a plurality of frequency components of the ultrasound data using an autoregressive model and compute a mean frequency component of the plurality of frequency components, the processing unit being further configured to detect frequency components corresponding to a clutter signal based on the plurality of frequency components and the mean frequency component and perform clutter filtering upon the ultrasound data by using the frequency components corresponding to the clutter signal.

[0010] In another embodiment, a method of performing cluttering filtering in an ultrasound system, comprises: a) performing a transmit/receive operation including transmitting ultrasound signals to a target object and receiving ultrasound echoes reflected from the target object to thereby acquire ultrasound data for color Doppler imaging; b) extracting a plurality of frequency components of the ultrasound data using an autoregressive model; c) detecting a mean frequency component of the plurality of frequency components; d) detecting frequency components corresponding to a clutter signal based on the plurality of frequency components and the mean frequency component; and e) performing clutter filtering upon the ultrasound data by using the frequency components corresponding to the clutter signal.

[0011] 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

[0012]

FIG. 1 is a block diagram showing an illustrative embodiment of an ultrasound system.
FIG. 2 is a schematic diagram showing an example of displaying a brightness mode image and a region of interest.
FIG. 3 is a block diagram showing an illustrative embodiment of an ultrasound data acquisition unit.
FIG. 4 is a flowchart showing an illustrative embodiment of forming a color Doppler image.
FIG. 5 is a flowchart showing an illustrative embodiment of detecting the frequency components corresponding to the clutter signal.

DETAILED DESCRIPTION

[0013] A detailed description may be provided with reference to the accompanying drawings.

[0014] 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.

[0015] Referring to FIG. 1, an ultrasound system constructed in accordance with one embodiment is shown. The ultrasound system 100 includes a user input unit 110, an ultrasound data acquisition unit 120, a processing unit 130, a storage unit 140 and a display unit 150. The user input unit 110 receives input information of a user. The input information includes input information for setting a region of interest (ROI) on a brightness (B)-mode image BI, as illustrated in FIG. 2. The ROI includes a color box for acquiring ultrasound data for color Doppler imaging. However, the ROI may not be limited thereto. The user input unit 100 includes a control panel, a mouse, a keyboard, a track ball and the like.

[0016] The ultrasound data acquisition unit 120 is configured to transmit ultrasound beams to a target object and receive ultrasound echoes reflected from the target object to thereby form ultrasound data representative of the target object. An operation of the ultrasound acquisition unit will be described in detail by referring to FIG. 3.

[0017] FIG. 3 is a block diagram showing an illustrative embodiment of the ultrasound data acquisition unit 120. Referring to FIG. 3, the ultrasound data acquisition unit 120 includes a transmit (Tx) signal forming section 310. The Tx signal forming section 310 is configured to generate a plurality of Tx signals. The Tx signal forming section 310 forms a Tx pattern of the Tx signals according to image modes such as a brightness mode, a Doppler mode, a color Doppler mode and the like. In one embodiment, the Tx pattern of the Tx signals include a first Tx pattern for the brightness mode and a second Tx pattern based on an ensemble number for the color Doppler mode. The ensemble number represents the number for transmission/reception of ultrasound signals along one single scan line to acquire Doppler signals.

[0018] The ultrasound data acquisition unit 120 further includes an ultrasound probe 320, which is coupled to the Tx signal forming section 210. The ultrasound probe 320 includes an array transducer containing a plurality of transducer elements for reciprocal conversion between electric signals and ultrasound signals. The ultrasound probe 320 is configured to transmit ultrasound signals in response to the Tx signals. In one embodiment, the transmitted ultrasound signals include first ultrasound signals based on the first Tx pattern of the Tx signals and second ultrasound signals based on the second Tx pattern of the Tx signals. The ultrasound probe 320 is be further configured to receive ultrasound echoes reflected from the target object to thereby output receive signals. In one embodiment, the receive signals include first receive signals associated with the first ultrasound signals and second receive signals associated with the second ultrasound signals. The ultrasound probe 320 includes a convex probe, a linear probe and the like.

[0019] The ultrasound data acquisition unit 120 further includes a beam forming section 330, which is coupled to the ultrasound probe 320. The beam forming section 330 is configured to digitize the receive signals into digital signals. The beam forming section 330 is configured to apply delays to the digital signals in consideration of distances between the elements of the ultrasound probe 320 and focal points. The beam forming section 330 further sums the delayed digital signals to form receive-focused signals. In one embodiment, the beam forming section 330 forms first receive-focused signals based on the first receive signals and second receive-focused signals based on the second receive signals.

[0020] The ultrasound data acquisition unit 120 further includes an ultrasound data forming section 340, which is coupled to the beam forming section 330. The ultrasound data forming section 340 is configured to form ultrasound data based on the receive-focused signals. In one embedment, the ultrasound data forming section 340 forms first ultrasound data for a B-mode image BI. The first ultrasound data are radio frequency data, although it may not be limited thereto. The ultrasound data forming section 340 forms second ultrasound data corresponding to the ROI for a Color Doppler image (i.e., ensemble data). The second ultrasound data include in-phase/quadrature data, although the second ultrasound data may not be limited thereto.

[0021] Referring to FIG. 1, the processing unit 130, which is coupled to the ultrasound data acquisition unit 120, may be embodied with at least one of a central processing unit, a microprocessor, a graphic processing unit and the like. However, the processing unit 130 may not be limited thereto.

[0022] FIG. 4 is a flowchart showing an illustrative embodiment of forming a color Doppler image. Referring to FIG. 4, the processing unit 130 forms a B-mode image BI based on the first ultrasound data, which are provided from the ultrasound data acquisition unit 120 at S402. The B-mode image BI is displayed on the display unit 150 for allowing a user to set the ROI thereon by using the user input unit 110.

[0023] If the input information is provided through the user input unit 110, then the processing unit 130 sets the ROI on the B-mode image based on the input information at S404.
In response to setting the ROI, the processing unit 130 controls the ultrasound data acquisition unit 120 for operation in the color Doppler mode to thereby obtain the second ultrasound data from the ROI (i.e., ensemble data).

[0024] The processing unit 130 is configured to estimate a plurality of frequency components and first strengths (or powers) of the second ultrasound data by using the autoregressive (AR) model at S406. Generally, a function H(z) of an m^{th} order AR model may be expressed as the following equation.

$$H(z) = \frac{\sqrt{e}}{1 + a_2 z^{-1} + \cdots + a_{(p+1)} z^{-m}} \qquad (1)$$

wherein a numerator may be represented by a minimized dispersion *e* and poles, which are roots of a denominator, may be represented by a polynomial of linear prediction coefficients a_k and z .

[0025] Linear prediction may be adopted to estimate the linear prediction coefficients a_k of equation (1). The linear prediction is a technique that estimates a current value based on linear sum of previous values of a given signal. Assuming that N discrete signals $(x_n)_{n \in [0, N]}$ are provided, forward linear prediction y_n and backward linear prediction z_n are indicated as linear prediction coefficients $(a_n)_{n \in [1, k]}$ of k coefficients.

$$\begin{aligned} y_n &= -\sum_{i=1}^{k} a_i x_{n-i} \\ z_n &= -\sum_{i=1}^{k} a_i x_{n+i} \end{aligned} \qquad (2)$$

[0026] The forward linear prediction y_n is represented by the minimized *sum* F_k of squared errors, as follows.

$$F_k = \sum_{n=k}^{N} (x_n - y_n)^2 = \sum_{n=k}^{N} \left(x_n - (-\sum_{i=1}^{k} a_i x_{n-i}) \right)^2 \qquad (3)$$

[0027] Typically, the linear prediction coefficients $(a_n)_{n \in [1, N]}$ are selected through minimization of the sum of squared errors. The backward linear prediction Z_n is represented by the minimized sum B_k of squared errors, as follows.

$$B_k = \sum_{n=k}^{N}(x_n - z_n)^2 = \sum_{n=k}^{N}\left(x_n - (-\sum_{i=1}^{k} a_i x_{n+i})\right)^2 \qquad (4)$$

[0028] To estimate the linear prediction coefficients $(a_n)_{n\in[1,N]}$ for minimizing the error of the forward linear prediction or the backward linear prediction, initial state parameters may be stabilized by the Burg's recursion based on the Levinson-Durbin recursion.

[0029] If the linear prediction coefficients of the AR model, in which the initial state parameters are stabilized by the Burg's recursion based on the Levinson-Durbin recursion, are estimated, then all poles of the denominator in equation (1) may be estimated.

[0030] In one embodiment, the processing unit 130 is configured to detect two poles for the second ultrasound data by using the second order AR model and detect frequency components and strengths corresponding to the respective two poles. In one embodiment, the AR model may not be limited to the second order AR model. The second order AR model may be defined as follows.

$$H(z) = \frac{z^2\sqrt{e}}{z^2 + a_1 z + a_2} = \frac{z^2\sqrt{e}}{(z - p_1)(z - p_2)} \qquad (5)$$

wherein p_1 represents a first pole of the second order AR model function H(z) and p_2 represents a second pole of the second order AR model function $H(z)$.

[0031] The processing unit 130 is further configured to detect frequency components ω_1 and ω_2 corresponding to the respective two poles of the second ultrasound data as the following equation.

$$\omega_1 = \tan^{-1}\left(\frac{\mathrm{Im}(p_1)}{\mathrm{Re}(p_1)}\right)$$
$$\omega_2 = \tan^{-1}\left(\frac{\mathrm{Im}(p_2)}{\mathrm{Re}(p_2)}\right) \qquad (6)$$

[0032] Further, the processing unit 130 is further configured to compute a mean frequency component ω_3 and a second strength (or power) corresponding to the second ultrasound data by using auto-correlation at S408. In another embodiment, the processing unit 130 is configured to compute a mean frequency component ω_3 and a second strength (or power) corresponding to the second ultrasound data by using the fast Fourier transform.

[0033] The processing unit 130 is configured to detect frequency components corresponding to the clutter signal by using the frequency components ω_1 and ω_2 and the mean frequency component ω_3 at S410. The step of S410 will be described in detail by referring to FIG. 5.

[0034] FIG. 5 is a flowchart showing an illustrative embodiment of detecting the frequency components corresponding to the clutter signal. Referring to FIG. 5, the processing unit 130 is configured to compare the frequency components ω_1 and ω_2, which have been detected by using the second order AR model, with a predetermined Doppler threshold D_{th} at S502. In such a case, the Doppler threshold D_{th} is an arbitrary value estimated by using a plurality of clinical data and set to different values according to parts of organs in the target object.

[0035] If it is determined that the frequency components ω_1 and ω_2 are greater than the Doppler threshold D_{th} at S502, then the processing unit 130 is configured to determine that the clutter signal does not exist in the Doppler signal. This isso that the detection of the frequency components corresponding to the clutter signal may not be carried out.

[0036] On the other hand, if it is determined that at least one of the frequency components ω_1 and ω_2 is less than the Doppler threshold D_{th} at S502, then the processing unit 130 is configured to compare the frequency components ω_1 and ω_2 with a predetermined clutter threshold C_{th} at S504. If it is determined that the frequency components ω_1 and ω_2 are less than the clutter threshold C_{th} at S502, then the frequency components ω_1 and ω_2 may be considered as a noise and a clutter signal. This is so that the processing unit 130 is configured to detect the mean frequency component ω_3

as the frequency component corresponding to the clutter signal at S506.

[0037] However, if it is determined that at least one of the frequency components ω_1 and ω_2 is greater than the Clutter threshold C_{th} at S504, then the processing unit 130 is configured to compare the frequency components ω_1 and ω_2 with the mean frequency component ω_3 at S508. The processing unit 130 is further configured to detect proximate frequency components from the mean frequency component ω_3 as the frequency components corresponding to the clutter signal at S510.

[0038] Referring back to FIG. 4, the processing unit 130 is configured to perform filtering upon the second ultrasound data by using the frequency components corresponding to the clutter signal at S412. In one embodiment, the processing unit 130 may be configured to set the frequency components corresponding to the clutter signal as the frequency down mixing frequencies. The processing unit 130 may be further configured to perform the frequency down mixing upon the second ultrasound data based on the down mixing frequencies. The processing unit 130 may be configured to restore the clutter-filtered second ultrasound data to the original frequencies.

[0039] Further, if the frequency components corresponding to the clutter signal are not detected, then the processing unit 130 is configured to compare the first strengths and the second strengths for the second ultrasound data to perform noise removal upon the second ultrasound data. The noise removal may be performed by using a well-known method, so that the detailed description thereof will be omitted herein. The processing unit 130 may be configured to form a color Doppler image by using the second ultrasound data with the clutter signal filtered at S414.

[0040] Referring to FIG. 1, the storage unit 140, which is coupled to the ultrasound data acquisition unit 120 via the processing unit 130, is configured to store the ultrasound data (first ultrasound data and second ultrasound data) acquired in the ultrasound data acquisition unit 120. Also, the storage unit 140 is configured to store the Doppler threshold D_{th} and the clutter threshold C_{th}. Further, the storage unit 140 may further include the second ultrasound data with the clutter signal filtered.

[0041] The display unit 150 displays the B-mod image and the color Doppler image, which have been formed in the processing unit 130. The display unit 150 includes at least one of a cathode ray tube (CRT) display, a liquid crystal display (LCD), an organic light emitting diode (OLED) display and the like.

[0042] 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, comprising:

   an ultrasound data acquisition unit configured to perform a transmit/receive operation including transmitting ultrasound signals to a target object and receiving ultrasound echoes reflected from the target object to thereby acquire ultrasound data for color Doppler imaging; and
   a processing unit configured to extract a plurality of frequency components of the ultrasound data using an autoregressive model and compute a mean frequency component of the plurality of frequency components, the processing unit being further configured to detect frequency components corresponding to a clutter signal based on the plurality of frequency components and the mean frequency component and perform clutter filtering upon the ultrasound data by using the frequency components corresponding to the clutter signal.

2. The ultrasound system of Claim 1, wherein the processing unit is configured to extract the plurality of frequency components corresponding to a plurality of poles from the ultrasound data by using the autoregressive model

3. The ultrasound system of Claim 2, wherein the processing unit is configured to:

   compare each of the plurality of frequency components with a predetermined Doppler threshold,
   compare, when at least one of the frequency components is less than the predetermined Doppler threshold, each of the plurality of frequency components with a predetermined clutter threshold, and
   compare, when at least one of the frequency components is greater than the predetermined clutter threshold, each of the plurality of frequency components with the mean frequency component to detect frequency components proximate to the mean frequency component as the frequency components corresponding to the clutter signal.

4. The ultrasound system of Claim 3, wherein the processing unit is configured to set, when the frequency components are greater than the predetermined clutter threshold, the mean frequency component as the frequency component corresponding to the clutter signal.

5. The ultrasound system of Claim 1, wherein the processing unit is configured to:

set the frequency components corresponding to the clutter signal as frequency down mixing frequencies,
perform frequency down mixing upon the ultrasound data based on the frequency down mixing frequencies, and
perform the clutter filtering upon the frequency down mixed ultrasound data.

6. A method of performing cluttering filtering in an ultrasound system, comprising:

a) performing a transmit/receive operation including transmitting ultrasound signals to a target object and receiving ultrasound echoes reflected from the target object to thereby acquire ultrasound data for color Doppler imaging;
b) extracting a plurality of frequency components of the ultrasound data using an autoregressive model;
c) detecting a mean frequency component of the plurality of frequency components
d) detecting frequency components corresponding to a clutter signal based on the plurality of frequency components and the mean frequency component; and
e) performing clutter filtering upon the ultrasound data by using the frequency components corresponding to the clutter signal.

7. The method of Claim 6, wherein the step b) includes extracting the plurality of frequency components corresponding to a plurality of poles from the ultrasound data by using the autoregressive model.

8. The method of Claim 7, wherein the step d) includes:

d1) comparing each of the plurality of frequency components with a predetermined Doppler threshold;
d2) comparing, when at least one of the frequency components is less than the predetermined Doppler threshold, each of the plurality of frequency components with a predetermined clutter threshold, and
d3) comparing, when at least one of the frequency components is greater than the predetermined clutter threshold, each of the plurality of frequency components with the mean frequency component to detect frequency components proximate to the mean frequency component as the frequency components corresponding to the clutter signal.

9. The method of Claim 8, wherein the step d) includes setting, when the frequency components are greater than the predetermined clutter threshold, the mean frequency component as the frequency component corresponding to the clutter signal.

10. The method of Claim 6, wherein the step e) includes:

setting the frequency components corresponding to the clutter signal as frequency down mixing frequencies,
performing frequency down mixing upon the ultrasound data based on the frequency down mixing frequencies, and
performing the clutter filtering upon the frequency down mixed ultrasound data.

FIG. 1

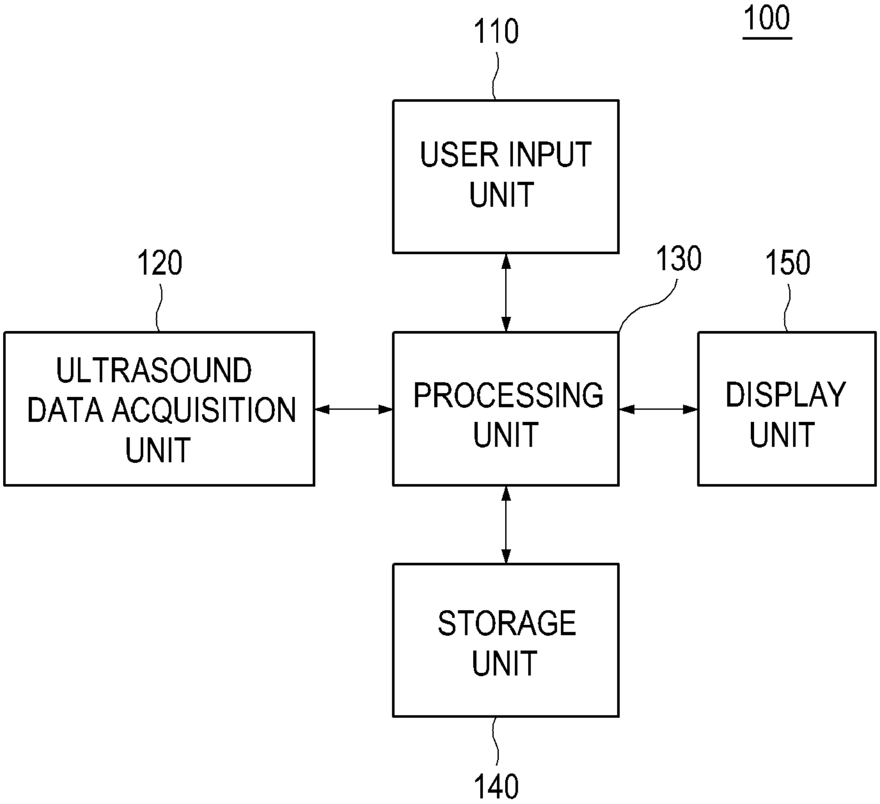

100
110
USER INPUT UNIT
120
ULTRASOUND DATA ACQUISITION UNIT
130
PROCESSING UNIT
150
DISPLAY UNIT
STORAGE UNIT
140

FIG. 2

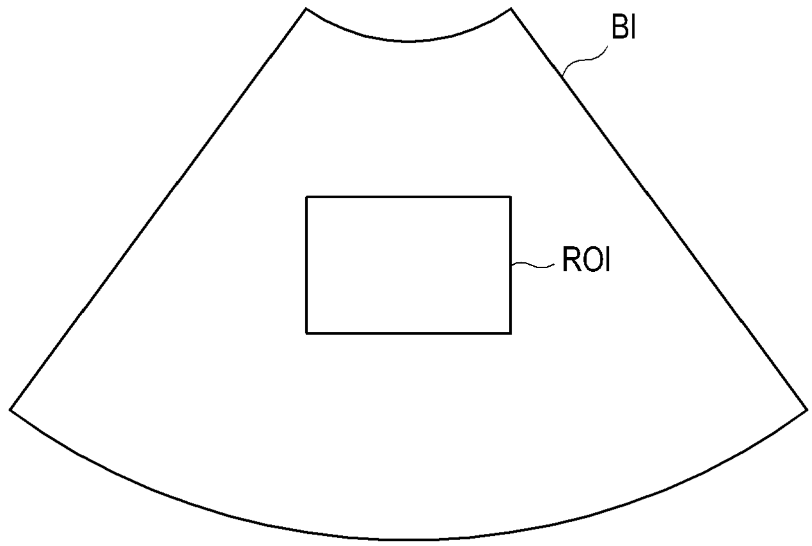

BI
ROI

FIG. 3

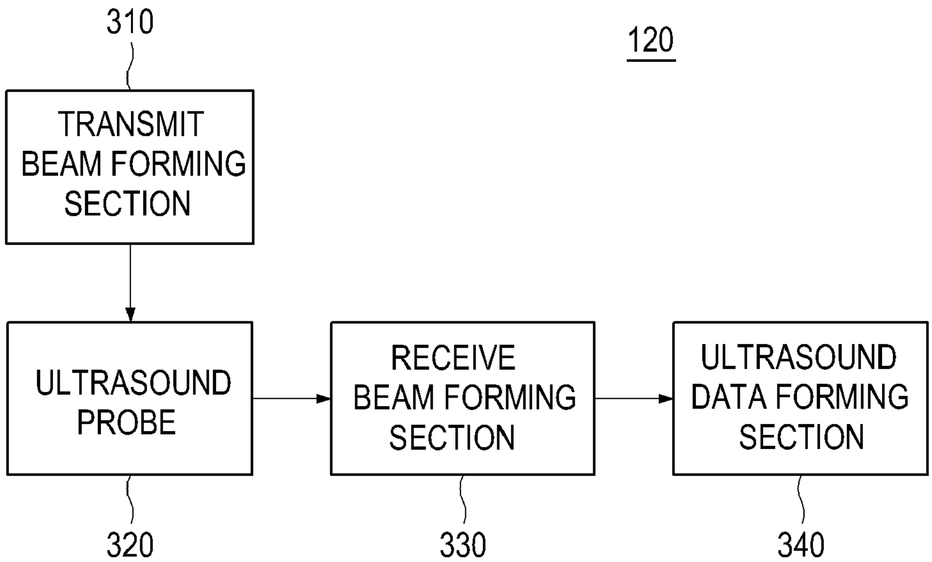

310
120
TRANSMIT BEAM FORMING SECTION
ULTRASOUND PROBE
RECEIVE BEAM FORMING SECTION
ULTRASOUND DATA FORMING SECTION
320
330
340

FIG. 4

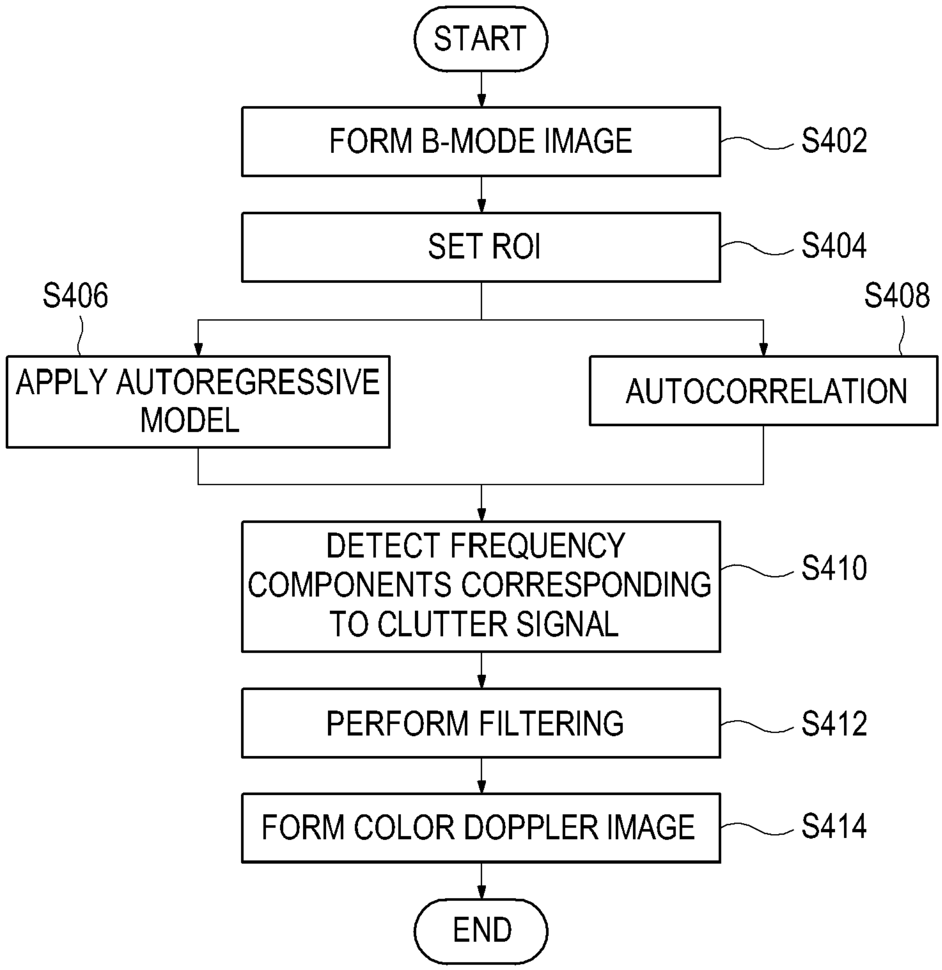
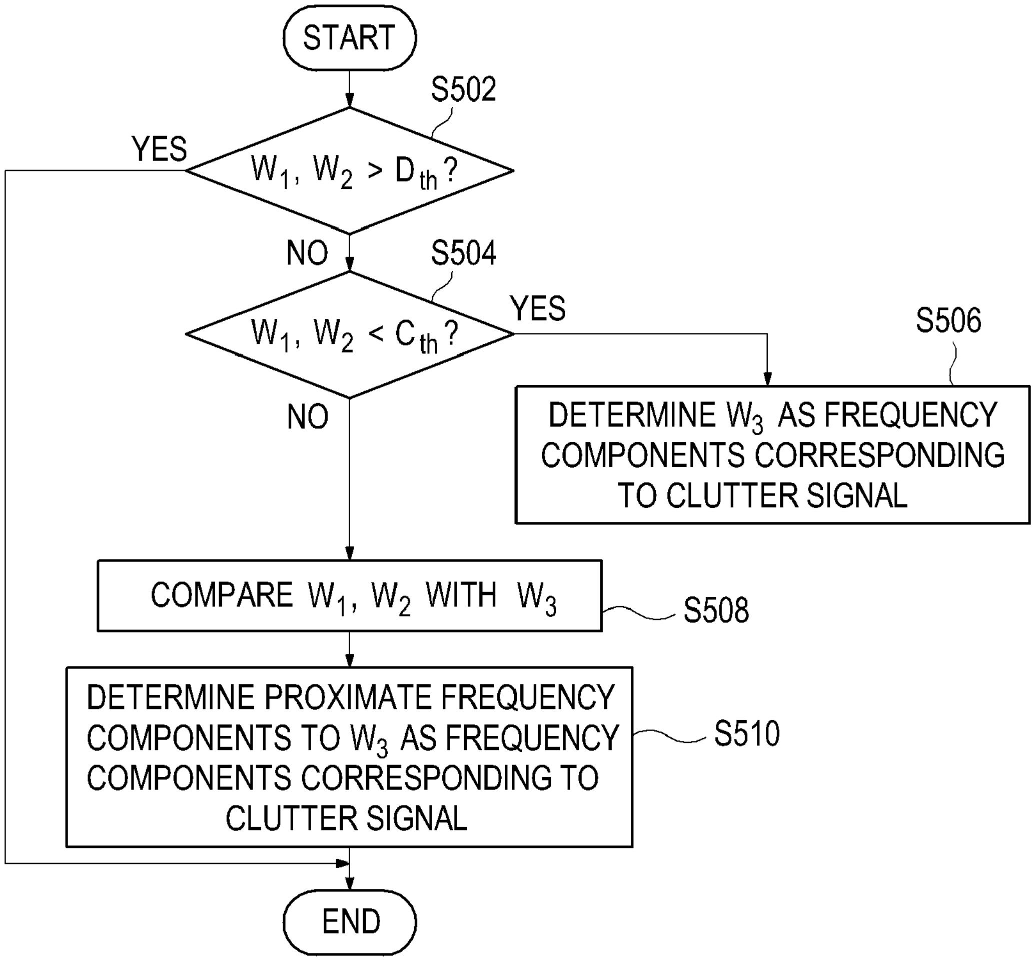

START
FORM B-MODE IMAGE
S402
SET ROI
S404
S406
S408
APPLY AUTOREGRESSIVE MODEL
AUTOCORRELATION
DETECT FREQUENCY COMPONENTS CORRESPONDING TO CLUTTER SIGNAL
S410
PERFORM FILTERING
S412
FORM COLOR DOPPLER IMAGE
S414
END

FIG. 5


START
S502
YES
W1, W2 > Dth ?
NO
S504
YES
W1, W2 < Cth ?
S506
DETERMINE W3 AS FREQUENCY COMPONENTS CORRESPONDING TO CLUTTER SIGNAL
NO
COMPARE W1, W2 WITH W3
S508
DETERMINE PROXIMATE FREQUENCY COMPONENTS TO W3 AS FREQUENCY COMPONENTS CORRESPONDING TO CLUTTER SIGNAL
S510
END

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EUROPEAN SEARCH REPORT

Application Number
EP 11 16 3392

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	YOUNG BOK AHN ET AL: "ESTIMATION OF MEAN FREQUENCY AND VARIANCE OF ULTRASONIC DOPPLER SIGNAL BY USING SECOND-ORDER AUTOREGRESSIVE MODEL", IEEE TRANSACTIONS ON ULTRASONICS, FERROELECTRICS AND FREQUENCY CONTROL, IEEE, US, vol. 38, no. 3, 1 May 1991 (1991-05-01), pages 172-182, XP000206313, ISSN: 0885-3010, DOI: 10.1109/58.79600	1,2,6,7	INV. A61B8/06 G01S15/89
Y	* the whole document *	5,10	

Y	XIAOTAO WANG ET AL: "An Novel Clutter Rejection Filters Applied to Wideband Blood Flow Velocity Estimation", ENGINEERING IN MEDICINE AND BIOLOGY SOCIETY, 2005. IEEE-EMBS 2005. 27T H ANNUAL INTERNATIONAL CONFERENCE OF THE SHANGHAI, CHINA 01-04 SEPT. 2005, PISCATAWAY, NJ, USA,IEEE, 1 January 2005 (2005-01-01), pages 7289-7292, XP031000887, DOI: 10.1109/IEMBS.2005.1616194 ISBN: 978-0-7803-8741-6 * section "C. An Novel Scheme for Wideband Blood Flow Velocity Estimation" under "II. BASIC PRINCIPLES" on p. 7291 * * figure 2 *	5,10	TECHNICAL FIELDS SEARCHED (IPC): A61B G01S

	-/--		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 July 2011	Willig, Hendrik

1

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EUROPEAN SEARCH REPORT

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X	PEIDONG WANG ET AL: "An Improved Mean Frequency Estimator for Ultrasonic Color Flow Imaging Using Second-Order Autoregressive Model", ENGINEERING IN MEDICINE AND BIOLOGY SOCIETY, 2005. IEEE-EMBS 2005. 27T H ANNUAL INTERNATIONAL CONFERENCE OF THE SHANGHAI, CHINA 01-04 SEPT. 2005, PISCATAWAY, NJ, USA,IEEE, 1 September 2005 (2005-09-01), pages 5643-5646, XP010907173, DOI: 10.1109/IEMBS.2005.1615766 ISBN: 978-0-7803-8741-6 * the whole document * -----	1,2,6,7	
			TECHNICAL FIELDS SEARCHED (IPC)

1

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O : non-written disclosure
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T : theory or principle underlying the invention
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D : document cited in the application
L : document cited for other reasons
....
& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

REFERENCES CITED IN THE DESCRIPTION

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- KR 1020110018707 **[0001]**

专利名称(译)	超声系统中的自适应杂波滤波		
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[标]申请(专利权)人(译)	三星麦迪森株式会社		
申请(专利权)人(译)	三星MEDISON CO.，LTD.		
当前申请(专利权)人(译)	三星MEDISON CO.，LTD.		
[标]发明人	BAE MOO HO LEE YOUNG SEOK PARK SUNG BAE LEE KYOUNG BO		
发明人	BAE, MOO HO LEE, YOUNG SEOK PARK, SUNG BAE LEE, KYOUNG BO		
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代理机构(译)	SCHMID，WOLFGANG		
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摘要(译)

公开了用于在超声系统中执行杂波滤波的实施例。在一个实施例中，超声数据获取单元从目标对象获取超声数据以进行彩色多普勒成像，并且处理单元使用自回归模型提取超声数据的多个频率分量并计算多个频率的平均频率分量组件。处理单元基于多个频率分量和平均频率分量检测与杂波信号对应的频率分量，并且通过使用与杂波信号对应的频率分量对超声数据执行杂波滤波。

FIG. 1