(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 249 175 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
11.06.2014 Bulletin 2014/24

(51) Int Cl.:
G01S 7/52 *(2006.01)* ***G01S 15/89*** *(2006.01)*
A61B 8/08 *(2006.01)*

(21) Application number: **10160682.0**

(22) Date of filing: **22.04.2010**

(54) Color doppler mode image processing in an ultrasound system

Farbdopplermodus-Bildverarbeitung in einem Ultraschallsystem

Processeur d'images en mode Doppler couleur dans un système à ultrasons

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR

(30) Priority: **30.04.2009 KR 20090038474**

(43) Date of publication of application:
10.11.2010 Bulletin 2010/45

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Printed by Jouve, 75001 PARIS (FR)

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority from Korean Patent Application No. 10-10-2009-0038474 filed on April 30, 2009.

TECHNICAL FIELD

[0002] The present disclosure relates to ultrasound image processing, and more particularly to color Doppler mode image processing in an ultrasound system.

BACKGROUND

[0003] Recently, an ultrasound system has been extensively used in the medical field due to its non-invasive and non-destructive nature. Modem high-performance ultrasound imaging diagnostic systems and techniques are typically used to produce two- or three-dimensional ultrasound images of internal features of patients. 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.

[0004] In the Doppler mode, the ultrasound system provides a color Doppler mode image visualizing velocities of moving objects such as blood flow, heart, etc. The color Doppler mode image includes a power image visualizing powers of Doppler signals as 2-dimensional distribution and a velocity image visualizing velocities of the moving objects, which may be computed from the Doppler signals, as 2-dimensional distribution. The color Doppler mode image may visualize the blood flow in real time and a wide range from the blood flow of a high velocity in a large vessel to the blood flow of a low velocity in a small vessel.

[0005] Conventionally, smoothing has been carried out upon the velocity image for enhancement. However, since the blood flow on the velocity image may be extended to the vessel region due to the smoothing, bleeding, which shows blood escape from the real vessel on the velocity image, may be caused. Further, a loss of small vessels may occur. Also, the connectivity loss, i.e., portions of vessel are cut in the velocity image, may be generated. The peaks of the blood flow may be important clinical information in the velocity image. However, the peak loss, i.e., peaks of the blood flow are disappeared in the velocity image, may be also generated due to the smoothing thereupon.

[0006] Further, the effectiveness of pixels in the power image is determined through the fixed thresholding method. However, since the power of blood flow varies according to the heartbeat, the vascular collapse, i.e., the blood vessel region is collapsed in the power image, may occur.

[0007] An ultrasound system according to the preamble of claim 1 and a method of processing a color Doppler mode image in an ultrasound system according to the preamble of claim 9 are known from EP 0 871 043 A2.

SUMMARY

[0008] Embodiments for processing a color Doppler mode image in an ultrasound system are provided. The ultrasound system comprises the features as stated in claim 1.

[0009] A method of processing a color Doppler mode image in an ultrasound system including a Doppler signal acquisition unit and a processing unit comprises the features as stated in claim 9.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

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 signal acquisition unit in FIG. 1.

FIG. 3 is a block diagram showing an illustrative embodiment of a processing unit in FIG. 1.

FIG. 4 is an exemplary diagram showing an example of a graph of mean powers for power images and formation of compound images.

FIG. 5A is a diagram showing an example of setting a mask.

FIG. 5B is a diagram showing an example of detecting contours of a mask.

FIG. 5C is a diagram showing an example of smoothed contours of a mask.

FIG. 5D is a diagram showing an example resulting from performing filling upon a mask.

FIG. 6 is a diagram showing an example of a distance transform image.

DETAILED DESCRIPTION

[0011] A detailed description is provided with reference to the accompanying drawings.

[0012] Referring to FIG. 1, an illustrative embodiment of an ultrasound system 100 is shown. As depicted therein, the ultrasound system. 100 includes a signal acquisition unit 110. The signal acquisition unit 110 is operable to alternately transmit and receive ultrasound signals to and from a moving target object (e.g., heart, blood flow, etc). The signal acquisition unit 110 acquires Doppler signals corresponding to a plurality of frames based on the received ultrasound signals. In one embodiment, the frames may include color Doppler mode image frames.

[0013] FIG. 2 is a block diagram showing an illustrative embodiment of the signal acquisition unit 110 in FIG. 1. Referring to FIG 2, the signal acquisition unit 110 includes a transmit (Tx) signal generating section 111. The Tx signal generating section 111 is operable to generate a plurality of transmit signals.

[0014] The signal acquisition unit 110 further includes an ultrasound probe 112 containing a plurality of transducer elements for reciprocally converting ultrasound signals and electrical signals. The ultrasound probe 122 is operable to transmit ultrasound signals into a target object in response to the transmit signals. The ultrasound probe 112 is 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.

[0015] The signal acquisition unit 110 further includes a beam forming section 113. The beam forming section 113 is operable to convert the electrical receive signals into digital signals. The beam forming section 113 is 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.

[0016] The signal acquisition unit 110 further includes a Doppler signal forming section 114 that is operable to form Doppler signals based on the digital receive-focused signals. The Doppler signals contain power information and velocity information. The Doppler forming section 114 is operable to perform signal processing (e.g., gain adjustment, filtering and the like) necessary for forming the Doppler signals upon the digital receive-focused signals.

[0017] The ultrasound system 100 further includes a processing unit 120 coupled to the signal acquisition unit 110. The processing unit 120 is operable to form a color Doppler mode image based on the Doppler signals provided from the signal acquisition unit 110. The processing unit 120 is further operable to form a mask for detecting a blood vessel region by using the color Doppler mode image and perform masking upon the color Doppler mode image. The color Doppler mode image includes a power image indicative of powers of the Doppler signals as 2-dimensional distribution and a velocity image indicative of velocities of the Doppler signals as 2-dimensional distribution.

[0018] FIG. 3 is a block diagram showing an illustrative embodiment of the processing unit. Referring to FIG. 3, the processing unit 120 includes an image forming section 121, a mask forming section 122, a first image processing section 123 and a second image processing section 124.

[0019] The image forming section 121 is operable to a power image and a velocity image based on the Doppler signals provided from the signal acquisition unit 121. The mask forming section 122 is operable to form a mask for detecting a blood vessel region, which is a region of interest, on the power image. In one embodiment, the mask forming section 122 includes a power image processing section 122a, a mask setting section 122b, a mask processing section 122c and a flash noise removing section 122d.

[0020] The power image processing section 122a is operable to analyze the power images sequentially provided from the image forming section 121 to set a reference power image. In one embodiment, a power image having a mean power greater than a predetermined threshold is set as the reference power image. The power image processing section 122a is further operable to compound power images, of which mean powers are less than the predetermined threshold, with the reference power image to thereby form compound images.

[0021] FIG. 4 shows an example of mean powers of the power images and examples of setting the reference power image to form the compound images by using the power images. Referring to FIG. 4, if a first power image PI_1 is provided, then the power image processing section 122a is operable to compute a mean power of the first power image (hereinafter, referred to as "first mean power"). The power image processing section 122a initially sets the first power image PI1 and the first mean power as the reference power image and the reference mean power.

[0022] If a second power image PI_2 is provided from the image forming section 121, then the power image processing section 122a is operable to compute the mean power of the second power image PI_2 (hereinafter, referred to as "second mean power"). The power image processing section 112a checks whether the second mean power is greater than the predetermined threshold (e.g., reference mean power $\times$ 0.8). If the second mean power is greater than the predetermined threshold, then the power image processing section 122a is operable to set the second power image PI_2 as a new reference power image.

[0023] If a third power image PI_3 is provided from the image forming section 121, then the power image processing section 122a is operable to compute the mean power of the third power image PI_3 (hereinafter, referred to as "third mean power"). The power image processing section 122a checks whether the third mean power is greater than the predetermined threshold (e.g., reference mean power $\times$ 0.8). If the third mean power is greater than the predetermined threshold, then the power image processing section 122a is operable to set the third power image PI_3 as a new reference power image.

[0024] If a fourth power image PI_4 is provided from the image forming section 121, then the power image processing section 122a is operable to compute the mean power of the fourth power image PI_4 (hereinafter, referred to as "fourth mean power"). The power image processing section 122a checks whether the fourth mean power is greater than the predetermined threshold (e.g., reference mean power 0.8). If the fourth mean power is less than the predetermined threshold, then the power image processing section 122a is operable to compound the fourth power image PI_4 and the reference power image, thereby forming a compound image CI_4. In one embodiment, since the power image having relatively low mean power is compounded with the reference power image, it may be prevented that the blood vessel region is indicated as a small region on the power image due to the low mean power.

[0025] If fifth to eighth power images PI_5-PI_8 are provided from the image forming section 121, then the power image processing section 122a is operable to compute mean powers of the fifth to eighth power images PI_5-PI_8 (hereinafter, referred to as "fifth to eighth mean powers"). The power image processing section 122a compares the fifth to eighth mean powers with the predetermined threshold (e.g., reference mean power $\times$ 0.8). If the fifth to eighth mean powers are less than the predetermined threshold, then the power image processing section 122a is operable to compound the respective fifth to eighth power images PI_5-PI_8 with the reference power image.

[0026] If a ninth power image PI9 is provided from the image forming section 121, then the power image processing section 122a is operable to compute the mean power of the ninth power image PI_9 (hereinafter, referred to as "ninth mean power"). The power image processing section 122a checks whether the ninth mean power is greater than the predetermined threshold (e.g., reference mean power 0.8). If the ninth mean power is greater than the predetermined threshold, then the power image processing section 122a is operable to set the ninth power image PI_9 as a new reference power image.

[0027] If tenth to twelfth power images PI_{10}-PI_{12} are provided from the image forming section 121, then the power image processing section 122a is operable to compute mean powers of the tenth to twelfth power images PI_{10}-PI_{12} (hereinafter, referred to as "tenth to twelfth mean powers"). The power image processing section 122a compares each of the tenth to twelfth mean powers with the predetermined threshold (e.g., reference mean power $\times$ 0.8). If the tenth to twelfth mean powers are less than the predetermined threshold, then the power image processing section 122a is operable to compound each of the tenth to twelfth power images PI_{10}-PI_{12} with the reference power image PI_9, thereby forming compound images CI_{10}-CI_{12}.

[0028] The mask setting section 122b is operable to set a region of interest, i.e., a mask for detecting a blood vessel region on each of the reference power images PI_1-PI_3 and PI_9 and the compound images CI_4-CI_8 and CI_{10}-CI_{12}, as shown in FIG. 5A. The mask includes one or more sub regions. In one embodiment, the mask is set by using various well-known methods, such as a thresholding method, an area expanding method, an area segmenting method, a contour extracting method, a graph method, a watershed method, and the like.

[0029] The mask processing section 122c is operable to detect contours of the mask set in the mask setting section 122b, as illustrated in FIG. 5B. In one embodiment, by way of non-limiting example, the contours are detected by using contour following, mathematical morphological operation and the like. The mask processing section 122c is operable to perform smoothing upon the detected contours of the mask, as shown in FIG. 5C. The smoothing is performed through at least one of Fourier descriptor based algorithm, chain codes, active contour and the like. The mask processing section 122c is further operable to perform filling upon the smoothed mask, as shown in FIG. 5D.

[0030] The flash noise removing section 122d is operable to remove flash noises from the mask provided from the mask processing section 122c. The flash noises occur due to muscles neighboring to the blood vessels, heart muscles and the like whose moving velocities are slower than those of the blood flows while their moving powers are greater than those of the blood flows. The flash noises are appeared and disappeared in a flash. In one embodiment, the flash noise removing section 122d is operable to perform region labeling upon the mask of the frame (reference power image or compound image) to assign a specific index to each of the sub regions in the mask. The flash noise removing section 122d compares the mask of the current frame with the masks of the predetermined number of the previous frames (e.g., 3 frames). If the indices in the mask of the current frame are not identical to those of the respective sub regions of the predetermined number of the previous frames, then the flash noise removing section 122d determines the different indexed sub region(s) in the mask of the current frame as the flash noises to thereby remove them. In another embodiment, the flash noise removing section 122d checks whether each of the sub regions in the mask is effective as the blood vessel. The flash noise removing section 122d removes the sub regions, which do not have the effective values. The effectiveness is determined by checking whether the maximum value of pixels in each sub region in the mask is greater than a predetermined value. When the maximum value of pixels in the sub region is less than the predetermined value, the corresponding region sub is determined as the noise. Also, the effectiveness is determined by checking whether the contours of the sub regions in the mask are flat over a predetermined portion.

[0031] The first image processing section 123 uses the mask provided from the mask forming section 122 to mask the velocity images, which are sequentially provided form the image forming section 121. Referring to FIG. 3, the first image processing section 123 includes a first smoothing section 123a, a first masking section 123b, a first filtering section 123c and a peak restoring section 123d.

[0032] The first smoothing section 123a is operable to perform smoothing upon the velocity images. In one embodiment, by way of non-limiting example, the smoothing is carried out through one of the mean filtering, Gaussian filtering, median filtering, low pass filtering, graph regularization and the like.

[0033] The first masking section 123b uses the mask provided from the mask forming section 122 to mask the smoothed velocity images. The first masking section 123b is operable to use the mask to set regions corresponding to the blood vessels for each of pixels of the respective velocity images as "1" and regions except for the blood vessel regions as "0."

[0034] The first filtering section 123c is operable to apply distance weighting to the masked velocity images and then perform border smoothing thereupon. The distance weighting is performed such thai the velocities of the blood flow at blood vessel border portions are indicated slower than those at the center portion of the blood flow. The first filtering section 123c is operable to form distance transform images by using the masked velocity images. The first filtering section 123c sets pixels corresponding to background (i.e., not blood vessel regions) as "0" and the rest of the pixels as minimum distance values from the background, as shown in FIG. 6, to thereby form the distance transform images. Distance weighting corresponding to the pixels of the distance transform image is expressed as a function of the pixels. In one embodiment, the distance weighting is defined as w(i)=min(i*0.2+0.6, 1), wherein i represents a pixel value in the distance transform image. Thus, if a pixel value of the smoothed velocity image is f(x, y), this pixel value is transformed to f(x, y)*w(f(x, y)). The first filtering section 123c is further operable to detect blood vessel border portion in the distance weighted velocity image and then perform smoothing upon the detected border portions.

[0035] The peak restoring section 123d is operable to restore peaks in the velocity images provided from the first filtering section 123c. The maximum velocity (i.e., peak) of the blood flow in the blood vessel provides clinically important information, so that the peaks should be maintained. However, the peaks are blurred during the smoothing, which makes the peak values lowered. Thus, the peak restoring section 123d is operable to compute image differences between the velocity images provided form the image forming section 121 and the smoothed velocity images. The peak restoring section 123d checks peak candidates, which are regions over the image difference of "()," and then detect regions greater than a predetermined threshold as the peak regions among the peak candidates. The peak restoring section 123d is operable to restore the peaks in the smoothed velocity image by using the detected peak regions.

[0036] The second image processing section 124 is operable to use the mask provided from the mask forming section 122 to mask the power images sequentially provided from the image forming section 121. In one embodiment, the second image processing section 124 includes a second smoothing section 124a, a second masking section 124b and a second filtering section 124c.

[0037] If the power images are provided from the image forming section 121, the second smoothing section 124a is operable to perform smoothing upon the power images. In one embodiment, the smoothing may be performed through mean filtering, Gaussian filtering, median filtering, low pass filtering, graph regularization and the like.

[0038] The second masking section 124b uses the mask provided from the mask forming section 122 to mask the smoothed power images. The second masking section 124b is operable to use the mask to set regions corresponding to the blood vessels for each of pixels of the respective power images as "1" and regions except for the blood vessel regions as "0."

[0039] The second filtering section 124c is operable to apply distance weighting to the masked power image and then perform border smoothing thereupon. The distance weighting is performed such that the powers of the blood flow at blood vessel border portions are indicated lower than those at the center portion of the blood flow. The second filtering section 124c is operable to form distance transform images by using the masked power images. The second filtering section 124c is further operable to detect blood vessel border portion in the distance weighted power images and then perform smoothing upon the detected border portions.

[0040] Referring back to FIG 1, the display unit 130 includes at least one of a CRT monitor, a LCD monitor, a plate display and the like. The display unit 130 displays the color Doppler mode images formed in the processing unit 120, i.e., velocity images and power images. The control unit 140 is operable to control the formation, image processing and display of the power images and the velocity images.

[0041] In another embodiment, instructions for performing the above method of processing the color Doppler mode image are recorded in a computer readable medium using computer-readable instructions. The computer readable medium includes any types of record media, which can be read by a computer system. The computer readable medium includes read only memory (ROM), random access memory (RAM), CD-ROM, magnetic tape, floppy disk, optical-data recording apparatus and the like. The computer readable medium comprises computer executable instructions that is configured to perform the following acts: a) transmitting and receiving ultrasound signals to and from a target object to acquire first Doppler signals; b) forming color Doppler images including power images and velocity images; c) forming a mask for detecting a region of interest by using the color Doppler images; and d) masking the power images and the velocity image by using the mask.

Claims

1. An ultrasound system (100), comprising:

a signal acquisition unit (110) configured to transmit and receive ultrasound signals to and from a target object to acquire Doppler signals; and

a processing unit (120) configured to form color Doppler mode images including power images visualizing powers of the Doppler signals as 2-dimensional distributions and velocity images, wherein the processing unit (120) is further configured to analyze the power images to set a reference power image whose mean power is greater than a predetermined threshold, to compound the reference power image with respective power images whose mean power is less than the predetermined threshold to form compound images, to form a mask for detecting a region of interest by using the reference power image and the compound images to detect contours of the mask, to perform smoothing upon the detected contours, and to perform filling upon the smoothed mask, and to mask the power images and the velocity images by using the mask.

2. The ultrasound system (100) of Claim 1, wherein the processing unit (120) includes:

an image forming section (121) configured to form the power images and the velocity images;
a mask forming section (122) configured to form the mask by using the power image;
a first image processing section (123) configured to mask the velocity images by using the mask; and
a second image processing section (124) configured to mask the power images by using the mask.

3. The ultrasound system (100) of Claim 2, wherein the mask forming section (122) includes:

a power image processing section (122a) configured to analyze the power images to set a the reference power image whose mean power is greater than the predetermined threshold, and to compound the reference power image with respective power images whose mean power is less than the predetermined threshold to form the compound images;
a mask setting section (122b) configured to set the mask for detecting the region of interest by using the reference power image and the compound images; and
a mask processing section (122c) configured to detect contours of the mask, perform smoothing upon the detected contours, and perform filling upon the smoothed mask.

4. The ultrasound system (100) of Claim 3, wherein the predetermined threshold is a value obtained by multiplying the reference mean power by a predetermined value.

5. The ultrasound system (100) of Claim 4, wherein the mask forming section includes a flash noise removing section to remove flash noises in the mask.

6. The ultrasound system (100) of Claim 4, wherein the power image processing section (122a) is configured to:

compute a first mean power of a first power image provided from the image forming section to set a reference mean power;
set the first power image as a reference power image;
compute an i^{th} mean power of an i^{th} power image provided from the image processing section, wherein i is a positive integer greater than 1;
compare the i^{th} mean power with the predetermined threshold;
set, when the i^{th} mean power is greater than the predetermined threshold, the ith mean power as a new reference mean power and set the ith power image as a new reference power image; and
compound, when the i^{th} mean power is less than the predetermined threshold, the i^{th} power image to the reference power image.

7. The ultrasound system (100) of Claim 2, wherein the first image processing section (123) includes:

a first smoothing section (123a) configured to perform smoothing upon the velocity images;
a first masking section (123b) configured to mask the smoothed velocity images by using the mask;
a first filtering section (123c) configured to perform distance weighting and border smoothing upon the masked velocity images; and
a peak restoring section (123d) configured to obtain difference image between the velocity image provided from the image forming section (121) and the distance-weighted and border-smoothed velocity images, detect peak regions by using the difference images, and restore peaks of the distance-weighted and border-smoothed velocity images by using the detected peak regions.

8. The ultrasound system (100) of Claim 2, wherein the second image processing section (124) includes:

a second smoothing section (124a) configured to perform smoothing upon the power images;
a second masking section (124b) configured to mask the smoothed power images; and
a second filtering section (124c) configured to perform distance weighting and border smoothing upon the masked power images.

9. A method of processing a color Doppler mode image in an ultrasound system (100) including a signal acquisition unit (110) and a processing unit (120), comprising:

a) at the signal acquisition unit (110), transmitting and receiving ultrasound signals to and from a target object to acquire Doppler signals; and
b) at the processing unit (120), forming color Doppler mode images including power images visualizing powers of the Doppler signals as 2-dimensional distributions and velocity images,
c) at the processing unit (120), forming a mask for detecting a region of interest by using the power images,
d) at the processing unit (120), masking the power images and the velocity images by using the mask, **characterised in that** step c) include:

c1) analyzing the power images to set a reference power image whose mean power is greater than a predetermined threshold, and compounding the reference power image with respective power images whose mean power is less than the predetermined threshold to form compound images;
c2) setting the mask for detecting the region of interest by using the reference power image and the compound images; and
c3) detect contours of the mask to perform smoothing upon the detected contours; and
c4) performing filling upon the smoothed mask.

10. The method of Claim 9, wherein the c) further includes removing flash noises from the mask.

11. The method of Claim 9, wherein the predetermined threshold is a value obtained by multiplying the reference mean power by a predetermined value.

12. The method of Claim 9, wherein the c1) includes:

computing a first mean power of a first power image provided from the image forming section to set a reference mean power;
setting the first power image as a reference power image;
computing an i^{th} mean power of an i^{th} power image provided from the image processing section, wherein i is a positive integer greater than 1;
comparing the i^{th} mean power with the predetermined threshold;
setting, when the i^{th} mean power is greater than the predetermined threshold, the i^{th} mean power as a new reference mean power and set the i^{th} power image as a new reference power image; and
compounding, when the i^{lh} mean power is less than the predetermined threshold, the i^{th} power image to the reference power image.

13. The method of Claim 9, wherein the d) includes:

performing smoothing upon the velocity images;
masking the smoothed velocity images by using the mask;
performing distance weighting and border smoothing upon the masked velocity images;
obtaining difference image between the velocity image provided from the image processing section and the distance-weighted and border-smoothed velocity images;
detecting peak regions by using the difference images; and
restoring peaks of the distance-weighted and border smoothed velocity images by using the detected peak regions.

14. The method of Claim 9, wherein the d) include:

performing smoothing upon the power images;
masking the smoothed power images; and
performing distance weighting and border smoothing upon the masked power images.

Patentansprüche

1. Ultraschallsystem (100), welches folgendes aufweist:

Eine Signalerlangungseinheit (110), die dafür vorgesehen ist, Ultraschallsignale zu einem Zielobjekt zu übertragen und von demselben zu empfangen, um Dopplersignale zu erlangen; und
eine Verarbeitungseinheit (120), die dafür vorgesehen ist, Farbdopplermodus Bilder einschließlich Leistungsbilder zu erzeugen, welche Leistungen der Dopplersignale als 2-dimensionale Verteilungen und Geschwindigkeitsbilder visualisieren,
wobei die Verarbeitungseinheit (120) des Weiteren dafür vorgesehen ist, die Leistungsbilder zu analysieren, um ein Referenzleistungsbild festzulegen, dessen durchschnittliche Leistung größer ist als ein vorbestimmter Grenzwert, das Referenzleistungsbild mit entsprechenden Leistungsbildern zu verbinden, deren durchschnittliche Leistung geringer ist als der vorbestimmte Grenzwert, um Verbundbilder zu erzeugen, eine Abdeckung zum Detektieren eines interessierenden Bereichs unter Verwendung der Referenzleistungsbilder und
der Verbundbilder zu erzeugen, Konturen der Abdeckung zu detektieren, an den detektierten Konturen eine Glättung durchzuführen, ein Füllen an der geglätteten Abdeckung durchzuführen und die Leistungsbilder und die Geschwin-

digkeitsbilder unter Verwendung der Maske abzudecken.

2. Ultraschallsystem (100) nach Anspruch 1, wobei die Verarbeitungseinheit (120) folgendes aufweist:

Einen Bilderzeugungsabschnitt (121), der dafür vorgesehen ist, die Leistungsbilder und die Geschwindigkeitsbilder zu erzeugen;
einen Abdeckungserzeugungsabschnitt (122), der dafür vorgesehen ist, die Maske unter Verwendung des Leistungsbildes zu erzeugen;
einen ersten Bildverarbeitungsabschnitt (123), der dafür vorgesehen ist, die Geschwindigkeitsbilder unter Verwendung der Abdeckung abzudecken;
und einen zweiten Bildverarbeitungsabschnitt (124), der dafür vorgesehen ist, die Leistungsbilder unter Verwendung der Abdeckung abzudecken.

3. Ultraschallsystem (100) nach Anspruch 2, wobei der Abdeckungserzeugungsabschnitt (122) folgendes aufweist:

Einen Leistungsbilderzeugungsabschnitt (122a), der dafür vorgesehen ist, die Leistungsbilder zu analysieren, um das Referenzleistungsbild, dessen durchschnittliche Leistung größer ist als der vorbestimmte Grenzwert, festzulegen und das Referenzleistungsbild mit entsprechenden Leistungsbildern zu verbinden, deren durchschnittliche Leistung geringer ist als der vorbestimmte Grenzwert, um die Verbundbilder zu erzeugen;
einen Abdeckungsfestlegungsabschnitt (122b), der dafür vorgesehen ist, die Maske zum Detektieren des interessierenden Bereichs unter Verwendung des Referenzleistungsbildes und der Verbundbilder festzulegen; und
einen Abdeckungsverarbeitungsabschnitt (122c), der dafür vorgesehen ist, Konturen der Masken zu detektieren, an den detektierten Konturen eine Glättung durchzuführen und ein Füllen an der geglätteten Abdeckung durchzuführen.

4. Ultraschallsystem (100) nach Anspruch 3, wobei der vorbestimmte Grenzwert ein Wert ist, der durch Multiplizieren der durchschnittlichen Referenzleistung mit einem vorbestimmten Wert erhalten wird.

5. Ultraschallsystem (100) nach Anspruch 4, wobei der Abdeckungserzeugungsabschnitt einen Blitzrauschen-Entfernungsabschnitt beinhaltet, um Blitzrauschen in der Abdeckung zu entfernen.

6. Ultraschallsystem (100) nach Anspruch 4, wobei der Leistungsbilderzeugungsabschnitt (122a) für Folgendes vorgesehen ist:

Berechnen einer ersten durchschnittlichen Leistung eines ersten Leistungsbilds, das von dem Bilderzeugungsabschnitt zur Verfügung gestellt wurde, um eine durchschnittliche Referenzleistung festzulegen;
das erste Leistungsbild als ein Referenzleistungsbild festzulegen;
eine i-te durchschnittliche Leistung eines i-ten Leistungsbilds, das von dem Bildverarbeitungsabschnitt zur Verfügung gestellt wurde, zu berechnen, wobei i eine positive ganze Zahl größer als 1 ist;
die i-te durchschnittliche Leistung mit dem vorbestimmten Grenzwert zu vergleichen;
wenn die i-te durchschnittliche Leistung größer ist als der vorbestimmte Grenzwert, die i-te durchschnittliche Leistung als eine neue durchschnittliche Referenzleistung festzulegen und das i-te Leistungsbild als ein neues Referenzleistungsbild festzulegen; und
wenn die i-te durchschnittliche Leistung geringer ist als der vorbestimmte Grenzwert, das i-ten Leistungsbilds zu dem Referenzleistungsbild zu verbinden.

7. Ultraschallsystem (100) nach Anspruch 2, wobei der erste Bildverarbeitungsabschnitt (123) Folgendes aufweist:

einen ersten Glättungsabschnitt (123a), der dafür vorgesehen ist, an den Geschwindigkeitsbildern eine Glättung durchzuführen;
einen ersten Abdeckungsabschnitt (123b), der dafür vorgesehen ist, die geglätteten Geschwindigkeitsbilder unter Verwendung der Abdeckung abzudecken;
einen ersten Filterabschnitt (123c), der dafür vorgesehen ist, eine Abstandsgewichtung und eine Grenzglättung an den abgedeckten Geschwindigkeitsbildern durchzuführen; und
einen Höchstwertwiederherstellungsabschnitt (123d), der dafür vorgesehen ist, ein Differenzbild zwischen dem Geschwindigkeitsbild, das von dem Bilderzeugungsabschnitt (121) zur Verfügung gestellt wurde, und den abstandsgewichteten und grenzgeglätteten Geschwindigkeitsbildern zu erlangen, Höchstwertregionen unter Verwendung der Differenzbilder zu detektieren und Höchstwerte der abstandsgewichteten und grenzgeglätteten Geschwindigkeitsbilder unter Verwendung der detektierten Höchstwertregionen wiederherzustellen.

8. Ultraschallsystem (100) nach Anspruch 2, wobei der zweite Bildverarbeitungsabschnitt (124) Folgendes aufweist:

einen zweiten Glättungsabschnitt (124a), der dafür vorgesehen ist, eine Glättung an den Leistungsbildern durchzuführen;
einen zweiten Abdeckungsabschnitt (124b), der dafür vorgesehen ist, die geglätteten Leistungsbilder abzudecken; und
einen zweiten Filterabschnitt (124c), der dafür vorgesehen ist, eine Abstandsgewichtung und eine Grenzglättung an den abgedeckten Leistungsbildern durchzuführen.

9. Verfahren zur Verarbeitung eines Farbdopplermodus-Bilds in einem Ultraschallsystem (100), welches eine Signalerlangungseinheit (110) und eine Verarbeitungseinheit (120) aufweist, welches Folgendes aufweist:

a) an der Signalerlangungseinheit (110) Übertragen und Empfangen von Ultraschallsignalen zu und von einem Zielobjekt, um Doppler-Signale zu erlangen; und
b) an der Verarbeitungseinheit (120) Erzeugen von Farbdopplermodus-Bildern einschließlich Leistungsbildern, welche Leistungen der Doppler-Signale als 2-dimensionale Verteilungen und Geschwindigkeitsbilder visualisieren,
c) an der Verarbeitungseinheit (120) Erzeugen einer Abdeckung zum Detektieren eines interessierenden Bereichs unter Verwendung der Leistungsbilder;
d) an der Verarbeitungseinheit (120) Abdecken der Leistungsbilder und der Geschwindigkeitsbilder unter Verwendung der Maske,
dadurch gekennzeichnet, dass
der Schritt c) Folgendes aufweist:

c1) Analysieren der Leistungsbilder, um ein Referenzleistungsbild festzulegen, dessen durchschnittliche Leistung größer ist als ein vorbestimmter Grenzwert und Vergleichen der Referenzleistungsbilder mit entsprechenden Leistungsbildern, deren durchschnittliche Leistung geringer ist als der vorbestimmte Grenzwert, um Verbundbilder zu erzeugen;
c2) Festlegen der Abdeckung zum Detektieren des interessierenden Bereichs unter Verwendung des Referenzleistungsbilds und der Verbundbilder; und
c3) Detektieren von Konturen der Abdeckung, um an den detektierten Konturen eine Glättung durchzuführen; und
c4) Durchführen eines Füllens an der geglätteten Abdeckung.

10. Verfahren nach Anspruch 9, wobei der Schritt c) des Weiteren das Entfernen von Blitzrauschen von der Abdeckung beinhaltet.

11. Verfahren nach Anspruch 9, wobei der vorbestimmte Grenzwert ein Wert ist, der durch Multiplizieren der durchschnittlichen Referenzleistung mit einem vorbestimmten Wert erhalten wird.

12. Verfahren nach Anspruch 9, wobei der Schritt c1) Folgendes aufweist:

Berechnen einer ersten durchschnittlichen Leistung eines ersten Leistungsbilds, das von dem Bilderzeugungsabschnitt zur Verfügung gestellt wurde, um eine durchschnittliche Referenzleistung festzulegen;
Festlegen des ersten Leistungsbilds als ein Referenzleistungsbild; Berechnen einer i-ten durchschnittlichen Leistung eines i-ten Leistungsbilds, das von dem Bildverarbeitungsabschnitt zur Verfügung gestellt wurde, wobei i eine positive ganze Zahl größer als 1 ist;
Vergleichen der i-ten durchschnittlichen Leistung mit dem vorbestimmten Grenzwert;
wenn die i-te durchschnittliche Leistung größer ist als der vorbestimmte Grenzwert, Festlegen der i-ten durchschnittlichen Leistung als eine neue durchschnittliche Referenzleistung und Festlegen des i-ten Leistungsbilds als ein neues Referenzleistungsbild; und
wenn die i-te durchschnittliche Leistung geringer ist als der vorbestimmte Grenzwert, Verbinden des i-ten Leistungsbilds mit dem Referenzleistungsbild.

13. Verfahren nach Anspruch 9, wobei der Schritt d) Folgendes aufweist:

Durchführen einer Glättung an den Geschwindigkeitsbildern;
Abdecken des geglätteten Geschwindigkeitsbilds unter Verwendung der Abdeckung;
Durchführen einer Abstandsgewichtung und einer Grenzglättung an den abgedeckten Geschwindigkeitsbildern;
Erlangen eines Differenzbilds zwischen dem Geschwindigkeitsbild, das von dem Bildverarbeitungsabschnitt zur Verfügung gestellt wurde, und den abstandsgewichteten und grenzgeglätteten Geschwindigkeitsbildern;
Detektieren von Höchstwertbereichen unter Verwendung der Differenzbilder; und
Wiederherstellen von Höchstwerten der abstandsgewichteten und
grenzgeglätteten Geschwindigkeitsbildern unter Verwendung der detektierten Höchstwertbereiche.

14. Verfahren nach Anspruch 9, wobei der Schritt d) Folgendes aufweist:

Durchführen einer Glättung an den Leistungsbildern;
Abdecken der geglätteten Leistungsbilder; und
Durchführen einer Abstandsgewichtung und einer Grenzglättung an den abgedeckten Leistungsbildern.

Revendications

1. Système ultrasonique (100) comportant :

une unité d'acquisition de signal (110) configurée pour transmettre et recevoir des signaux ultrasoniques vers et en provenance d'un objet cible pour acquérir des signaux Doppler ; et
une unité de traitement (120) configurée pour former des images couleur en mode Doppler incluant des images de puissance visualisant les puissances des signaux Doppler sous la forme d'images de distributions en 2-D et des images de vitesse,
dans lequel l'unité de traitement (120) est en outre configurée pour analyser les images de puissance pour définir une image de puissance de référence dont la puissance minimale est supérieure à une moyenne prédéterminée, pour calculer l'image de puissance de référence par rapport aux images de puissances dont la puissance minimale est inférieure à la valeur moyenne prédéterminée, pour former des images calculées et constituer un masque pour détecter une zone d'intérêt en utilisant l'image de puissance de référence et les images calculées, pour détecter les contours du masque, pour effectuer un lissage des contours détectés et pour effectuer le remplissage du masque lissé, et pour masquer les images de puissance et les images de vitesse en utilisant le masque.

2. Système ultrasonique (100) selon la revendication 1, dans lequel l'unité de traitement (120) comprend :

une section (121) de formation d'image configurée pour former les images de puissance et les images de vitesse ;
une section (122) de formation d'un masque, configurée pour réaliser un masque en utilisant l'image de puissance ;
une première section de traitement d'image (123) configurée pour masquer les images de vitesses en utilisant le masque ; et
une seconde section de traitement d'image (124) configurée pour masquer les images de puissance en utilisant le masque.

3. Système ultrasonique (100) selon la revendication 2, dans lequel la section (122) de formation d'un masque comprend :

une section de traitement d'image de puissance (122a) configurée pour analyser les images de puissance pour définir une image de puissance de référence dont la puissance minimale est supérieure à la moyenne prédéterminée et pour calculer l'image de puissance de référence des images de puissance respectives, dont la puissance minimale est inférieure à la moyenne prédéterminée pour former les images calculées ;
une section de détermination de masque (122b), configurée pour déterminer le masque pour détecter la zone d'intérêt en utilisant l'image de puissance de référence et les images calculées ; et
une section de traitement de masque (122c) configurée pour détecter des contours du masque, effectuer un lissage sur les contours détectés et effectuer le remplissage du masque lissé.

4. Système ultrasonique (100) selon la revendication 3, dans lequel la moyenne prédéterminée est une valeur obtenue en multipliant la puissance minimale de référence par une valeur prédéterminée.

5. Système ultrasonique (100) selon la revendication 4, dans lequel la section de formation du masque inclut une unité d'élimination du bruit flash pour éliminer les bruits flash du masque.

6. Système ultrasonique (100) selon la revendication 4, dans lequel la section de traitement (122a) de l'image de puissance est configurée pour :

calculer la puissance minimale de l'image de puissance produite par la section de formation de l'image pour déterminer une puissance minimale de référence ;
déterminer la première image de puissance de référence comme référence d'image de puissance ;
calculer une $i^{ème}$ puissance minimale d'une $i^{ème}$ image de puissance produite par la section de formation de l'image, dans lequel i est un nombre entier positif supérieur à 1 ;
comparer la $i^{ème}$ puissance minimale avec la moyenne prédéterminée ;
déterminer, lorsque la $i^{ème}$ puissance minimale est supérieure à la moyenne prédéterminée, la puissance minimale comme une nouvelle puissance minimale de référence et déterminer la $i^{ème}$ image de puissance comme nouvelle image de puissance de référence ; et
calculer, lorsque la $i^{ème}$ puissance minimale est inférieure à la moyenne prédéterminée, la $i^{ème}$

image de puissance comme nouvelle image de puissance de référence.

7. Système ultrasonique (100) selon la revendication 2, dans lequel la section de traitement (123) de l'image comporte :

une première section (123a) de lissage configurée pour effectuer un lissage sur les images de vitesse ;
une première section de masquage (123b) configurée pour masquer les images de vitesses lissées en utilisant le masque ;
une première section de filtrage (123c) configurée pour effectuer un pesage à distance et pour border le lissage sur les images de vitesse masquées ; et
une section de restauration de pic (123d), configurée pour obtenir une différence d'image entre une image de vitesse produite par la section de formation d'image (121) et des images de vitesse pesées et à bords lissés, détecter des zones de pic en utilisant les différences d'image et restaurer les pics des images pesées à distance et des images de vitesse à bords lissés, en utilisant les zones de pics détectés.

8. Système ultrasonique (100) selon la revendication 2, dans lequel la section de traitement (124) de l'image comporte :

une seconde section (124a) de lissage configurée pour effectuer un lissage sur les images de puissance ;
une seconde section de masquage (124b) configurée pour masquer les images de puissances lissées; et
une seconde section de filtrage (124c) configurée pour effectuer un pesage à distance et pour border le lissage sur les images de puissance masquées.

9. Procédé de traitement d'une image couleur en mode Doppler dans un système ultrasonique (100) comportant une unité d'acquisition (110) et une unité de traitement (120), comportant :

a) à l'unité d'acquisition (110) de signaux, la transmission et la réception de signaux ultrasoniques de et vers un objet cible pour acquérir des signaux Doppler ultrasoniques ; et
b) à l'unité de traitement (120), la formation d'images couleur en mode Doppler incluant la visualisation des puissances des signaux Doppler sous la forme d'images de distributions en 2-D et d'images de vitesse,
c) à l'unité de traitement (120), la réalisation d'un masque pour détecter une zone d'intérêt utilisant les images de puissance ;
d) à l'unité de traitement (120), le masquage des images de puissance et des images de vitesse en utilisant le masque,
caractérisé par les étapes suivantes :

c1) analyser les images de puissance pour déterminer une image de puissance de référence dont la puissance minimale est supérieure à une moyenne prédéterminée, et calculer l'image de puissance de référence par rapport aux images de puissance dont la puissance maximale est inférieure à la valeur moyenne prédéterminée, pour former des images calculées ;
c2) constituer un masque pour détecter une zone d'intérêt en utilisant l'image de puissance de référence et les images calculées ; et
c3) détecter les contours du masque, pour effectuer un lissage des contours détectés ; et
c4) effectuer le remplissage du masque lissé.

10. Procédé selon la revendication 9, dans lequel l'étape c) comporte en outre l'élimination du bruit de flash du masque.

11. Procédé selon la revendication 9, dans lequel la moyenne prédéterminée est une valeur obtenue en multipliant la puissance minimale de référence par une valeur prédéterminée.

12. Procédé selon la revendication 9, dans lequel l'étape c1) comprend :

le calcul d'une première puissance minimale d'une première image de puissance produite par la section de formation d'image pour déterminer une puissance minimale de référence ;
la détermination d'une première image de puissance comme image de puissance de référence ;
le calcul d'une $i^{ème}$ puissance minimale d'une $i^{ème}$ image de puissance produite par la section de traitement d'image, dans lequel i est un nombre positif entier supérieur à 1 ;
la comparaison de la $i^{ème}$ puissance minimale avec la moyenne prédéterminée ;
la détermination, lorsque la $i^{ème}$ puissance minimale est supérieure à la moyenne prédéterminée, de la $i^{ème}$ puissance minimale comme nouvelle puissance minimale de référence et la détermination de la $i^{ème}$ image de puissance comme nouvelle image de puissance de référence ; et
le calcul, lorsque la $i^{ème}$ puissance minimale est

inférieure à la moyenne prédéterminée, de la $i^{ème}$ image de puissance comme image de puissance de référence.

13. Procédé selon la revendication 9, dans lequel l'étape d) comprend :

le lissage des images de vitesse ;
le masquage du lissage des images de vitesse en utilisant le masque ;
la réalisation du pesage à distance et du lissage des bords suite au masquage des images de vitesses ;
l'obtention de différence d'image entre l'image de vitesse produite par la section de traitement d'image et le pesage à distance et le lissage des images de vitesse ;
la détection des zones de pics en utilisant les différences d'image ; et
la restauration des pics des images de pesées à distance et des images de vitesse lissées en utilisant les zones de pics détectés.

14. Procédé selon la revendication 9, dans lequel l'étape d) comprend :

la réalisation du lissage sur les images de puissance ;
le masquage des images de puissance lissées ; et
la réalisation du pesage à distance et du lissage des bords sur les images de puissance masquées.

FIG. 1

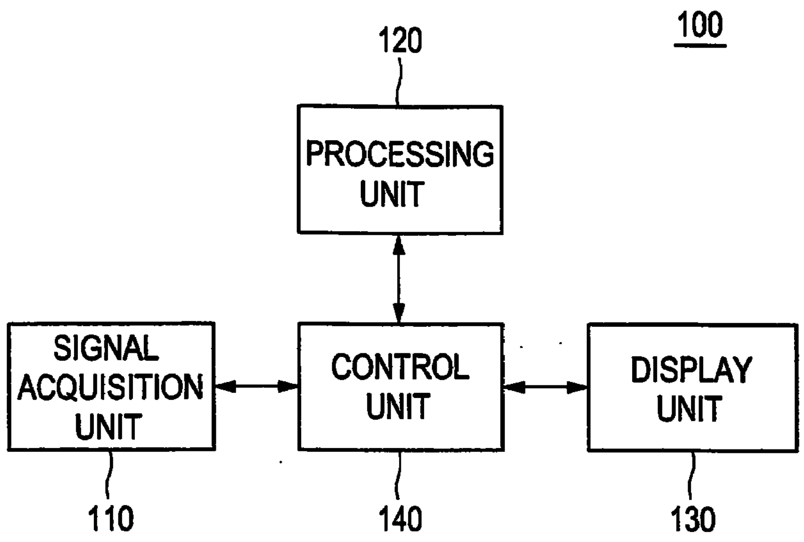
100
120
PROCESSING UNIT
SIGNAL ACQUISITION UNIT
CONTROL UNIT
DISPLAY UNIT
110
140
130

FIG. 2

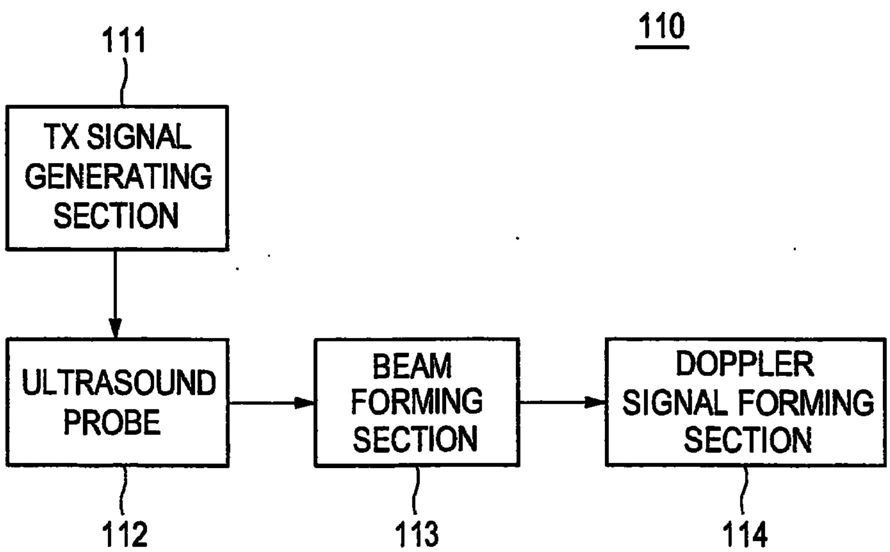
110
111
TX SIGNAL GENERATING SECTION
ULTRASOUND PROBE
BEAM FORMING SECTION
DOPPLER SIGNAL FORMING SECTION
112
113
114

FIG. 3

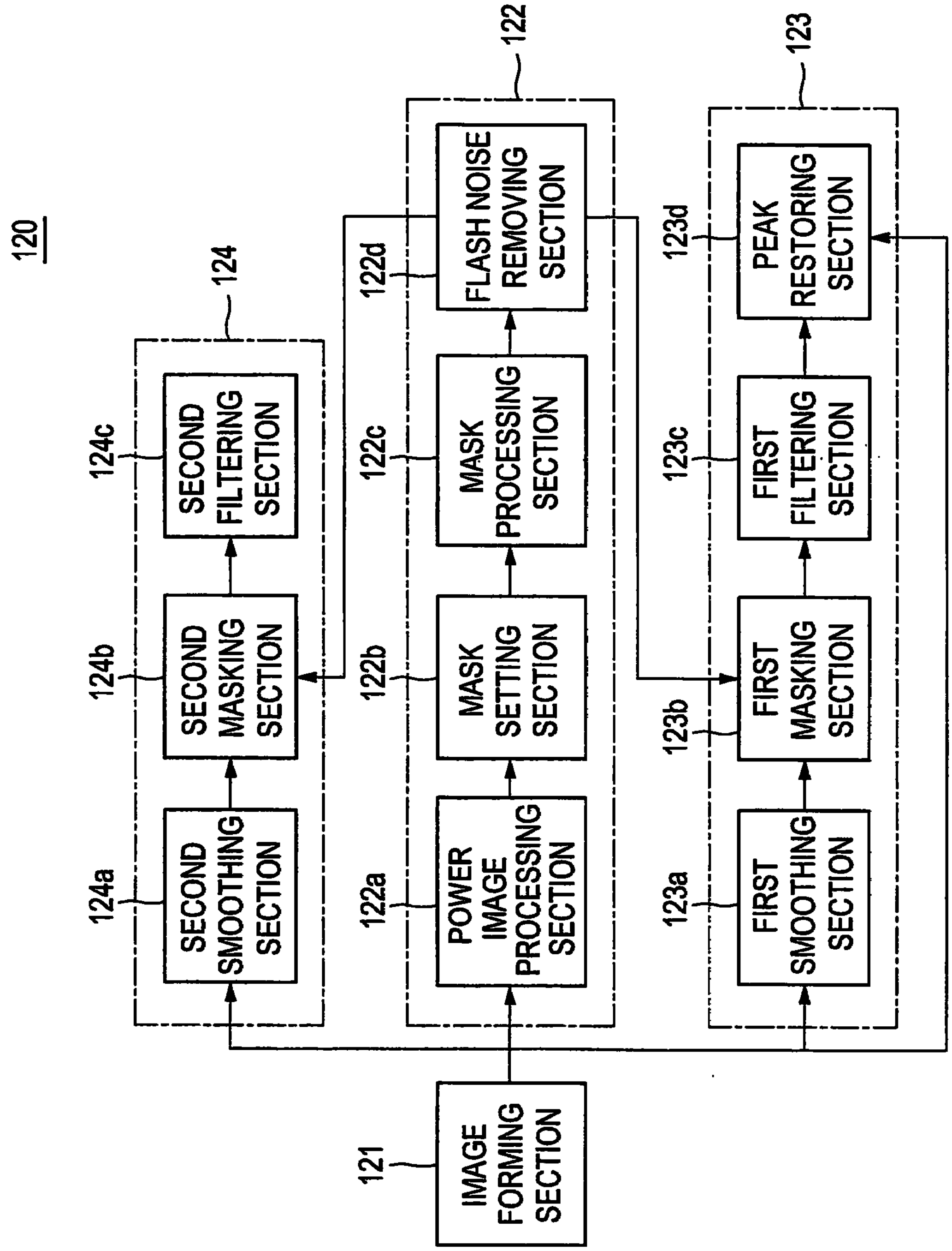
120
121
IMAGE FORMING SECTION
122
122a
POWER IMAGE PROCESSING SECTION
122b
MASK SETTING SECTION
122c
MASK PROCESSING SECTION
122d
FLASH NOISE REMOVING SECTION
123
123a
FIRST SMOOTHING SECTION
123b
FIRST MASKING SECTION
123c
FIRST FILTERING SECTION
123d
PEAK RESTORING SECTION
124
124a
SECOND SMOOTHING SECTION
124b
SECOND MASKING SECTION
124c
SECOND FILTERING SECTION

FIG. 4

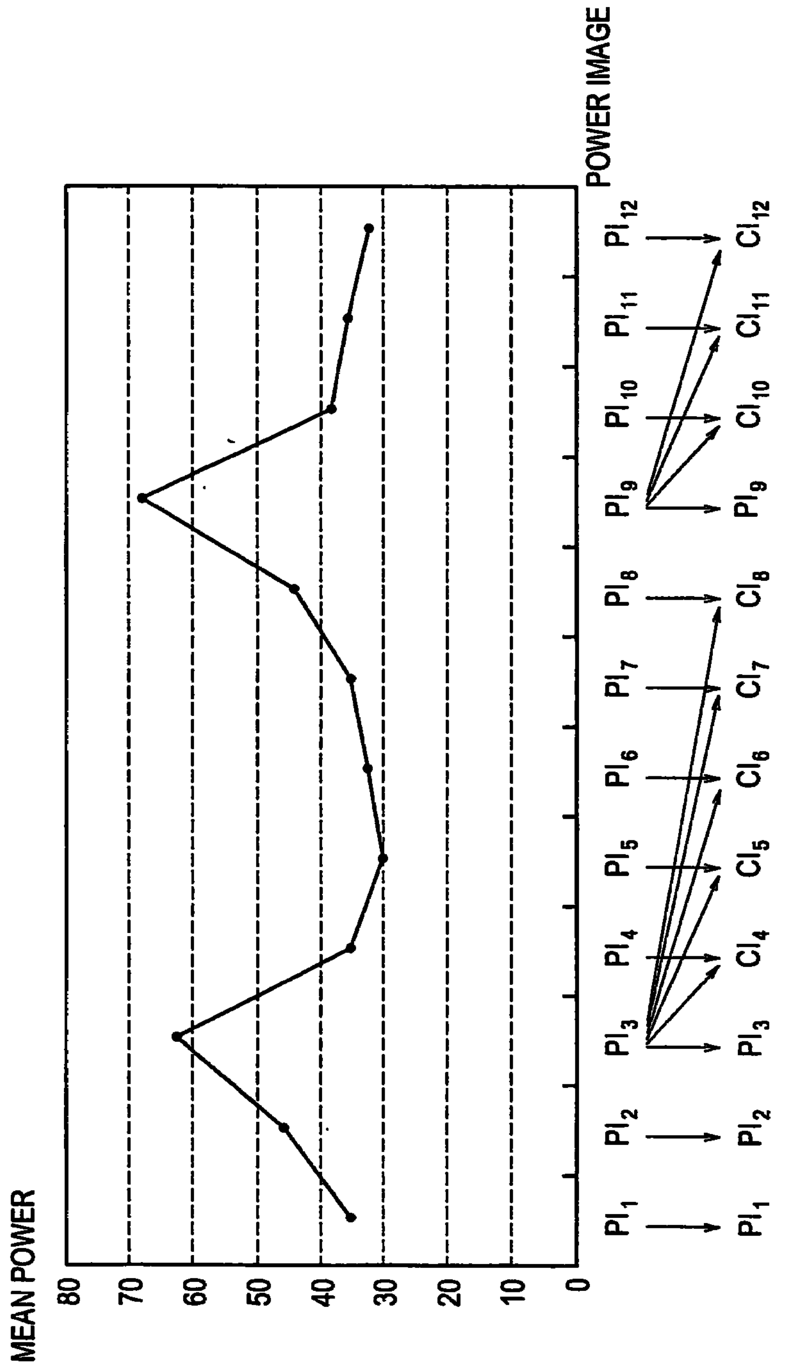
MEAN POWER
80
70
60
50
40
30
20
10
0
POWER IMAGE
PI1 PI2 PI3 PI4 PI5 PI6 PI7 PI8 PI9 PI10 PI11 PI12
PI1 PI2 PI3 CI4 CI5 CI6 CI7 CI8 PI9 CI10 CI11 CI12

FIG. 5A

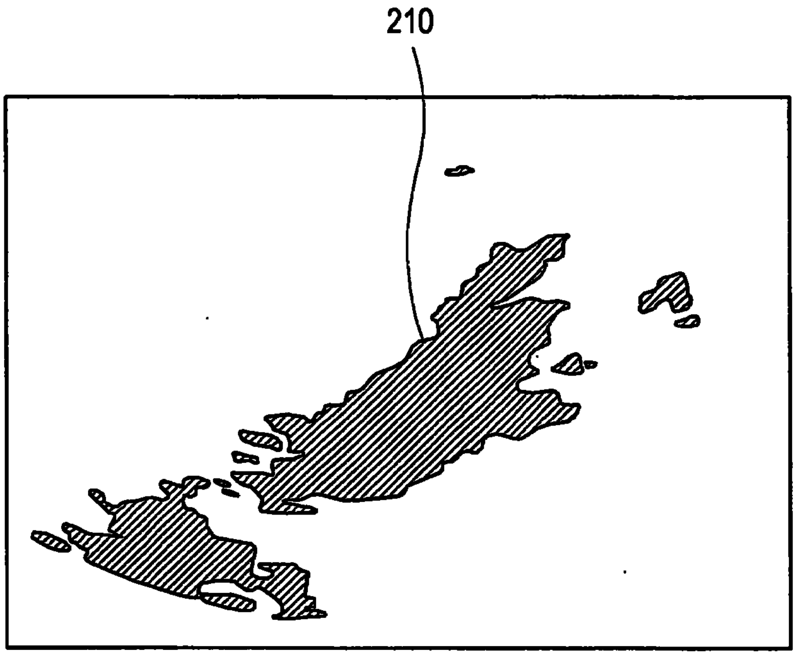

FIG. 5B

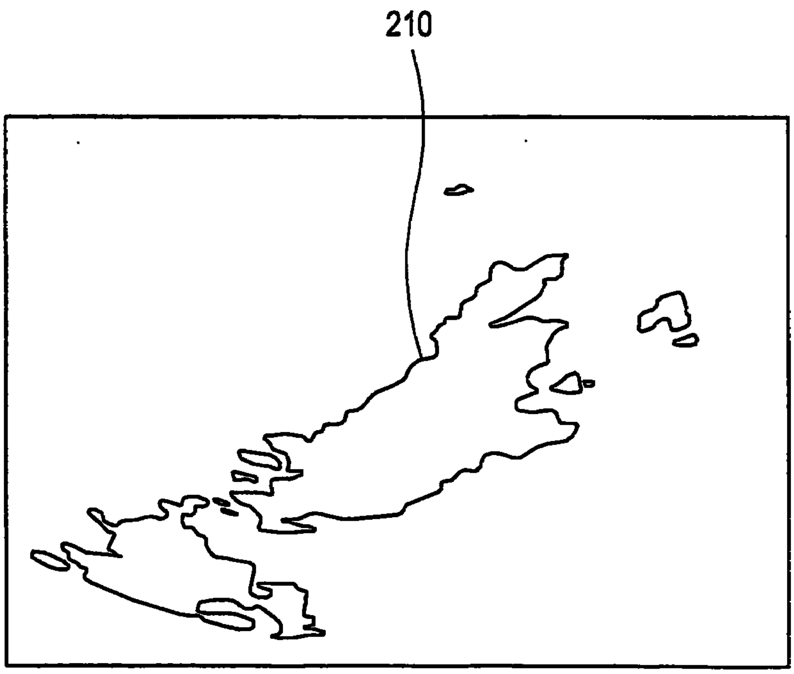

FIG. 5C

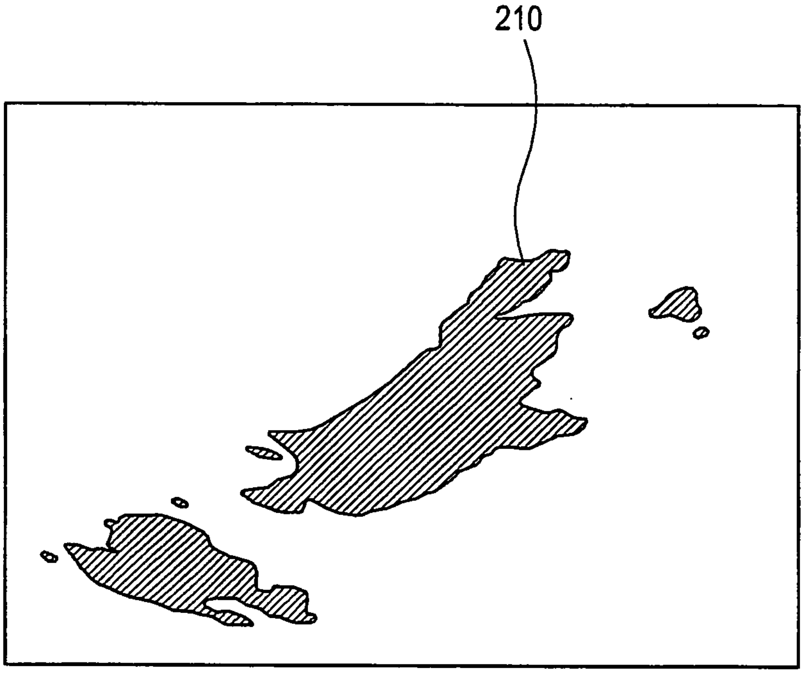

FIG. 5D

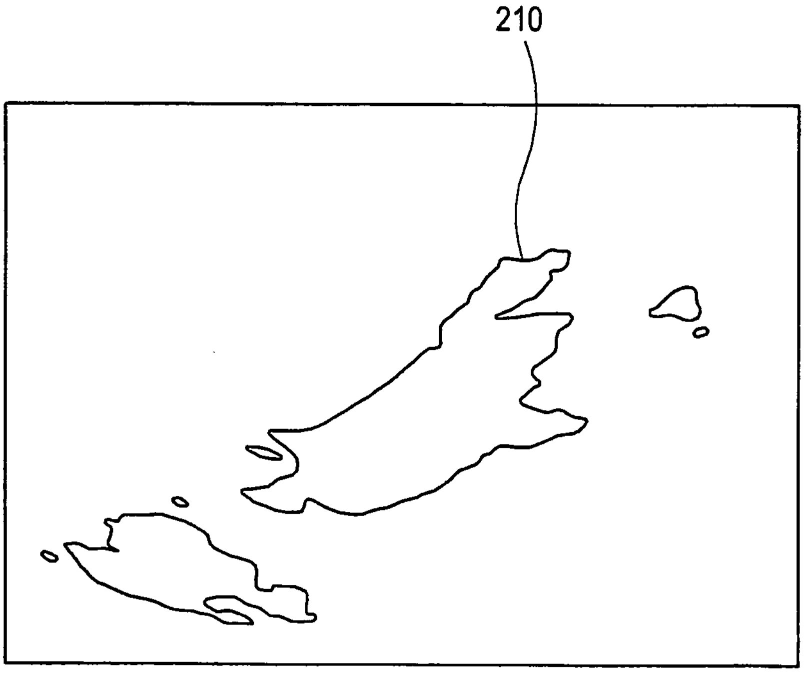

FIG. 6

0	0	0	0	0	0	0	0
0	1	1	1	1	1	1	0
0	1	2	2	2	2	1	0
0	1	2	3	3	2	1	0
0	1	2	2	2	2	1	0
0	1	1	1	1	1	1	0
0	0	0	0	0	0	0	0

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- KR 101020090038474 **[0001]**
- EP 0871043 A2 **[0007]**

专利名称(译)	超声系统中的彩色多普勒模式图像处理		
公开(公告)号	EP2249175B1	公开(公告)日	2014-06-11
申请号	EP2010160682	申请日	2010-04-22
申请(专利权)人(译)	MEDISON CO. , LTD.		
当前申请(专利权)人(译)	三星MEDISON CO. , LTD.		
[标]发明人	KIM BAEK SOP LEE HYEONG DO		
发明人	KIM, BAEK SOP LEE, HYEONG DO		
IPC分类号	G01S7/52 G01S15/89 A61B8/08 A61B8/06		
CPC分类号	G01S15/8979 A61B8/08 A61B8/488 G01S7/5206 G01S7/52077 G06T7/11 G06T7/136 G06T2207/10132		
代理机构(译)	SCHMID , WOLFGANG		
优先权	1020090038474 2009-04-30 KR		
其他公开文献	EP2249175A1		
外部链接	Espacenet		

摘要(译)

公开了用于在超声系统中处理彩色多普勒模式图像的实施例。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，用于通过所述彩色流图像形成包括功率图像和速度图像的彩色多普勒图像和用于检测感兴趣区域的掩模，所述处理单元还用于通过使用所述彩色图像和所述速度图像来屏蔽所述功率图像和所述速度图像。面具。

FIG. 1

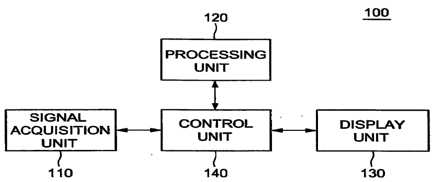

FIG. 2