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(54) Apparatus and method for processing an ultrasound spectrum image

Vorrichtung und Verfahren zur Verarbeitung eines Ultraschall-Spektralbildes

Appareil et procédé de traitement d'une image spectrale ultrasonore

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(73) Proprietor: **Samsung Medison Co., Ltd.**
Hongcheon-gun, Gangwon-do, 25108 (KR)

(72) Inventors:

- **Kim, Hye Jung**
Gangnam-gu
Seoul 135-280 (KR)
- **Lee, Ki Jong**
Gangnam-gu
Seoul 135-280 (KR)
- **Kim, Sung Ho**
Gangnam-gu
Seoul 135-280 (KR)
- **Yang, Eun Ho**
Gangnam-gu
Seoul 135-280 (KR)

- **Kim, Cheol An**
Gangnam-gu
Seoul 135-280 (KR)

(74) Representative: **Lorenz, Markus**
Lorenz & Kollegen
Patentanwälte Partnerschaftsgesellschaft mbB
Alte Ulmer Straße 2
89522 Heidenheim (DE)

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Description

[0001] The present invention generally relates to ultrasound diagnostic systems, and more particularly to an ultrasound diagnostic system for processing an ultrasound spectrum image and a method of implementing the same.

[0002] Document US 2002/0116141 A1 describes an ultrasound transmitter that generates ultrasound signals at an adjustable pulse repetition rate. According to the method described therein, the positive and negative frequency portions of the spectral data are rearranged. Furthermore, the aliasing of the spectral data according to positions of edge 1 and edge 2 in the re-arranged spectral data is checked.

[0003] US 6,050,948 discloses an ultrasound Doppler diagnostic apparatus for accurately tracing a maximum or minimum frequency in each of Doppler-shifted frequency spectra arranged in a sequential order of time on the time axis as an m-mode Doppler image.

[0004] An ultrasound diagnostic system is now widely used to inspect the internal condition of a human body. The ultrasound diagnostic system may obtain an image of the single layer or blood flow of a soft tissue without using an invasive needle. This is typically performed through the process of radiating an ultrasound signal from the body surface of a target object to be diagnosed to a desired portion in the body, receiving the reflected ultrasound signal, and processing the received ultrasound signal (ultrasound echo signal). Compared to other medical imaging systems (e.g., X-ray diagnostic system, X-ray Computerized Tomography (CT) scanner, Magnetic Resonance Imaging (MRI) system, nuclear medicine diagnostic system, etc.), the ultrasound diagnostic system is relatively small in size and inexpensive. The ultrasound diagnostic system is further capable of displaying images in real-time and is highly safe from exposure to X-ray radiation or the like. Due to such advantages, the ultrasound diagnostic system is widely employed to diagnose the heart, abdomen and urinary organs, especially in the fields of obstetrics, gynecology and the like.

[0005] In a conventional ultrasound diagnostic system, transducers transmit ultrasound signals to a target object and receive signals reflected by the target object (echo signals). The echo signals show different patterns depending on whether the target object is stationary or moving. When the target object is moving toward the transducers, received signals have higher frequencies than when the target object is stationary. On the other hand, when the target object is moving away from the transducers, received signals have lower frequencies than when the target object is stationary. As such, the echo signals reflected by the moving target object are subject to the Doppler shift phenomenon. Due to the Doppler shift, the ultrasound diagnostic system can obtain velocity information that can be displayed on a display device. Further, the ultrasound diagnostic system can offer the

velocity measurement of a blood flow based on the obtained velocity information.

[0006] Generally, contour tracing is required to detect the contour (sometimes referred to as a 'trace line') of a spectrum image. However, even when the spectrum image has aliasing, the conventional ultrasound diagnostic system does not consider the magnitude and direction of the aliasing when performing contour tracing. For this reason, the conventional ultrasound diagnostic system is disadvantageous since it cannot perform accurate contour tracing, as shown in Fig. 1. Therefore, the conventional ultrasound diagnostic system cannot provide accurate peak tracing.

[0007] Further, as the pulse wave (PW) gain for a spectrum image increases, the noise also tends to increase. Also, the noise varies for each spectrum image. However, when the conventional ultrasound diagnostic system performs the contour tracing on a spectrum image with increased noise, it determines a threshold for removing the noise based on the PW gain without analyzing the noise. Thus, since the noise varies depending on external environments (e.g., gel existence, probe type, etc.), the conventional ultrasound diagnostic system is disadvantageous in that it cannot perform accurate contour tracing, as shown in Fig. 2. Therefore, the conventional ultrasound diagnostic system cannot provide accurate peak tracing.

[0008] It is, therefore, an object of the present invention to address and resolve the above-mentioned deficiencies of the prior art. In this regard, the object of the present invention is to provide an apparatus and method for processing an ultrasound spectrum image, which can accurately perform both contour tracing and peak tracing by removing the noise from a noise-containing spectrum image and removing aliasing from an aliasing-containing spectrum image through automatically shifting the baseline.

[0009] According to one aspect of the present invention, there is provided a method of processing an ultrasound spectrum image, according to claim 1.

[0010] According to still yet another aspect of the present invention, there is provided an ultrasound diagnostic system, according to claim 19.

[0011] The above and other objects and features of the present invention will become apparent from the following descriptions of preferred embodiments given in conjunction with the accompanying drawings, in which:

Fig. 1 shows the result of contour tracing for an aliasing-containing spectrum image in a conventional ultrasound diagnostic system;

Fig. 2 shows the result of contour tracing for a spectrum image with increased pulse wave (PW) gain in a conventional ultrasound diagnostic system;

Fig. 3 is a schematic block diagram illustrating an ultrasound diagnostic system constructed in accordance with one embodiment of the present invention;

Fig. 4 is a flowchart showing the operations of an

image processor included in the ultrasound diagnostic system shown in Fig. 3;

Fig. 5 is a flowchart showing the process of determining a threshold for discriminating between a noise and a spectrum in a spectrum image and removing the noise from the spectrum image based on the determined threshold;

Fig. 6A shows a noise-containing spectrum image;

Fig. 6B shows a noise-removed spectrum image;

Fig. 6C is a graph of velocity versus time, wherein a frequency component at a specific time and velocity is represented by gray shading;

Fig. 7 is a flowchart showing the process of determining the range of a spectrum in a noise-removed spectrum image;

Fig. 8 shows the accumulation of gray values of a spectrum along a horizontal axis, as well as a spectrum start position and a spectrum end position, in accordance with one embodiment of the present invention;

Figs. 9A to 9C show the spectrum models in accordance with one embodiment of the present invention; Fig. 10 is a flowchart showing the process of converting an aliasing-containing spectrum image into an aliasing-removed spectrum image by shifting a baseline based on its spectrum model;

Fig. 11A shows an aliasing-containing spectrum image;

Fig. 11B shows a spectrum image with a baseline shifted in accordance with one embodiment of the present invention;

Fig. 12 is a flowchart showing the process of determining a contour tracing direction for a spectrum image and performing contour tracing in the determined direction;

Fig. 13 is a flowchart showing the process of performing mean contour tracing for a spectrum image;

Fig. 14 shows the contour points, mean contour points, result of contour tracing and result of mean contour tracing, which are obtained in accordance with one embodiment of the present invention;

Fig. 15 is a flowchart showing the process of determining the peak tracing direction of a spectrum image;

Fig. 16 is a flowchart showing the process of performing 1-peak tracing in a peak tracing direction of a spectrum image;

Fig. 17A shows an example wherein the number of peaks, which are above their respective grade thresholds, are constant up to a specific grade threshold in accordance with one embodiment of the present invention;

Fig. 17B shows an example wherein the number of peaks, which are above their respective grade thresholds, are not constant in accordance with one embodiment of the present invention;

Fig. 18 shows the end diastolic velocity (EDV) verification condition, EDVs and peak systolic velocities

(PSVs);

Fig. 19 shows the result of 1-peak tracing in accordance with one embodiment of the present invention; Fig. 20 is a flowchart showing the process of performing 2-peak tracing in a peak tracing direction of a spectrum image;

Fig. 21 shows the result of 2-peak tracing in accordance with one embodiment of the present invention; and

Fig. 22 shows a spectrum image with a baseline shifted back to an original position after completing contour tracing and peak tracing in accordance with one embodiment of the present invention.

[0012] The preferred embodiments of the present invention will be described below with reference to Figs. 3 to 22.

[0013] Referring now to Fig. 3, an ultrasound diagnostic system 100, which is constructed in accordance with the present invention, generally includes a probe 110, a beam-former 120, an image processor 130, a memory 140 and a display unit 150.

[0014] The probe 110 preferably includes a one-dimensional (1D) or two-dimensional (2D) array of transducers 112. The probe 110 is configured to transmit ultrasound signals to a target object and receive ultrasound echo signals. The beam-former 120 controls the transmission and reception of the probe 110. Further, in order to form a coherent beam of the echo signals from the target object, the beam-former 120 processes the received ultrasound echo signals. The image processor 130 produces spectrum signals based on the ultrasound echo signals and produces a noise-removed spectrum image based on the spectrum signals, wherein a frequency component at a specific time and velocity is represented by a shade of gray. The image processor 130 then performs contour tracing and peak tracing on the produced spectrum image to thereby provide a processed spectrum image. The processed spectrum image, which is provided by the image processor 130, is stored in the memory 140 and/or is displayed on the display unit 150. Alternatively, the memory 140 may store the raw spectrum signals instead of the resulting spectrum image.

[0015] The image processor 130, which is constructed in accordance with the present invention, will be described below in detail with reference to Figs. 4 to 22.

[0016] Fig. 4 is a flowchart showing the operations of the image processor 130. The image processor 130 determines a threshold for discriminating between a noise and a spectrum in a spectrum image. It then removes the noise based on the determined threshold (S100). Step S100 will be described in more detail in view of Figs. 5, 6A and 6B.

[0017] As shown in Fig. 5, the image processor 130 produces a spectrum image based on the spectrum signals (S110). Then, the image processor 130 divides the produced spectrum image into a number of sections (S120). Each of the sections may or may not overlap with

neighboring sections. Thereafter, for each of the sections, the image processor 130 calculates the average intensity of pixels, the intensities of which are greater than a specific magnitude (S130). Next, the image processor 130 compares the average intensities calculated for the respective sections so as to detect a section with the smallest average intensity (S140). The section having the smallest average intensity is assumed to contain only the noise and not the spectrum. The image processor 130 then detects the maximum intensity of the noise by analyzing a histogram of the section having the smallest average intensity (S150). The image processor 130 then determines the detected maximum intensity of the noise as the threshold for discriminating between the noise and the spectrum (S160). The image processor 130 removes the noise from the spectrum image based on the determined threshold (S170). That is, the image processor 130 removes the noise from the noise-containing spectrum image (as shown in Fig. 6A) based on the determined threshold, thereby providing a spectrum image containing only the spectrum (as shown in Fig. 6B). Fig. 6C represents Fig. 6B in more detail, wherein a frequency component at a specific time and velocity is represented by a gray scale variation.

[0018] After completing step S100, the image processor 130 determines a range covering the spectrum in the noise-removed spectrum image (S200). Step S200 will be described in more detail with reference to Figs. 7 and 8.

[0019] The image processor 130 accumulates gray values of the spectrum in the noise-removed spectrum image along the spectrum movement direction (direction of X-axis), as shown in Fig. 8 (S210). The image processor 130 then detects the range including upper side and lower side spectrums from a baseline (S220). The image processor 130 determines the highest position (or velocity) of the upper side spectrum from the baseline as a spectrum start position 210 (S230). Further, the image processor 130 determines the lowest position (or velocity) of the lower side spectrum from the baseline as a spectrum end position 220 (S240).

[0020] In an alternative embodiment, the image processor 130 may detect the velocities of the upper side and lower side spectrums from the baseline. It can then determine the highest spectrum velocity in the upper side spectrum as the spectrum start position, while further determining the highest spectrum velocity in the lower side spectrum as the spectrum end position.

[0021] After completing step S200, the image processor 130 checks whether an aliasing exists in the spectrum image or not. In case the spectrum image contains the aliasing, the image processor 130 shifts the baseline of the spectrum image to convert the aliasing-containing spectrum image into an aliasing-removed spectrum image (S300). Whether an aliasing exists or not is determined based on the spectrum models, which represent the spectrum types. More specifically, the spectrum models may include the spectrum types wherein a spectrum

resides in the upper side of the baseline (Fig. 9A), the spectrum types wherein a spectrum resides in the lower side of the baseline (Fig. 9B), and the spectrum types wherein a spectrum resides in both the upper side and lower side of the baseline (Fig. 9C). Step S300 will be described in more detail with reference to Figs. 10, 11A and 11B.

[0022] As shown in Fig. 10, the image processor 130 matches the spectrum image with the spectrum types in the spectrum models (S310). By doing so, the image processor 130 detects a spectrum type that corresponds to the spectrum image (S320). For example, by matching the spectrum image (as shown in Fig. 11A) with the spectrum types (as shown in Figs. 9A to 9C), the image processor 130 detects the second spectrum type in Fig. 9C as the spectrum type corresponding to the spectrum image. Thereafter, the image processor 130 checks whether the detected spectrum type contains the aliasing or not (S330). In case the detected spectrum type does not contain the aliasing, it proceeds to step S400. In case the aliasing exists in the detected spectrum type, the image processor 130 detects the direction of the aliasing in the spectrum type and determines the direction in which the baseline should be shifted based on the detected direction (S340). For example, the image processor 130 determines that the spectrum type corresponding to the spectrum image shown in Fig. 11A (second spectrum type in Fig. 9C) contains the aliasing in the upper side spectrum, and further determines that the baseline should be shifted downward. Moreover, the image processor 130 analyzes the spectrum between the spectrum start position and the spectrum end position in the spectrum image (S350) so as to obtain the height of the aliasing from the spectrum start position or the spectrum end position (S360). Then, the image processor 130 shifts the baseline of the spectrum image based on the aliasing direction detected at step S340 and the aliasing height obtained at step S360 in order to remove the aliasing, as shown in Fig. 11B (S370).

[0023] After completing step S300, the image processor 130 determines a contour tracing direction of the spectrum image and performs contour tracing in the determined direction (S400). Step S400 will be described in more detail with reference to Fig. 12.

[0024] As shown in Fig. 12, the image processor 130 checks whether the contour tracing direction selected by an operator is all of the directions or an up/down direction (S410). If the up direction is selected, the contour tracing is performed for the upper side spectrum above the baseline. If the down direction is selected, the contour tracing is performed for the lower side spectrum below the baseline. If all the directions are selected, the contour tracing is performed for both the upper side and lower side spectrums.

[0025] In case it is determined that the contour tracing direction is all of the directions at step 410, the contour tracing is performed for each of the upper side and lower side spectrums (S420) to detect contour points in the

respective spectrums (S430). Next, for each of the upper side and lower side spectrums, the image processor 130 calculates the sum of the intensities of the detected contour points (S440). The intensity refers to the sum of frequency components with regard to specific velocities and time points in a spectrum. For example, as the contour point A in Fig. 6C includes the information of frequency components of various velocities (60 cm/sec, 65 cm/sec, 70 cm/sec, 75 cm/sec and 80 cm/sec), the image processor 130 calculates the intensity of the contour point A by summing up the velocity magnitude multiplied by the frequency components. The image processor 130 compares the calculated sum of intensities between the upper side spectrum and the lower side spectrum (S450) to select the contour points of the spectrum having the greater sum of intensities (S460).

[0026] On the other hand, in case it is determined that the contour tracing direction is the up or down direction at step 410, the image processor 130 performs the contour tracing in the corresponding contour tracing direction (S470) to detect contour points (S480).

[0027] After completing step S400, the image processor 130 performs mean contour tracing to detect mean contour points (S500). The intensity at each of the mean contour points is half the intensity at the corresponding contour point. Step S500 will be described in more detail with reference to Figs. 13 and 14.

[0028] As shown in Fig. 13, the image processor 130 calculates the intensities of the contour points (S510). The image processor 130 then performs mean contour tracing (S520) to detect mean contour points (S530). For example, as shown in Fig. 14, the image processor 130 performs the mean contour tracing to detect a mean contour point 321 for a contour point 311 (the former having half the intensity of the latter) when the baseline is adopted as the reference. In Fig. 14, reference numeral 312 represents the result of the contour tracing, while reference numeral 322 represents the result of the mean contour tracing.

[0029] After completing step S500, the image processor 130 determines a peak tracing direction of the spectrum image (S600). Step S600 will be described in more detail with reference to Fig. 15.

[0030] As shown in Fig. 15, the image processor 130 checks whether the peak tracing direction selected by an operator is all of the directions or an up/down direction (S610). If the selected peak tracing direction is all of the directions, then the image processor 130 analyzes the density, intensity and/or velocity for each of the upper side and lower side spectrums from the baseline (S620). The image processor 130 determines the peak tracing direction based on the result of the analysis (S630). Preferably, the image processor 130 determines the peak tracing direction to correspond to the spectrum having the higher density, intensity and/or velocity (between the upper side spectrum and the lower side spectrum). However, if the peak tracing direction is the up/down direction, then it proceeds to step S700.

[0031] After completing step S600, the image processor 130 checks whether the peak tracing, which is performed to detect peaks, is 1-peak tracing or 2-peak tracing (S700). The 1-peak tracing is generally used for a spectrum image having one peak per cycle (e.g., a spectrum image obtained far from the heart) to detect peaks and peak start positions. The 2-peak tracing is generally used for a spectrum image having two peaks per cycle (e.g., a spectrum image obtained near the heart) to detect two peaks for each cycle.

[0032] In case it is determined that the peak tracing is the 1-peak tracing at step S700, the image processor 130 performs the 1-peak tracing in the peak tracing direction (S800). Step S800 will be described in more detail with reference to Figs. 16 to 19.

[0033] As shown in Fig. 16, the image processor 130 performs the 1-peak tracing (S810) to detect candidate peaks (S820). The candidate peaks include actual peaks corresponding to the peak systolic velocity (PSV) and quasi-peaks, which are similar to the actual peaks. The image processor 130 determines grade thresholds, which divide the range between the spectrum start position and the spectrum end position into several grades of the peak velocity (S830). Then, for each of the grade thresholds starting from the spectrum start position (or the spectrum end position), the image processor 130 detects the number of candidate peaks higher than the corresponding grade threshold (S840). For illustration, the image processor 130 may determine the grade thresholds between the spectrum start position and the spectrum end position (as shown in Fig. 17A or Fig. 17B) and then detect the number of candidate peaks residing above each of the grade thresholds. In Fig. 17A, the number of candidates peaks above the first grade threshold is four and above the second grade threshold is four. Further, the number of candidate peaks above the third grade threshold is five and above the fourth grade threshold is eight.

[0034] The image processor 130 checks whether or not the number of candidate peaks above the respective grade thresholds are constantly repeated up to a specific grade threshold (S850). If it is determined that the number of candidate peaks above the grade thresholds are constantly repeated up to the specific grade threshold at step S850, then the image processor 130 detects the candidate peak of the lowest position among the candidate peaks above the specific grade threshold (S860). Then, the image processor 130 determines as a first peak-filtering threshold, which is used for filtering the candidate peaks, the grade threshold immediately below the detected candidate peak of the lowest position (S870). For illustration, in case of Fig. 17A, the image processor 130 determines that the number of candidate peaks are constantly repeated at four up to the second grade threshold. The image processor 130 then determines the first grade threshold located immediately below the candidate peak 150, which has the lowest position among the candidate peaks above the second grade threshold, as the first

peak-filtering threshold. In another embodiment, the image processor 130 may determine as the first peak-filtering threshold the position of the candidate peak of the lowest position among the candidate peaks above the specific grade threshold.

[0035] On the other hand, at step S850, it may be determined that the number of candidate peaks above the respective grade thresholds are not constantly repeated up to any specific grade threshold. For example, in Fig. 17B, the number of candidate peaks are as follows: above the first grade threshold is four; above the second grade threshold is eight; above the third grade threshold is ten; and above the fourth grade threshold is twelve. In such a case, the image processor 130 calculates the height differences in every pair of the candidate peaks (S880). Then, the image processor 130 calculates the variance for each of the candidate peaks based on the calculated height differences (S890). The image processor 130 then detects the candidate peak having the smallest variance and determines as a second peak-filtering threshold, which is used for filtering the candidate peaks, the grade threshold immediately below the detected candidate peak (S900).

[0036] Based on the distance between the spectrum start position and the spectrum end position, the image processor 130 determines the end diastolic velocity (EDV) verification condition, which is used for verifying the peak start positions, to be a position corresponding to a specific distance (preferably 30% of the distance between the spectrum start position and the spectrum end position) from the spectrum end position (S910). The image processor 130 selects the candidate peaks satisfying the first or second peak-filtering threshold out of all the candidate peaks (S920). Then, the image processor 130 detects the peak start positions corresponding to the selected candidate peaks (S930). The image processor 130 checks whether each of the detected peak start positions satisfies the EDV verification condition determined at step S910 or not (S940).

[0037] If the peak start position is determined to satisfy the EDV verification condition at step S940, then the peak start position is determined as an EDV and the candidate peak corresponding thereto is determined as a PSV (S950). For example, in Fig. 18, the image processor 130 detects the peak start positions 621, 622, 623 and 624 for the respective candidate peaks 611, 612, 613 and 614 that satisfy the first or second peak-filtering threshold. Then, the image processor 130 selects the peak start positions 621 and 623, which satisfy the EDV verification condition, out of the detected peak start positions 621, 622, 623 and 624. The image processor 130 determines the peak start positions 621 and 623 as EDVs and determines the candidate peaks 611 and 613 corresponding to the peak start positions 621 and 623 as PSVs.

[0038] On the other hand, if the peak start position is determined not to satisfy the EDV verification condition at step S940, then the peak start position and the candidate peak corresponding thereto are removed (S970).

For example, in Fig. 18, the peak start positions 622 and 624 and the candidate peaks 612 and 614 corresponding thereto are removed. By determining EDVs and PSVs along the aforementioned steps, the image processor 130 can automatically detect individual cycles in the spectrum image. The image processor 130 then outputs the result of the 1-peak tracing, as shown in Fig. 19.

[0039] However, if it is determined that the peak tracing is 2-peak tracing at step S700, then the image processor 130 performs the 2-peak tracing in the peak tracing direction (S1000). Step S1000 will be described in more detail with reference to Figs. 20 and 21.

[0040] As shown in Fig. 20, the image processor 130 performs the 2-peak tracing in the peak tracing direction within a range determined by an operator (S1010) so as to detect candidate peaks (S1020). Next, among the detected candidate peaks, the image processor 130 determines a first detected candidate peak as an E-peak (end of rapid filling peak) (S1030) and further determines a candidate peak detected after the E-peak as an A-peak (atrial contraction peak) (S1040). Thereafter, the image processor 130 outputs the result of the 2-peak tracing as shown in Fig. 21.

[0041] After completing step S800 or S1000, in case the baseline of the spectrum image was shifted at step S340, the image processor 130 shifts the baseline of the spectrum image back to the original position (i.e., the position before the shift at step S340), as shown in Fig. 22 (S1100). Step S1100 is carried out only for a spectrum image determined to contain an aliasing at step S330 and the baseline of which was shifted at step S340. Step S1100 is not carried out for a spectrum image that was determined not to contain an aliasing at step S330. Thereafter, the image processor 130 stores the processing result in the memory unit 140 and/or displays the same on the display unit 150 (S1200).

[0042] As discussed above, the present invention can remove the noise from a noise-containing spectrum image, as well as being able to remove the aliasing from an aliasing-containing spectrum image by automatically shifting the baseline. As such, the present invention can provide accurate contour tracing and accurate peak tracing.

[0043] While the present invention has been shown and described with respect to a preferred embodiment, those skilled in the art will recognize that various changes and modifications may be made.

Claims

1. A method of processing an ultrasound spectrum image in an ultrasound diagnostic system, comprising the steps of:

(a) forming a spectrum image based on ultrasound data, said spectrum image representing a velocity at a specific time;

- (b) removing a noise from the spectrum image to provide a noise-removed spectrum image;
characterized by
(c) matching the noise-removed spectrum image with one or more spectrum models representing specific spectrum types to check whether or not the noise-removed spectrum image contains an aliasing;
(d) if it is determined that the noise-removed spectrum image contains the aliasing, then removing the aliasing from the noise-removed spectrum image to provide a noise-removed spectrum image without the aliasing;
(e) performing a contour tracing on the noise-removed spectrum image without the aliasing to detect contour points; and
(f) performing a peak tracing on the noise-removed spectrum image without the aliasing to detect peaks.
2. The method of Claim 1, wherein the step (b) comprises:
- (b1) determining a first threshold for discriminating between the noise and a spectrum in the spectrum image; and
(b2) removing the noise from the spectrum image based on the first threshold.
3. The method of Claim 2, wherein the step (b1) comprises:
- dividing the spectrum image into a number of sections;
calculating an average intensity of pixels in each of the sections;
comparing the average intensities calculated for the sections to select a section having a smallest average intensity;
analyzing a histogram of the section having the smallest average intensity to detect the maximum intensity in the histogram; and
determining the detected maximum intensity as the first threshold.
4. The method of Claim 1, wherein the step (d) comprises:
- if it is determined that the noise-removed spectrum image contains the aliasing, then detecting a direction and a magnitude of the aliasing based on the matched spectrum model; and
shifting a baseline of the noise-removed spectrum image based on the detected direction and magnitude of the aliasing to remove the aliasing.
5. The method of Claim 1, wherein the step (e) comprises:
- (e1) receiving a contour tracing direction selected by an operator and checking whether the contour tracing direction indicates performing the contour tracing for both upper side and lower side spectrums or performing the contour tracing for either the upper side or the lower side spectrum;
(e2) if it is determined that the contour tracing direction indicates performing the contour tracing for both the upper side and lower side spectrums, then performing the contour tracing for both the upper side and lower side spectrums to detect the contour points; and
(e3) if it is determined that the contour tracing direction indicates performing the contour tracing for either the upper side or the lower side spectrum, then performing the contour tracing for the corresponding spectrum to detect the contour points.
6. The method of Claim 5, wherein the step (e2) comprises:
- for each of the upper side and lower side spectrums, calculating the sum of intensities of the contour points in the corresponding spectrum; comparing the sum of intensities of the contour points in the upper side spectrum and the sum of intensities of the contour points in the lower side spectrum to determine which of the spectrums has the greater sum of intensities; and selecting the contour points of the spectrum having the greater sum of intensities.
7. The method of Claim 6, wherein the sum of intensities is calculated based on velocities and frequency components of the corresponding spectrum.
8. The method of Claim 5, wherein the step (e) further comprises:
- calculating intensities of the contour points; and performing mean contour tracing in the contour tracing direction to detect mean contour points, wherein intensities of the mean contour points are half of the intensities of the corresponding contour points.
9. The method of Claim 1, wherein the step (f) comprises:
- (f1) determining a peak tracing direction for the spectrum image; and
(f2) performing the peak tracing in the peak tracing direction.
10. The method of Claim 9, wherein the step (f1) comprises:

checking whether or not the peak tracing direction indicates performing the peak tracing for both upper side and lower side spectrums; if it is determined that the peak tracing direction indicates performing the peak tracing for both the upper side and lower side spectrums, then analyzing at least one of density, intensity and velocity for each of the upper side spectrum and the lower side spectrum; comparing said at least one of the density, intensity and velocity between the upper side spectrum and the lower side spectrum to select one of the spectrums; and determining the peak tracing direction so that the peak tracing is performable for the selected spectrum.

11. The method of Claim 9, wherein the step (f2) comprises:

(f21) checking whether the peak tracing is 1-peak tracing or 2-peak tracing;
(f22) if it is determined that the peak tracing is the 1-peak tracing, then performing the 1-peak tracing on the spectrum image; and
(f23) if it is determined that the peak tracing is the 2-peak tracing, then performing the 2-peak tracing on the spectrum image.

12. The method of Claim 11, wherein the step (f22) comprises:

(g1) performing the 1-peak tracing on the spectrum image to detect candidate peaks including actual peaks and quasi-peaks; and
(g2) selecting the actual peaks out of the candidate peaks.

13. The method of Claim 12, wherein the step (g2) comprises:

(g21) determining a second threshold for filtering the candidate peaks;
(g22) selecting candidate peaks satisfying the second threshold out of the candidate peaks;
(g23) detecting peak start positions for the selected candidate peaks;
(g24) determining a specific distance from the lowest position of a spectrum in the spectrum image as a third threshold for verifying the peak start positions; and
(g25) selecting peak start positions satisfying the third threshold out of the peak start positions and selecting the candidate peaks corresponding to the selected peak start positions as the actual peaks out of the candidate peaks selected in the step (g23).

14. The method of Claim 13, wherein the step (g21) comprises:

(h1) determining grade thresholds in a range of the spectrum;
(h2) for each of the grade thresholds, calculating the number of candidate peaks above the grade threshold;
(h3) determining the second threshold based on whether or not the calculated number of candidate peaks are constantly repeated up to a specific grade threshold.

15. The method of Claim 14, wherein the step (h3) comprises:

if it is determined that the calculated numbers of candidate peaks are constantly repeated up to the specific grade threshold, then detecting a candidate peak of the lowest position among candidate peaks above the specific grade threshold; and
determining a grade threshold immediately below the detected candidate peak as the second threshold.

16. The method of Claim 14, wherein the step (h3) comprises:

if it is determined that the calculated number of candidate peaks are not constantly repeated up to the specific grade threshold, then calculating height differences in every pair of the candidate peaks;
calculating a variance for each of the candidate peaks by using the calculated height differences;
detecting a candidate peak having the smallest variance; and
determining a grade threshold corresponding to the detected candidate peak as the second threshold.

17. The method of Claim 13, wherein the step (g25) comprises:

(i1) checking whether or not one of the peak start positions satisfies the third threshold;
(i2) if it is determined that the peak start position satisfies the third threshold, then determining the peak start position as an end diastolic velocity (EDV) and determining the candidate peak corresponding to the peak start position as a peak systolic velocity (PSV);
(i3) if it is determined that the peak start position does not satisfy the third threshold, then removing the peak start position and the candidate peak corresponding to the peak start position;

and

(i4) repeating the steps (i1) to (i3) for each of the peak start positions.

18. The method of Claim 11, wherein the step (f23) comprises: 5

performing the 2-peak tracing to detect candidate peaks;
determining a first detected candidate peak as an E-peak (end of rapid filling peak); and
determining a candidate peak detected after the E-peak as an A-peak (atrial contraction peak). 10

19. An ultrasound diagnostic system, comprising: 15

means for forming a spectrum image based on ultrasound data, said spectrum image representing a velocity at a specific time;

means (130) for removing a noise from the spectrum image to provide a noise-removed spectrum image; 20

characterized by

means (130) for matching the noise-removed spectrum image with one or more spectrum models representing specific spectrum types to check whether or not the noise-removed spectrum image contains an aliasing; 25

if it is determined that the noise-removed spectrum image contains the aliasing, means (130) for removing the aliasing from the noise-removed spectrum image to provide a noise-removed spectrum image without the aliasing; 30

means (130) for performing contour tracing on the noise-removed spectrum image without the aliasing to detect contour points; and 35

means (130) for performing peak tracing on the noise-removed spectrum image without the aliasing to detect peaks. 40

Patentansprüche

1. Verfahren zum Verarbeiten eines Ultraschallspektralbilds in einem Ultraschalldiagnosesystem, welches die folgenden Schritte aufweist: 45

a) Erzeugen eines Spektralbilds basierend auf Ultraschalldaten, wobei das Spektralbild eine Geschwindigkeit zu einer spezifischen Zeit repräsentiert; 50

b) Entfernen von Rauschen aus dem Spektralbild, um ein Spektralbild zu erzeugen, aus dem das Rauschen entfernt wurde;

gekennzeichnet durch 55

c) Vergleichen des Spektralbilds, aus dem das Rauschen entfernt wurde, mit einem oder mehreren Spektralmodellen, die spezifische Spek-

tralarten repräsentieren, um zu prüfen, ob das Spektralbild, aus dem das Rauschen entfernt wurde, einen Alias-Effekt aufweist;

d) wenn festgestellt wird, dass das Spektralbild, aus dem das Rauschen entfernt wurde, den Alias-Effekt aufweist, Entfernen des Alias-Effekts aus dem Spektralbild, aus dem das Rauschen entfernt wurde, um ein Spektralbild, aus dem das Rauschen entfernt wurde, ohne den Alias-Effekt zu erzeugen;

e) Durchführen einer Konturverfolgung an dem Spektralbild, aus dem das Rauschen entfernt wurde, ohne den Alias-Effekt, um Konturpunkte zu detektieren; und

f) Durchführen einer Peakverfolgung an dem Spektralbild, aus dem das Rauschen entfernt wurde, ohne den Alias-Effekt, um Peaks zu detektieren.

2. Verfahren nach Anspruch 1, wobei der Schritt (b) folgendes aufweist:

(b1) Ermitteln eines ersten Grenzwerts zum Unterscheiden zwischen dem Rauschen und einem Spektrum in dem Spektralbild, und
(b2) Entfernen des Rauschens aus dem Spektralbild basierend auf dem ersten Grenzwert.

3. Verfahren nach Anspruch 2, wobei der Schritt (b1) folgendes aufweist:

Einteilen des Spektralbilds in eine Vielzahl von Abschnitten;
Berechnen einer durchschnittlichen Intensität von Pixeln in jedem der Abschnitte;
Vergleichen der durchschnittlichen Intensitäten, die für die Abschnitte berechnet wurden, um einen Abschnitt auszuwählen, der eine geringste durchschnittliche Intensität aufweist;
Analysieren eines Histogramms des Abschnitts, welcher die geringste durchschnittliche Intensität aufweist, um die maximale Intensität in dem Histogramm zu detektieren; und
Festlegen der detektierten maximalen Intensität als den ersten Grenzwert.

4. Verfahren nach Anspruch 1, wobei der Schritt (d) folgendes aufweist:

wenn festgestellt wird, dass das Spektralbild, aus dem das Rauschen entfernt wurde, den Alias-Effekt aufweist, Detektieren einer Richtung und einer Größe des Alias-Effekts basierend auf dem angepassten bzw. verglichenen Spektralmodell; und
Verschieben einer Basis des Spektralbilds, aus dem das Rauschen entfernt wurde, basierend auf der ermittelten Richtung und Größe des Ali-

as-Effekts, um den Alias-Effekt zu entfernen.

5. Verfahren nach Anspruch 1, wobei der Schritt (e) folgendes aufweist:

(e1) Empfangen einer Konturverfolungsrichtung, die von einer Bedienperson ausgewählt wurde, und Prüfen, ob die Konturverfolungsrichtung die Durchführung der Konturverfolgung sowohl für das oberseitige als auch für das unterseitige Spektrum anzeigt, oder Durchführen der Konturverfolgung entweder für das oberseitige oder das unterseitige Spektrum;
(e2) wenn ermittelt wird, dass die Konturverfolungsrichtung die Durchführung der Konturverfolgung sowohl für das oberseitige als auch für das unterseitige Spektrum anzeigt, Durchführen der Konturverfolgung sowohl für das oberseitige als auch für das unterseitige Spektrum, um die Konturpunkte zu detektieren; und
(e3) wenn festgestellt wird, dass die Konturverfolungsrichtung die Konturverfolgung entweder für das oberseitige oder für das unterseitige Spektrum anzeigt, Durchführen der Konturverfolgung für das entsprechende Spektrum, um die Konturpunkte zu detektieren.

6. Verfahren nach Anspruch 5, wobei der Schritt (e2) folgendes aufweist:

für jedes der oberseitigen und unterseitigen Spektren Berechnen der Summe der Intensitäten der Konturpunkte in dem entsprechenden Spektrum;
Vergleichen der Summe der Intensitäten der Konturpunkte in dem oberseitigen Spektrum und der Summe der Intensitäten der Konturpunkte in dem unterseitigen Spektrum, um zu ermitteln, welches der Spektren die größere Summe an Intensitäten aufweist; und
Auswählen der Konturpunkte des Spektrums, welches die größere Summe von Intensitäten aufweist.

7. Verfahren nach Anspruch 6, wobei die Summe der Intensitäten basierend auf Geschwindigkeiten und Frequenzkomponenten des entsprechenden Spektrums berechnet wird.

8. Verfahren nach Anspruch 5, wobei der Schritt (e) des Weiteren folgendes aufweist:

Berechnen von Intensitäten der Konturpunkte; und
Durchführen einer mittleren Konturverfolgung in der Konturverfolungsrichtung, um mittlere Konturpunkte zu detektieren, wobei Intensitäten der mittleren Konturpunkte die Hälfte der Inten-

sitäten der entsprechenden Konturpunkte sind.

9. Verfahren nach Anspruch 1, wobei der Schritt (f) folgendes aufweist:

(f1) Ermitteln einer Peakverfolungsrichtung für das Spektralbild; und
(f2) Durchführen der Peakverfolgung in der Peakverfolungsrichtung.

10. Verfahren nach Anspruch 9, wobei der Schritt (f1) folgendes aufweist:

Prüfen, ob die Peakverfolungsrichtung das Durchführen der Peakverfolgung sowohl für das oberseitige als auch für das unterseitige Spektrum anzeigt;
wenn festgestellt wird, dass die Peakverfolungsrichtung das Durchführen der Peakverfolgung sowohl für das oberseitige als auch für das unterseitige Spektrum anzeigt, Analysieren von wenigstens einem von Dichte, Intensität und Geschwindigkeit sowohl für das oberseitige Spektrum als auch für das unterseitige Spektrum;
Vergleichen von wenigstens einem von Dichte, Intensität und Geschwindigkeit zwischen dem oberseitigen Spektrum und dem unterseitigen Spektrum, um eines der Spektren auszuwählen; und
Ermitteln der Peakverfolungsrichtung, so dass die Peakverfolgung für das ausgewählte Spektrum durchführbar ist.

11. Verfahren nach Anspruch 9, wobei der Schritt (f2) folgendes aufweist:

(f21) Prüfen, ob die Peakverfolgung eine 1-Peakverfolgung oder eine 2-Peakverfolgung ist;
(f22) wenn festgestellt wird, dass die Peakverfolgung die 1-Peakverfolgung ist, Durchführen der 1-Peakverfolgung an dem Spektralbild; und
(f23) wenn festgestellt wird, dass die Peakverfolgung die 2-Peakverfolgung ist, Durchführen der 2-Peakverfolgung an dem Spektralbild.

12. Verfahren nach Anspruch 11, wobei der Schritt (f22) folgendes aufweist:

(g1) Durchführen der 1-Peakverfolgung an dem Spektralbild, um Kandidaten-Peaks zu ermitteln, die tatsächliche Peaks und Quasi-Peaks beinhalten; und
(g2) Auswählen der tatsächlichen Peaks aus den Kandidaten-Peaks.

13. Verfahren nach Anspruch 12, wobei der Schritt (g2) folgendes aufweist:

- (g21) Ermitteln eines zweiten Grenzwerts zum Filtern der Kandidaten-Peaks;
 (g22) Auswählen derjenigen Kandidaten-Peaks, die den zweiten Grenzwert erfüllen, aus den Kandidaten-Peaks;
 (g23) Ermitteln von Peak-Startpositionen für die ausgewählten Kandidaten-Peaks;
 (g24) Ermitteln eines spezifischen Abstands von der untersten Position eines Spektrums in dem Spektralbild als einen dritten Grenzwert zum Verifizieren der Peak-Startpositionen; und
 (g25) Auswählen derjenigen Peak-Startpositionen, welche den dritten Grenzwert erfüllen, aus den Peak-Startpositionen und Auswählen derjenigen Kandidaten-Peaks, welche mit den ausgewählten Peak-Startpositionen korrespondieren, als die tatsächlichen Peaks aus den Kandidaten-Peaks, die in dem Schritt (g23) ausgewählt wurden.
14. Verfahren nach Anspruch 13, wobei der Schritt (g21) folgendes aufweist:
- (h1) Ermitteln von Stufengrenzwerten in einem Bereich des Spektrums;
 (h2) Berechnen der Anzahl von Kandidaten-Peaks oberhalb des Stufengrenzwerts für jeden der Stufengrenzwerte;
 (h3) Ermitteln des zweiten Grenzwerts basierend darauf, ob die berechnete Anzahl an Kandidaten-Peaks bis zu einem spezifischen Stufengrenzwert konstant wiederholt werden oder nicht.
15. Verfahren nach Anspruch 14, wobei der Schritt (h3) folgendes aufweist:
- wenn festgestellt wird, dass die berechnete Anzahl von Kandidaten-Peaks bis zu dem spezifischen Stufengrenzwert konstant wiederholt werden, Detektieren eines Kandidaten-Peaks der untersten Position unter den Kandidaten-Peaks oberhalb des spezifischen Stufengrenzwerts; und
 Ermitteln eines Stufengrenzwerts unmittelbar unterhalb des detektierten Kandidaten-Peaks als den zweiten Grenzwert.
16. Verfahren nach Anspruch 14, wobei der Schritt (h3) folgendes aufweist:
- wenn festgestellt wird, dass die berechnete Anzahl an Kandidaten-Peaks nicht bis zu dem spezifischen Stufengrenzwert konstant wiederholt wird, Berechnen von Höhendifferenzen in jedem Paar der Kandidaten-Peaks;
 Berechnen einer Varianz für jeden der Kandidaten-Peaks unter Verwendung der berechneten
- Höhendifferenzen;
 Detektieren eines Kandidaten-Peaks, der die geringste Varianz aufweist; und
 Ermitteln eines Stufengrenzwerts, das mit dem detektierten Kandidaten-Peak korrespondiert, als den zweiten Grenzwert.
17. Verfahren nach Anspruch 13, wobei der Schritt (g25) folgendes aufweist:
- (i1) Prüfen ob eine der Peak-Startpositionen den dritten Grenzwert erfüllt oder nicht;
 (i2) wenn festgestellt wird, dass die Peak-Startposition den dritten Grenzwert erfüllt, Festlegen der Peak-Startposition als eine end-diastolische Geschwindigkeit (EDV) und Festlegen des Kandidaten-Peaks, der mit der Peak-Startposition korrespondiert, als eine systolische Peakgeschwindigkeit (PSV);
 (i3) wenn festgestellt wird, dass die Peak-Startposition den dritten Grenzwert nicht erfüllt, Entfernen der Peak-Startposition und des Kandidaten-Peaks, der der Peak-Startposition entspricht; und
 (i4) Wiederholen der Schritte (i1) bis (i3) für jede der Peak-Startpositionen.
18. Verfahren nach Anspruch 11, wobei der Schritt (f23) folgendes aufweist:
- Durchführen der 2-Peakverfolgung, um Kandidaten-Peaks zu ermitteln;
 Festlegen eines ersten detektierten Kandidaten-Peaks als einen E-Peak (Ende des schnell füllenden Peaks); und
 Ermitteln eines Kandidaten-Peaks, das nach dem E-Peak ermittelt wurde, als ein A-Peak (Atriumkontraktions-Peak).
19. Ultraschalldiagnosesystem, welches folgendes aufweist:
- eine Einrichtung zum Erzeugen eines Spektralbilds basierend auf Ultraschalldaten, wobei das Spektralbild eine Geschwindigkeit zu einer spezifischen Zeit repräsentiert;
 eine Einrichtung (130) zum Entfernen von Rauschen aus dem Spektralbild, um ein Spektralbild zu erzeugen, aus dem das Rauschen entfernt wurde;
gekennzeichnet durch
 eine Einrichtung zum Vergleichen des Spektralbilds, aus dem das Rauschen entfernt wurde, mit einem oder mehreren Spektralmodellen, die spezifische Spektralarten repräsentieren, um zu prüfen, ob das Spektralbild, aus dem das Rauschen entfernt wurde, einen Alias-Effekt aufweist oder nicht;

wenn festgestellt wird, dass das Spektralbild, aus dem das Rauschen entfernt wurde, den Alias-Effekt aufweist, eine Einrichtung (130) zum Entfernen des Alias-Effekts aus dem Spektralbild, aus dem das Rauschen entfernt wurde, um ein Spektralbild, aus dem das Rauschen entfernt wurde, ohne den Alias-Effekt zu erzeugen; eine Einrichtung (130) zum Durchführen einer Konturverfolgung an dem Spektralbild, aus dem das Rauschen entfernt wurde, ohne den Alias-Effekt, um Konturpunkte zu detektieren; und eine Einrichtung (130) zum Durchführen einer Peakverfolgung an dem Spektralbild, aus dem das Rauschen entfernt wurde, ohne den Alias-Effekt, um Peaks zu detektieren.

Revendications

1. Méthode de traitement d'une image spectrale ultrasonore dans un système de diagnostic ultrasonore, comprenant les étapes consistant à :
 - (a) former une image spectrale sur la base de données ultrasonores, ladite image spectrale représentant une vitesse à un instant spécifique ;
 - (b) éliminer un bruit à partir de l'image spectrale pour fournir une image spectrale à bruit supprimé ;
 - caractérisée par** les étapes consistant à
 - (c) faire correspondre l'image spectrale à bruit supprimé avec un ou plusieurs modèles de spectre représentant des types de spectre spécifiques pour vérifier si l'image spectrale à bruit supprimé contient ou non un crénelage ;
 - (d) s'il est déterminé que l'image spectrale à bruit supprimé contient le crénelage, éliminer alors le crénelage à partir de l'image spectrale à bruit supprimé pour fournir une image spectrale à bruit supprimé sans le crénelage ;
 - (e) effectuer un traçage de contour sur l'image spectrale à bruit supprimé sans le crénelage pour détecter des points de contour ; et
 - (f) effectuer un traçage de pic sur l'image spectrale à bruit supprimé sans le crénelage pour détecter des pics.
2. Méthode selon la revendication 1, dans laquelle l'étape (b) comprend les étapes consistant à :
 - (b1) déterminer un premier seuil de discrimination entre le bruit et un spectre dans l'image spectrale ; et
 - (b2) éliminer le bruit à partir de l'image spectrale sur la base du premier seuil.
3. Méthode selon la revendication 2, dans laquelle

l'étape (b1) comprend les étapes consistant à :

diviser l'image spectrale en un certain nombre de sections ;
calculer une intensité moyenne de pixels dans chacune des sections ;
comparer les intensités moyennes calculées pour les sections afin de sélectionner une section ayant une intensité moyenne la plus petite ;
analyser un histogramme de la section ayant la plus petite intensité moyenne pour détecter l'intensité maximum dans l'histogramme ; et
déterminer l'intensité maximum détectée en tant que premier seuil.

4. Méthode selon la revendication 1, dans laquelle l'étape (d) comprend les étapes consistant à :

s'il est déterminé que l'image de spectre à bruit supprimé contient le crénelage, détecter alors une direction et une amplitude du crénelage sur la base du modèle de spectre adapté ; et
décaler une ligne de base de l'image spectrale à bruit supprimé sur la base de la direction et de l'amplitude détectées du crénelage afin de supprimer le crénelage.

5. Méthode selon la revendication 1, dans laquelle l'étape (e) comprend les étapes consistant à :

(e1) recevoir une direction de traçage de contour sélectionnée par un opérateur et vérifier si la direction de traçage de contour indique l'exécution du traçage de contour pour des spectres côté supérieur et côté inférieur ou l'exécution du traçage de contour pour le spectre de côté supérieur ou de côté inférieur ;
(e2) s'il est déterminé que la direction de traçage de contour indique l'exécution du traçage de contour pour les spectres côté supérieur et côté inférieur, alors exécuter le traçage de contour pour les spectres côté supérieur et côté inférieur pour détecter les points de contour ; et
(e3) s'il est déterminé que la direction de traçage de contour indique l'exécution du traçage de contour pour le spectre de côté supérieur ou de côté inférieur, alors exécuter le traçage de contour pour le spectre correspondant pour détecter les points de contour.

6. Méthode selon la revendication 5, dans laquelle l'étape (e2) comprend les étapes consistant à :

pour chacun des spectres de côté supérieur et de côté inférieur, calculer la somme d'intensités des points de contour dans le spectre correspondant ;
comparer la somme d'intensités des points de

- contour dans le spectre de côté supérieur et la somme d'intensités des points de contour dans le spectre de côté inférieur pour déterminer lequel des spectres a la somme d'intensités plus importante ; et
5
sélectionner les points de contour du spectre ayant la somme d'intensités plus importante.
7. Méthode selon la revendication 6, dans laquelle la somme d'intensités est calculée sur la base de vitesses et de composantes fréquentielles du spectre correspondant. 10
8. Méthode selon la revendication 5, dans laquelle l'étape (e) comprend en outre les étapes consistant à : 15
- calculer des intensités des points de contour ; et effectuer un traçage de contour moyen dans la direction de traçage de contour pour détecter des points de contour moyens, dans laquelle des intensités des points de contour moyens représentent la moitié des intensités des points de contour correspondants. 20
9. Méthode selon la revendication 1, dans laquelle l'étape (f) comprend les étapes consistant à : 25
- (f1) déterminer une direction de traçage de pic pour l'image spectrale ; et 30
(f2) effectuer le traçage de pic dans la direction de traçage de pic.
10. Méthode selon la revendication 9, dans laquelle l'étape (f1) comprend les étapes consistant à : 35
- vérifier si la direction de traçage de pic indique ou non l'exécution du traçage de pic pour les spectres de côté supérieur et de côté inférieur ; s'il est déterminé que la direction de traçage de pic indique l'exécution du traçage de pic pour les spectres de côté supérieur et de côté inférieur, analyser alors au moins l'une d'une densité, d'une intensité et d'une vitesse pour chacun du spectre de côté supérieur et du spectre de côté inférieur ; 40
- comparer ladite au moins une de la densité, de l'intensité et de la vitesse entre le spectre de côté supérieur et le spectre de côté inférieur pour sélectionner l'un des spectres ; et 45
- déterminer la direction de traçage de pic afin que le traçage de pic soit réalisable pour le spectre sélectionné. 50
11. Méthode selon la revendication 9, dans laquelle l'étape (f2) comprend les étapes consistant à : 55
- (f21) vérifier si le traçage de pic est un traçage à un pic ou un traçage à deux pics ;
(f22) s'il est déterminé que le traçage de pic est le traçage à un pic, exécuter alors le traçage à un pic sur l'image spectrale ; et
(f23) s'il est déterminé que le traçage de pic est le traçage à deux pics, exécuter alors le traçage à deux pics sur l'image spectrale.
12. Méthode selon la revendication 11, dans laquelle l'étape (f22) comprend les étapes consistant à :

(g1) effectuer le traçage à un pic sur l'image spectrale pour détecter des pics candidates, y compris des pics réels et des quasi-pics ; et
(g2) sélectionner les pics réels parmi les pics candidats.
13. Méthode selon la revendication 12, dans laquelle l'étape (g2) comprend les étapes consistant à :

(g21) déterminer un deuxième seuil pour filtrer les pics candidats ;
(g22) sélectionner des pics candidats satisfaisant le deuxième seuil parmi les pics candidats ;
(g23) détecter des positions de début de pic pour les pics candidats sélectionnés ;
(g24) déterminer une distance spécifique à partir de la position la plus basse d'un spectre dans l'image spectrale en tant que troisième seuil pour vérifier les positions de début de pic ; et
(g25) sélectionner des positions de début de pic satisfaisant le troisième seuil parmi les positions de début de pic et sélectionner les pics candidats correspondant aux positions de début de pic sélectionnées en tant que pics réels parmi les pics candidats sélectionnés à l'étape (g23).
14. Méthode selon la revendication 13, dans laquelle l'étape (g21) comprend les étapes consistant à :

(h1) déterminer des seuils de niveau dans une plage du spectre ;
(h2) pour chacun des seuils de niveau, calculer le nombre de pics candidats au-dessus du seuil de niveau ;
(h3) déterminer le deuxième seuil sur la base de la répétition constante ou non du nombre calculé de pics candidats jusqu'à un seuil de niveau spécifique.
15. Méthode selon la revendication 14, dans laquelle l'étape (h3) comprend les étapes consistant à :

s'il est déterminé que les nombres calculés de pics candidats sont constamment répétés jusqu'au seuil de niveau spécifique, détecter alors un pic candidat de la position la plus basse parmi des pics candidats au-dessus du seuil de niveau

- spécifique ; et
déterminer un seuil de niveau immédiatement
en dessous du pic candidat détecté en tant que
deuxième seuil.
- 5
16. Méthode selon la revendication 14, dans laquelle
l'étape (h3) comprend les étapes consistant à :
- s'il est déterminé que le nombre calculé de pics
candidats n'est pas constamment répété jus- 10
qu'au seuil de pente spécifique, alors calculer
les différences de hauteur dans chaque paire
de pics candidats ;
calculer une variance pour chacun des pics can- 15
didats en utilisant les différences de hauteur
calculées ;
détecter un pic candidat ayant la plus petite
variance ; et
déterminer un seuil de niveau correspondant au 20
pic candidat détecté en tant que deuxième seuil.
17. Méthode selon la revendication 13, dans laquelle
l'étape (g25) comprend les étapes consistant à :
- (i1) vérifier si l'une des positions de début de pic 25
satisfait ou non au troisième seuil ;
(i2) s'il est déterminé que la position de début
de pic satisfait le troisième seuil, déterminer
alors la position de début de pic en tant que vi- 30
tesse diastolique finale (EDV) et déterminer le
pic candidat correspondant à la position de dé-
but de pic en tant que vitesse systolique de pic
(PSV) ;
(i3) s'il est déterminé que la position de début 35
de pic ne satisfait pas au troisième seuil, éliminer
alors la position de début de pic et le pic candidat
correspondant à la position de début de pic ; et
(i4) répéter les étapes (i1) à (i3) pour chacune
des positions de début de pic. 40
18. Méthode selon la revendication 11, dans laquelle
l'étape (f23) comprend les étapes consistant à :
- effectuer le traçage à deux pics pour détecter 45
des pics candidats ;
déterminer un premier pic candidat détecté en
tant que pic E (fin de pic de remplissage rapide) ;
et
déterminer un pic candidat détecté après le pic 50
E en tant que pic A (pic de contraction auricu-
laire).
19. Système de diagnostic par ultrasons, comprenant :
- des moyens pour former une image spectrale 55
sur la base de données ultrasonores, ladite ima-
ge spectrale représentant une vitesse à un ins-
tant spécifique ;

des moyens (130) pour éliminer un bruit à partir
de l'image spectrale pour fournir une image
spectrale à bruit supprimé ;

caractérisé par

des moyens (130) pour faire correspondre l'ima-
ge spectrale à bruit supprimé avec un ou plu-
sieurs modèles de spectre représentant des ty-
pes de spectre spécifiques pour vérifier si l'ima-
ge spectrale à bruit supprimé contient ou non
un crénelage ;

s'il est déterminé que l'image spectrale à bruit
supprimé contient le crénelage, des moyens
(130) pour éliminer le crénelage à partir de l'ima-
ge spectrale à bruit supprimé pour fournir une
image spectrale à bruit supprimé sans le
crénelage ;

des moyens (130) pour effectuer un traçage de
contour sur l'image spectrale à bruit supprimé
sans le crénelage pour détecter des points de
contour ; et

des moyens (130) pour effectuer un traçage de
pic sur l'image spectrale à bruit supprimé sans
le crénelage pour détecter des pics.

Fig. 1

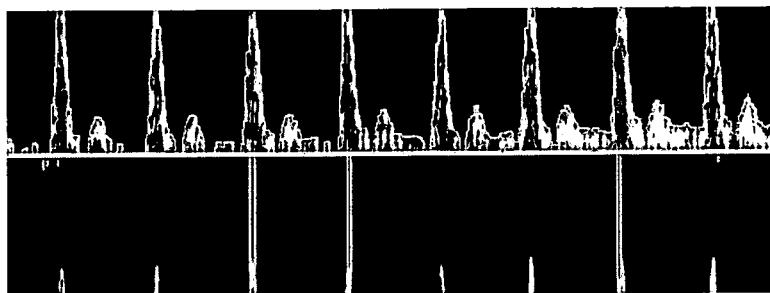


Fig. 2

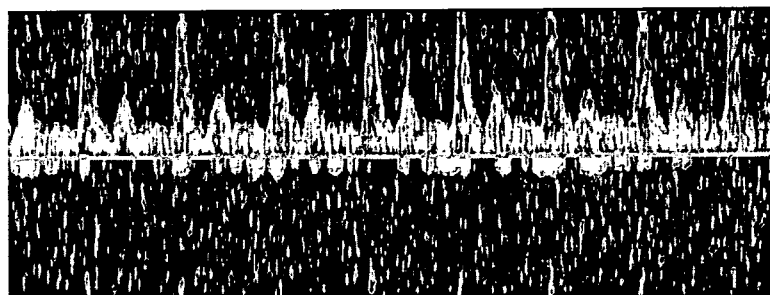


Fig. 3

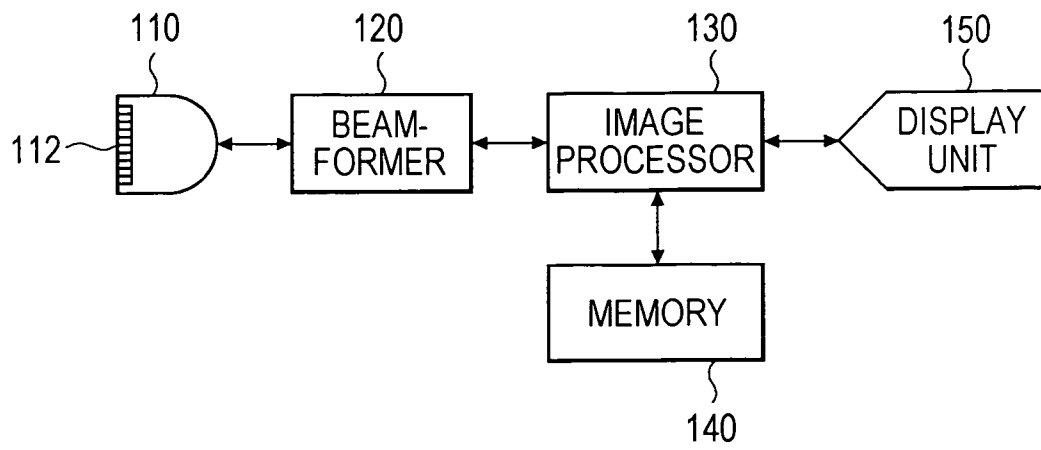


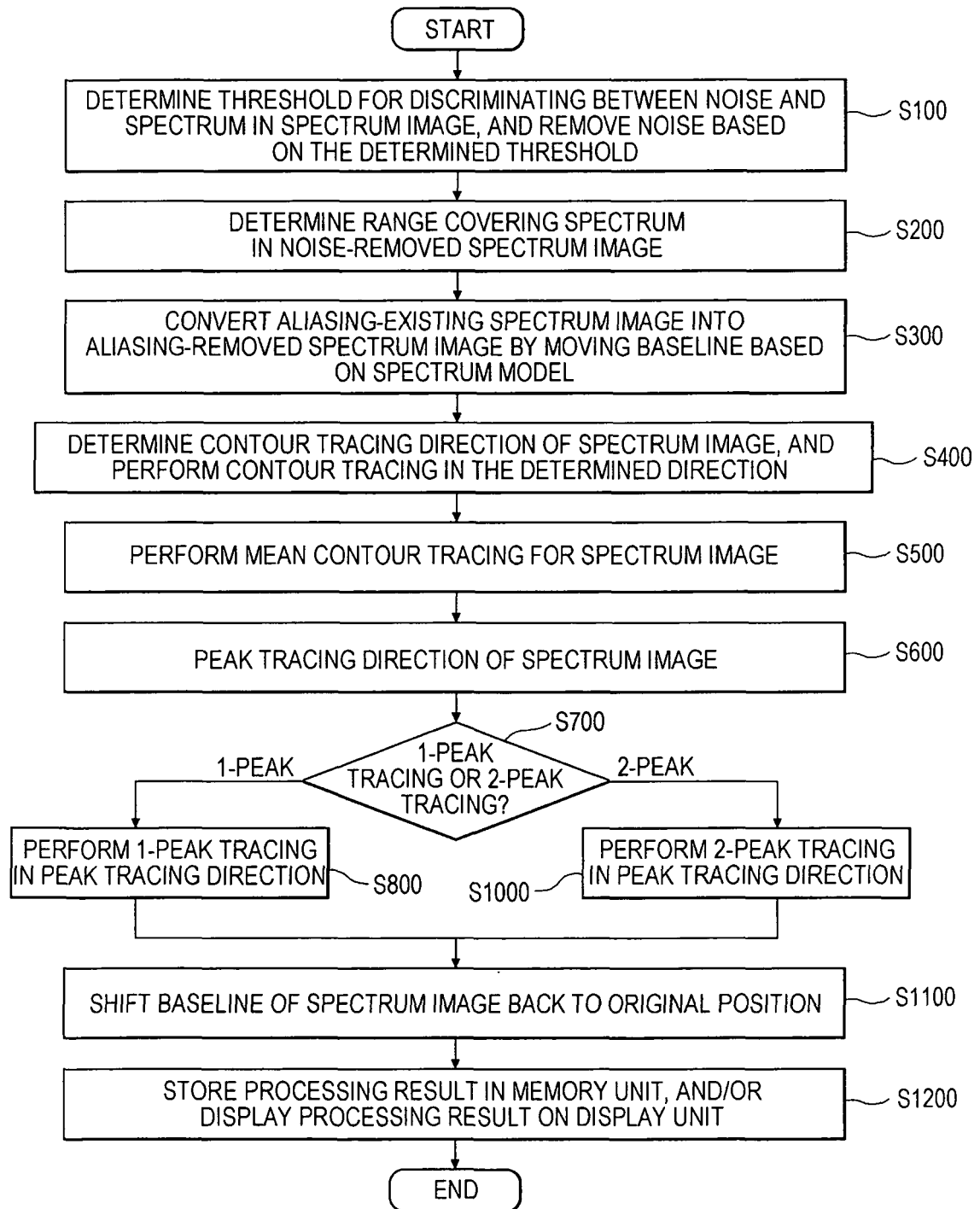
Fig. 4

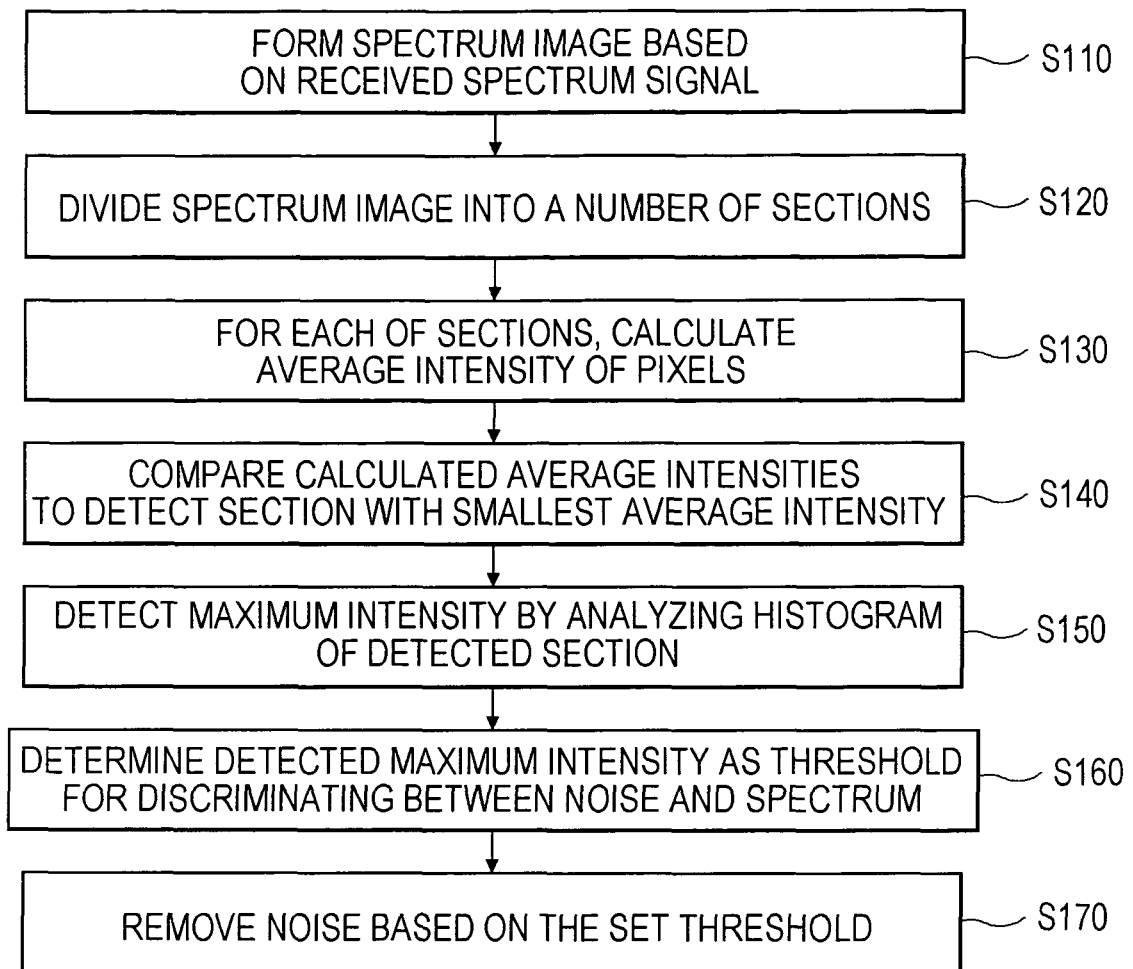
Fig. 5

Fig. 6A

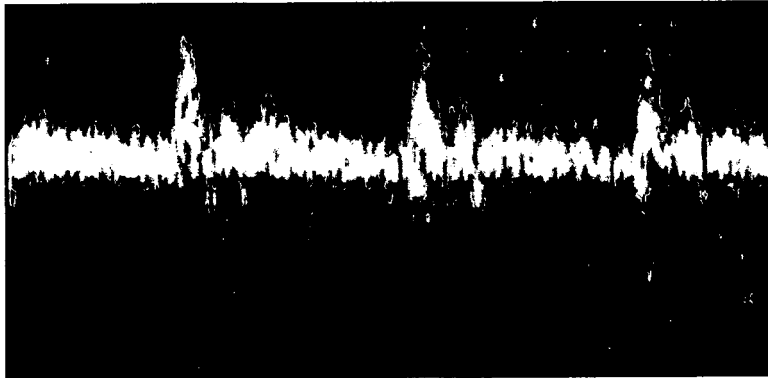


Fig. 6B

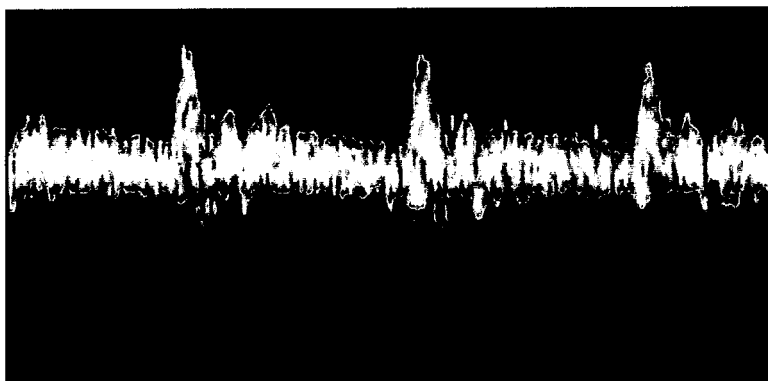


Fig. 6C

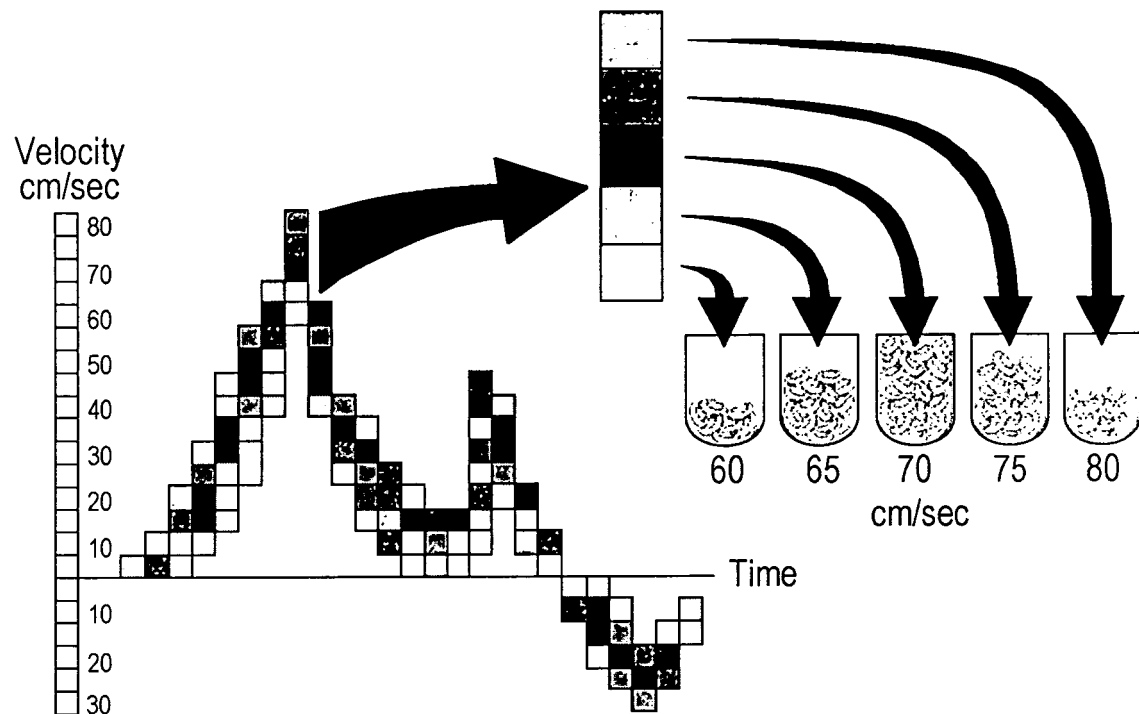


Fig. 7

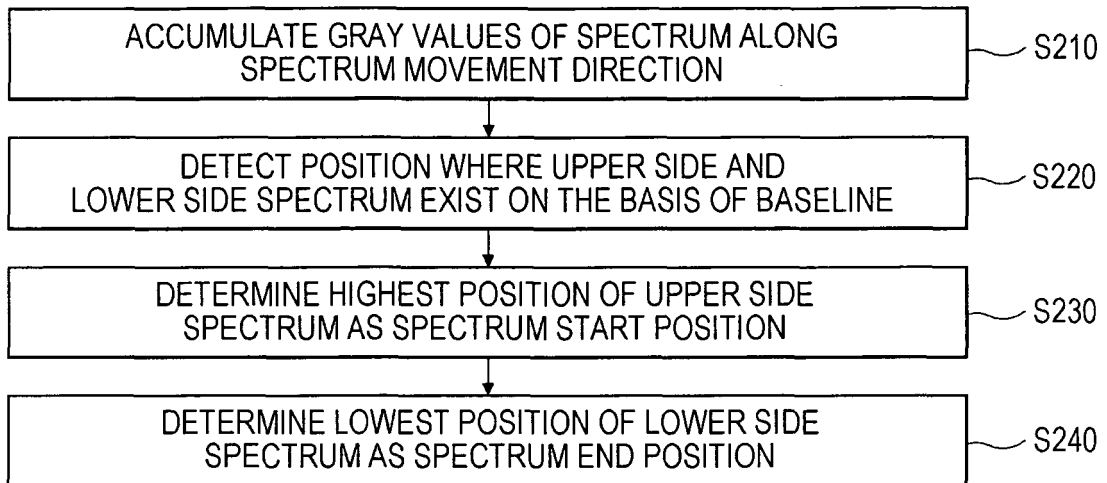


Fig. 8

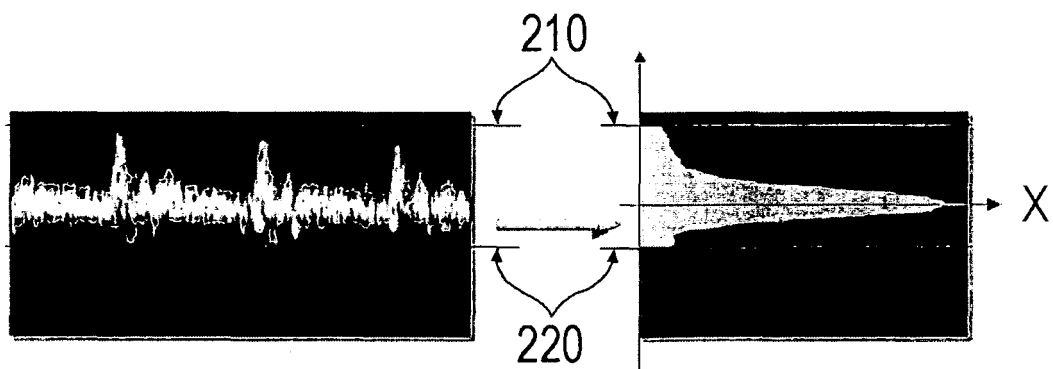


Fig. 9A

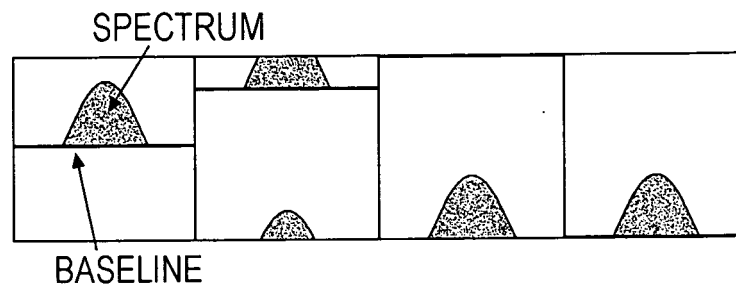


Fig. 9B

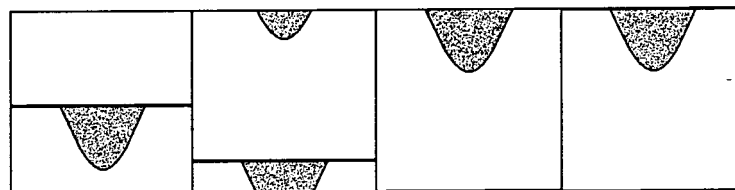


Fig. 9C

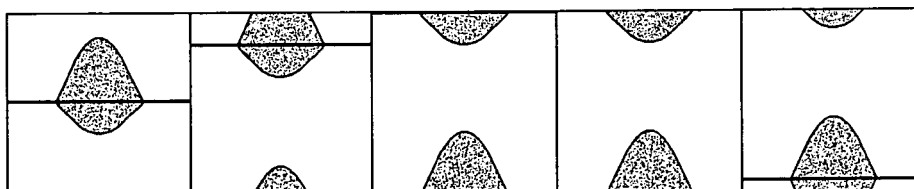


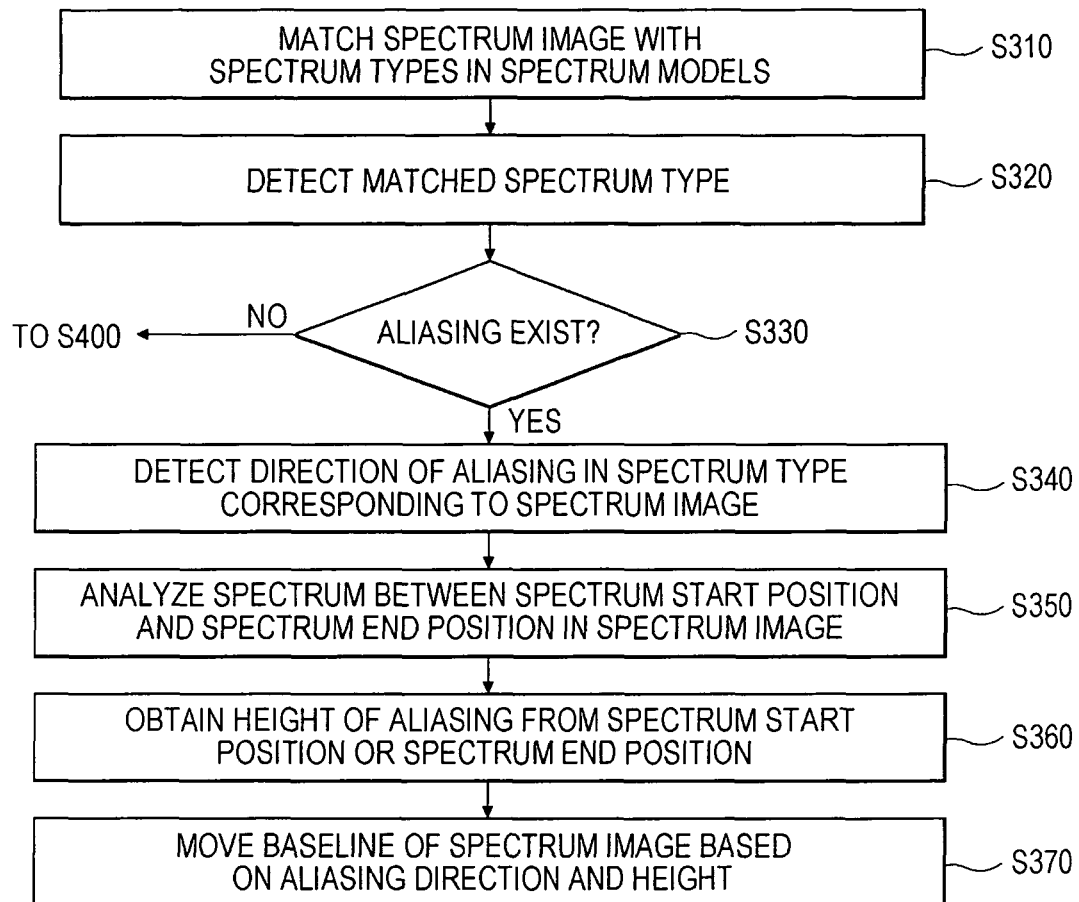
Fig. 10

Fig. 11A

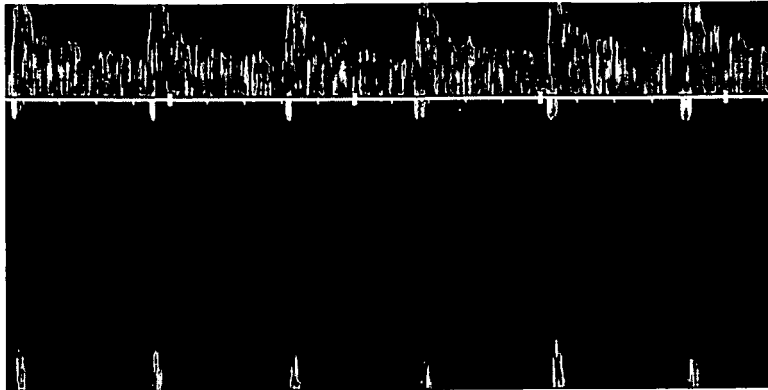


Fig. 11B

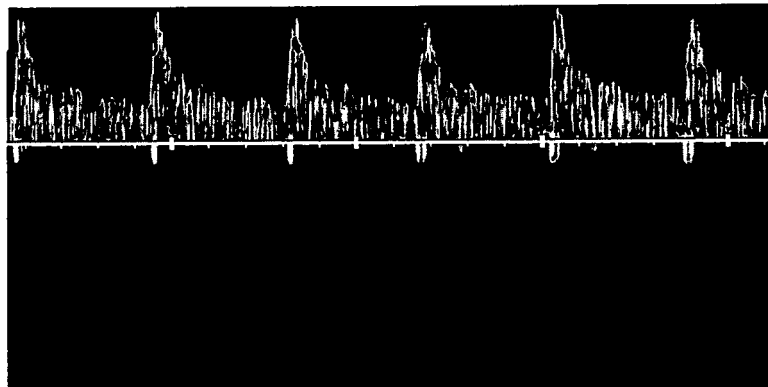


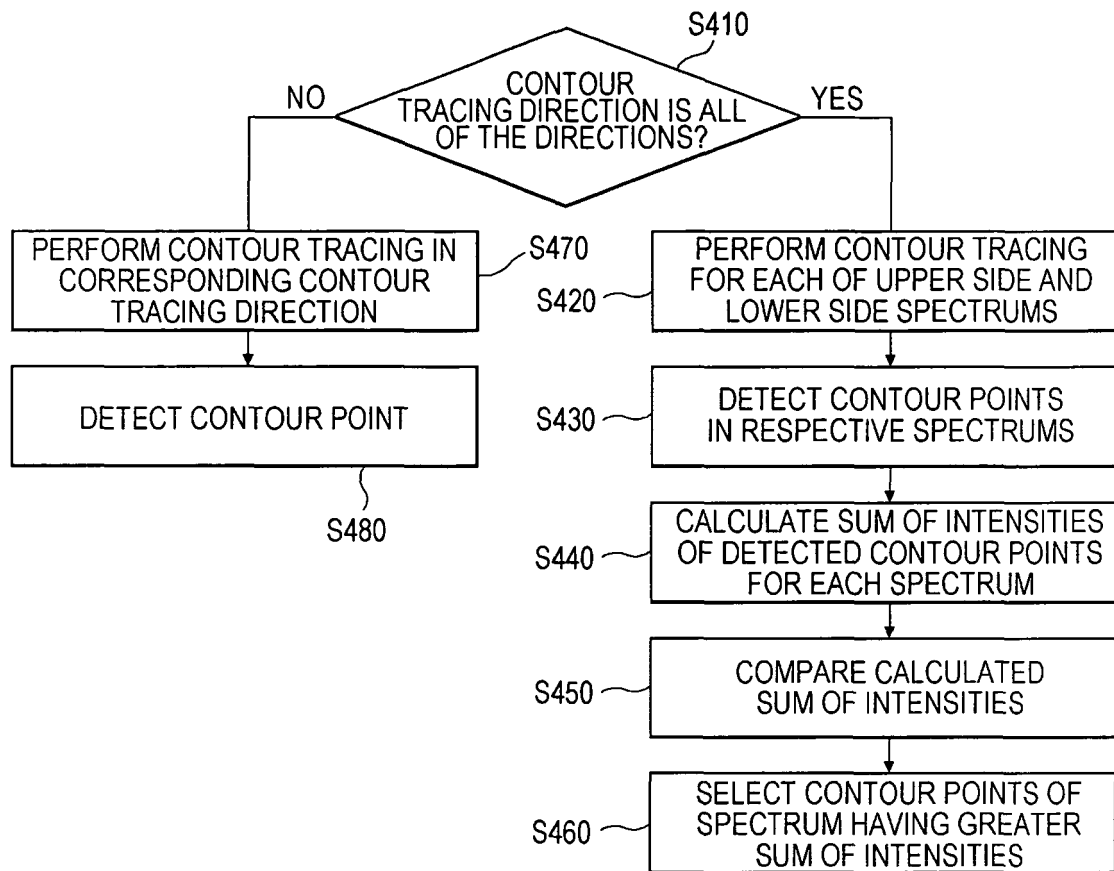
Fig. 12

Fig. 13

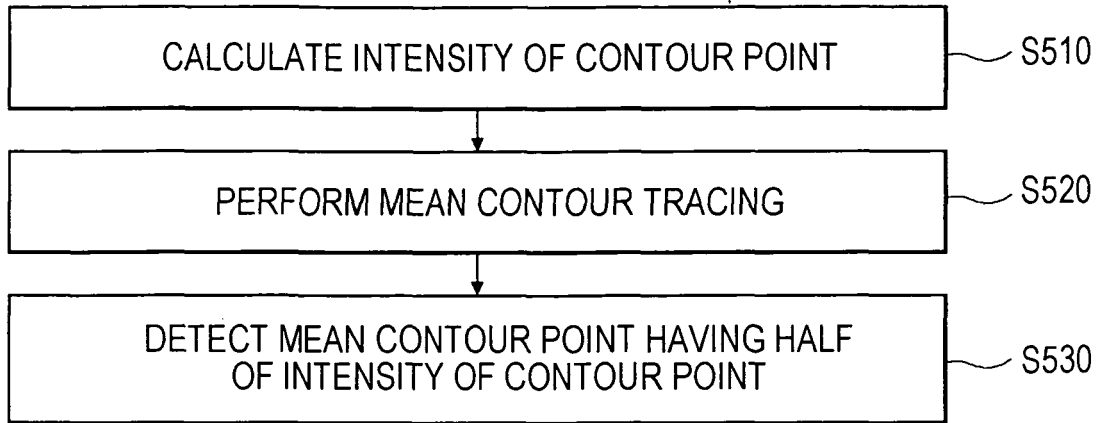


Fig. 14

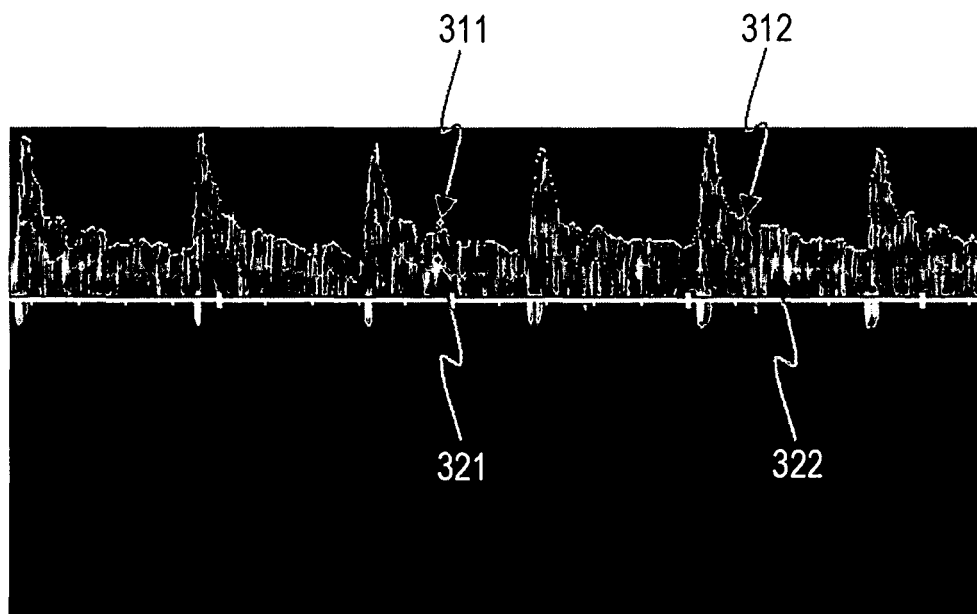


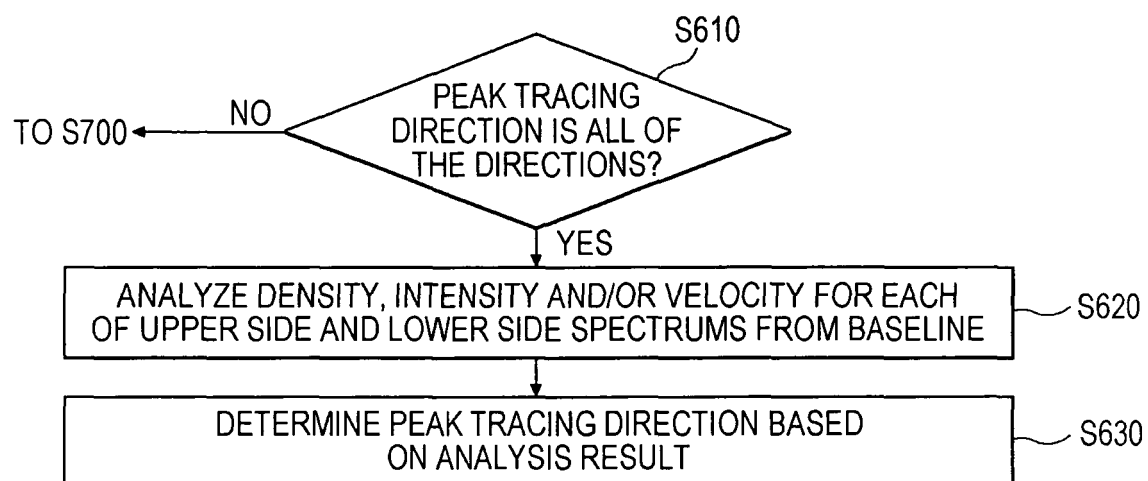
Fig. 15

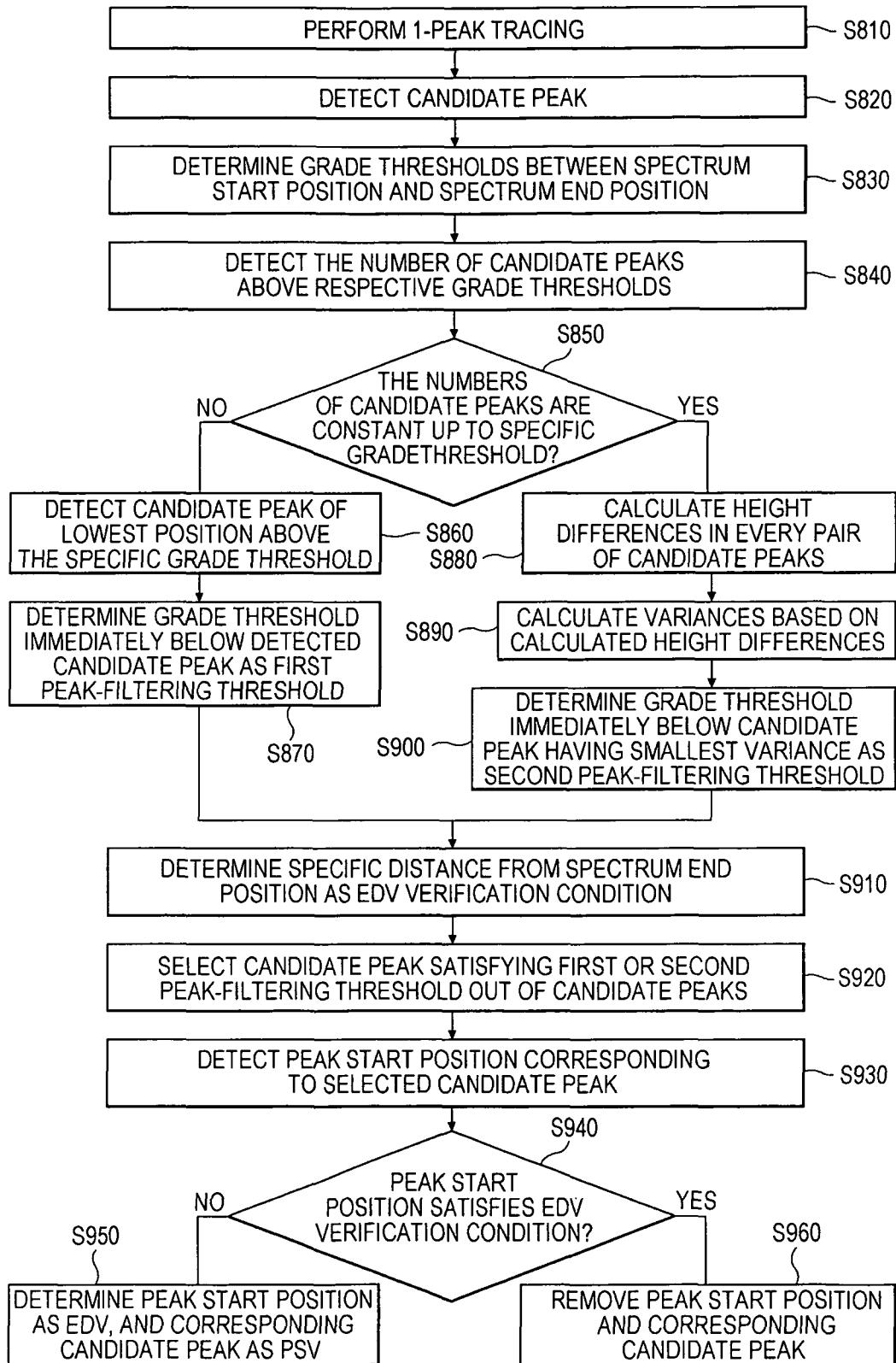
Fig. 16

Fig. 17A

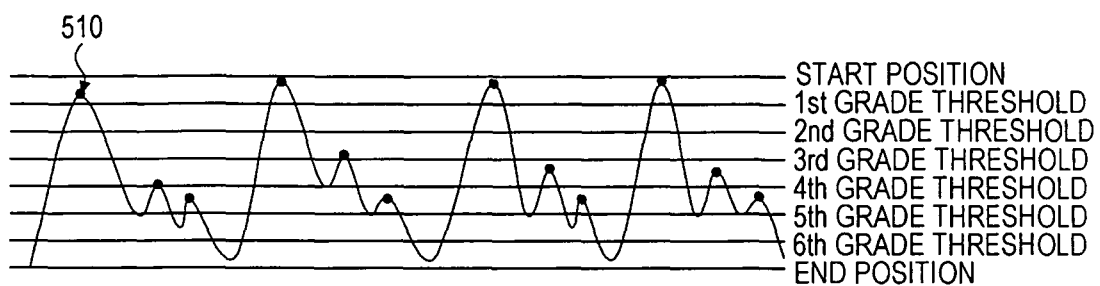


Fig. 17B

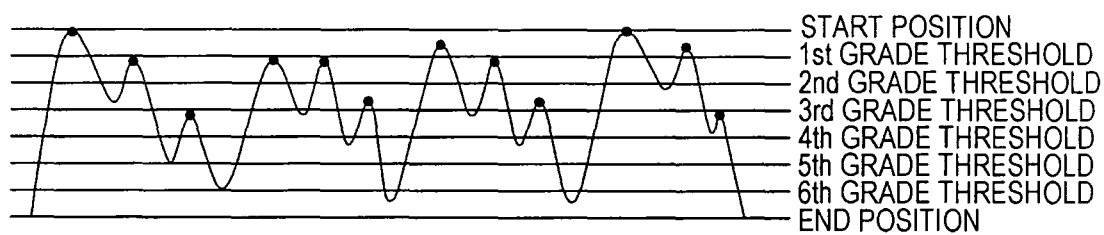


Fig. 18

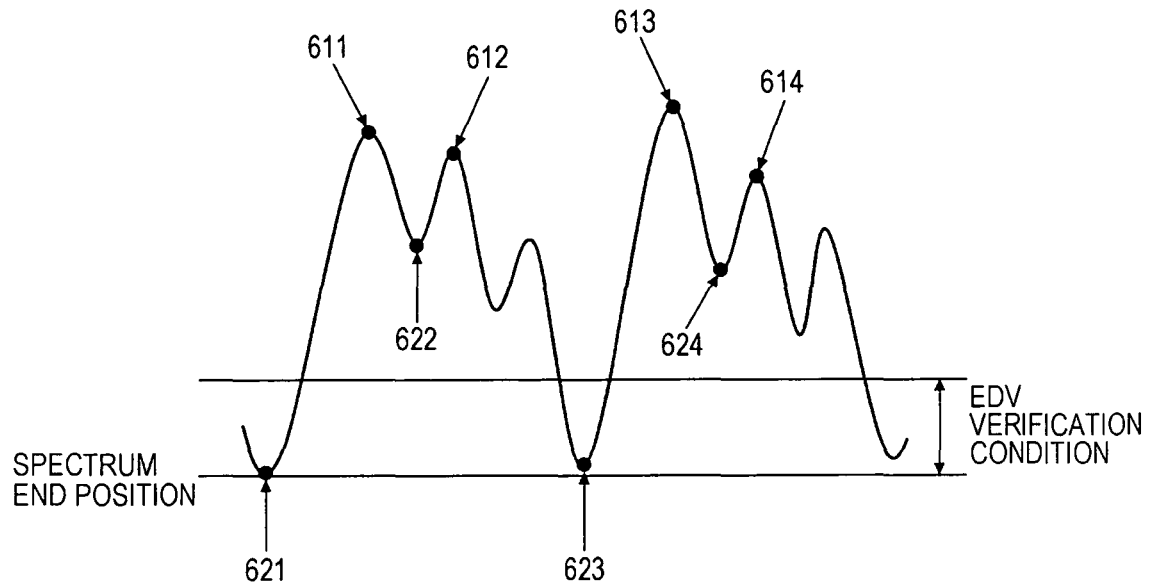


Fig. 19

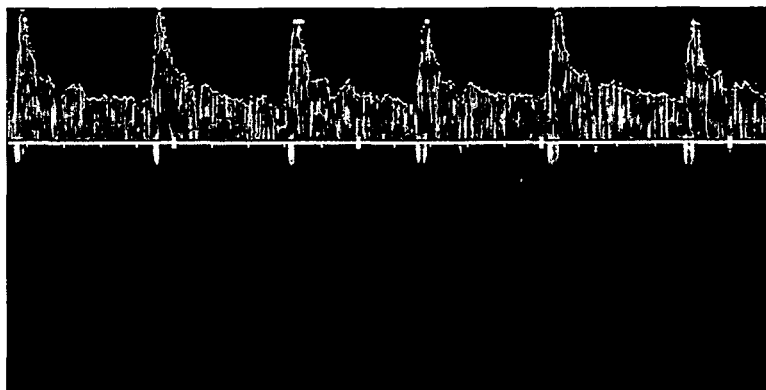


Fig. 20

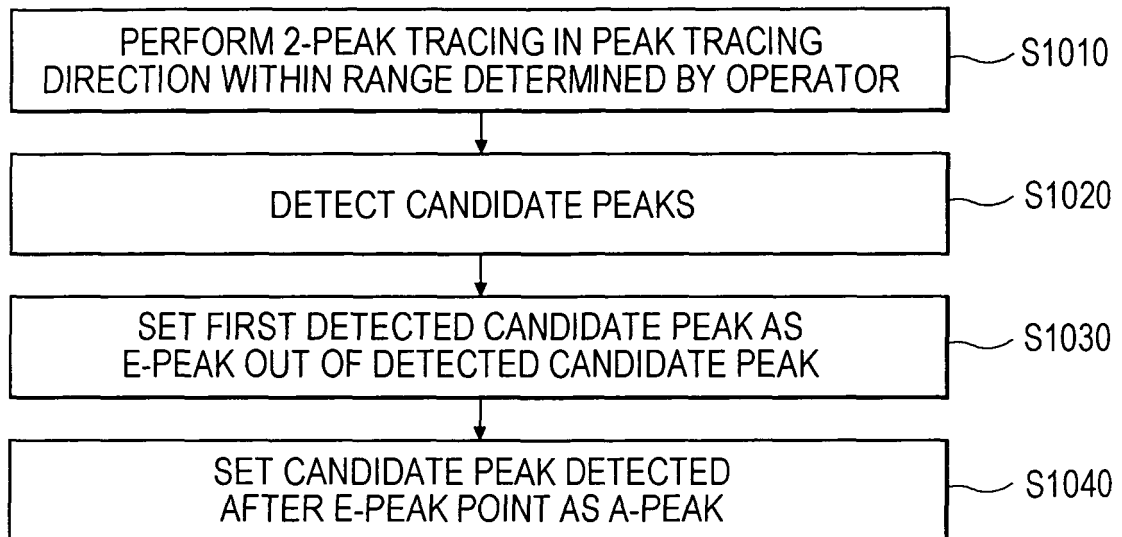


Fig. 21

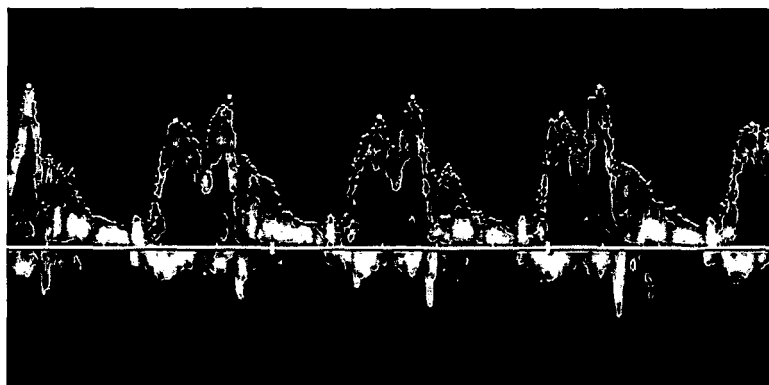
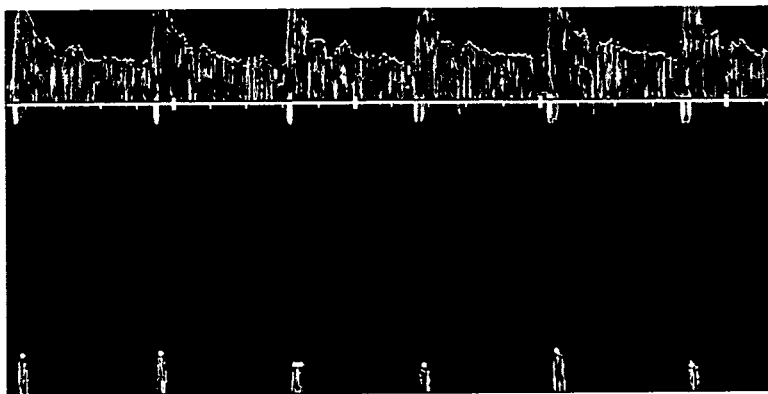


Fig. 22



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20020116141 A1 [0002]
- US 6050948 A [0003]

专利名称(译)	用于处理超声频谱图像的设备和方法		
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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 HYE JUNG LEE KI JONG KIM SUNG HO YANG EUN HO KIM CHEOL AN		
发明人	KIM, HYE JUNG LEE, KI JONG KIM, SUNG HO YANG, EUN HO KIM, CHEOL AN		
IPC分类号	A61B8/06		
CPC分类号	A61B8/06 G01S7/52026 G01S7/52077 G01S15/584 G01S15/8979 G06K9/0055		
代理机构(译)	LORENZ , MARKUS		
优先权	1020050044360 2005-05-26 KR		
其他公开文献	EP1726262A1		
外部链接	Espacenet		

摘要(译)

提供了一种处理超声频谱图像的方法。根据这种方法，基于超声数据形成频谱图像，然后从频谱图像中去除噪声。去除噪声的频谱图像与代表特定频谱类型的一个或多个频谱模型匹配。然后，检查去除噪声的频谱图像是否包含混叠。如果去除噪声的频谱图像包含混叠，则从去除噪声的频谱图像中去除混叠，以提供没有混叠的去除噪声的频谱图像。此后，在没有混叠的情况下对去除噪声的频谱图像执行轮廓跟踪以检测轮廓点。此外，在去除噪声的频谱图像上执行峰追踪而没有混叠以检测峰。

Fig. 1

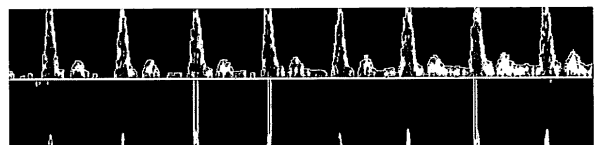


Fig. 2

