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(54) **Ultrasound diagnostic system and method for displaying a doppler spectrum image**

(57) An ultrasound diagnostic system for displaying an enhanced Doppler spectrum image. The ultrasound diagnostic system includes: a period setting unit operable to set a period for computing spectral Doppler components from ultrasound data obtained by transmitting/receiving ultrasound signals to/from a target object; a Doppler spectrum data acquiring unit operable to compute the spectral Doppler components at the set period from the ultrasound data for acquiring Doppler spectrum data; a storage unit operable to store the acquired Doppler spectrum data; a user input unit operable to receive sweep speed information from a user for selecting a sweep speed; a data adjusting unit operable to compare the set period with the selected sweep speed and adjust the Doppler spectrum data based on the comparison result; and a display unit operable to display a Doppler spectrum image based on the adjusted Doppler spectrum data.

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Description

[0001] The present application claims priority from Korean Patent Application No. 10-2007-0026173 filed on March 16, 2007, the entire subject matter of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[Technical Field]

[0002] The present invention generally relates to ultrasound diagnostic systems, and more particularly to an ultrasound diagnostic system and a method for displaying a Doppler spectrum image.

[Background Art]

[0003] The ultrasound diagnostic system has become an important and popular diagnostic tool due to its non-invasive and non-destructive nature. Modem high-performance ultrasound imaging diagnostic systems and techniques are commonly used to produce two- or three-dimensional images of internal features of patients.

[0004] An ultrasound diagnostic system generally uses a probe containing an array of piezoelectric elements to transmit and receive ultrasound signals. The ultrasound diagnostic system forms an image of human internal tissues by electrically exciting transducer elements to generate ultrasound signals that travel into the body. Echoes reflected from tissues and organs return to the transducer element and are converted into electrical signals, which are amplified and processed to produce a diagnostic image.

[0005] In the ultrasound diagnostic system, the Doppler effect is used to measure the velocity of red blood cells flowing within a blood vessel or the velocity of heart motion. FIG. 1 shows an example of displaying a B-mode image and a Doppler spectrum image at the same time. The B-mode image BI is an image that displays the brightness, which indicates the intensities of the ultrasound signals reflected from the target object, on a screen. If a user sets a sample volume SV on a blood vessel in the B-mode image BI by using a user input interface such as a track ball, then the ultrasound diagnostic system repeatedly transmits/receives ultrasound signals to/from a region corresponding to the sample volume. The ultrasound diagnostic system computes spectral Doppler components based on the reception signals and provides a Doppler spectrum image DS or sound corresponding to the frequency or velocity based on the computed spectral Doppler components. The Doppler spectrum image DS may indicate the motion direction and motion velocity of a moving object such as red blood cells or heart. In the Doppler spectrum image DS, a horizontal axis represents the time, while a vertical axis represents the velocity (or frequency).

[0006] FIG. 2 is a schematic diagram showing an example of computing the spectral Doppler components. Referring to FIG. 2, a sample volume is set on the B-mode image. The ultrasound diagnostic system transmits/receives ultrasound signals to/from a region corresponding to the sample volume at a pulse repetition frequency (PRF). The ultrasound diagnostic system acquires ultrasound data based on the received ultrasound echo signals. The ultrasound diagnostic system computes the spectral Doppler components from the ultrasound data at a repetition period (RP) to obtain Doppler spectrum data. The RP is usually determined according to a sweep speed, which is adjustable by a user through an input unit such as a keyboard, a trackball or the like, in the conventional ultrasound diagnostic system. The sweep speed represents the time for scanning the sample volume. The time interval for displaying each Doppler spectrum in the Doppler spectrum image depends on the sweep speed.

[0007] If the user selects the sweep speed, then the ultrasound diagnostic system sets RP corresponding to the selected sweep speed to compute spectral Doppler components and obtains Doppler spectrum data based on the computed spectral Doppler components. The obtained Doppler spectrum data may be stored in a memory such as a buffer. In displaying the Doppler spectrum image based on the stored Doppler spectrum data, the sweep speed may be adjusted to be slower or faster so as to magnify or de-magnify the Doppler spectrum image on a time axis. In such a case, there is a problem in that the resolution of the Doppler spectrum image is limited. Also, since the RP for computing the Doppler components is determined according to the sweep speed, an adjustment of the sweep speed is limited (especially the maximum sweep speed).

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1 is a photo showing an example of simultaneously displaying a B-mode image and a Doppler spectrum image.

[0009] FIG. 2 is a schematic diagram showing a procedure of displaying a Doppler spectrum image according to the prior art.

[0010] FIG. 3 is a block diagram showing an ultrasound diagnostic system constructed in accordance with the present invention.

[0011] FIG. 4 is a schematic diagram showing a procedure of displaying a Doppler spectrum image in accordance with the present invention.

[0012] FIG. 5 is a flowchart showing a method of displaying a Doppler spectrum image in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0013] FIG. 3 is a block diagram showing an ultrasound diagnostic system constructed in accordance with the present invention. Referring to FIG. 3, the ultrasound di-

agnostic system 300 include a repetition period (RP) setting unit 310, a Doppler spectrum data acquiring unit 320, a storage unit 330, a user input unit 340, a data adjusting unit 350 and a display unit 360.

[0014] The RP setting unit 310 may be operable to calculate the fastest computable time necessary for computing spectral Doppler components from ultrasound data, which are obtained by transmitting/receiving ultrasound signals at a pulse repetition frequency (PRF), in the ultrasound diagnostic system. The RP setting unit 310 may add a predetermined margin to the calculated time to thereby set an RP. The RP may depend on the performance of the ultrasound diagnostic system. The predetermined margin, which is determined by considering a delay occurring in the ultrasound diagnostic system, may be set to about 1-10 % of the calculated time for a stable operation of the ultrasound diagnostic system.

[0015] The Doppler spectrum data acquiring unit 320 may be operable to compute the spectral Doppler components from the ultrasound data at the RP to thereby acquire Doppler spectrum data constituted with spectral Doppler components. The acquired Doppler spectrum data may be stored in the storage unit 330 such as a buffer, etc.

[0016] The user input unit 340 may enable a user to select the sweep speed. The sweep speed may affect the time interval at which a spectral Doppler component such as velocity or frequency is computed and displayed on a screen of the display unit 360, wherein the time interval is referred to as a Doppler display interval. The data adjusting unit 350 may be operable to read out the Doppler spectrum data stored in the storage unit 330 and compare the sweep speed with the RP to properly adjust the Doppler spectrum data. For example, if the sweep speed is faster than the RP, then the data adjusting unit 350 may be operable to interpolate the Doppler spectrum data such that the Doppler display interval is identical to the selected sweep speed. On the other hand, if the sweep speed is slower than the RP, then the data adjusting unit 350 may be operable to decimate the Doppler spectrum data such that the Doppler display interval is identical to the sweep speed. The display unit 360 may display the Doppler spectrum image based on the adjusted Doppler spectrum data.

[0017] FIG. 4 is a schematic diagram showing a procedure of displaying a Doppler spectrum image in accordance with the present invention. As illustrated in FIG. 4, the RP setting unit 310 may be operable to calculate the fastest computable time and add the predetermined margin to the calculated time to thereby set the RP. That is, the RP may be determined regardless of the sweep speed in accordance with one embodiment of the present invention.

[0018] Hereinafter, a method of displaying the Doppler spectrum image in accordance with the present invention will be described. FIG. 5 is a flowchart showing a method of displaying a Doppler spectrum image.

[0019] Referring to FIG. 5, the fastest computable time for computing spectral Doppler components from ultrasound data obtained by transmitting/receiving ultrasound signals to/from the target object may be calculated and a predetermined margin is added to the calculated fastest computable time to thereby set a RP at step S510. The ultrasound diagnostic system transmits the ultrasound signals at a pulse repetition frequency (PRF) to a predetermined region in the target object to obtain the ultrasound data. The spectral Doppler components may be computed from the ultrasound data at the set RP to thereby obtain the Doppler spectrum data at step S520. The Doppler spectrum data may be stored in the storage unit 330.

[0020] Thereafter, if the sweep speed information for selecting a sweep speed is inputted from the user, then the sweep speed is compared with the RP to determine the adjustment of the Doppler spectrum data at step S530. If the sweep speed does not coincide with the RP, then the Doppler spectrum data may be adjusted through an interpolation process or a decimation process at step S540. That is, if the sweep speed is faster than the RP, then the interpolation process may be carried out upon the Doppler spectrum data. However, if the sweep speed is slower than the RP, then the decimation process may be carried out upon the Doppler spectrum data. For example, when the Doppler spectrum data are acquired at the RP of 1 KHz and the sweep speed inputted from the user is 100Hz, 200Hz or 500Hz, the Doppler spectrum data may be decimated at a ratio of 10:1, 5:1 or 2:1. On the other hand, when the inputted sweep speed is 2 KHz, the Doppler spectrum data may be interpolated at a ratio of 1:2. The Doppler spectrum image may be displayed based on the adjusted Doppler spectrum data.

[0021] As mentioned above, since the acquisition period of the Doppler spectrum data is fixed to a maximum computable period, the period for displaying the Doppler spectrum image may be easily adjusted without incurring any degradation of the Doppler spectrum image.

[0022] In accordance with one embodiment of the present invention, there is provided an ultrasound diagnostic system configured to display a Doppler spectrum image, comprising: a period setting unit operable to set a repetition period; a Doppler spectrum data acquiring unit operable to compute spectral Doppler components at the set repetition period from the ultrasound data representative of a target object, said computed spectral Doppler components being used to acquire Doppler spectrum data; a storage unit operable to store the acquired Doppler spectrum data; a user input unit operable to enable to a user to select a sweep speed; a data adjusting unit operable to compare the set repetition period with the selected sweep speed to adjust the Doppler spectrum data; and a display unit operable to display a Doppler spectrum image based on the adjusted Doppler spectrum data.

[0023] In accordance with another embodiment of the present invention, there is provided a method of display-

ing a Doppler spectrum image in an ultrasound diagnostic system, comprising: setting a repetition period; computing the spectral Doppler components at the set period from ultrasound data representative of a target object; acquiring Doppler spectrum data based on the computed spectral Doppler components; storing the acquired Doppler spectrum data; enabling a user to select a sweep speed; comparing the set repetition period with the selected sweep speed to adjust the Doppler spectrum data; and displaying a Doppler spectrum image based on the adjusted Doppler spectrum data.

[0024] Any reference in this specification to "one embodiment," "an embodiment," "example embodiment," etc. means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. The appearances of such phrases in various places in the specification are not necessarily all referring to the same embodiment. Further, when a particular feature, structure or characteristic is described in connection with any embodiment, it is submitted that it is within the purview of one skilled in the art to effect such feature, structure or characteristic in connection with other ones of the embodiments.

[0025] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, numerous variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

Claims

1. An ultrasound diagnostic system for displaying a Doppler spectrum image, comprising:

   a period setting unit operable to set a repetition period;
   a Doppler spectrum data acquiring unit operable to compute spectral Doppler components at the set repetition period from the ultrasound data representative of a target object, said computed spectral Doppler components being used to acquire Doppler spectrum data;
   a storage unit operable to store the acquired Doppler spectrum data;
   a user input unit operable to enable a user to select a sweep speed;
   a data adjusting unit operable to compare the set repetition period with the selected sweep speed to adjust the Doppler spectrum data; and
   a display unit operable to display a Doppler spectrum image based on the adjusted Doppler spectrum data.

2. The ultrasound diagnostic system of Claim 1, wherein the set repetition period is set by calculating a fastest computable time for computing the spectral Doppler components in the ultrasound diagnostic system.

3. The ultrasound diagnostic system of Claim 2, wherein the set repetition period is set by adding a predetermined margin to the fastest computable time.

4. The ultrasound diagnostic system of Claim 3, wherein the data adjusting unit interpolates the Doppler spectrum data when the sweep speed is faster than the set repetition period and decimates the Doppler spectrum data when the sweep speed is slower than the set repetition period.

5. A method of displaying a Doppler spectrum image in an ultrasound diagnostic system, comprising:

   setting a repetition period;
   computing the spectral Doppler components at the set period from ultrasound data representative of a target object;
   acquiring Doppler spectrum data based on the computed spectral Doppler components;
   storing the acquired Doppler spectrum data;
   enabling a user to select a sweep speed;
   comparing the set repetition period with the selected sweep speed to adjust the Doppler spectrum data; and
   displaying a Doppler spectrum image based on the adjusted Doppler spectrum data.

6. The method of Claim 5, wherein the set repetition period is set by calculating a fastest computable time for computing the spectral Doppler components in the ultrasound diagnostic system.

7. The ultrasound diagnostic system of Claim 6, wherein the set repetition period is set by adding a predetermined margin to the fastest computable time.

8. The ultrasound diagnostic system of Claim 7, wherein, in the step adjusting the Doppler spectrum data, if the selected sweep speed is faster than the set repletion period, then the Doppler spectrum data are interpolated, and if the selected sweep speed is slower than the set repetition period, then the Doppler spectrum data are decimated.

FIG. 1
(PRIOR ART)

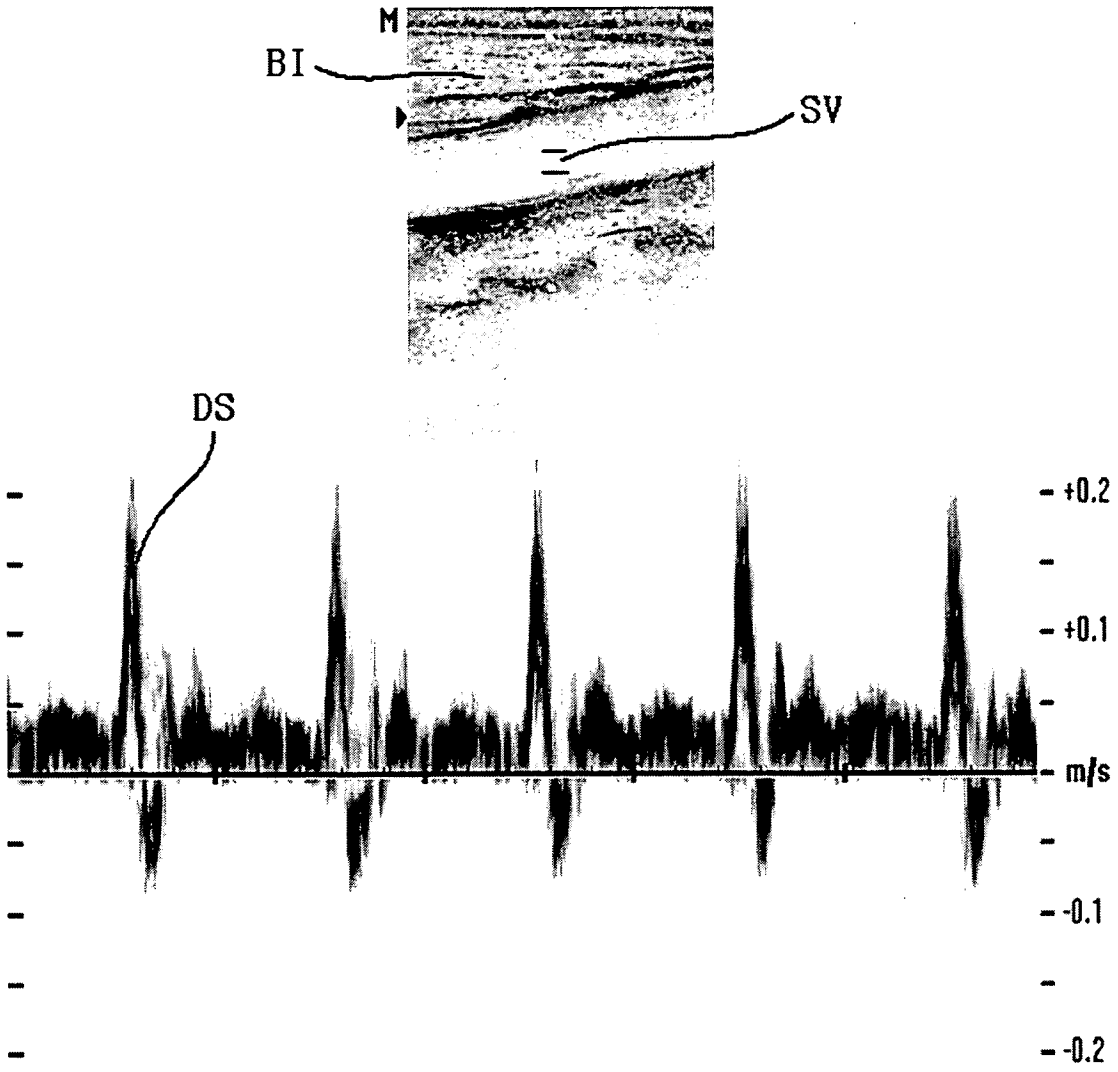


FIG. 2
(PRIOR ART)

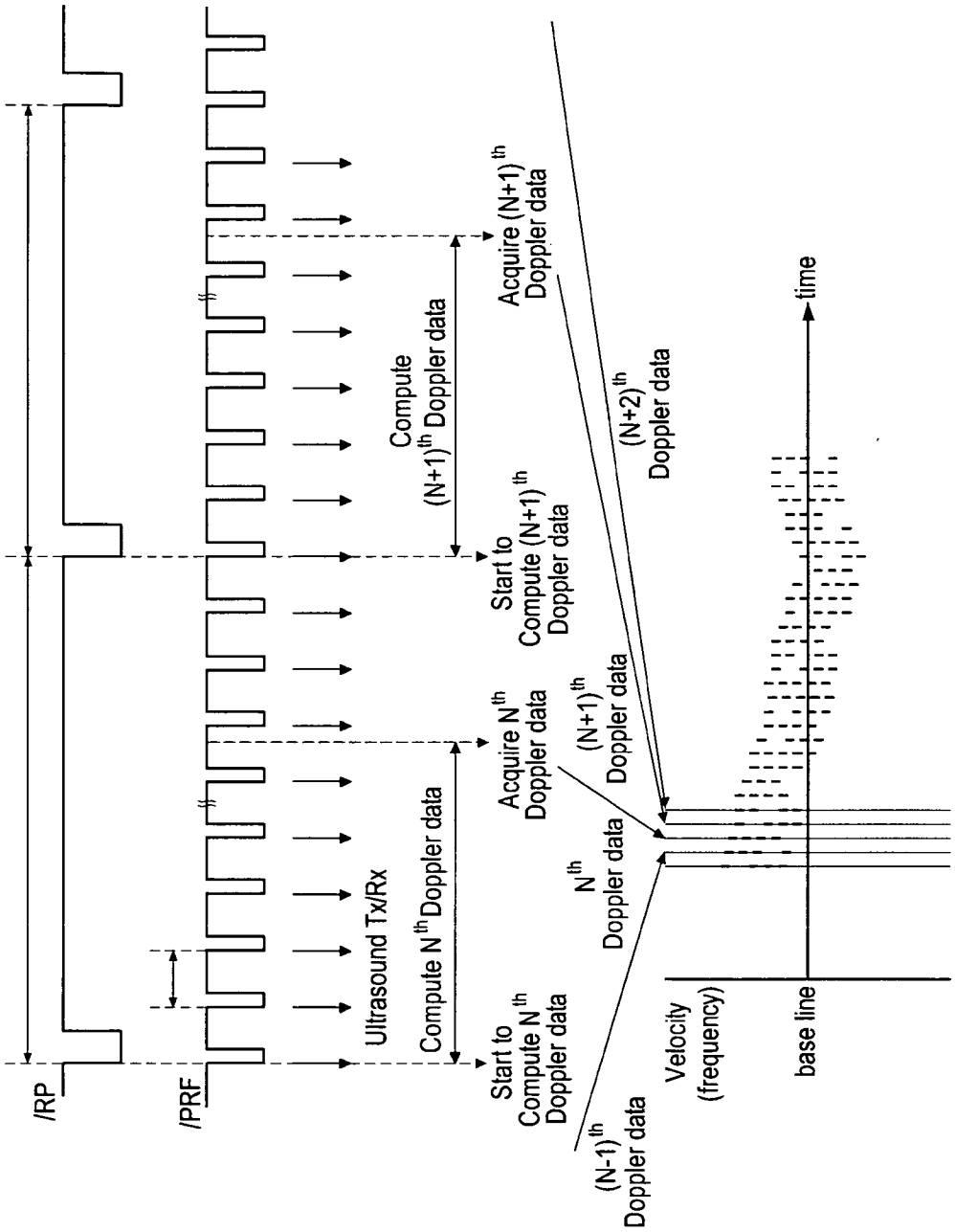


FIG. 3

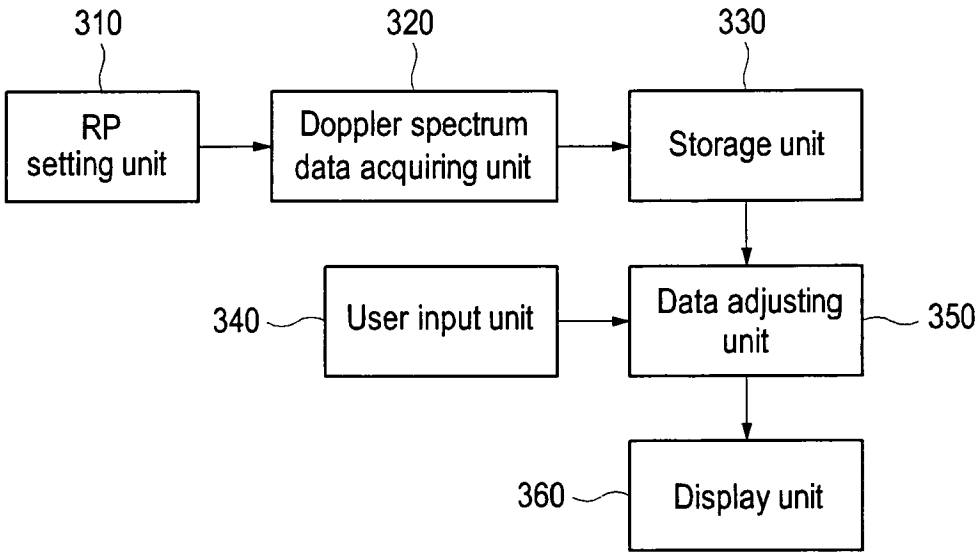

310
320
330
RP setting unit
Doppler spectrum data acquiring unit
Storage unit
340
User input unit
Data adjusting unit
350
360
Display unit

FIG. 4

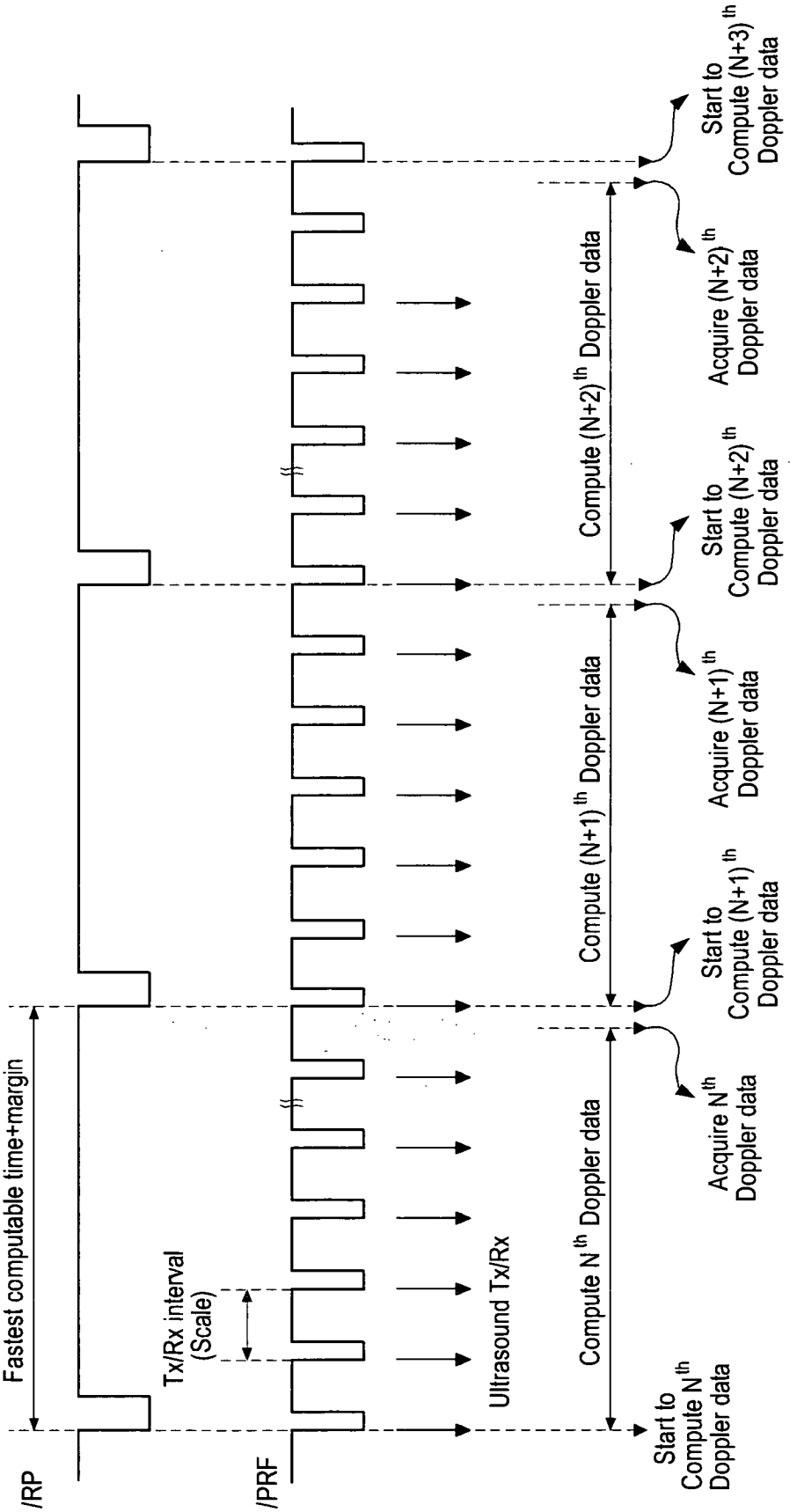
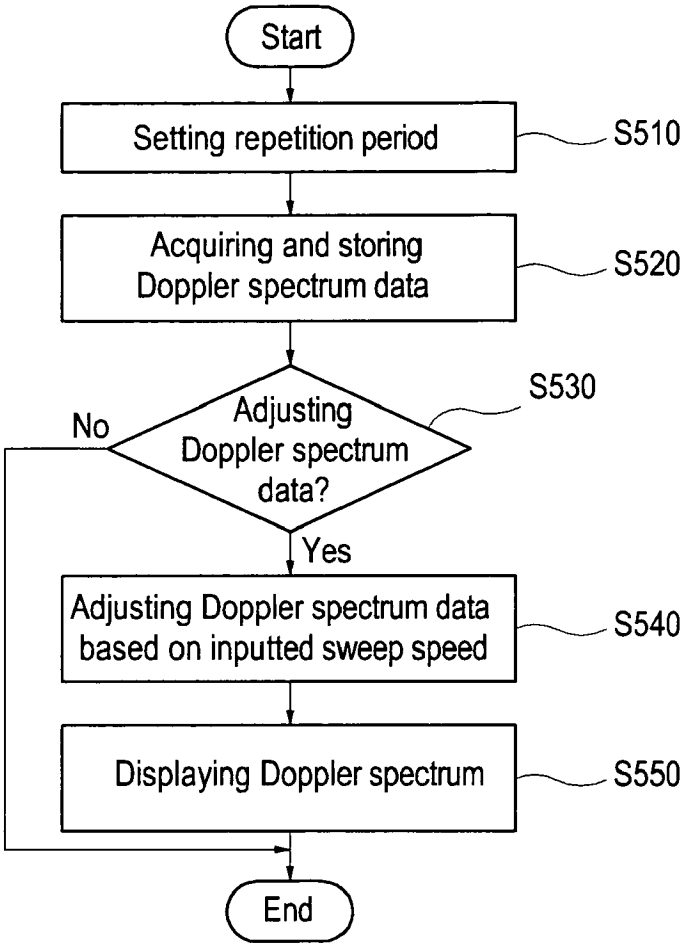

/RP
/PRF
Fastest computable time+margin
Tx/Rx interval (Scale)
Ultrasound Tx/Rx
Compute N th Doppler data
Compute (N+1) th Doppler data
Compute (N+2) th Doppler data
Acquire N th Doppler data
Acquire (N+1) th Doppler data
Acquire (N+2) th Doppler data
Start to Compute N th Doppler data
Start to Compute (N+1) th Doppler data
Start to Compute (N+2) th Doppler data
Start to Compute (N+3) th Doppler data

FIG. 5


Start
Setting repetition period
S510
Acquiring and storing Doppler spectrum data
S520
Adjusting Doppler spectrum data?
S530
No
Yes
Adjusting Doppler spectrum data based on inputted sweep speed
S540
Displaying Doppler spectrum
S550
End

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 08 00 4765

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A	US 2006/084873 A1 (BABA TATSURO [JP] ET AL) 20 April 2006 (2006-04-20) * paragraphs [0003], [0017] - [0020], [0041], [0042], [0051] - [0053], [0076] - [0078]; figure 3 *	1-8	
A	EP 1 016 880 A (GEN ELECTRIC [US]) 5 July 2000 (2000-07-05) * paragraphs [0001] - [0010], [0035] *	1-8	
			TECHNICAL FIELDS SEARCHED (IPC)
			A61B G01S

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	15 July 2008	Pohjamo, Terhi

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 08 00 4765

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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15-07-2008

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EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- KR 1020070026173 **[0001]**

专利名称(译)	超声诊断系统和显示多普勒频谱图像的方法		
公开(公告)号	EP1970011A1	公开(公告)日	2008-09-17
申请号	EP2008004765	申请日	2008-03-14
申请(专利权)人(译)	MEDISON CO.，LTD.		
当前申请(专利权)人(译)	MEDISON CO.，LTD.		
[标]发明人	KIM JONG SIK KIM CHAN MO		
发明人	KIM, JONG SIK KIM, CHAN MO		
IPC分类号	A61B8/06		
CPC分类号	A61B8/06 A61B8/13 G01S7/52066 G01S7/52085 G01S15/8979		
代理机构(译)	SCHMID，WOLFGANG		
优先权	1020070026173 2007-03-16 KR		
其他公开文献	EP1970011B1		
外部链接	Espacenet		

摘要(译)

一种用于显示增强的多普勒频谱图像的超声诊断系统。超声诊断系统包括：周期设定单元，可操作以根据通过向/从目标对象发送/接收超声信号而获得的超声数据来设置用于计算频谱多普勒分量的周期;多普勒频谱数据获取单元，用于根据超声数据计算设定周期内的频谱多普勒分量，以获取多普勒频谱数据;存储单元，用于存储所获取的多普勒频谱数据;用户输入单元，用于接收来自用户的扫描速度信息，以选择扫描速度;数据调整单元，用于将设定周期与所选择的扫描速度进行比较，并根据比较结果调整多普勒频谱数据;显示单元，用于根据调整后的多普勒频谱数据显示多普勒频谱图像。