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(54) **ULTRASOUND IMAGE DISPLAYING METHOD AND ULTRASOUND DIAGNOSTIC APPARATUS**

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(57) **ABSTRACT**

An ultrasound image displaying method includes creating a 3D image based on B mode data with a high luminance and a low luminance in a B mode image being inverted, creating a color overlaid 3D image by applying colors based on color Doppler mode data only for pixels of the 3D image having a luminance not more than a predetermined value in the B mode image, and displaying the color overlaid 3D image.

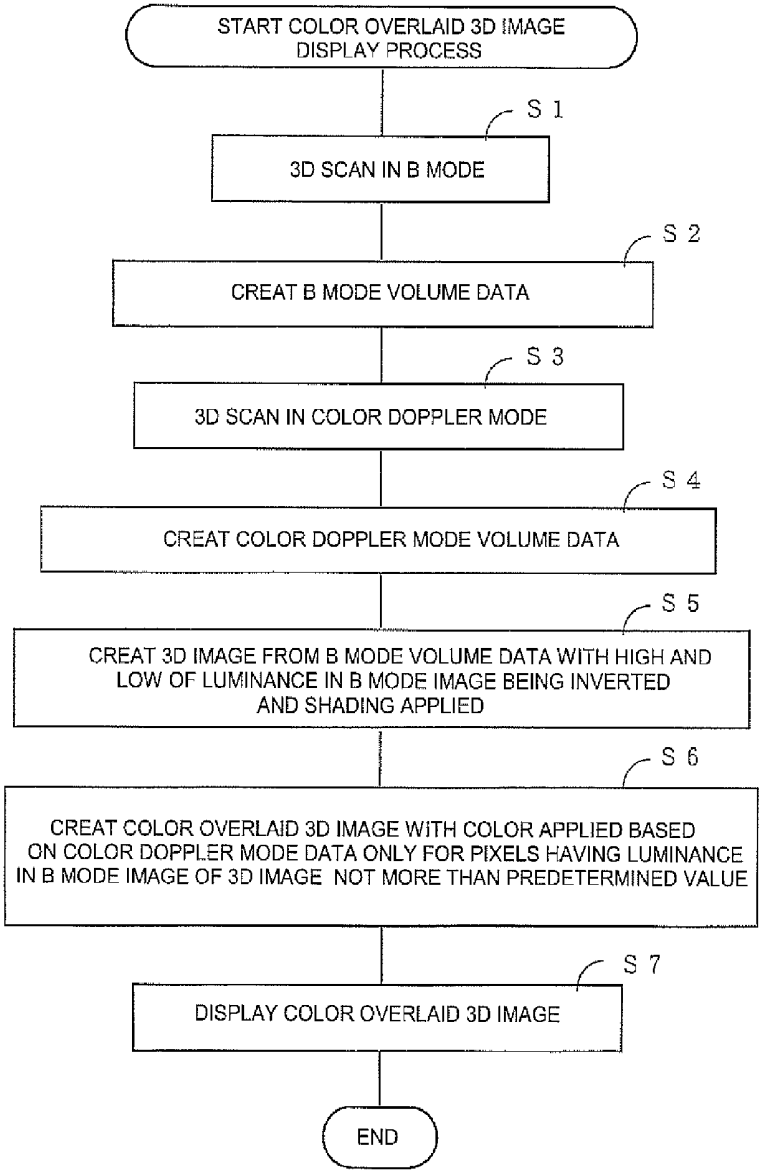


FIG. 1

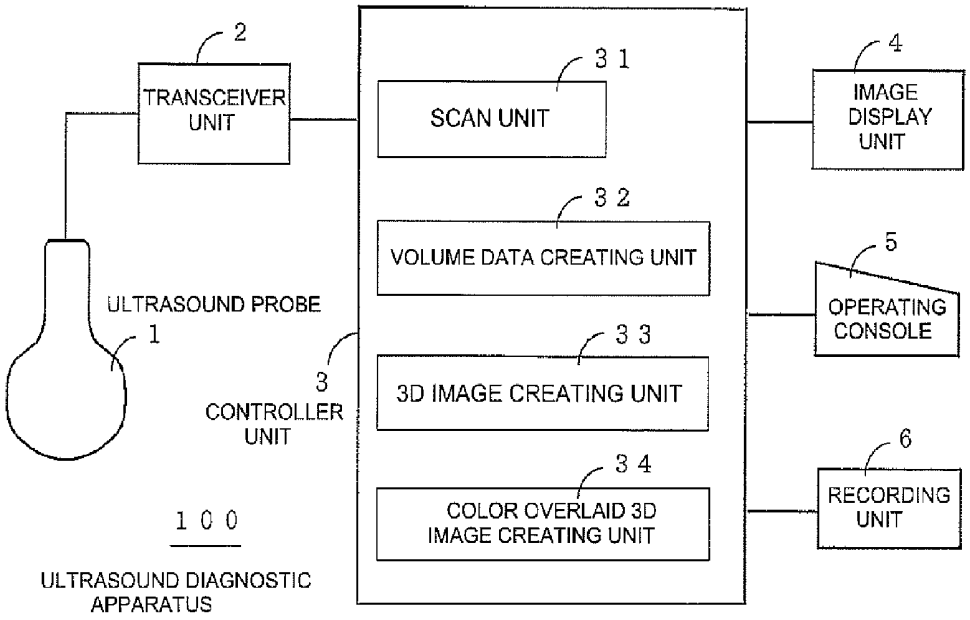

2
TRANSCEIVER UNIT
31
SCAN UNIT
4
IMAGE DISPLAY UNIT
32
VOLUME DATA CREATING UNIT
5
OPERATING CONSOLE
ULTRASOUND PROBE
1
33
3
CONTROLLER UNIT
3D IMAGE CREATING UNIT
6
34
COLOR OVERLAID 3D IMAGE CREATING UNIT
RECORDING UNIT
100
ULTRASOUND DIAGNOSTIC APPARATUS

FIG. 2

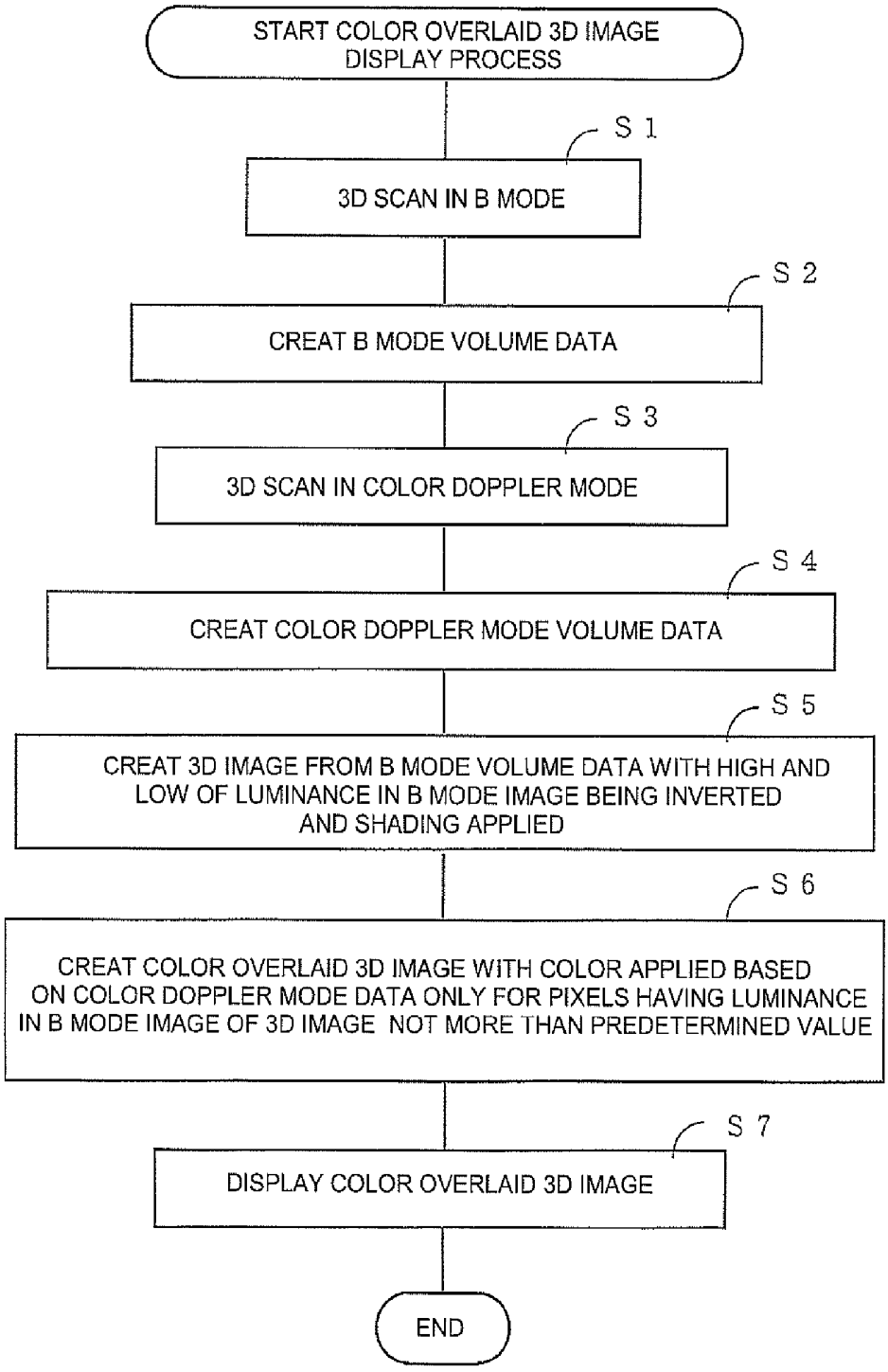

START COLOR OVERLAID 3D IMAGE DISPLAY PROCESS
S 1
3D SCAN IN B MODE
S 2
CREAT B MODE VOLUME DATA
S 3
3D SCAN IN COLOR DOPPLER MODE
S 4
CREAT COLOR DOPPLER MODE VOLUME DATA
S 5
CREAT 3D IMAGE FROM B MODE VOLUME DATA WITH HIGH AND LOW OF LUMINANCE IN B MODE IMAGE BEING INVERTED AND SHADING APPLIED
S 6
CREAT COLOR OVERLAID 3D IMAGE WITH COLOR APPLIED BASED ON COLOR DOPPLER MODE DATA ONLY FOR PIXELS HAVING LUMINANCE IN B MODE IMAGE OF 3D IMAGE NOT MORE THAN PREDETERMINED VALUE
S 7
DISPLAY COLOR OVERLAID 3D IMAGE
END

FIG. 3

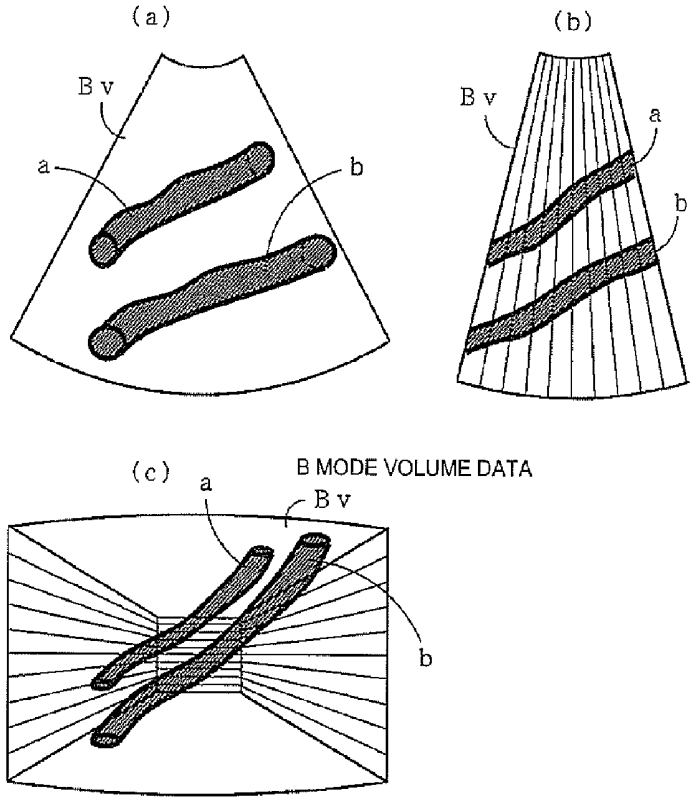

(a)
Bv
a
b
(b)
Bv
a
b
(c)
B MODE VOLUME DATA
a
Bv
b

FIG. 4

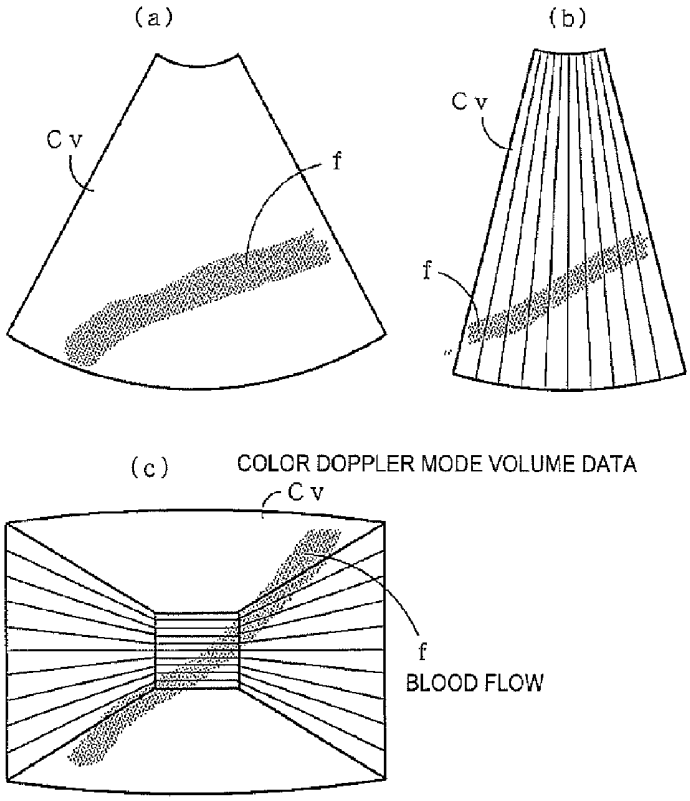
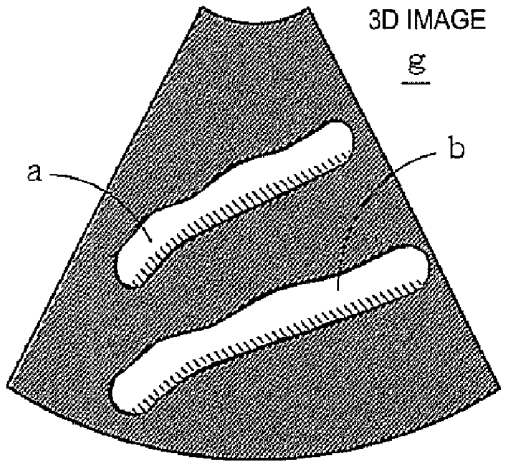
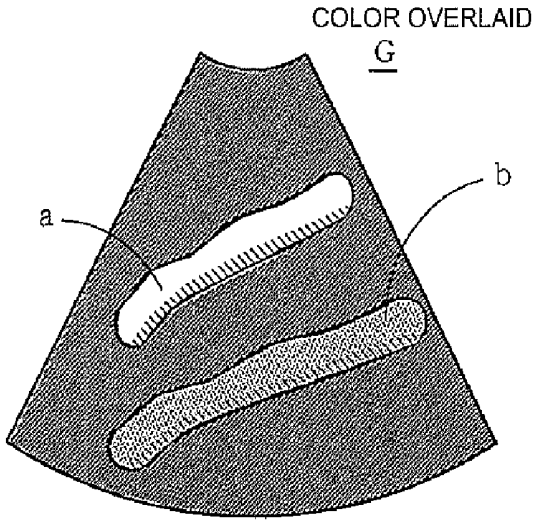

(a)
Cv
f
(b)
Cv
f
(c)
COLOR DOPPLER MODE VOLUME DATA
Cv
f
BLOOD FLOW

FIG. 5





ULTRASOUND IMAGE DISPLAYING METHOD AND ULTRASOUND DIAGNOSTIC APPARATUS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Japanese Patent Application No. 2007-043100 filed Feb. 23, 2007.

BACKGROUND OF THE INVENTION

[0002] The field of the present invention relates to an ultrasound image displaying method and an ultrasound diagnostic apparatus and, more specifically, to an ultrasound image displaying method and an ultrasound diagnostic apparatus that enable viewing a 3D structure of a vessel and obtaining 3D images by applying color of a color Doppler image.

[0003] Conventionally in the art there is known an ultrasound diagnostic apparatus which is capable of creating and displaying a synthetic image by applying a power Doppler image onto an inverted B mode image with the black and white of the B mode image being inverted (for example, WO97/34530 A1).

[0004] In the conventional ultrasound diagnostic apparatus disclosed, a 2D image may be obtained in which the blood vessel may be viewed in white on a black background, and the color of power Doppler image is applied.

[0005] However, because the image is in 2D, it may be difficult to distinguish a 3D structure such as a blood vessel.

SUMMARY OF THE INVENTION

[0006] In a first aspect, the invention provides an ultrasound image displaying method that includes creating a 3D image based on B mode data with a high luminance and a low luminance in a B mode image being inverted, creating a color overlaid 3D image by applying colors based on color Doppler mode data only for pixels of the 3D image having a luminance not more than a predetermined value in the B mode image, and displaying the color overlaid 3D image.

[0007] In accordance with the ultrasound image displaying method of the first aspect described above, a 3D image with the luminance of the B mode image inverted is created so that the 3D structure such as blood vessels and lumens appear in white on the black background so as to facilitate distinguishing the 3D structure. Any color based on the color Doppler mode data is applied only for pixels having a luminance in the B mode image not more than a predetermined value so that the color will not be smudged out of the 3D structure to allow sightly coloring the structure. In addition, the color is applied only to the region of blood flow, so that the blood vessel (with blood flow) will be readily distinguished from a lumen (without blood flow).

[0008] In a second aspect, the invention provides an ultrasound image displaying method of the first aspect described above, in which the luminance of each pixel of the color overlaid 3D image is based on the B mode data, and the color thereof is based on the color Doppler mode data.

[0009] The ultrasound image displaying method in accordance with the second aspect described above, any information included in the B mode data and the information included in the color Doppler mode data may be exploitable.

[0010] In a third aspect, the invention provides an ultrasound image displaying method of the first or the second aspect described above, further comprising the step of shading the 3D image.

[0011] The ultrasound image displaying method in accordance with the third aspect described above, a stereoscopic 3D image may be obtained.

[0012] In a fourth aspect, the invention provides an ultrasound image displaying method in accordance with the first or the second aspect described above, further comprising the step of shading the color overlaid 3D image.

[0013] The ultrasound image displaying method in accordance with the fourth aspect described above, stereoscopic appearance will be obtained when displaying the color overlaid 3D image.

[0014] In a fifth aspect, the invention provides an ultrasound image displaying method in which a 3D image is created based on B mode data with a high luminance and a low luminance in the B mode image being inverted. A color overlaid 3D image is then created by applying color based on power Doppler mode data only for pixels in the 3D image having a luminance in the B mode image not more than a predetermined value. The color overlaid 3D image is then displayed.

[0015] In the ultrasound image displaying method in accordance with the fifth aspect described above, a 3D image is created with the high and low of the luminance in the B mode image being inverted, so that the 3D structure such as vessels and lumens appear in white on a black background to facilitate distinguishing the 3D structure. Any color is applied based on the power Doppler mode data only for pixels having a luminance in the B mode image not more than a predetermined value so that the color will not be smudged out of the 3D structure to allow sightly coloring the structure. In addition, the color is applied only to the region of blood flow, so that the blood vessel (with blood flow) may be readily distinguished from a lumen (without blood flow).

[0016] In a sixth aspect, the invention provides an ultrasound image displaying method in accordance with the fifth aspect described above, in which the luminance of each pixel of the color overlaid 3D image is based on the B mode data, and the color thereof is based on the power Doppler mode data.

[0017] The ultrasound image displaying method in accordance with the sixth aspect described above, any information included in the B mode data and the information included in the power Doppler mode data may be exploitable.

[0018] In a seventh aspect, the invention provides an ultrasound image displaying method in accordance with the fifth or the sixth aspect, further comprising the step of shading the 3D image.

[0019] In accordance with the ultrasound image displaying method of the seventh aspect described above, a stereoscopic 3D image may be obtained.

[0020] In an eighth aspect, the invention provides an ultrasound image displaying method in accordance with the fifth or the sixth aspect described above, further comprising the step of shading the color overlaid 3D image.

[0021] In accordance with the ultrasound image displaying method of the eighth aspect described above, a stereoscopic appearance will be obtained when displaying the color overlaid 3D image.

[0022] In a ninth aspect, the invention provides an ultrasound diagnostic apparatus comprising: that includes a 3D

image creating device for creating a 3D image based on B mode data with a high luminance and a low luminance in a B mode image being inverted; a inverted. The apparatus also includes a color overlaid 3D image creating device for creating a color overlaid 3D image by applying color based on color Doppler mode data only for pixels in the 3D image having a luminance not more than a predetermined value in the B mode image; image, and an image display device for displaying the color overlaid 3D image.

[0023] In accordance with the ultrasound diagnostic apparatus of the ninth aspect described above, a 3D image is created with the high luminance and the low luminance in B mode image being inverted, so that the 3D structure such as blood vessels and lumens will be appeared appear in white on a black background so as to facilitate distinguishing the 3D structure. Also, any color based on the color Doppler mode data is applied only for pixels having a luminance in the B mode image not more than a predetermined value so that the color will not be smudged out of the 3D structure and to allow sightly coloring the structure. In addition, the color is applied only to the region of blood flow, so that the blood vessel (with blood flow) may be readily distinguished from a lumen (without blood flow).

[0024] In a tenth aspect, the invention provides an ultrasound diagnostic apparatus in accordance with the ninth aspect described above, in which the luminance of each pixels in the color overlaid 3D image is based on the B mode data, and the color thereof is based on the color Doppler mode data.

[0025] The ultrasound diagnostic apparatus in accordance with the tenth aspect described above, any information included in the B mode data and the information included in the color Doppler mode data may be exploitable.

[0026] In an eleventh aspect, the invention provides an ultrasound diagnostic apparatus in accordance with the ninth or the tenth aspect, in which the 3D image creating device applies shading to the 3D image.

[0027] A stereoscopic 3D image may be obtained by using the ultrasound diagnostic apparatus described above in accordance with the eleventh aspect.

[0028] In a twelfth aspect, the invention provides an ultrasound diagnostic apparatus in accordance with the ninth and the tenth aspect, in which the 3D image creating device applies shading to the color overlaid 3D image.

[0029] The ultrasound diagnostic apparatus in accordance with the twelfth aspect described above a stereoscopic 3D appearance will be obtained when displaying a color overlaid 3D image.

[0030] In a thirteenth aspect, the invention provides an ultrasound diagnostic apparatus that includes a 3D image creating device for creating a 3D image with a high luminance and a low luminance in a B mode image being inverted based on B mode data. The apparatus also includes a color overlaid 3D image creating device for creating a color overlaid 3D image by applying color based on power Doppler mode data only for pixels in the 3D image with a luminance in the B mode image not more than a predetermined value, and an image display device for displaying the color overlaid 3D image.

[0031] In the ultrasound diagnostic apparatus described above in accordance with the thirteenth aspect, a 3D image is created with a high luminance and a low luminance in a B mode image being inverted, so that the 3D structure such as vessels and lumens appear in white on a black background to facilitate distinguishing the 3D structure. Also, any color based on the power Doppler mode data is applied only for pixels having a luminance in the B mode image not more than a predetermined value so that the color will not be smudged out of the 3D structure and to allow coloring the structure. In addition, the color is applied only to the region of blood flow, so that the blood vessel (with blood flow) may be readily distinguished from a lumen (without blood flow).

[0032] In a fourteenth aspect, the invention provides an ultrasound diagnostic apparatus in accordance with the thirteenth aspect, in which the luminance of each pixels of the color overlaid 3D image is based on the B mode data, and the color thereof is based on the power Doppler mode data.

[0033] The ultrasound diagnostic apparatus in accordance with the fourteenth aspect described above, any information included in the B mode data and the information included in the power Doppler mode data may be exploitable.

[0034] In a fifteenth aspect, the invention provides an ultrasound diagnostic apparatus in accordance with the thirteenth or the fourteenth aspect, in which the 3D image creating device applies shading to the 3D image.

[0035] A stereoscopic 3D image may be obtained using the ultrasound diagnostic apparatus described above in accordance with the fifteenth aspect.

[0036] In a sixteenth aspect, the invention provides an ultrasound diagnostic apparatus in accordance with the thirteenth or the fourteenth aspect, in which the color overlaid 3D image creating device applies shading to the color overlaid 3D image.

[0037] The ultrasound diagnostic apparatus in accordance with the sixteenth aspect described above, a stereoscopic 3D appearance will be obtained when displaying a color overlaid 3D image.

[0038] In accordance with the ultrasound image displaying method and the ultrasound diagnostic apparatus of the invention, the three dimensional structure of a blood vessel or a lumen may be visualized. The color will not be smudged out of the three dimensional structure, while sightly well colorized. In addition, the color is applied only to the region of blood flow, so as to facilitate distinguishing the blood vessel (with blood flow) from a lumen (without blood flow).

[0039] The ultrasound image displaying method and the ultrasound diagnostic apparatus in accordance with the invention may be used for the diagnosis of a blood vessel and a lumen.

[0040] Further objects and advantages of the present invention will be apparent from the following description of the preferred embodiments of the invention as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] FIG. **1** is a schematic block diagram illustrating a ultrasound diagnostic apparatus in accordance with the first embodiment of the invention;

[0042] FIG. **2** is a flow chart illustrating the color overlaid 3D image display process in accordance with the first embodiment of the invention;

[0043] FIG. **3** is a front view, side view, and top view conceptually illustrating the B mode volume data;

[0044] FIG. **4** is a front view, side view, and top view conceptually illustrating the color Doppler mode volume data;

[0045] FIG. **5** is an example illustrating a 3D image; and

[0046] FIG. **6** is an example illustrating a color overlaid 3D image.

DETAILED DESCRIPTION OF THE INVENTION

[0047] The invention will be described in greater details herein below with reference to some embodiments shown in the accompanying drawings. It should be noted here that the disclosed embodiments may not be considered to limit the invention.

[0048] FIG. **1** shows a schematic block diagram of an ultrasound diagnostic apparatus **100** in accordance with the first embodiment.

[0049] The ultrasound diagnostic apparatus **100** includes an ultrasound probe **1** capable of 2D scan by electronic scan as well as of 3D scan by electric scan (scan by means of a motor) or electronic scan; a transceiver unit **2** for driving the ultrasound probe **1** to perform 2D scan and 3D scan within the body of an examinee by means of ultrasound beam; a controller unit **3**; an image display unit **4** for displaying an ultrasound image; an operating console **5** for inputting an instruction or data by an operator; and a recording unit **6** for recording the ultrasound images.

[0050] The controller unit **3** includes a scan unit **31** for controlling the 2D scan and 3D scan; a volume data creating unit **32** for creating volume data; a 3D image creating unit **33** for projecting the volume data in a predetermined projection direction to create a 3D image with the high and low of luminance in the B mode image being inverted; and a color overlaid 3D image creating unit **34** for creating a color overlaid 3D image by applying color based on the color Doppler mode data only for the pixels in a 3D image having the luminance of B mode image not more than a predetermined value.

[0051] FIG. **2** shows a flow chart illustrating the color overlaid 3D image display process in accordance with the first embodiment.

[0052] In step S**1**, 3D scan is completed in B mode.

[0053] In step S**2**, B mode volume data By as shown in FIG. **3** is created. In the B mode volume data By the luminance, in the B mode image, of the pixels of the blood vessel or lumen regions a and b will be not more than a predetermined value.

[0054] In step S**3**, 3D scan is completed in color Doppler mode.

[0055] In step S**4**, color Doppler mode volume data Cv as shown in FIG. **4** is created. In the color Doppler mode volume data Cv the region having blood flow f is applied with a color.

[0056] In step S**5** a 3D image g is created from the B mode volume data By, as shown in FIG. **5**, with the high and low of luminance of the B mode image being inverted and shading applied.

[0057] In step S**6**, by means of MIP process or rendering process, a color overlaid 3D image G will be created with the color based on the color Doppler mode volume data Cv being applied only for the pixels in the region a and b (i.e., pixels having luminance not more than a predetermined value in B mode image) of the 3D image g, as shown in FIG. **6**. For example, the luminance of each pixel in the color overlaid 3D image G may be defined according to the B mode volume data By, while the color thereof may be defined according to the color Doppler mode volume data Cv.

[0058] In the example shown in FIG. **6**, the region a is not colorized since there is no color information in the color Doppler mode volume data Cv. The region b, on the other hand, is colorized since there is color information in the color Doppler mode volume data Cv.

[0059] In step S**7**, the color overlaid 3D image G is displayed.

[0060] In accordance with the ultrasound diagnostic apparatus **100** in the first embodiment, one or more of the following effects may be obtained. Regions a and b of the blood vessel and the lumen appear in white on a black background to facilitate visually distinguishing the three dimensional structure. Moreover, the color may not be smudged out of the regions a and b of blood vessel and lumen, so that the image will be colorized. Further, the color will be applied only to the region with blood flow so as to allow identifying that the region a is a lumen without blood flow and that the region b is a blood vessel with blood flow.

[0061] In an alternative embodiment, although the shading is applied at the step of 3D image g in the preceding first embodiment, the shading may also be applied at the step of color overlaid 3D image G, or may not be applied at all.

[0062] In another alternative embodiment, although the color Doppler mode is cited in the first embodiment, power Doppler mode may also be applied with the invention.

[0063] Many widely different embodiments of the invention may be configured without departing from the spirit and the scope of the present invention. It should be understood that the present invention is not limited to the specific embodiments described in the specification, except as defined in the appended claims.

1. An ultrasound image displaying method, comprising:
creating a 3D image based on B mode data with a high luminance and a low luminance in a B mode image being inverted;
creating a color overlaid 3D image by applying colors based on color Doppler mode data only for pixels of said 3D image having a luminance not more than a predetermined value in said B mode image; and
displaying said color overlaid 3D image.

2. An ultrasound image displaying method according to claim **1**, wherein:
a luminance of each pixel of said color overlaid 3D image is based on said B mode data, and a color of each pixel of said color overlaid 3D image is based on said color Doppler mode data.

3. An ultrasound image displaying method according to claim **1**, further comprising:
shading said 3D image.

4. An ultrasound image displaying method according to claim **1**, further comprising:
shading said color overlaid 3D image.

5. An ultrasound image displaying method, comprising:
creating a 3D image based on B mode data with a high luminance and a low luminance in the B mode image being inverted;
creating a color overlaid 3D image by applying color based on power Doppler mode data only for the pixels in said 3D image having a luminance in said B mode image not more than a predetermined value; and
displaying said color overlaid 3D image.

6. An ultrasound image displaying method according to claim **5**, wherein:
a luminance of each pixel of said color overlaid 3D image is based on said B mode data, and a color of each pixel of said color overlaid 3D image is based on said power Doppler mode data.

7. An ultrasound image displaying method according to claim 5, further comprising:
shading said 3D image.
8. An ultrasound image displaying method according to claim 5, further comprising:
shading said color overlaid 3D image.
9. An ultrasound diagnostic apparatus, comprising:
a 3D image creating device for creating a 3D image based on B mode data with a high luminance and a low luminance in a B mode image being inverted;
a color overlaid 3D image creating device for creating a color overlaid 3D image by applying color based on color Doppler mode data only for pixels in said 3D image having a luminance not more than a predetermined value in said B mode image; and
an image display device for displaying said color overlaid 3D image.
10. An ultrasound diagnostic apparatus according to claim 9, wherein:
a luminance of each pixel in said color overlaid 3D image is based on said B mode data, and a color of each pixel in said color overlaid 3D image is based on said color Doppler mode data.
11. An ultrasound diagnostic apparatus according to claim 9, wherein:
said 3D image creating device applies shading to said 3D image.
12. An ultrasound diagnostic apparatus according to claim 10, wherein:
said 3D image creating device applies shading to said 3D image.
13. An ultrasound diagnostic apparatus according to claim 9, wherein:
said 3D image creating device applies shading to said color overlaid 3D image.
14. An ultrasound diagnostic apparatus according to claim 10, wherein:
said 3D image creating device applies shading to said color overlaid 3D image.
15. An ultrasound diagnostic apparatus, comprising:
a 3D image creating device for creating a 3D image with a high luminance and a low luminance in a B mode image being inverted based on B mode data;
a color overlaid 3D image creating device for creating a color overlaid 3D image by applying color based on power Doppler mode data only for pixels in said 3D image with a luminance in said B mode image not more than a predetermined value; and
an image display device for displaying said color overlaid 3D image.
16. An ultrasound diagnostic apparatus according to claim 15, wherein:
a luminance of each pixel of said color overlaid 3D image is based on said B mode data, and a color of each pixel of said color overlaid 3D image is based on said power Doppler mode data.
17. An ultrasound diagnostic apparatus according to claim 15, wherein:
said 3D image creating device applies shading to said 3D image.
18. An ultrasound diagnostic apparatus according to claim 16, wherein:
said 3D image creating device applies shading to said 3D image.
19. An ultrasound diagnostic apparatus according to claim 15, wherein:
said color overlaid 3D image creating device applies shading to said color overlaid 3D image.
20. An ultrasound diagnostic apparatus according to claim 16, wherein:
said color overlaid 3D image creating device applies shading to said color overlaid 3D image.

* * * * *

专利名称(译)	超声图像显示方法和超声诊断设备		
公开(公告)号	US20080208053A1	公开(公告)日	2008-08-28
申请号	US12/034485	申请日	2008-02-20
[标]申请(专利权)人(译)	桥本HIROSHI		
申请(专利权)人(译)	桥本HIROSHI		
当前申请(专利权)人(译)	桥本HIROSHI		
[标]发明人	HASHIMOTO HIROSHI		
发明人	HASHIMOTO, HIROSHI		
IPC分类号	A61B8/14		
CPC分类号	A61B8/06 A61B8/13 G01S15/8993 G01S15/8979 G01S7/52071		
优先权	2007043100 2007-02-23 JP		
外部链接	Espacenet USPTO		

摘要(译)

超声图像显示方法包括：在B模式图像被反转的情况下基于B模式数据创建具有高亮度和低亮度的3D图像，通过仅基于彩色多普勒模式数据应用颜色来创建颜色重叠3D图像。在B模式图像中具有不大于预定值的亮度的3D图像，并显示覆盖3D图像的颜色。