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(54) SURFACE RENDERING FOR VOLUME DATA IN AN ULTRASOUND SYSTEM

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(57) **ABSTRACT**

Embodiments for performing surface rendering upon volume data in an ultrasound system are disclosed. An ultrasound data acquisition unit transmits and receives ultrasound signals to and from a target object to thereby acquire ultrasound data corresponding to a plurality of frames. A volume data forming unit forms volumes data corresponding to the plurality of frames based on the ultrasound data. The volume data includes a plurality of voxels. A processing unit detects edges of a region of interest (ROI) of the target object in the volume data and performs surface rendering upon voxels within the detected edges to thereby form a 3-dimensional ultrasound image.

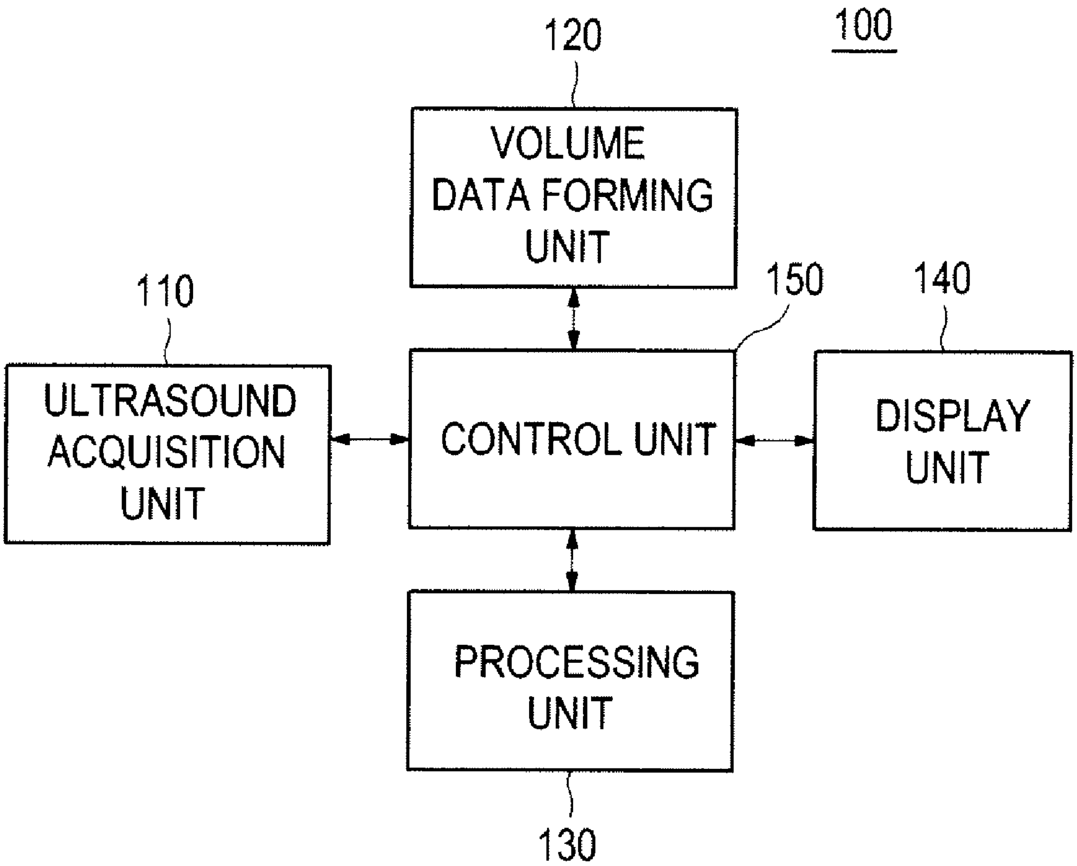


FIG. 1

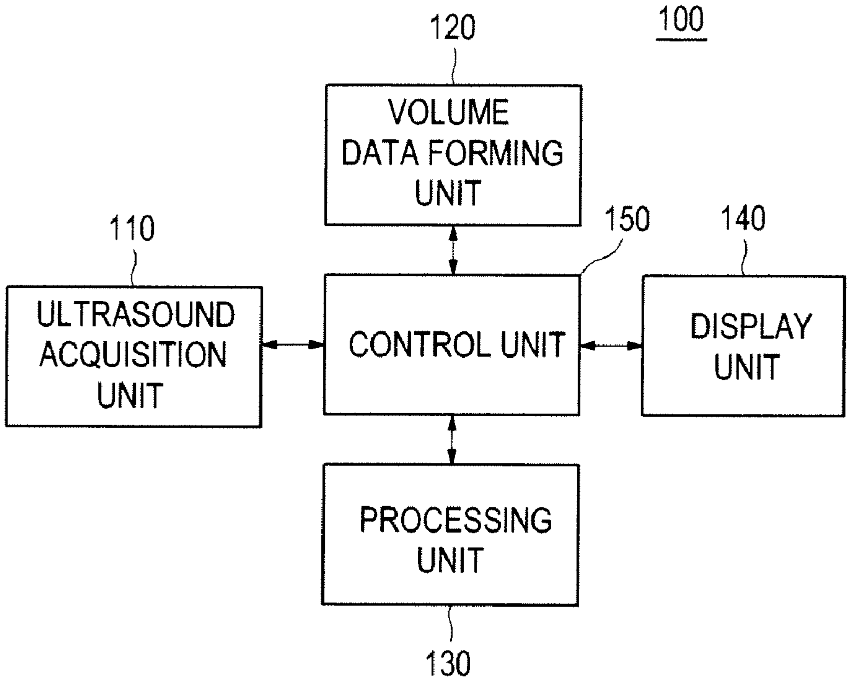

100
120
VOLUME DATA FORMING UNIT
110
ULTRASOUND ACQUISITION UNIT
150
CONTROL UNIT
140
DISPLAY UNIT
PROCESSING UNIT
130

FIG. 2

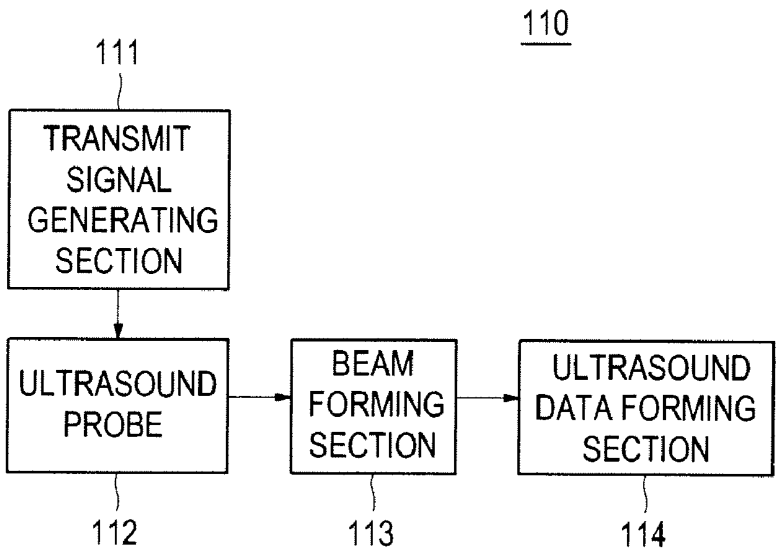
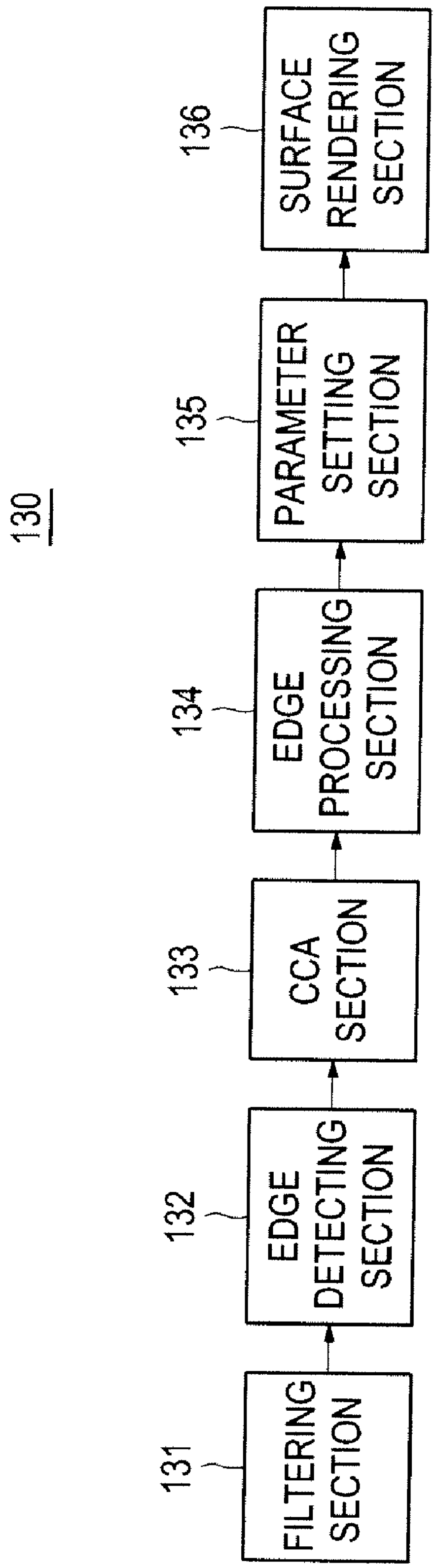

110
111
TRANSMIT SIGNAL GENERATING SECTION
ULTRASOUND PROBE
BEAM FORMING SECTION
ULTRASOUND DATA FORMING SECTION
112
113
114

FIG. 3


130
131
FILTERING SECTION
132
EDGE DETECTING SECTION
133
CCA SECTION
134
EDGE PROCESSING SECTION
135
PARAMETER SETTING SECTION
136
SURFACE RENDERING SECTION

SURFACE RENDERING FOR VOLUME DATA IN AN ULTRASOUND SYSTEM

[0001] The present application claims priority from Korean Patent Application No. 10-2009-0024682 filed on Mar. 24, 2009, the entire subject matter of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure generally relates to ultrasound systems, and more particularly to an ultrasound system and method of performing surface rendering upon volume data.

BACKGROUND

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

[0004] The ultrasound system may transmit ultrasound signals to a target object and receive echo signals reflected from the target object. The ultrasound system may form volume data based on the received echo signals, and then perform rendering upon the volume data to thereby form a 3-dimensional ultrasound image. The 3-dimensional ultrasound image may be indicative of clinical information such as spatial information, anatomical information, etc. of the target object, which may not be visualized in a 2-dimensional ultrasound image.

[0005] Generally, rendering a 3-dimensional image may be carried out by using volume data obtained from a target object. Such rendering technique is referred to as volume rendering and may be implemented by synthesizing reflection coefficients of data at all sampling points on a ray casted into the volume data in addition to data corresponding to the surface of a region of interest in the target object.

SUMMARY

[0006] Embodiments for performing surface rendering upon volume data are disclosed herein. In one embodiment, by way of non-limiting example, an ultrasound system comprises: an ultrasound data acquisition unit configured to transmit and receive ultrasound signals to and from a target object to thereby acquire ultrasound data corresponding to a plurality of frames; a volume data forming unit configured to form volume data corresponding to the plurality of frames based on the ultrasound data, the volume data including a plurality of voxels; and a processing unit configured to detect edges of a region of interest (ROI) of the target object from the volume data and perform surface rendering upon voxels within the detected edges to thereby form a 3-dimensional ultrasound image.

[0007] In another embodiment, a method of performing surface rendering upon volume data in an ultrasound system including an ultrasound data acquisition unit, a volume data forming unit and a processing unit, comprises: a) at the ultrasound data acquisition unit, transmitting and receiving ultrasound signals to and from a target object to thereby acquire ultrasound data corresponding to a plurality of frames; b) at the volume data forming unit, forming volume data corresponding to the plurality of frames based on the ultrasound data, the volume data including a plurality of voxels; and c) at the processing unit, detecting edges of a region of interest (ROI) of the target object from the volume data; and d) at the processing unit, performing surface rendering upon voxels within the detected edges to thereby form a 3-dimensional ultrasound image.

[0008] The Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used in determining the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a block diagram showing an illustrative embodiment of an ultrasound system.

[0010] FIG. **2** is a block diagram showing an illustrative embodiment of an ultrasound data acquisition unit.

[0011] FIG. **3** is a block diagram showing an illustrative embodiment of a processing unit.

DETAILED DESCRIPTION

[0012] A detailed description may be provided with reference to the accompanying drawings. One of ordinary skill in the art may realize that the following description is illustrative only and is not in any way limiting. Other embodiments of the present invention may readily suggest themselves to such skilled persons having the benefit of this disclosure.

[0013] FIG. **1** is a block diagram showing an illustrative embodiment of an ultrasound system. As depicted therein, the ultrasound system **100** may include an ultrasound data acquisition unit **110**. The ultrasound data acquisition unit **110** may be configured to transmit and receive ultrasound signals to and from a target object to thereby form ultrasound data indicative of the target object.

[0014] Referring to FIG. **2**, the ultrasound data acquisition unit **110** may include a transmit signal generating section **111**. The transmit signal generating section **111** may be operable to generate a plurality of transmit signals. The ultrasound data acquisition unit **110** may further include an ultrasound probe **112** containing a plurality of elements for reciprocally converting ultrasound signals and electrical signals. The ultrasound probe **112** may be configured to transmit ultrasound signals into a target object in response to the transmit signals. The ultrasound probe **112** may be further configured to receive echo signals reflected from the target object to thereby output electrical receive signals, which may be analog signals.

[0015] The ultrasound data acquisition unit **110** may further include a beam forming section **113**. The beam forming section **113** may be configured to convert the electrical receive signals into digital signals. The beam forming section **113** may be further configured to apply delays to the digital signals in consideration of distances between the elements and focal points, thereby outputting digital receive-focused signals.

[0016] The ultrasound data acquisition unit **10** may further include an ultrasound data forming section **114** that may be operable to form ultrasound data based on the digital receive-focused signals. The ultrasound data forming section **114** may perform signal processing such as gain adjustment, filtering and the like upon the digital receive-focused signals in forming the ultrasound data.

[0017] Referring back to FIG. **1**, the ultrasound system **100** may further include a volume data forming unit **120** that may be operable to form volume data corresponding to a plurality of frames by using the ultrasound data. The volume data may include a plurality of voxels, wherein each voxel has a brightness value.

[0018] The ultrasound system **100** may further include a processing unit **130** that may be operable to perform surface rendering upon the volume data to form a 3-dimensional image. The processing unit **130** may be operable to detect edges corresponding to a region of interest (ROI) from the volume data and perform the surface rendering upon voxels within the detected edges from volume data.

[0019] FIG. **3** is a block diagram showing an illustrative embodiment of the processing unit **130**. The processing unit **130** may include a filtering section **131** that may be operable to perform filtering upon the volume data for edge enhancement and noise removal. In one embodiment, by way of non-limiting example, the filtering section **130** may be embodied by a denoising filter including a total variation filter, an anisotropic diffusion filter and the like.

[0020] The processing unit **130** may further include an edge detecting section **132** that may be operable to detect edges from frames included in the filtered volume data. In one embodiment, the edges may be detected by using an edge mask such as Sobel, Prewitt, Robert, Canny and the like. Alternatively, the edges may be detected by using eigenvalue differences using an edge structure tensor.

[0021] The processing unit **130** may further include a connected component analysis (CCA) section **133**. The CCA section **133** may be operable to perform CCA upon the detected edges to detect voxels corresponding to the edges connected to each other. The CCA section **133** may be further operable to perform labeling upon the detected voxels and group the labeled voxels into a plurality of voxel groups, wherein each voxel group has an identical label.

[0022] The processing unit **130** may further include an edge processing section **134** that may be operable to compare the voxel groups to determine a voxel group having the largest number of voxels. The edge processing section **134** may be further operable to set the determined voxel group as the ROI, for example, a face of a fetus.

[0023] The processing unit **130** may further include a parameter setting section **135**. The parameter setting section **135** may be operable to set a first parameter for use in performing surface rendering upon the voxels within the ROI and a second parameter for use in processing skin tone. In one embodiment, the first parameter may include a parameter of a bidirectional surface scattering reflection distribution function (BSSRDF) model. The parameter of the BSSRDF model may be set by using various well-known methods. Thus, a detailed description thereof will be omitted herein. Also, the first parameter may include parameters of various surface scattering models. In one embodiment, the second parameter may be set manually by a user or automatically in the ultrasound system **100**.

[0024] The processing unit **130** may further include a surface rendering section **136**. The surface rendering section **136** may be operable to perform surface rendering and skin tone processing upon the voxels within the ROI by using the first and second parameters to thereby form a 3-dimensional ultrasound image. By doing so, a more realistic 3-dimensional ultrasound image may be formed.

[0025] Referring back to FIG. **1**, the ultrasound system **100** may further include a display unit **140** to display the 3-dimensional ultrasound image, and a control unit **150** that may be operable to control the entire operations of parts of the ultrasound system **100** including those shown in FIGS. **1**-**3**. For example, the control unit **150** may control the transmission and reception of the ultrasound signals, the surface rendering and the display of the 3-dimensional ultrasound image.

[0026] 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.

What is claimed is:

1. An ultrasound system, comprising:

an ultrasound data acquisition unit configured to transmit and receive ultrasound signals to and from a target object to thereby acquire ultrasound data corresponding to a plurality of frames;

a volume data forming unit configured to form volume data corresponding to the plurality of frames based on the ultrasound data, the volume data including a plurality of voxels; and

a processing unit configured to detect edges of a region of interest (ROI) of the target object from the volume data and perform surface rendering upon voxels within the detected edges to thereby form a 3-dimensional ultrasound image.

2. The ultrasound system of Claim **1**, wherein the processing unit includes:

an edge detecting section configured to detect edges from frames included in the volume data;

a connected component analysis (CCA) section configured to perform CCA upon the detected edges to thereby detect voxels of the edges connected to each other, labeling upon the detected edges and group the labeled voxels into a plurality of voxel groups, each voxel group having an identical label;

an edge processing section configured to determine a voxel group having the largest number of voxels among the voxel groups and set the determined voxel group as the ROI;

a parameter setting section configured to set a first parameter for performing surface rendering upon the voxels correspond to the ROI and a second parameter for processing skin tone; and

a surface rendering section configured to perform surface rendering upon the voxels within the ROI by using the first and second parameters to thereby form a 3-dimensional ultrasound image.

3. The ultrasound system of Claim **2**, wherein the first parameter includes a parameter of a surface scattering model.

4. The ultrasound system of Claim **2**, wherein the processing unit further includes a filtering section configured to perform filtering for edge enhancement and noise removal upon the volume data.

5. The ultrasound system of Claim **4**, wherein the filtering section includes a denoising filter.

6. The ultrasound system of Claim **1**, further comprising a display unit to display the 3-dimensional ultrasound image.

7. A method of performing surface rendering upon volume data in an ultrasound system including an ultrasound data acquisition unit, a volume data forming unit and a processing unit, comprising:

a) at the ultrasound data acquisition unit, transmitting and receiving ultrasound signals to and from a target object to thereby acquire ultrasound data corresponding to a plurality of frames;

b) at the volume data forming unit, forming volume data corresponding to the plurality of frames based on the ultrasound data, the volume data including a plurality of voxels; and

c) at the processing unit, detecting edges of a region of interest (ROI) of the target object from the volume data; and

d) at the processing unit, performing surface rendering upon voxels within the detected edges to thereby form a 3-dimensional ultrasound image.

8. The method of Claim **7**, further comprising performing filtering for edge enhancement and noise removal upon the volume data before the step c).

9. The method of Claim **7**, wherein the step c) includes performing edge detection upon the respective frames to detect the edges.

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

performing connected component analysis upon the detected edges to thereby detect voxels of the edges connected to each other;

labeling upon the detected edges;

grouping the labeled voxels into a plurality of voxel groups, each voxel group having an identical label;

comparing the voxels within the respective groups to determine a voxel group having the largest number of voxels;

setting the determined voxel group as the ROI;

setting a first parameter for performing surface rendering upon the voxels within the ROI and a second parameter for processing skin tone; and

performing surface rendering upon the voxels within the ROI by using the first and second parameters to thereby form a 3-dimensional ultrasound image.

11. The method of Claim **10**, wherein the first parameter includes a parameter of a surface scattering model.

12. The method of Claim **7**, further comprising displaying the 3-dimensional ultrasound image on a display unit.

* * * * *

专利名称(译)	超声系统中体数据的表面绘制		
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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	LEE KWANG HEE AHN JUNE YOUNG		
发明人	LEE, KWANG HEE AHN, JUNE YOUNG		
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外部链接	Espacenet USPTO		

摘要(译)

公开了用于在超声系统中对体数据执行表面渲染的实施例。超声数据获取单元向目标对象发送超声信号并从目标对象接收超声信号，从而获取与多个帧相对应的超声数据。体数据形成单元基于超声数据形成与多个帧相对应的体数据。体数据包括多个体素。处理单元检测体数据中的目标对象的感兴趣区域（ROI）的边缘，并且对检测到的边缘内的体素执行表面渲染，从而形成3维超声图像。