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(54) **ULTRASOUND SYSTEM AND SIGNAL PROCESSING UNIT CONFIGURED FOR TIME GAIN AND LATERAL GAIN COMPENSATION**

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(Continued)

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See application file for complete search history.

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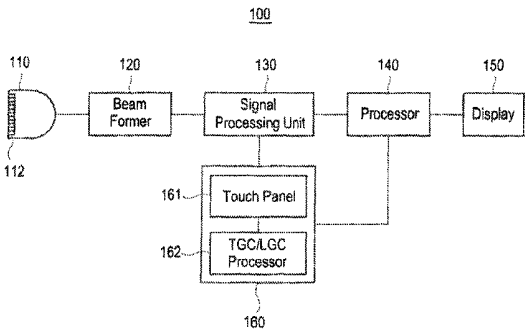
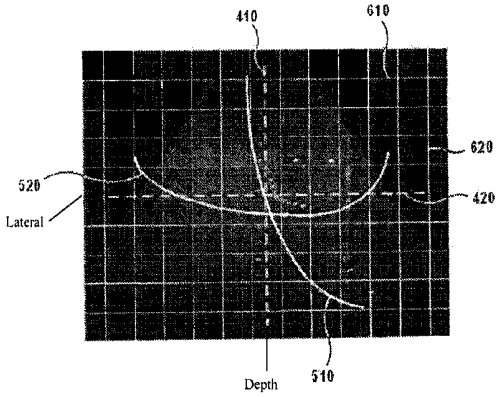
(57) **ABSTRACT**

The present invention provides an ultrasound system, which comprises: a signal acquiring unit to transmit an ultrasound signal to an object and acquire an echo signal reflected from the object; a signal processing unit to control TGC (Time Gain Compensation) and LGC (Lateral Gain Compensation) of the echo signal; a TGC/LGC setup unit adapted to set TGC and LGC values based on TGC and LGC curves inputted by a user; and an image producing unit adapted to produce an ultrasound image of the object based on the echo signal. The signal processing unit is further adapted to control the TGC and the LGC of the echo signal based on the TGC and LGC values set by the TGC/LGC setup unit.

30 Claims, 8 Drawing Sheets





(51) **Int. Cl.**
G01S 7/52 (2006.01)
A61B 8/14 (2006.01)

(52) **U.S. Cl.**
CPC ***G01S 7/52033*** (2013.01); ***G01S 7/52084*** (2013.01); ***A61B 8/14*** (2013.01); ***A61B 8/4254*** (2013.01); ***A61B 8/4444*** (2013.01); ***A61B 8/5269*** (2013.01); ***A61B 8/54*** (2013.01); ***A61B 8/461*** (2013.01)

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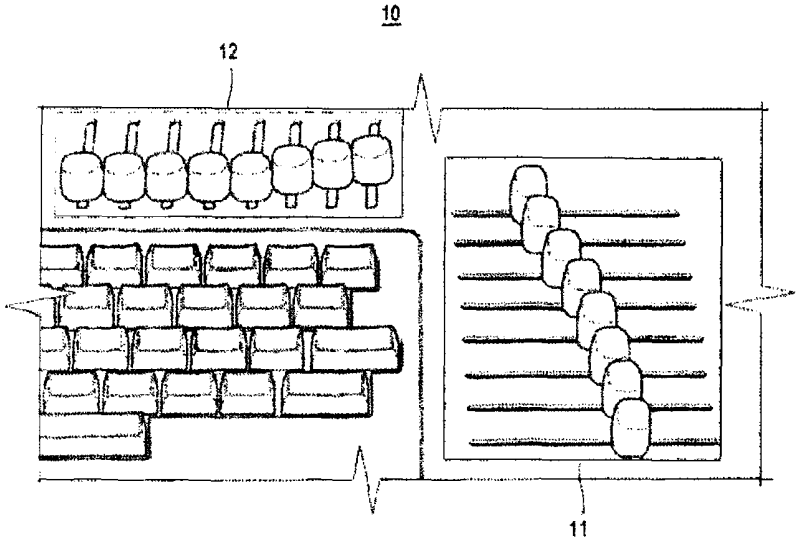
FIG. 1



PRIOR ART

FIG. 2

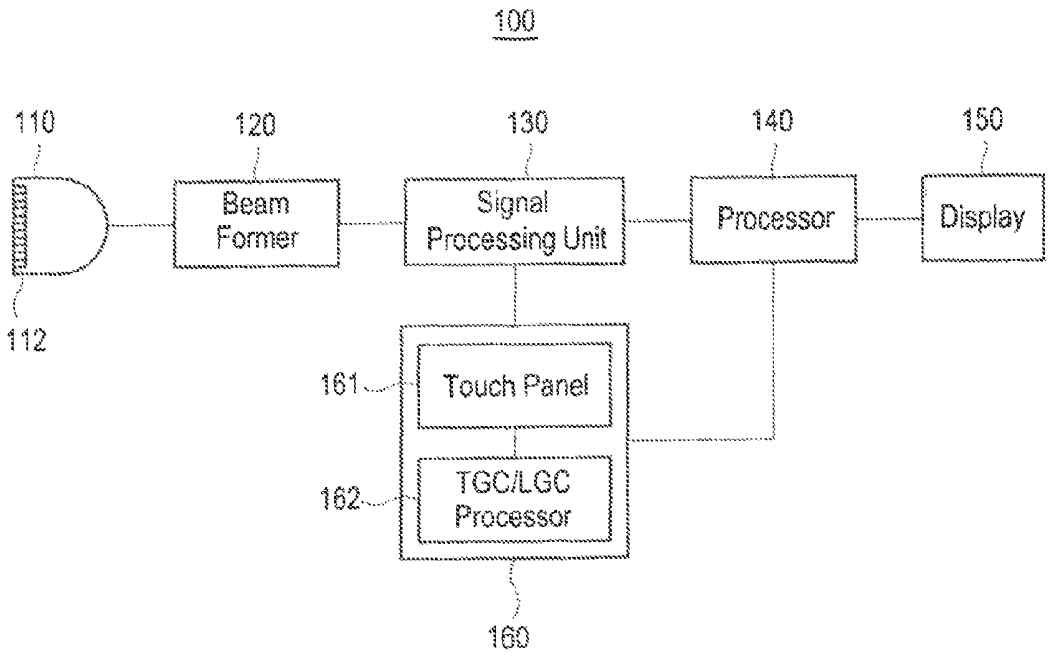

100
110
120
130
140
150
Beam Former
Signal Processing Unit
Processor
Display
112
161
Touch Panel
162
TGC/LGC Processor
160

FIG. 3

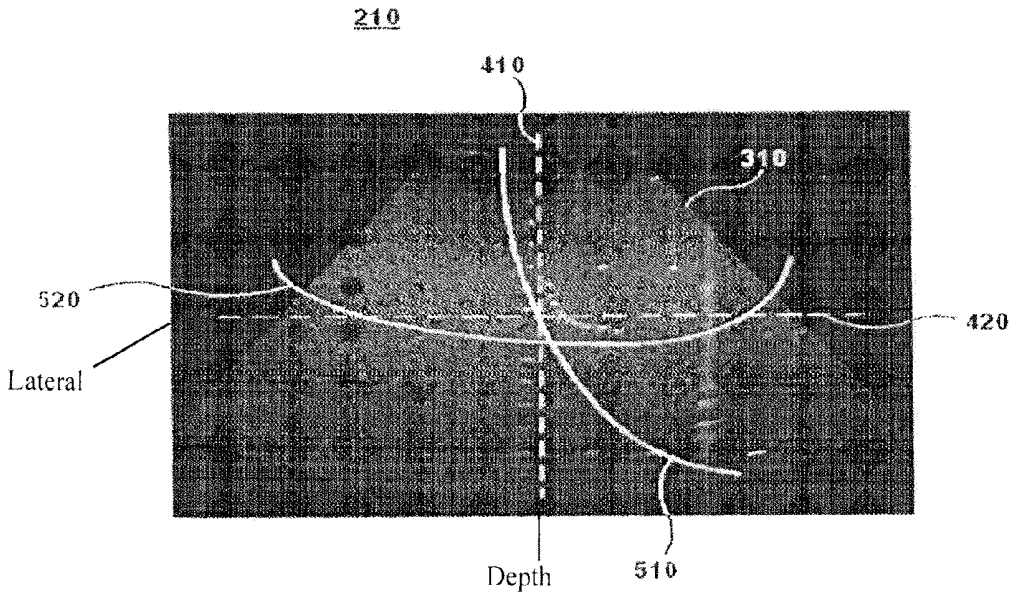


FIG. 4

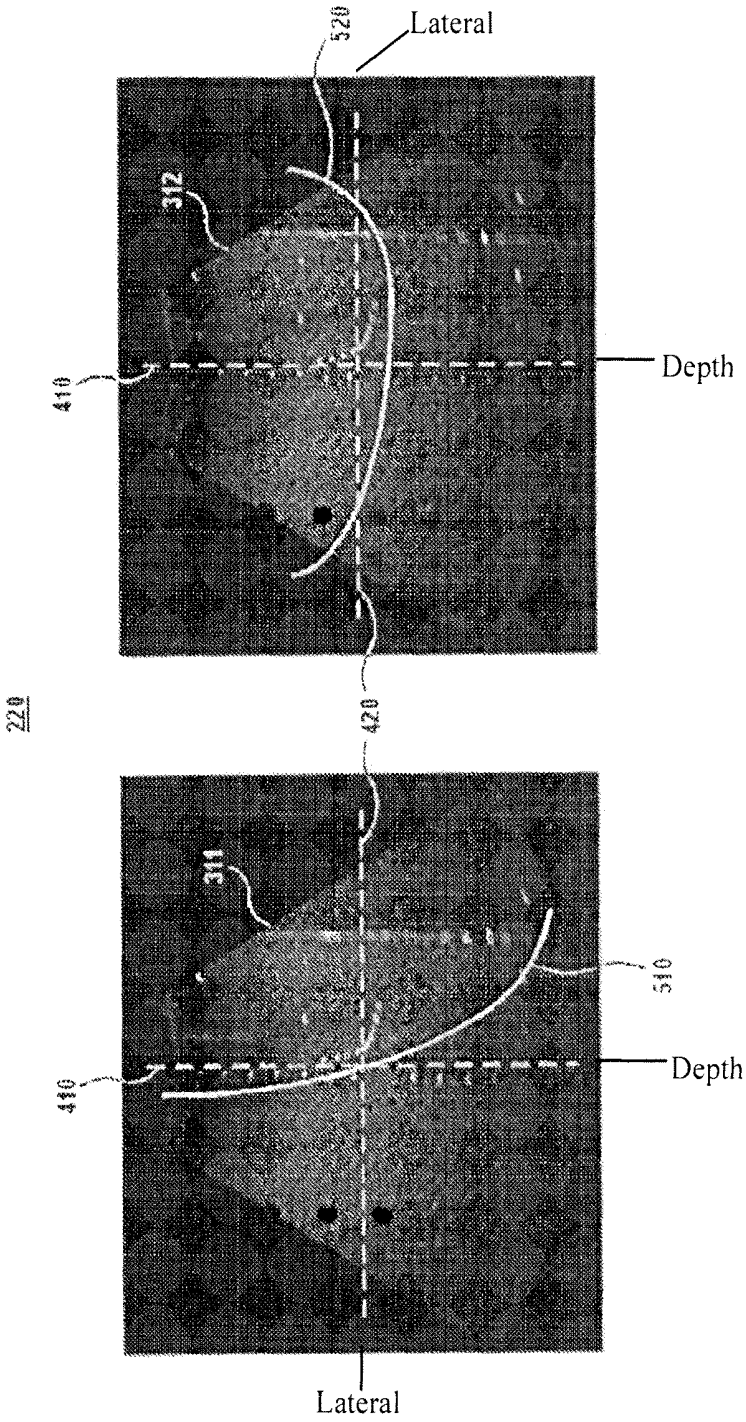


FIG. 5

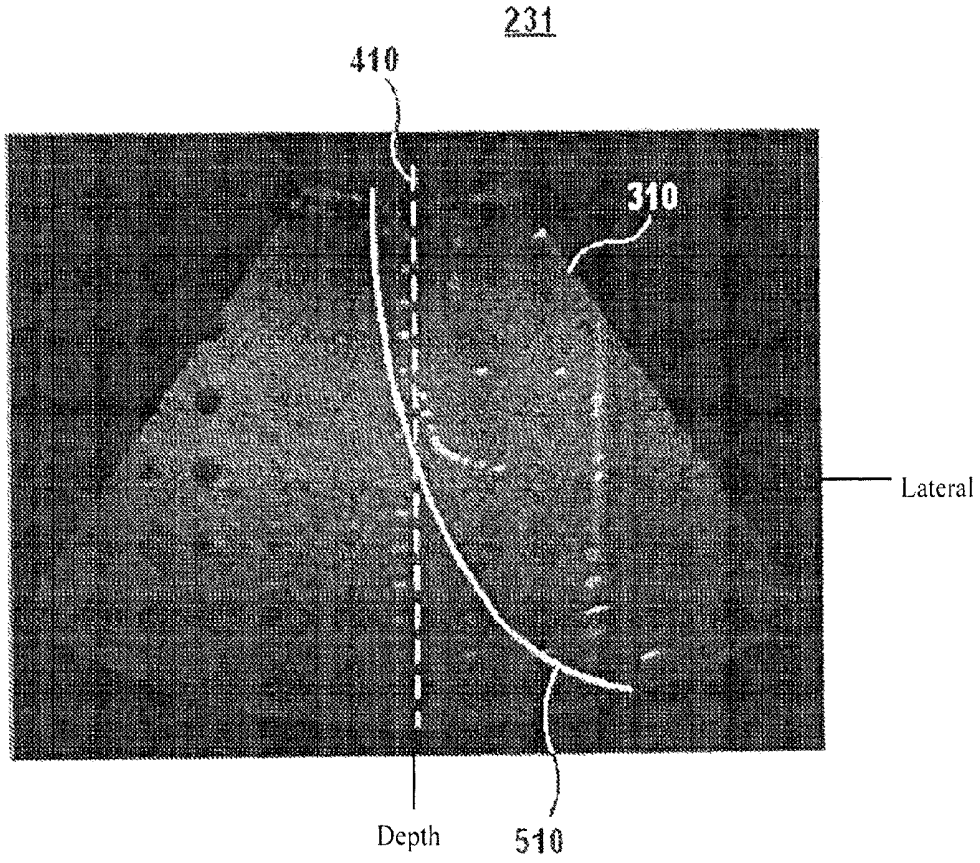


FIG. 6

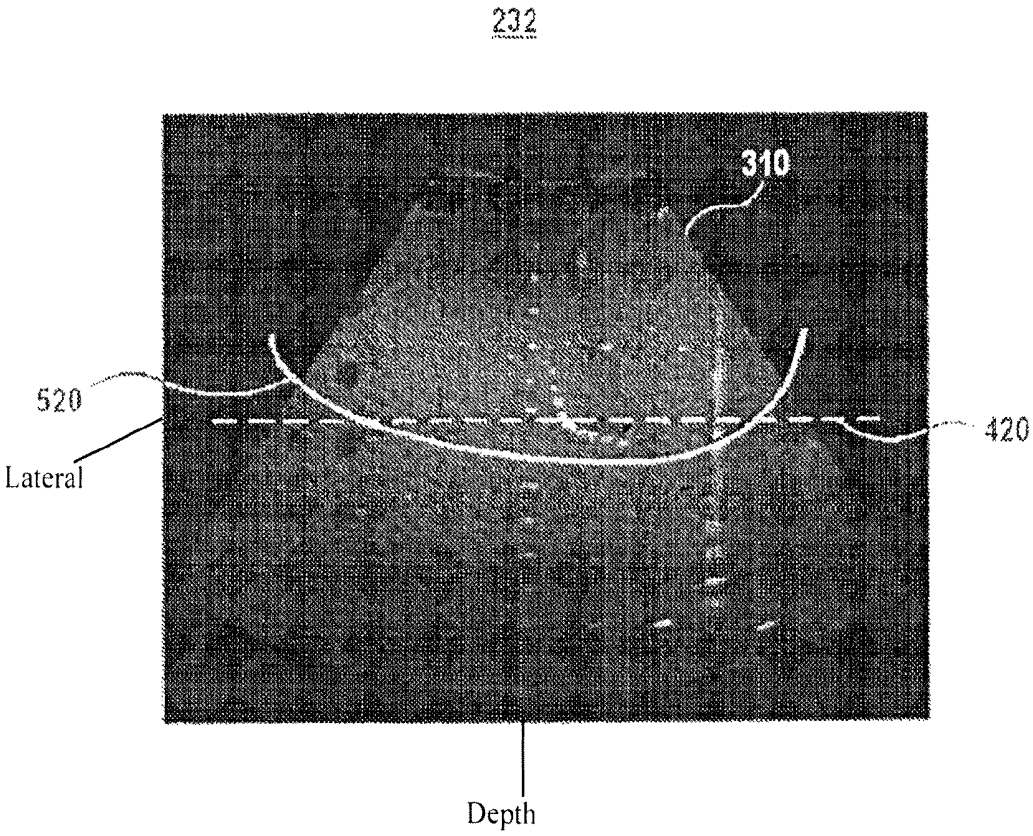


FIG. 7

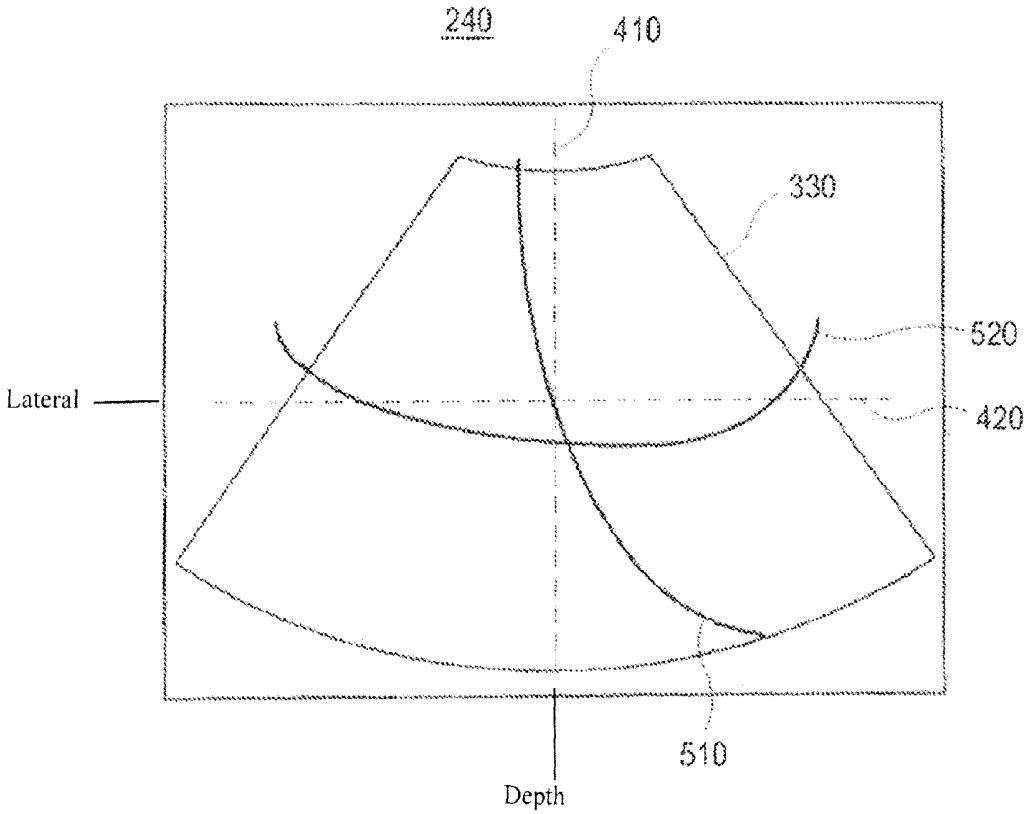
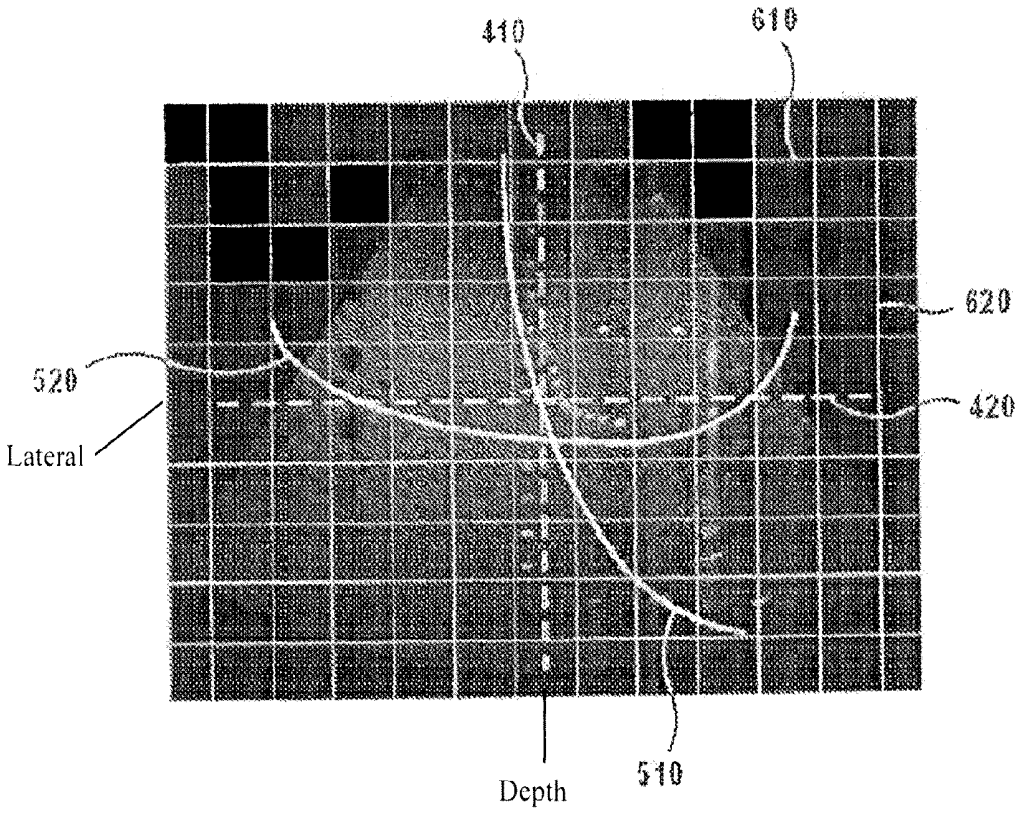


FIG. 8



ULTRASOUND SYSTEM AND SIGNAL PROCESSING UNIT CONFIGURED FOR TIME GAIN AND LATERAL GAIN COMPENSATION

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is a Continuation of U.S. application Ser. No. 13/184,094, filed on Jul. 15, 2011, now U.S. Pat. No. 8,403,855 which is a Continuation of U.S. application Ser. No. 11/857,860, filed on Sep. 19, 2007, now U.S. Pat. No. 8,016,759, which claims priority from Korean Patent Application No. 10-2006-0123752 filed on Dec. 7, 2006, the entire subject matter of each of which is incorporated herein by reference.

BACKGROUND

1. Field

The present invention generally relates to an ultrasound system, and more particularly to an ultrasound system adapted to precisely and easily perform TGC (Time Gain Compensation) and LGC (Lateral Gain Compensation).

2. Background

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.

In order to transmit and receive ultrasound signals, the ultrasound system is generally provided with a probe including a wideband transducer. When the transducer is electrically stimulated, it produces ultrasound signals and transmits them into a human body. The ultrasound signals transmitted into the human body are reflected from borders between human tissues and then returned to the transducer. The returned ultrasound echo signals are converted into electric signals. Thereafter, ultrasound image data for imaging the tissues is produced by amplifying and signal-processing the echo signals.

Typically, the ultrasound system is provided with a control panel including a plurality of input units in order to perform a control function of acquiring the ultrasound image, a menu control function, a measurement and annotation function, etc. The control panel is comprised of a touch panel, an image control unit, a measurement control unit, etc. The touch panel displays menus for optimizing an ultrasound image displayed on a display unit. The menus on the touch panel can be touched and selected by a user. The image control unit controls the ultrasound image, whereas the measurement control unit measures a distance to the object, a circumference of the object, etc. As illustrated in FIG. **1**, the image control unit includes a plurality of TGC control keys **11** and a plurality of LGC control keys **12**. The TGC control keys **11** are used to control a gain of each echo signal based on depth of the position from which the echo signal is reflected. Further, since the echo signal is attenuated at the outer right and left sides, the LGC control keys **12** are used to control a gain of the attenuated echo signal.

In the conventional system, the TGC control keys **11** and the LGC control keys **12** are arranged on different areas of the control panel. The problem associated with such an arrangement is that the size of the control panel must be inevitably

increased. Further, a user of the system suffers a great inconvenience when operating the TGC control keys **11** and the LGC control keys **12**. Another problem of the conventional system is that since the TGC control keys **11** and the LGC control keys **12** are comprised of slide-type variable resistors, it is very difficult for an unskilled user to finely control TGC and LGC with the TGC control keys **11** and the LGC control keys **12**.

In order to resolve the above problems, the present invention is directed to providing an ultrasound system adapted to display a setup screen used to input TGC and LGC curves on a touch panel and perform TGC and LGC based on the inputted TGC and LGC curves.

The present invention provides an ultrasound system, which comprises: a signal acquiring unit adapted to transmit an ultrasound signal to an object and acquire an echo signal reflected from the object; a signal processing unit adapted to perform TGC (Time Gain Compensation) and LGC (Lateral Gain Compensation) upon the echo signal at a coarse compensation mode based on predetermined TGC and LGC values; an image producing unit adapted to produce an ultrasound image of the object based on the TGC and LGC compensated echo signal; an input unit adapted to allow a user to provide TGC and LGC curves; and a TGC/LGC setup processor adapted to set TGC and LGC values based on the TGC and LGC curves provided by the user. The signal processing unit is further adapted to perform the TGC and LGC upon the echo signal at a fine compensation mode based on the TGC and LGC values set by the TGC/LGC setup processor.

In addition, the present invention provides an ultrasound system, which comprises: a processor adapted to configure a setup screen for display; and a touch panel adapted to display the setup screen so as to allow a user to input TGC and LGC curves. The processor is further adapted to calculate the TGC and LGC values based on the inputted TGC and the LGC curves.

BRIEF DESCRIPTION OF THE DRAWINGS

Arrangements and embodiments may be described in detail with reference to the following drawings in which like reference numerals refer to like elements and wherein:

FIG. **1** is a schematic diagram illustrating conventional TGC and LGC control keys;

FIG. **2** is a block diagram showing a structure of an ultrasound system according to one embodiment of the present invention;

FIGS. **3** to **7** illustrate a setup screen according to one embodiment of the present; and

FIG. **8** illustrates an exemplary distinction between TGC and LGC curves according to one embodiment of the present invention.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

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.

Certain embodiments of the present invention will be explained below with reference to FIGS. **2** to **8**.

As illustrated in FIG. **2**, an ultrasound system **100** comprises: a probe **110**; a beam former **120**; a signal processing

unit **130**; a processor **140**; a display unit **150**; and a TGC/LGC setup unit **160**. The probe **110** includes a plurality of transducers **112**. Each of the transducers **112** may be configured to transmit an ultrasound signal to an object and receive the ultrasound signal reflected from the object. The beam former **120** may be configured to focus the transmitted ultrasound signals from the transducers **112** on the object and collect the reflected ultrasound signals from the object to the transducers **112** together with corresponding time delay.

The signal processing unit **130** may be configured to amplify the signals collected by the beam former **120** and control gains of the amplified echo signals. Specifically, the signal processing unit **130** may be configured to perform TGC (Time Gain Compensation) and LGC (Lateral Gain Compensation) upon the echo signals based on predetermined TGC and LGC values at a coarse compensation mode (e.g., in an initial operation stage). The signal processing unit **130** may be further configured to perform TGC and LGC upon the echo signals based on TGC and LGC values calculated in a TGC/LGC setup unit **160** using a curve inputted by a user at a fine compensation mode (e.g., during operations).

The processor **140** may be configured to receive the echo signals from the signal processing unit **130** and produce an ultrasound image signal based on the echo signals. The display unit **150** may be adapted to receive the ultrasound image signal from the processor and display an ultrasound image based on the signal.

The TGC/LGC setup unit **160** may include a touch panel **161** and a TGC/LGC setup processor **162**.

The touch panel **161** may be configured to display a setup screen and detect TGC/LGC curves inputted by the user on the touch panel **161** to produce a detecting signal. The touch panel **161** detects the user's input according to either the pressure sensing method or the electromagnetic induction method. The touch panel **161** may be a touch panel included in a control panel (not shown) of the ultrasound system **100**. Alternatively, it may be separate and apart from the ultrasound system **100**.

In one embodiment of the present invention, the touch panel **161** may be configured to display a setup screen **210** (shown in FIG. **3**) including an ultrasound image **310** and first and second reference lines **410**, **420**. The ultrasound image **310** is based on the echo signal, the TGC and LGC of which are controlled based on the predetermined TGC and LGC values. The first and second reference lines **410**, **420** may be used to detect a TGC curve **510** and a LGC curve **520** inputted by the user (i.e., to determine whether a curve inputted by the user is a TGC curve **510** or a LGC curve **520**). After inputting a curve, the user can modify a portion of the curve.

In another embodiment of the present invention, the touch panel **161** may be configured to display a setup screen **220** (shown in FIG. **4**) including first and second ultrasound images **311**, **312** and first and second reference lines **410**, **420**. The first and second ultrasound images **311**, **312** are based on the echo signal, the TGC and LGC of which are controlled based on the predetermined TGC and LGC values. The first and second reference lines **410**, **420** may be used to detect whether a curve inputted by the user is a TGC curve **510** or a LGC curve **520**. The first ultrasound image **311** may be identical to the second initial ultrasound image **312**.

In yet another embodiment of the present invention, the touch panel **161** may be configured to display a first setup screen **231** (shown in FIG. **5**) including an ultrasound image **310** and a first reference line **410**. The ultrasound image **310** is based on the echo signal, the TGC and LGC of which are controlled based on the predetermined TGC and LGC values. The first reference line **410** may be used to detect a TGC curve **510** inputted by the user. The touch panel may then display a second setup screen **232** (shown in FIG. **6**) including the ultrasound image **310** and a second reference line **420**. The second reference lines **420** may be used to detect a LGC curve **520** inputted by the user. Alternatively, the touch panel **161** may be configured to display the second setup screen **232** before the first setup screen **231**.

In still yet another embodiment of the present invention, the touch panel **161** may be configured to display a setup screen **240** (shown in FIG. **7**) including a virtual ultrasound image **330** and first and second reference lines **410**, **420**.

The TGC/LGC setup processor **162** may be configured to detect TGC and LGC curves **510**, **520** inputted by the user on the touch panel **161**. The TGC/LGC setup processor **162** may then calculate new TGC and LGC values in consideration of the detected TGC and LGC curves and transmit the values to the signal processing unit **130**.

In one embodiment of the present invention, as illustrated in FIG. **8**, the TGC/LGC setup processor **162** may be configured to establish a first group of lines **610** and a second group of lines **620**. The first group of lines **610** is perpendicular to a first reference line **410** and the lines in said group are equally spaced apart from each other. The second group of lines **620** is perpendicular to a second reference line **420** and the lines in this group are equally spaced apart from each other. If it is determined that a curve inputted by the user (such as the curve **510**) intersects the first group of lines more often than the second group of lines, then the TGC/LGC setup processor **162** recognizes that the curve is a TGC curve. Alternatively, if it is determined that a curve inputted by the user (such as the curve **520**) intersects the second group of lines more often than the first group of lines, then the TGC/LGC setup processor **162** recognizes that the curve is a LGC curve. The TGC/LGC setup processor **162** then calculates the new TGC value corresponding to the TGC curve **510** based on the first reference line **410**. It also calculates the LUG value corresponding to the LUC curve **520** based on the second reference line **420**. The TGC value and the LGC value are transmitted to the signal processing unit **130**.

The present invention allows the user to accurately control the TGC and LUG by using the TGC and LGC curves inputted into the touch panel, thereby improving operational accuracy and time. Further, the present invention reduces the size of the control panel to thereby improve the spatial efficiency.

Although the present invention has been described with reference to a number of preferred 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:

a probe configured for transmitting an ultrasound signal to an object and receiving an echo signal reflected from the object;

a touch panel configured for receiving a touch input, the touch input comprising a plurality of touch input points including a first touch input point and a second touch input point; and

a processor configured for determining a first compensation value and a second compensation value at different

depths corresponding to the first touch input point and the second touch input point, performing compensation on the echo signal based on the determined first compensation value and second compensation value and generating an ultrasound image of the object based on the compensated echo signal,

wherein the first touch input point and the second touch input point for setting the first compensation value and the second compensation value are received via a single touch input forming a single curve corresponding to different depths, and

wherein the first touch input point and the second touch input point correspond to two different depths on the generated ultrasound image.

2. The ultrasound system of claim **1**, wherein the generated ultrasound image is displayed on the touch panel.

3. The ultrasound system of claim **2**,

wherein the generated ultrasound image is displayed on a first region of the touch panel and the touch input is received on a second region of the touch panel different from the first region.

4. The ultrasound system of claim **2**, wherein the touch input is received on the generated ultrasound image displayed on the touch panel.

5. The ultrasound system of claim **1**, wherein the generated ultrasound image is not displayed on the touch panel.

6. The ultrasound system of claim **1**, further comprising a display separate from the touch panel, wherein the generated ultrasound image is displayed on at least one of the display and touch panel.

7. The ultrasound system of claim **1**, further comprising a display configured for displaying the generated ultrasound image.

8. The ultrasound system of claim **7**, wherein a compensation line corresponding to the touch input is displayed on at least one of the touch panel and the display.

9. The ultrasound system of claim **8**, wherein the compensation line corresponding to the touch input is a Time Gain Compensation (TGC) line, representing gains of the echo signal with change of depths of the positions from which the echo signal is reflected, or a Lateral Gain Compensation (LGC) line, representing gains of the echo signal with lateral change of the positions from which the echo signal is reflected.

10. The ultrasound system of claim **9**, wherein the compensation is a TGC or a LGC depending upon whether the received compensation line is the TGC line or the LGC line.

11. The ultrasound system of claim **10**, wherein the processor is further configured to perform a second TGC or LGC on the echo signal at a coarse compensation mode based on a predetermined TGC or LGC value before the processor's performing of compensation.

12. The ultrasound system of claim **9**, wherein the processor causes the touch panel to display a first reference line and a second reference line, which are perpendicular to each other, to determine whether the compensation line is a TGC line or a LGC line.

13. The ultrasound system of claim **12**, wherein the processor is further configured to cause the touch panel to further display a first group of lines perpendicular to the first reference line, each of which is spaced apart from adjacent lines at a first uniform distance, and a second group of lines perpendicular to the second reference line, each of which is spaced apart from adjacent lines at a second uniform distance.

14. The ultrasound system of claim **13**, wherein the processor is further configured to determine that the received compensation line is a TGC line when the received compensation line intersects the first group of lines more than the second group of lines, and the processor is further configured to determine that the received compensation line is a LGC line when the received compensation line intersect the second group of lines more than the second group of lines more than the first group of lines.

15. The ultrasound system of claim **14**, wherein the processor is further configured to calculate a new TGC value based on the received compensation line and the first reference line if the received compensation line is the TGC, and the processor is further configured to calculate a new LGC value based on the received compensation line and the second reference line, if the received compensation line is the LGC line.

16. The ultrasound system of claim **15**, wherein the processor is further configured to perform compensation of the echo signal based on the new TGC value or the new LGC value.

17. An ultrasound system, comprising:

a probe configured for transmitting an ultrasound signal to an object and receiving an echo signal reflected from the object;

a display configured for displaying an ultrasound image of the object, the display including touch panel configured for receiving a touch input, the touch input comprising a plurality of touch input points including a first touch input point and a second touch input point; and

a processor configured for determining a first compensation value and a second compensation value at different depths corresponding to the first touch input point and the second touch input point, performing compensation on the echo signal based on the determined first compensation value and second compensation value and generating the ultrasound image of the object based on the compensated echo signal,

wherein the first touch input point and the second touch input point for setting the first compensation value and the second compensation value are received via a single touch input forming a single curve corresponding to different depths, and

wherein the first touch input point and the second touch input point correspond to two different depths on the generated ultrasound image.

18. The ultrasound system of claim **17**, wherein a compensation line corresponding to the touch input is not displayed on the touch panel and is displayed on the ultrasound image on the display.

19. The ultrasound system of claim **17**, wherein a compensation line corresponding to the touch input is on the area where the ultrasound image is displayed.

20. The ultrasound system of claim **17**, wherein a compensation line corresponding to the touch input is a Time Gain Compensation (TGC) line, representing gains of the echo signal with change of depths of the positions from which the echo signal is reflected, or a Lateral Gain Compensation (LGC) line, representing gains of the echo signal with lateral change of the positions from which the echo signal is reflected.

21. The ultrasound system of claim **20**, wherein the compensation is a TGC or a LGC depending upon whether the received compensation line is the TGC line or the LGC line.

22. The ultrasound system of claim **21**, wherein the processor is further configured to perform a second TGC or LGC on the echo signal at a coarse compensation mode based on a predetermined TGC or LGC value before the processor's performing of compensation.

23. The ultrasound system of claim **20**, wherein the processor is further configured to cause the touch panel to display

a first reference line and a second reference line, which are perpendicular to each other, on the ultrasound image to determine whether the compensation line is a TGC line or a LGC line.

24. The ultrasound system of claim **23**, wherein the processor is further configured to cause the touch panel to further display a first group of lines perpendicular to the first reference line, each of which is spaced apart from adjacent lines at a first uniform distance, and a second group of lines perpendicular to the second reference line, each of which is spaced apart from adjacent lines at a second uniform distance.

25. The ultrasound system of claim **24**, wherein the processor is further configured to determine that the received compensation line is a TGC line when the received compensation line intersects the first group of lines more than the second group of lines, and the processor is further configured to determine that the received compensation line is a LGC line when the received compensation line intersect the second group of lines more than the second group of lines more than the first group of lines.

26. The ultrasound system of claim **25**, wherein the processor is further configured to calculate a new TGC value based on the received compensation line and the first reference line if the received compensation line is the TGC, and the processor is further configured to calculate a new LGC value based on the received compensation line and the second reference line, if the received compensation line is the LGC line.

27. The ultrasound system of claim **26**, wherein the processor is further configured to compensate the echo signal based on the new TGC value or the new LGC value.

28. The ultrasound system of claim **17**, wherein the touch panel is separately located from the display.

29. The ultrasound system of claim **1**, wherein the processor is configured to cause the touch panel to display multiple reference lines corresponding to different depths, and the first compensation value and the second compensation value are compensation values at points where the single curve intersects two of the multiple reference lines.

30. The ultrasound system of claim **17**, wherein the processor is configured to cause the touch panel to display multiple reference lines corresponding to different depths, and the first compensation value and the second compensation value are compensation values at points where the single curve intersects two of the multiple reference lines.

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专利名称(译)	超声系统和信号处理单元配置用于时间增益和横向增益补偿		
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摘要(译)

本发明提供一种超声系统，包括：信号获取单元，用于将超声信号发送到物体并获取从物体反射的回波信号;信号处理单元，用于控制回波信号的TGC（时间增益补偿）和LGC（横向增益补偿）; TGC / LGC设置单元，适于根据用户输入的TGC和LGC曲线设置TGC和LGC值;图像产生单元，适于基于回波信号产生对象的超声图像。信号处理单元还适于基于由TGC / LGC设置单元设置的TGC和LGC值来控制回波信号的TGC和LGC。