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LEE et al.(10) **Pub. No.: US 2014/0148689 A1**(43) **Pub. Date: May 29, 2014**(54) **ULTRASOUND SYSTEM AND METHOD FOR
PROVIDING GUIDELINE OF NEEDLE**(52) **U.S. Cl.**CPC **A61B 8/0841** (2013.01)USPC **600/424**(71) Applicant: **SAMSUNG MEDISON CO., LTD.**,
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(57) **ABSTRACT**

Disclosed are an ultrasound system and method for providing a guideline of a needle. The ultrasound system includes an ultrasound data acquirer that transmits an ultrasound signal to an object with a needle inserted thereinto, and acquires ultrasound data corresponding to each of a plurality of ultrasound images by receiving an ultrasound echo signal reflected from the object, a user input unit that receives input information, used to set a point in an ultrasound image, from a user, and a processor that generates the plurality of ultrasound images with the ultrasound data, generates a mask image used to detect an input position of the needle by using the plurality of ultrasound images, detects the input position by using the mask image, and sets a guideline of the needle in the ultrasound image on a basis of the input position and the input information.

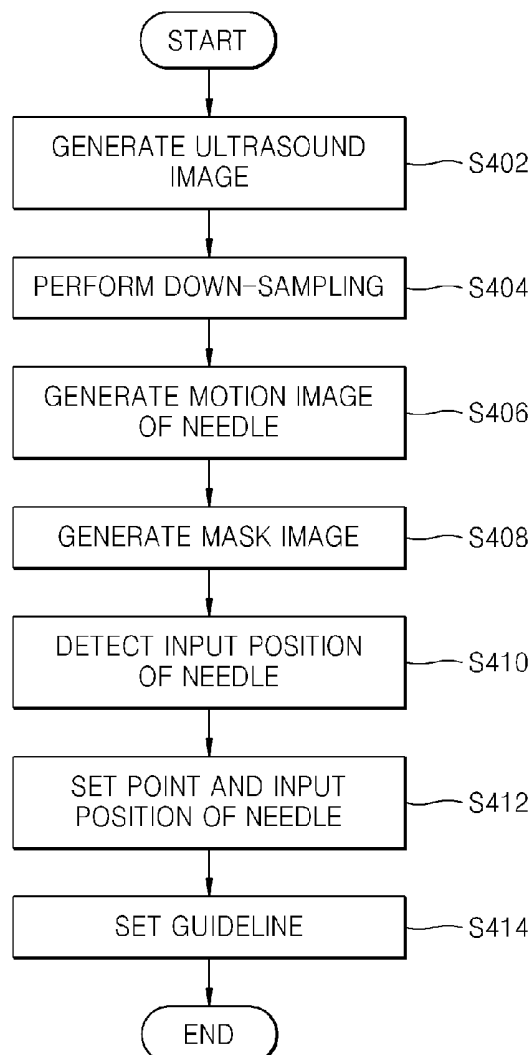


FIG. 1

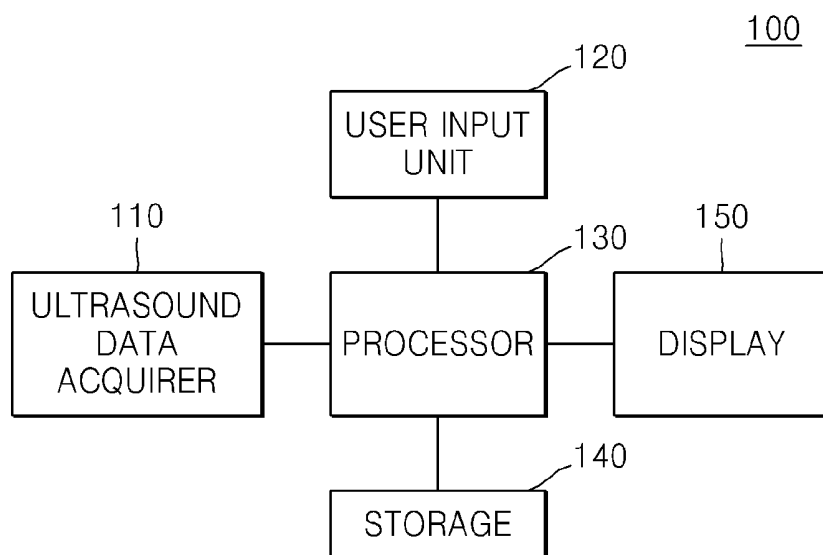


FIG. 2

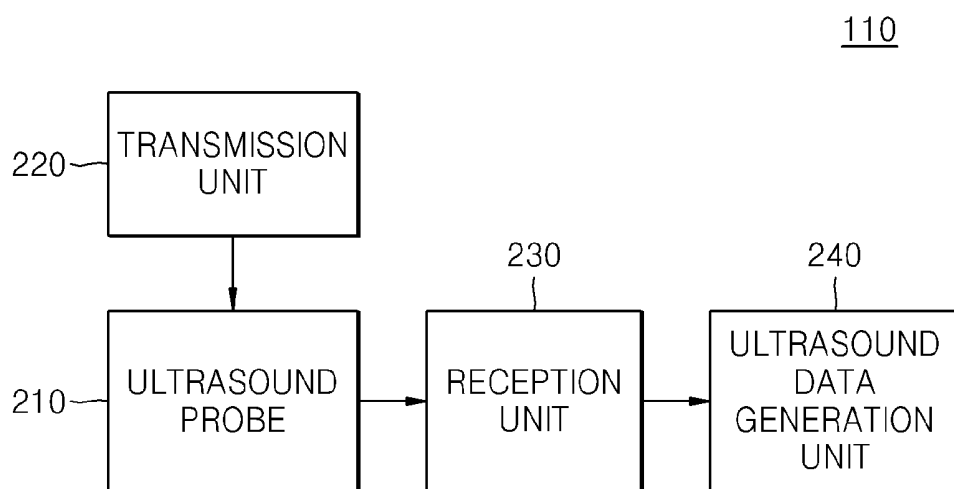


FIG. 3

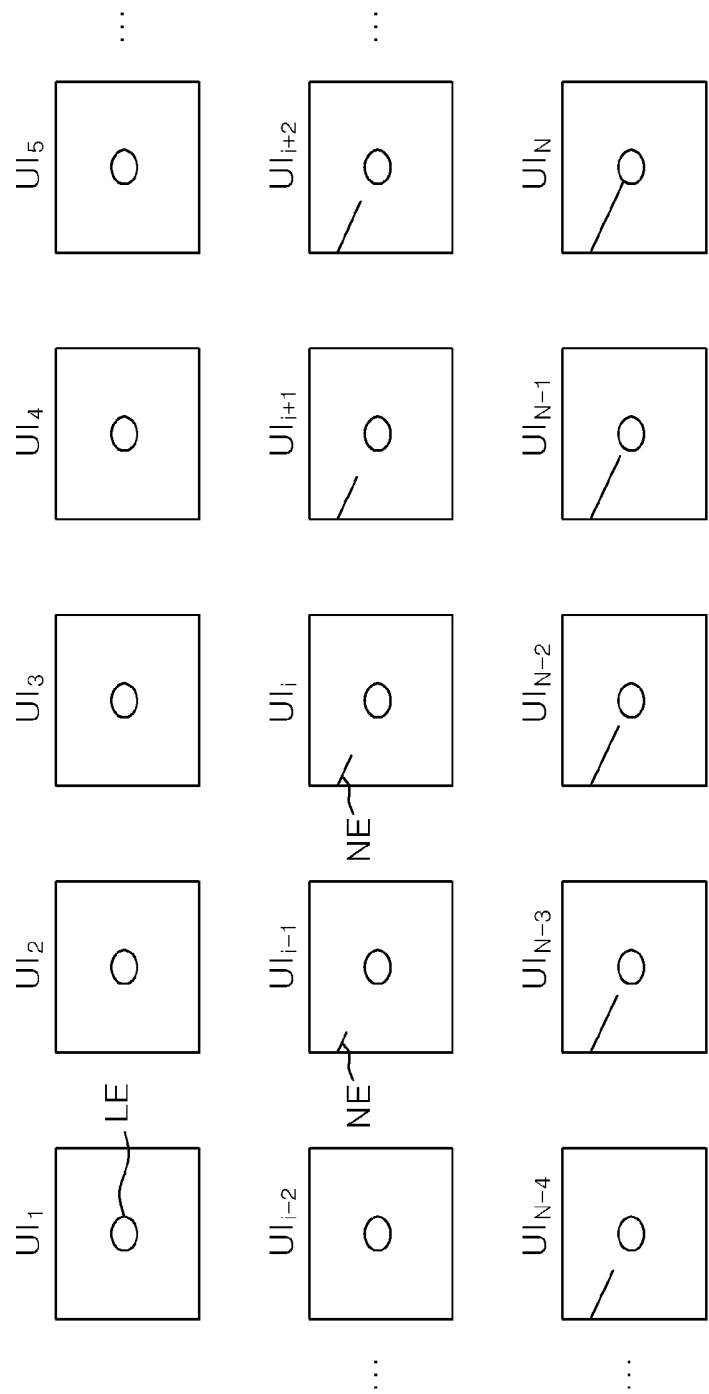


FIG. 4

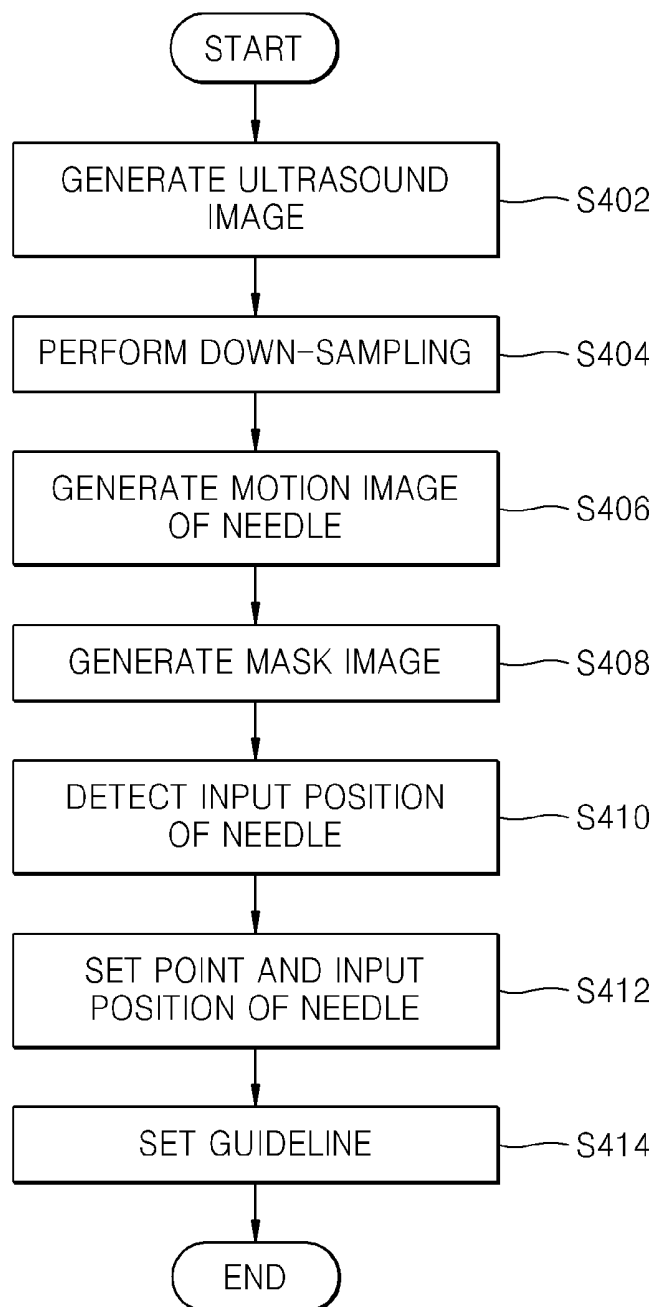


FIG. 5

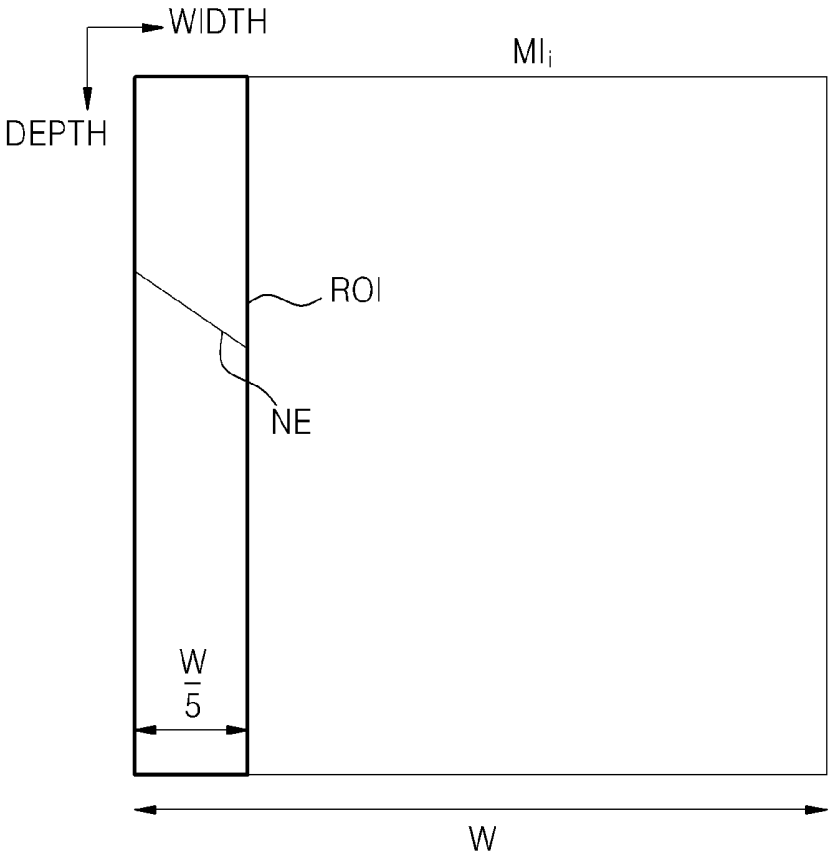


FIG. 6

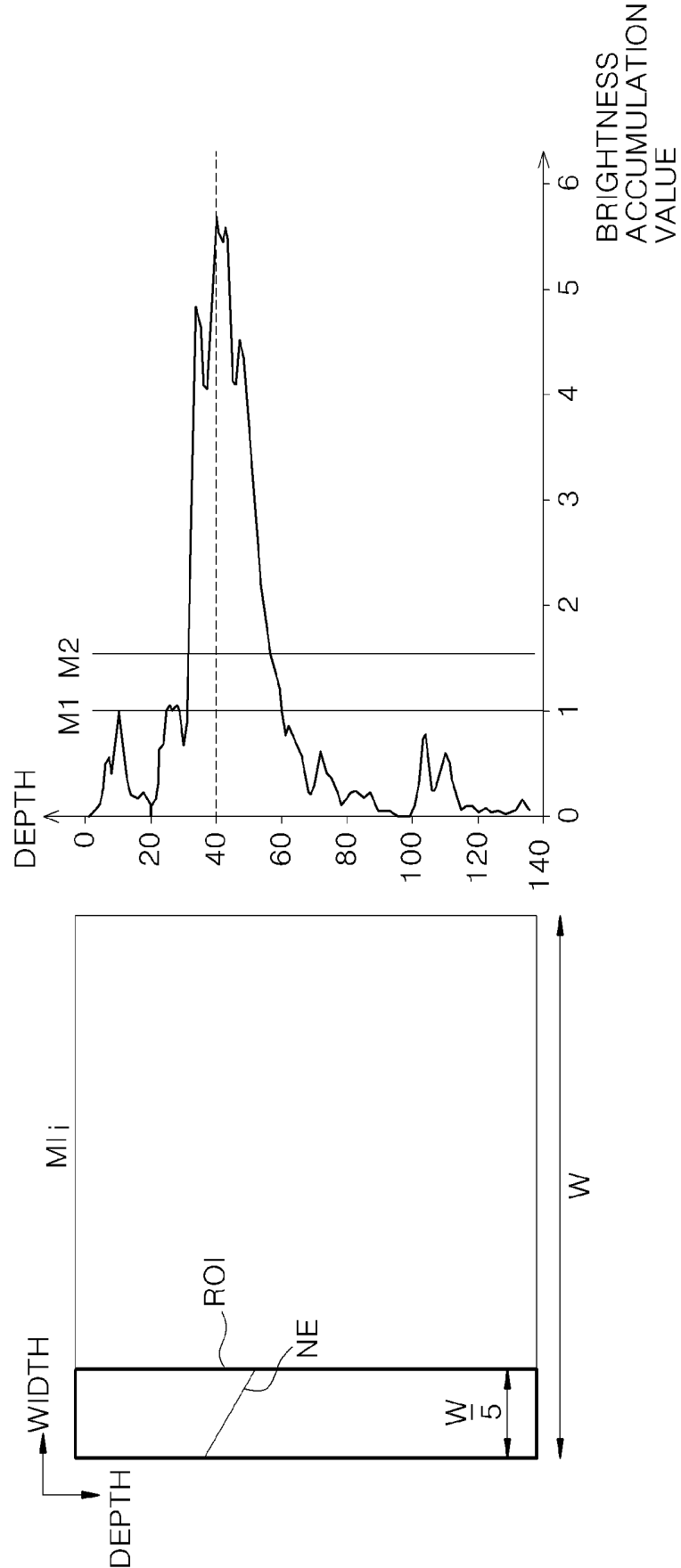


FIG. 7

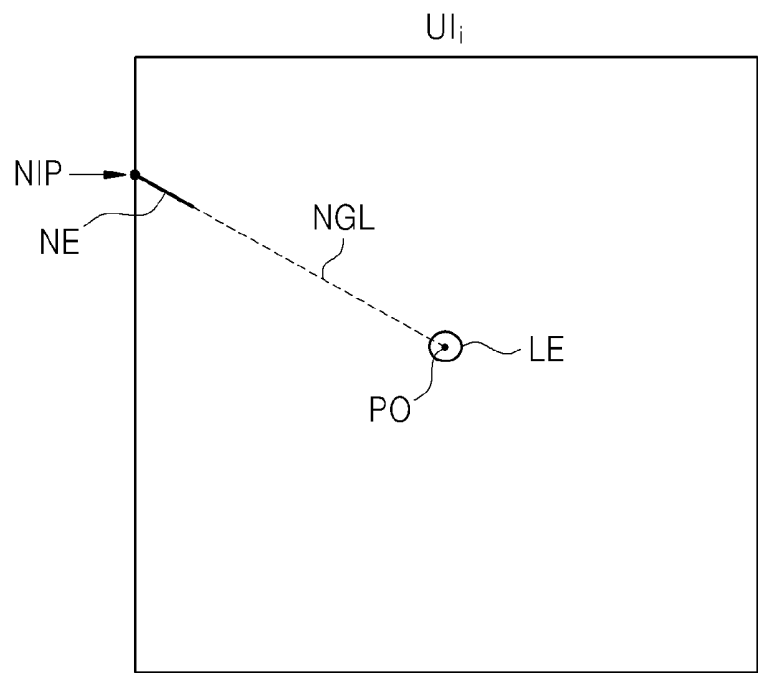


FIG. 8

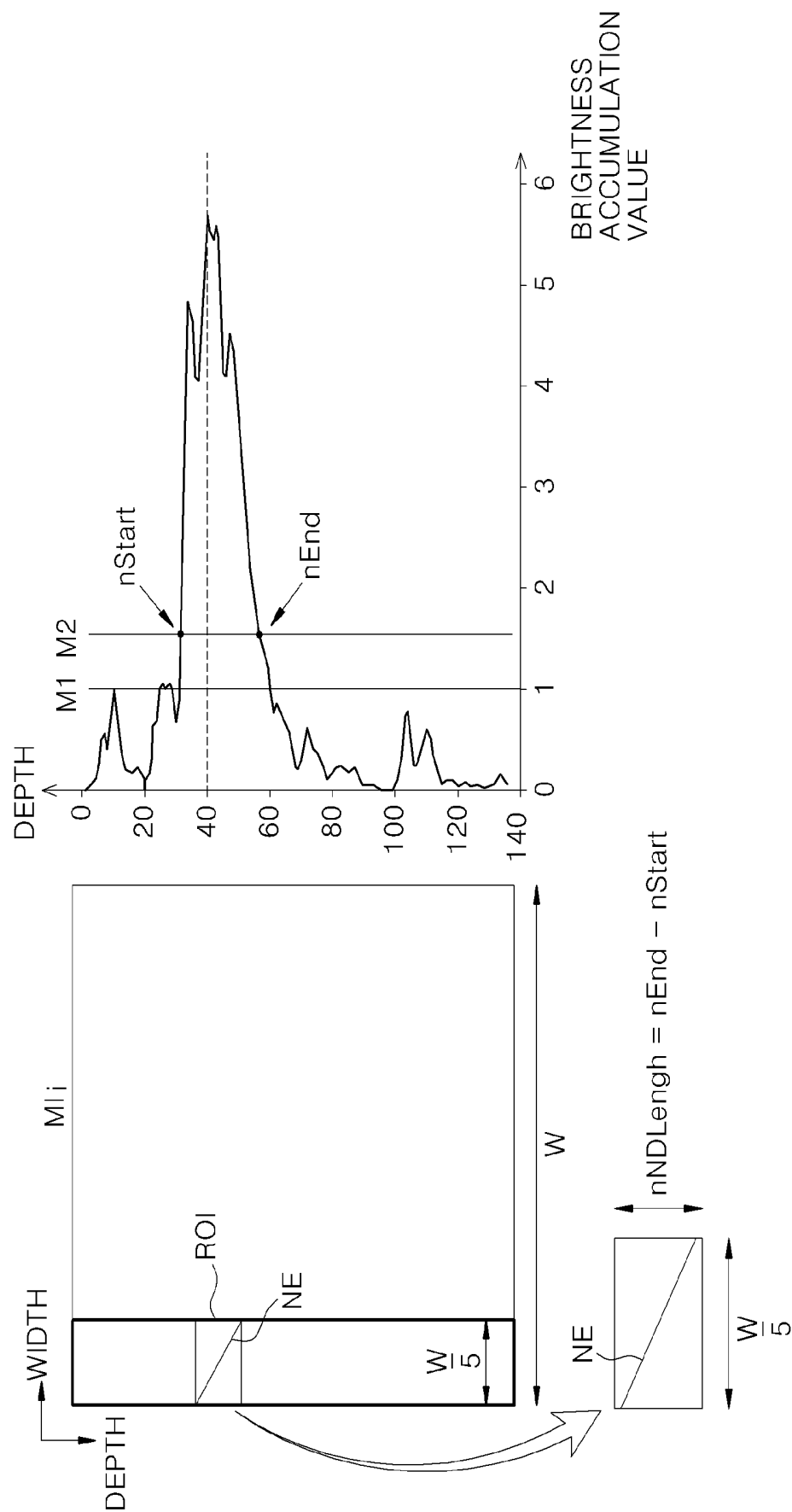
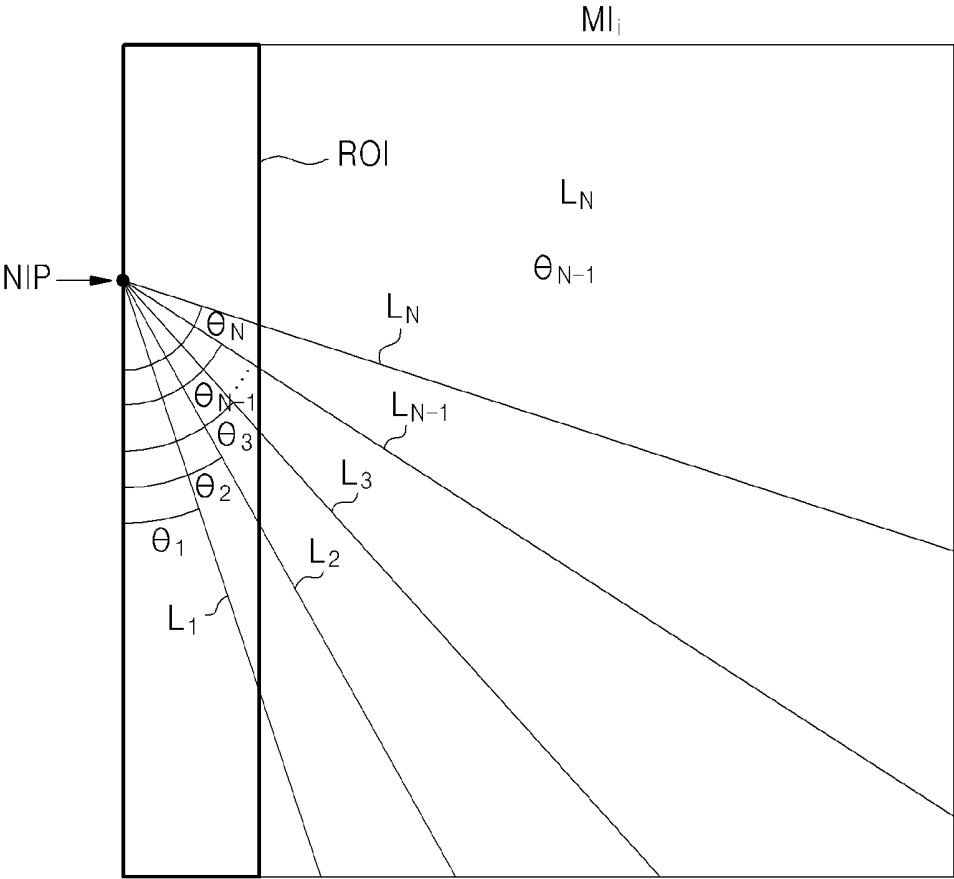


FIG. 9



ULTRASOUND SYSTEM AND METHOD FOR PROVIDING GUIDELINE OF NEEDLE

RELATED APPLICATIONS

[0001] This application claims the benefit of Korean Patent Application No. 10-2012-0134005, filed on Nov. 23, 2012, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND

[0002] 1. Field

[0003] One or more embodiments of the present invention relate to an ultrasound system, and more particularly, to an ultrasound system and method for providing a guideline of a needle.

[0004] 2. Description of the Related Art

[0005] With the advance of medical technology, technology is being used in which a user forms a minimum-size hole in an object without directly incising the object, inserts a medical needle, such as an ablator or a biopsy, into a body part having a lesion while looking at an internal image of the object, and treats or examines the lesion. Such a method performs a medical procedure while observing the inside of an object by using a medical image apparatus such as a computed tomography (CT) apparatus or a magnetic resonance imaging (MRI) apparatus, and thus is called a procedure therapy using an image or an interventional procedure therapy. That is, an interventional procedure denotes a medical procedure in which an operator directly brings a medical needle into contact with a lesion requiring an examination or a procedure while looking at an image obtained from an MRI apparatus or a CT apparatus during a medical procedure, and treats or examines the lesion. In comparison with a surgical treatment, the interventional procedure therapy does not require general anesthesia, is low in physical burden of an object, is low in pain, shortens a hospitalization period, and enables a patient to return to daily life early after a medical procedure, thus providing many benefits in terms of medical cost and effect.

[0006] However, when using a CT apparatus or an MRI apparatus, it is difficult to obtain an image of an object in real time. Also, when performing an interventional procedure with a CT apparatus, an operator and an object have a risk of being exposed to radioactivity for a long time. On the other hand, when using an ultrasound system, an ultrasound image is obtained in real time, and moreover, it is almost harmless to an object.

SUMMARY

[0007] One or more embodiments of the present invention include an ultrasound system and method that detect an input position of a needle by using an ultrasound image, and sets a guideline of the needle on the basis of the input position of the needle and a point which is set on the ultrasound image by a user. (see Claims for changes to the remaining Summary)

[0008] Additional aspects will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the presented embodiments.

[0009] According to one or more embodiments of the present invention, an ultrasound system includes: an ultrasound data acquirer that transmits an ultrasound signal to an object with a needle inserted thereto, and acquires ultra-

sound data corresponding to each of a plurality of ultrasound images by receiving an ultrasound echo signal reflected from the object; a user input unit that receives input information, used to set a point in an ultrasound image, from a user; and a processor that generates the plurality of ultrasound images with the ultrasound data, generates a mask image used to detect an input position of the needle by using the plurality of ultrasound images, detects the input position by using the mask image, and sets a guideline of the needle in the ultrasound image on a basis of the input position and the input information.

[0010] The processor may generate a plurality of copy ultrasound images by down-sampling the plurality of ultrasound images.

[0011] The processor may generate a motion image of the needle by using a certain number of copy ultrasound images among the plurality of copy ultrasound images.

[0012] The processor may select a certain number of copy ultrasound images in a temporal direction with respect to each of the plurality of copy ultrasound images.

[0013] The processor may generate the motion image of the needle with the following Equation (1):

$$NMI_i = \frac{|CUI_{i-2} - CUI_{i-1}| + |CUI_{i-1} - CUI_i| + |CUI_i - CUI_{i+1}| + |CUI_{i+1} - CUI_{i+2}|}{4} \quad (1)$$

where NMI_i denotes a needle motion image, and CUI_{i-2} to CUI_{i+2} respectively denote the selected copy ultrasound images.

[0014] The processor may generate a mask image used to emphasize the needle in the ultrasound image by using the ultrasound image and the motion image.

[0015] The processor may generate the mask image with the following Equation (2):

$$MI_i = UI_i \times \alpha + NMI_i \times (1 - \alpha) \quad (2)$$

where MI denotes the mask image, UI denotes the ultrasound image, and α denotes a weight value.

[0016] The processor may set a region of interest (ROI) having a predetermined size in the mask image in consideration of an input direction of the needle, calculate a plurality of brightness accumulation values by accumulating brightness values of respective pixels having different depths of the mask image in a width direction of the mask image, for a plurality of pixels in the ROI, detect a maximum brightness accumulation value from the plurality of the calculated brightness accumulation values, and detects a depth, corresponding to the detected maximum brightness accumulation value, as the input position of the needle.

[0017] The processor may set the input position and the point in the ultrasound image based on the input position of the needle and the input information, and set a line, which connects the input position and the point, as the guideline.

[0018] The processor may detect a motion of the point by performing motion tracking between adjacent ultrasound images with respect to the point set on each of the plurality of ultrasound images.

[0019] The processor may measure a distance between the point and the input position.

[0020] The processor may calculate an angle of the guideline with respect to the input position.

[0021] The processor may detect an input angle of the needle on a basis of the input position.

[0022] The processor may calculate a first average value of the plurality of brightness accumulation values, calculates a second average value of brightness accumulation values which are obtained by subtracting the first average value from the plurality of the brightness accumulation values, detects an intersection point between the second average value and the plurality of brightness accumulation values as a start point and an end point, calculates a length between the detected start point and end point, and calculates the input angle of the needle based on the calculated length.

[0023] The processor may calculate the input angle of the needle with the following Equation (3):

$$\theta_{IA} = \tan^{-1} \left(\frac{nNDLength}{\frac{W}{5}} \right) \quad (3)$$

where θ denotes the input angle of the needle, nNDLength denotes the length, and W denotes a width of the mask image.

[0024] The processor may set a plurality of angles with respect to the input position of the needle, set a line corresponding to each of the plurality of angles from the input position of the needle, calculate brightness accumulation values of pixels of a line corresponding to each of the plurality of angles, calculates a maximum brightness accumulation value from the calculated brightness accumulation values, and detect an angle, corresponding to the detected maximum brightness accumulation value, as the input angle of the needle.

[0025] According to one or more embodiments of the present invention, a method of providing a guideline of a needle includes: a) transmitting an ultrasound signal to an object with a needle inserted therein, and acquires ultrasound data corresponding to each of a plurality of ultrasound images by receiving an ultrasound echo signal reflected from the object; b) generating the plurality of ultrasound images with the ultrasound data; c) receiving input information, used to set a point in an ultrasound image, from a user; d) generating a mask image used to detect an input position of the needle by using the plurality of ultrasound images; e) detecting the input position by using the mask image; and f) setting a guideline of the needle in the ultrasound image based on the input position and the input information.

[0026] Operation d) may include d1) generating a plurality of copy ultrasound images by down-sampling the plurality of ultrasound images.

[0027] Operation d) may include d2) generating a motion image of the needle by using a certain number of copy ultrasound images among the plurality of copy ultrasound images.

[0028] Operation d2) may includes selecting a certain number of copy ultrasound images in a temporal direction with respect to each of the plurality of copy ultrasound images.

[0029] The generating of a motion image may include generating the motion image of the needle with the following Equation (1):

$$NMI_i = \frac{|CUI_{i-2} - CUI_{i-1}| + |CUI_{i-1} - CUI_i| + |CUI_i - CUI_{i+1}| + |CUI_{i+1} - CUI_{i+2}|}{4} \quad (1)$$

where NMI_i denotes a needle motion image, and CUI_{i-2} to CUI_{i+2} respectively denote the selected copy ultrasound images.

[0030] Operation d) may include d3) generating the mask image used to emphasize the needle in the ultrasound image by using the ultrasound image and the motion image.

[0031] Operation d3) may include generating the mask image with the following Equation (2):

$$MI_i = UI_i \times \alpha + NMI_i \times (1 - \alpha) \quad (2)$$

where MI denotes the mask image, UI denotes the ultrasound image, and α denotes a weight value.

[0032] Operation e) may include: setting a region of interest (ROI) having a predetermined size in the mask image in consideration of an input direction of the needle; calculating a plurality of brightness accumulation values by accumulating brightness values of respective pixels having different depths of the mask image in a width direction of the mask image, for a plurality of pixels in the ROI; detecting a maximum brightness accumulation value from the plurality of the calculated brightness accumulation values; and detecting a depth, corresponding to the detected maximum brightness accumulation value, as the input position of the needle.

[0033] Operation f) may include setting the input position and the point in the ultrasound image based on the input position of the needle and the input information, and setting a line, which connects the input position and the point, as the guideline.

[0034] Operation f) may include detecting a motion of the point by performing motion tracking between adjacent ultrasound images with respect to the point set on each of the plurality of ultrasound images.

[0035] The method may further include g) measuring a distance between the point and the input position.

[0036] Operation g) may include detecting an angle of the guideline with respect to the input position.

[0037] Operation g) may include detecting an input angle of the needle on a basis of the input position.

[0038] Operation g) may include: calculating a first average value of the plurality of brightness accumulation values; calculating a second average value of brightness accumulation values which are obtained by subtracting the first average value from the plurality of brightness accumulation values; detecting an intersection point between the second average value and the plurality of brightness accumulation values as a start point and an end point; calculating a length between the detected start point and end point; and calculating the input angle of the needle based on the calculated length.

[0039] The calculating of an input angle may include calculating the input angle of the needle with the following Equation (3):

$$\theta_{IA} = \tan^{-1} \left(\frac{nNDLength}{\frac{W}{5}} \right) \quad (3)$$

where θ denotes the input angle of the needle, $nNDLength$ denotes the length, and W denotes a width of the mask image.

[0040] Operation g) may include: setting a plurality of angles with respect to the input position of the needle; setting a line corresponding to each of the plurality of angles from the input position of the needle; calculating brightness accumulation values of pixels of a line corresponding to each of the plurality of angles; calculating a maximum brightness accumulation value from the calculated brightness accumulation values; and detecting an angle, corresponding to the detected maximum brightness accumulation value, as the input angle of the needle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] These and/or other aspects will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings in which:

[0042] FIG. 1 is a block diagram of a configuration of an ultrasound system according to an embodiment of the present invention;

[0043] FIG. 2 is a block diagram of a configuration of an ultrasound data acquirer according to an embodiment of the present invention;

[0044] FIG. 3 is an exemplary diagram illustrating a plurality of ultrasound images with time;

[0045] FIG. 4 is a flowchart of an operation of setting a guideline of a needle, according to an embodiment of the present invention;

[0046] FIG. 5 is an exemplary diagram illustrating a mask region and a first region of interest (ROI) according to an embodiment of the present invention;

[0047] FIG. 6 is an exemplary diagram illustrating a needle input position and a brightness accumulation value based on a depth, according to an embodiment of the present invention;

[0048] FIG. 7 is an exemplary diagram illustrating a needle guideline according to an embodiment of the present invention;

[0049] FIG. 8 is an exemplary diagram illustrating a first average value, a second average value, a start point, an end point, and a length for calculating an input angle of a needle, according to an embodiment of the present invention; and

[0050] FIG. 9 is an exemplary diagram illustrating a second region of interest (ROI), a plurality of angles, and a plurality of lines for calculating an input angle of a needle, according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0051] All terms including descriptive or technical terms which are used herein should be construed as having meanings that are obvious to one of ordinary skill in the art. However, the terms may have different meanings according to an intention of one of ordinary skill in the art, precedent cases, or the appearance of new technologies. In addition, some terms may be arbitrarily selected by the applicant, and in this case, the meaning of the selected terms will be described in detail in the detailed description. Thus, the terms used herein should be defined based on the meaning of the terms together with the description throughout the specification.

[0052] Further, when a part “includes” or “comprises” an element, unless there is a particular description contrary thereto, the part can further include other elements, not excluding the other elements. In the following description,

terms such as “unit” and “module” indicate a unit for processing at least one function or operation, wherein the unit and the block may be embodied as hardware or software or embodied by combining hardware and software.

[0053] Throughout the specification, “an ultrasound image” refers to an image which is obtained from an object by using ultrasonic waves. The object may refer to a part of the body. For example, the object may include an organ such as any one or more of a liver, a heart, a uterus, a brain, a breast, or an abdomen, or a fetus.

[0054] Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. In this regard, the present embodiments may have different forms and should not be construed as being limited to the descriptions set forth herein. Accordingly, the embodiments are merely described below, by referring to the figures, to explain aspects of the present description. As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items. Expressions such as “at least one of,” when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list.

[0055] Hereinafter, embodiments of the present invention will be described in detail with reference to the accompanying drawings.

[0056] FIG. 1 is a block diagram of a configuration of an ultrasound system 100 according to an embodiment of the present invention. Referring to FIG. 1, the ultrasound system 100 includes an ultrasound data acquirer 110, a user input unit 120, a processor 130, a storage 140, and a display 150. Also, the ultrasound system 100 includes a medical instrument (not shown) that is inserted into an object in a freehand type. The medical instrument includes a needle. However, the medical instrument is not limited thereto.

[0057] The ultrasound data acquirer 110 transmits an ultrasound signal to an object. The object includes an object (for example, a lesion, a heart, a liver). Also, the ultrasound data acquirer 110 receives the ultrasound signal (namely, an ultrasound echo signal) reflected from the object to acquire ultrasound data corresponding to an ultrasound image.

[0058] FIG. 2 is a block diagram of a configuration of the ultrasound data acquirer 110 according to an embodiment of the present invention. Referring to FIG. 2, the ultrasound data acquirer 110 includes an ultrasound probe 210, a transmission unit 220, a reception unit 230, and an ultrasound data generation unit 240.

[0059] The ultrasound probe 210 includes a plurality of transducer elements (not shown) that convert between an electrical signal and an ultrasound signal. The ultrasound probe 210 transmits an ultrasound signal to an object, and receives an ultrasound echo signal reflected from the object to output an electrical signal (hereinafter, referred to as a reception signal). The reception signal is an analog signal. The ultrasound probe 210 includes a convex probe, a linear probe, and a 3D probe.

[0060] The transmission unit 220 controls transmission of an ultrasound signal. Also, the transmission unit 220 generates an electrical signal (hereinafter, referred to as a transmission signal) for obtaining an ultrasound signal in consideration of a transducer element and a focusing point. In the embodiment, as illustrated in FIG. 3, the transmission unit 220 sequentially generates a plurality of transmission signals for respectively obtaining a plurality of ultrasound images

(UI_N ($N \geq 1$)). In FIG. 3, reference numeral LE refers to an lesion, and reference numeral NE refers to a medical instrument, namely, a needle. Therefore, the ultrasound probe 210 converts each of the transmission signals, sequentially supplied from the transmission unit 220, into an ultrasound signal, transmits the ultrasound signal to an object, and receives an ultrasound echo signal reflected from the object to generate a reception signal.

[0061] The reception unit 230 analog-digital-converts the reception signal supplied from the ultrasound probe 210 to generate a digital signal. Also, the reception unit 230 performs reception beamforming on the digital signal in consideration of the transducer element and the focusing point to generate a reception focusing signal. Reception beamforming may use various known methods, and thus, a detailed description thereof is not provided in the embodiment. In the embodiment, the reception unit 230 analog-digital-converts each of a plurality of reception signals sequentially supplied from the ultrasound probe 210 to generate a digital signal, and performs reception beamforming on the digital signal in consideration of the transducer element and the focusing point to generate a reception focusing signal.

[0062] The ultrasound data generation unit 240 generates ultrasound data corresponding to an ultrasound image by using the reception focusing signal supplied from the reception unit 230. The ultrasound data includes radio frequency (RF) data. However, the ultrasound data is not limited thereto. In the embodiment, the ultrasound data generation unit 240 generates ultrasound data corresponding to each of a plurality of ultrasound images (UI_N ($N \geq 1$)) by using a plurality of reception focusing signals sequentially supplied from the reception unit 230. Also, the ultrasound data acquirer 110 may perform various signal processing (for example, gain adjustment, etc.), which is necessary to generate the ultrasound data, on the reception focusing signal.

[0063] Referring again to FIG. 1, the user input unit 120 receives a user's input information. In the embodiment, the input information includes point setting information for setting a point on an ultrasound image. That is, the point setting information includes a size and position information of a point which is set on a lesion of the ultrasound image. However, the input information is not limited thereto. The user input unit 120 includes at least one of a control panel, a trackball, a touch screen, a keyboard, and a mouse.

[0064] The processor 130 is connected to the ultrasound data acquirer 110 and the user input unit 120. The processor 130 includes a central processing unit (CPU), a microprocessor, or a graphics processing unit (GPU).

[0065] FIG. 4 is a flowchart of an operation of setting a guideline of a medical instrument (i.e., a needle), according to an embodiment of the present invention. Referring to FIG. 4, the processor 130 generates an ultrasound image (UI_N ($N \geq 1$)) by using ultrasound data sequentially supplied from the ultrasound data acquirer 110 in operation S402.

[0066] The processor 130 down-samples the ultrasound image (UI_N ($N \geq 1$)) to generate a down-sampled ultrasound image (CUI_N ($N \geq 1$)) (hereinafter, referred to as a copy ultrasound image), for reducing a processing time and a storage space of the ultrasound image in operation S404. The down-sampling may use various known methods, and thus, a detailed description thereof is not provided in the embodiment.

[0067] The processor 130 generates a motion image (hereinafter, referred to as a needle motion image) by using a

certain number of copy ultrasound images in operation S406. In the embodiment, the processor 130 generates a needle motion image by using a certain number (for example, five) of copy ultrasound images CUI_{i-2} , CUI_{i-1} , CUI_i , CUI_{i+1} and CUI_{i+2} in a temporal direction with respect to the copy ultrasound image CUI_i . For example, the processor 130 generates a needle motion image NMI_i with the following Equation (1):

$$NMI_i = \frac{|CUI_{i-2} - CUI_{i-1}| + |CUI_{i-1} - CUI_i| + |CUI_i - CUI_{i+1}| + |CUI_{i+1} - CUI_{i+2}|}{4} \quad (1)$$

[0068] The processor 130 generates a mask image by using the ultrasound image UI_i and the needle motion image NMI_i in operation S408. The mask image is an image for emphasizing a needle portion in the ultrasound image UI_i . In the embodiment, the processor 130 generates a mask image MI_i with the following Equation (2):

$$MI_i = UI_i \times \alpha + NMI_i \times (1 - \alpha) \quad (2)$$

where α denotes a weight value, and is a preset value or a value set by a user.

[0069] The processor 130 detects an input position (an insertion position) of a needle by using the mask image MI_i . In the embodiment, the processor 130 sets a region of interest (ROI) having a predetermine size in the mask image MI_i in consideration of an input direction of the needle. The input direction of the needle may be manually set by a user, or may be automatically set by a system. For example, as illustrated in FIG. 5, the processor 130 sets an ROI having a size of a width W "0.2 × mask image MI_i " from the left of the mask image MI_i , in consideration of an input direction in which a needle NE is input from the left to the right with respect to the mask image MI_i . The processor 130, as illustrated in FIG. 6, accumulates brightness values of respective pixels having different depths in the ROI in a width direction of the mask image MI_i , thereby calculating a brightness accumulation value for each of the depths. The processor 130 detects the maximum brightness accumulation value from a plurality of the calculated brightness accumulation values, and detects a depth corresponding to the detected maximum brightness accumulation value as a needle input position NIP.

[0070] The processor 130, as illustrated in FIG. 7, sets the needle input position NIP and a point in the ultrasound image UI_i , on the basis of the needle input position NIP and input information (i.e., input information provided from the user input unit 120). The processor 130 sets a line, which connects the needle input position NIP and a point PO, as a needle guideline NGL.

[0071] In the above-described embodiment, it has been described above that an ultrasound image is down-sampled, and a needle motion image is generated by using the down-sampled image. However, in another embodiment, a needle motion image may be generated by using an ultrasound image without down-sampling the ultrasound image.

[0072] Alternatively, the processor 130 may perform motion tracking between adjacent ultrasound images with respect to a point set on each of a plurality of ultrasound images to detect a motion of the point, and reflect the detected motion of the point to set a guideline, indicating a path through which a needle is input, in an ultrasound image (UI_N ($N \geq 1$)).

[0073] Alternatively, the processor 130 may measure a distance between a point and an input position of a needle, and generate additional information including the measured distance. The distance may be measured by various known methods, and thus, a detailed description thereof is not provided in the embodiment.

[0074] Alternatively, as illustrated in FIG. 7, the processor 130 may calculate an angle (i.e., an angle indicating a degree of slope of a path through which a needle is input) of the guideline NGL with respect to the needle input position NIP, and generate additional information including the calculated angle. The angle may be calculated by various known methods, and thus, a detailed description thereof is not provided in the embodiment.

[0075] Alternatively, the processor 130 may calculate an input angle (an insertion angle) of a needle on the basis of the needle input position NIP, and generate additional information including the calculated input angle of the needle.

[0076] In an embodiment, as illustrated in FIG. 8, the processor 130 calculates a first average value “m1” of brightness accumulation values. The processor 130, as illustrated in FIG. 8, calculates a second average value “m2” of brightness accumulation values which are obtained by subtracting the first average value “m1” from the brightness accumulation values. The processor 130, as illustrated in FIG. 8, detects an intersection point between the second average value “m2” and the brightness accumulation values as a start point “nStart” and an end point “nEnd”. The processor 130 calculates a length “nNDLength” between the detected start point “nStart” and end point “nEnd”. The processor 130 calculates an input angle of a needle on the basis of the calculated length “nNDLength”. For example, the processor 130 may calculate the input angle “ θ_{IA} ” of the needle with the following Equation (3);

$$\theta_{IA} = \tan^{-1} \left(\frac{nNDLength}{\frac{W}{5}} \right) \quad (3)$$

[0077] In another embodiment, as illustrated in FIG. 9, the processor 130 sets a plurality of angles “ $\theta_i (1 \leq i \leq N)$ ” with respect to the needle input position NIP, and sets a line “ $L_i (1 \leq i \leq N)$ ” corresponding to each of the plurality of angles “ $\theta_i (1 \leq i \leq N)$ ” from the needle input position NIP. The processor 130 calculates brightness accumulation values of pixels respectively corresponding to the lines “ $L_i (1 \leq i \leq N)$ ”. The processor 130 detects the maximum brightness accumulation value from the calculated brightness accumulation values, and detects an angle, corresponding to the detected maximum brightness accumulation value, as an input angle of the needle.

[0078] Referring again to FIG. 1, the storage 140 stores ultrasound data acquired by the ultrasound data acquirer 110. Also, the storage 140 stores input information received by the user input unit 120. Also, the storage 140 stores an ultrasound image and a copy ultrasound image, which are generated by the processor 130. Also, the storage 140 stores additional information (including an input position, input angle, and guideline angle of a needle) generated by the processor 130.

[0079] The display 150 displays the ultrasound image and/or copy ultrasound image which is/is generated by the processor 130. Also, the display 150 displays the guideline set by the processor 130. Also, the display 150 displays the addi-

tional information (including the input position, input angle, and guideline angle of a needle) generated by the processor 130.

[0080] As described above, an ultrasound system provides a guideline of a needle in the freehand type that does not use an additional device such as a sensor and the like, and thus informs a user of a directionality and quantitative numerical information such as display of an angle and a distance. Accordingly, an accuracy of an interventional procedure using a needle increases, and a time is shortened in the interventional procedure.

[0081] It should be understood that the exemplary embodiments described therein should be considered in a descriptive sense only and not for purposes of limitation. Descriptions of features or aspects within each embodiment should typically be considered as available for other similar features or aspects in other embodiments.

[0082] While one or more embodiments of the present invention have been described with reference to the figures, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

What is claimed is:

1. An ultrasound system comprising:

an ultrasound data acquirer that transmits an ultrasound signal to an object with a needle inserted therein, and acquires ultrasound data corresponding to each of a plurality of ultrasound images by receiving an ultrasound echo signal reflected from the object;

a user input unit that receives input information, used to set a point in an ultrasound image, from a user; and

a processor that generates the plurality of ultrasound images with the ultrasound data, generates a mask image used to detect an input position of the needle by using the plurality of ultrasound images, detects the input position by using the mask image, and sets a guideline of the needle in the ultrasound image on a basis of the input position and the input information.

2. The ultrasound system of claim 1, wherein the processor generates a plurality of copy ultrasound images by down-sampling the plurality of ultrasound images.

3. The ultrasound system of claim 2, wherein the processor generates a motion image of the needle by using a certain number of copy ultrasound images among the plurality of copy ultrasound images.

4. The ultrasound system of claim 3, wherein the processor selects a certain number of copy ultrasound images in a temporal direction with respect to each of the plurality of copy ultrasound images.

5. The ultrasound system of claim 4, wherein the processor generates the motion image of the needle with a following Equation (1):

$$NMI_i = \frac{|CUI_{i-2} - CUI_{i-1}| + |CUI_{i-1} - CUI_i| + |CUI_i - CUI_{i+1}| + |CUI_{i+1} - CUI_{i+2}|}{4} \quad (1)$$

where NMI_i denotes a needle motion image, and CUI_{i-2} to CUI_{i+2} respectively denote the selected copy ultrasound images.

6. The ultrasound system of claim 3, wherein the processor generates a mask image used to emphasize the needle in the ultrasound image by using the ultrasound image and the motion image.

7. The ultrasound system of claim 6, wherein the processor generates the mask image with a following Equation (2):

$$MI_i = UI_i \times \alpha + NMI_i \times (1 - \alpha) \quad (2)$$

where MI denotes the mask image, UI denotes the ultrasound image, and α denotes a weight value.

8. The ultrasound system of claim 6, wherein the processor sets a region of interest (ROI) having a predetermined size in the mask image in consideration of an input direction of the needle, calculate a plurality of brightness accumulation values by accumulating brightness values of respective pixels having different depths of the mask image in a width direction of the mask image, for a plurality of pixels in the ROI, detects a maximum brightness accumulation value from the plurality of the calculated brightness accumulation values, and detects a depth, corresponding to the detected maximum brightness accumulation value, as the input position of the needle.

9. The ultrasound system of claim 8, wherein the processor sets the input position and the point in the ultrasound image based on the input position of the needle and the input information, and sets a line, which connects the input position and the point, as the guideline.

10. The ultrasound system of claim 9, wherein the processor detects a motion of the point by performing motion tracking between adjacent ultrasound images with respect to the point set on each of the plurality of ultrasound images.

11. The ultrasound system of claim 9, wherein the processor measures a distance between the point and the input position.

12. The ultrasound system of claim 9, wherein the processor calculates an angle of the guideline with respect to the input position.

13. The ultrasound system of claim 9, wherein the processor detects an input angle of the needle on a basis of the input position.

14. The ultrasound system of claim 13, wherein the processor calculates a first average value of the plurality of brightness accumulation values, calculates a second average value of brightness accumulation values which are obtained by subtracting the first average value from the plurality of the brightness accumulation values, detects an intersection point between the second average value and the plurality of brightness accumulation values as a start point and an end point, calculates a length between the detected start point and end point, and calculates the input angle of the needle based on the calculated length.

15. The ultrasound system of claim 13, wherein the processor calculates the input angle of the needle with a following Equation (3):

$$\theta_{IA} = \tan^{-1} \left(\frac{nNDLength}{W} \right) \quad (3)$$

where θ denotes the input angle of the needle, nNDLength denotes the length, and W denotes a width of the mask image.

16. The ultrasound system of claim 13, wherein the processor sets a plurality of angles with respect to the input

position of the needle, sets a line corresponding to each of the plurality of angles from the input position of the needle, calculates brightness accumulation values of pixels of a line corresponding to each of the plurality of angles, calculates a maximum brightness accumulation value from the calculated brightness accumulation values, and detects an angle, corresponding to the detected maximum brightness accumulation value, as the input angle of the needle.

17. A method of providing a guideline of a needle, the method comprising:

- a) transmitting an ultrasound signal to an object with a needle inserted therein, and acquires ultrasound data corresponding to each of a plurality of ultrasound images by receiving an ultrasound echo signal reflected from the object;
- b) generating the plurality of ultrasound images with the ultrasound data;
- c) receiving input information, used to set a point in an ultrasound image, from a user;
- d) generating a mask image used to detect an input position of the needle by using the plurality of ultrasound images;
- e) detecting the input position by using the mask image; and
- f) setting a guideline of the needle in the ultrasound image based on the input position and the input information.

18. The method of claim 17, wherein operation d) includes d1) generating a plurality of copy ultrasound images by down-sampling the plurality of ultrasound images.

19. The method of claim 17, wherein operation d) includes d2) generating a motion image of the needle by using a certain number of copy ultrasound images among the plurality of copy ultrasound images.

20. The method of claim 19, wherein operation d2) includes selecting a certain number of copy ultrasound images in a temporal direction with respect to each of the plurality of copy ultrasound images.

21. The method of claim 20, wherein the generating of a motion image includes generating the motion image of the needle with a following Equation (1):

$$NMI_i = \frac{|CUI_{i-2} - CUI_{i-1}| + |CUI_{i-1} - CUI_i| + |CUI_i - CUI_{i+1}| + |CUI_{i+1} - CUI_{i+2}|}{4} \quad (1)$$

where NMI_i denotes a needle motion image, and CUI_{i-2} to CUI_{i+2} respectively denote the selected copy ultrasound images.

22. The method of claim 19, wherein operation d) includes d3) generating the mask image used to emphasize the needle in the ultrasound image by using the ultrasound image and the motion image.

23. The method of claim 22, wherein operation d3) includes generating the mask image with a following Equation (2):

$$MI_i = UI_i \times \alpha + NMI_i \times (1 - \alpha) \quad (2)$$

where MI denotes the mask image, UI denotes the ultrasound image, and α denotes a weight value.

24. The method of claim 22, wherein operation e) includes: setting a region of interest (ROI) having a predetermined size in the mask image in consideration of an input direction of the needle;

calculating a plurality of brightness accumulation values by accumulating brightness values of respective pixels having different depths of the mask image in a width direction of the mask image, for a plurality of pixels in the ROI;

detecting a maximum brightness accumulation value from the plurality of the calculated brightness accumulation values; and

detecting a depth, corresponding to the detected maximum brightness accumulation value, as the input position of the needle.

25. The method of claim **24**, wherein operation f) includes setting the input position and the point in the ultrasound image based on the input position of the needle and the input information, and setting a line, which connects the input position and the point, as the guideline.

26. The method of claim **25**, wherein operation f) includes detecting a motion of the point by performing motion tracking between adjacent ultrasound images with respect to the point set on each of the plurality of ultrasound images.

27. The method of claim **24**, further comprising g) measuring a distance between the point and the input position.

28. The method of claim **24**, wherein operation g) includes detecting an angle of the guideline with respect to the input position.

29. The method of claim **24**, wherein operation g) includes detecting an input angle of the needle on a basis of the input position.

30. The method of claim **29**, wherein operation g) includes: calculating a first average value of the plurality of brightness accumulation values;

calculating a second average value of brightness accumulation values which are obtained by subtracting the first average value from the plurality of brightness accumulation values;

detecting an intersection point between the second average value and the plurality of brightness accumulation values as a start point and an end point;

calculating a length between the detected start point and end point; and

calculating the input angle of the needle based on the calculated length.

31. The method of claim **30**, wherein the calculating of an input angle includes calculating the input angle of the needle with a following Equation (3):

$$\theta_{IA} = \tan^{-1} \left(\frac{nNDLength}{\frac{W}{5}} \right) \quad (3)$$

where θ denotes the input angle of the needle, nNDLength denotes the length, and W denotes a width of the mask image.

32. The method of claim **29**, wherein operation g) includes: setting a plurality of angles with respect to the input position of the needle;

setting a line corresponding to each of the plurality of angles from the input position of the needle;

calculating brightness accumulation values of pixels of a line corresponding to each of the plurality of angles;

calculating a maximum brightness accumulation value from the calculated brightness accumulation values; and

detecting an angle, corresponding to the detected maximum brightness accumulation value, as the input angle of the needle.

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摘要(译)

公开了一种用于提供针的指导的超声系统和方法。超声系统包括超声数据获取器，其通过插入针来向对象发送超声信号，并且通过接收从对象反射的超声回波信号获取与多个超声图像中的每一个对应的超声数据，用户输入单元接收来自用户的用于设置超声图像中的点的输入信息，以及利用超声数据生成多个超声图像的处理器，生成用于通过使用所述超声图像检测针的输入位置的掩模图像。多个超声图像通过使用掩模图像来检测输入位置，并且基于输入位置和输入信息在超声图像中设置针的引导线。

