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Lin et al.

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(54) **APPARATUS, SYSTEM, AND METHOD FOR ADAPTIVELY CONTROLLING A FRAME INTERVAL BETWEEN ULTRASOUND SCANNING FRAMES FOR AN ULTRASOUND ELASTICITY IMAGING SCAN**

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A61B 8/00 (2006.01)

(52) **U.S. Cl.** **600/443**

(58) **Field of Classification Search** **600/443**
See application file for complete search history.

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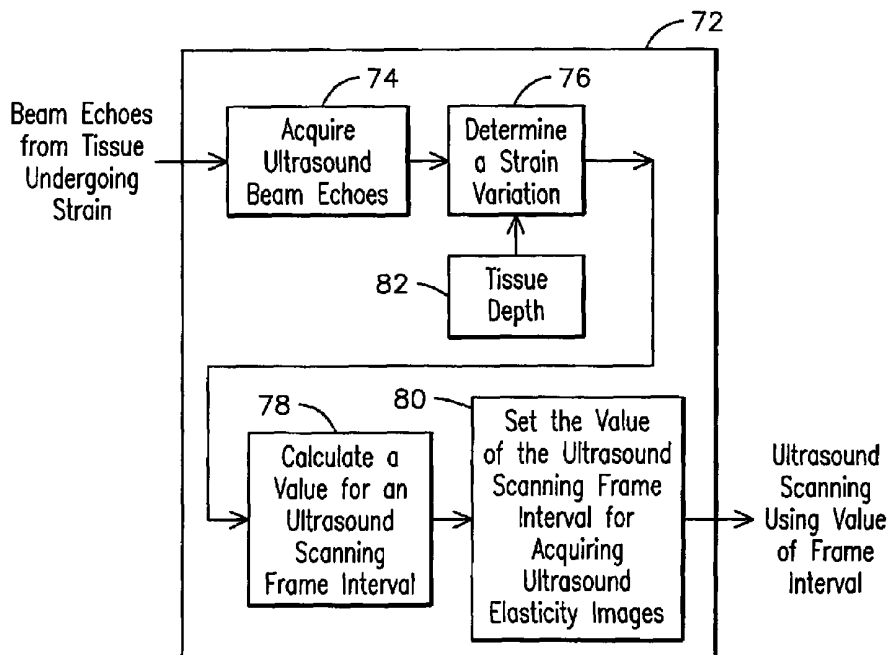
Assistant Examiner — Hien Nguyen

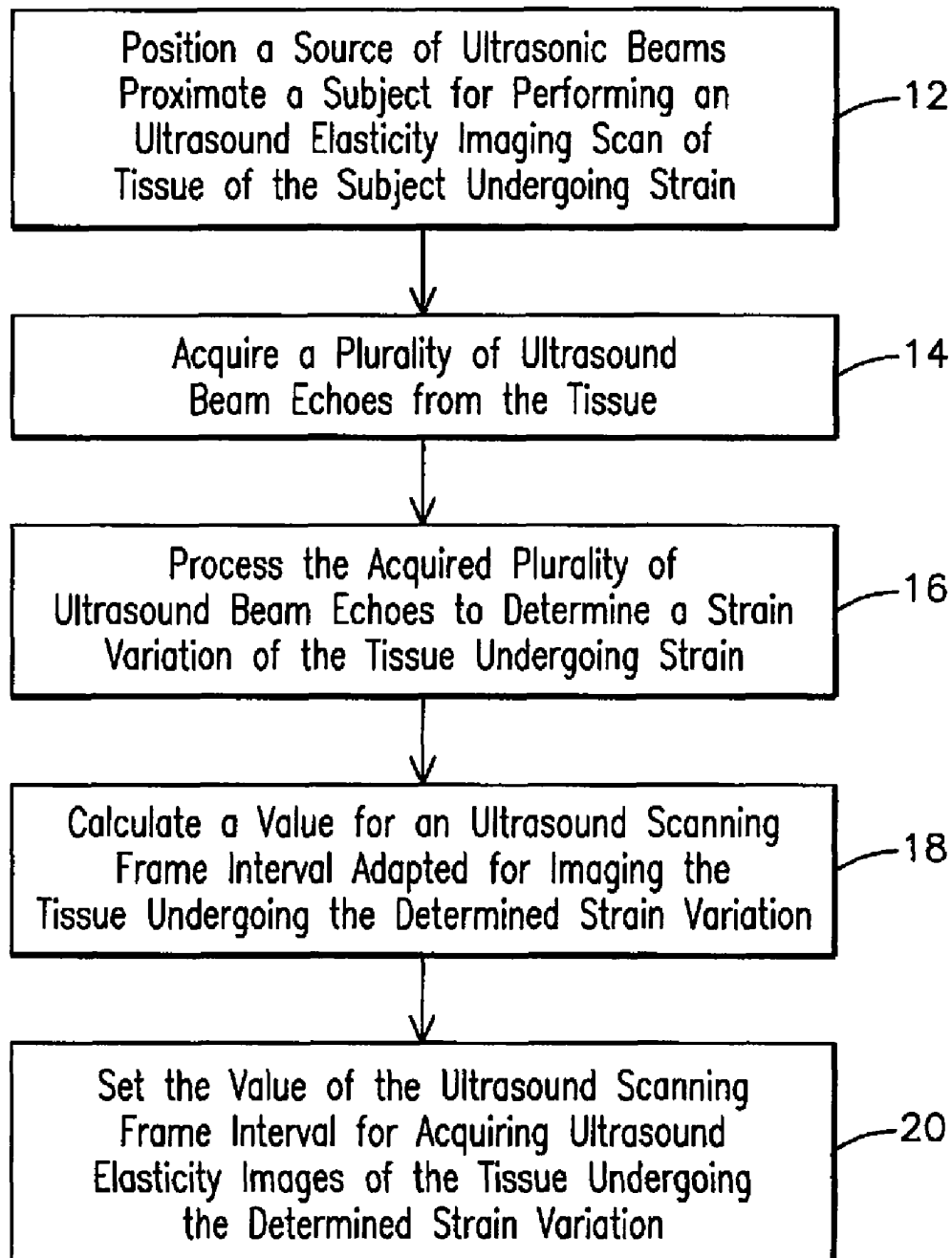
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(57) **ABSTRACT**

An apparatus, system and method for adaptively controlling a frame interval between ultrasound scanning frames of an ultrasound elasticity imaging scan. The system includes a transmitter for transmitting ultrasound beams to a subject during an ultrasound elasticity imaging scan, and a receiver for receiving ultrasound beam echoes from the subject responsive to transmitted ultrasound beams. The system also includes a processor for processing a plurality of the ultrasound beam echoes to determine a strain variation of the tissue undergoing strain, calculating a value for an ultrasound scanning frame interval adapted for imaging the tissue undergoing the determined strain variation, and setting the value of the ultrasound scanning frame interval for acquiring ultrasound elasticity images of the tissue undergoing the determined strain variation.

11 Claims, 4 Drawing Sheets



10*FIG. 1*

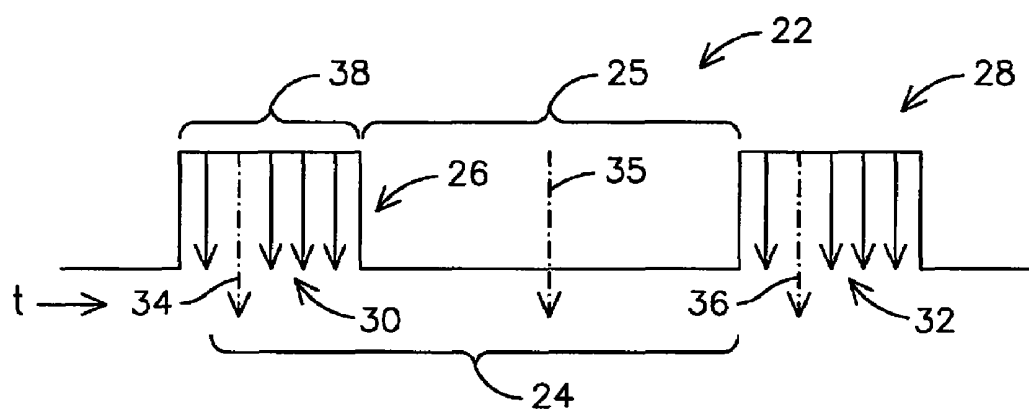


FIG. 2

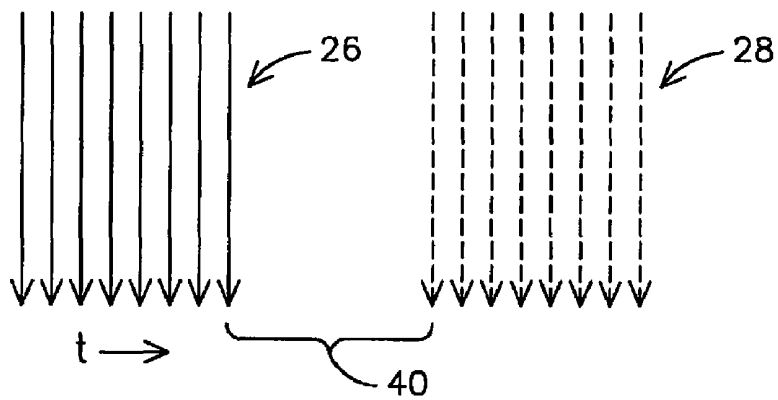


FIG. 3

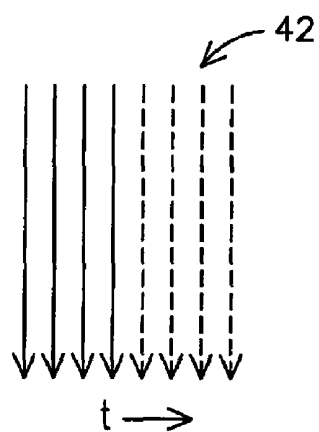
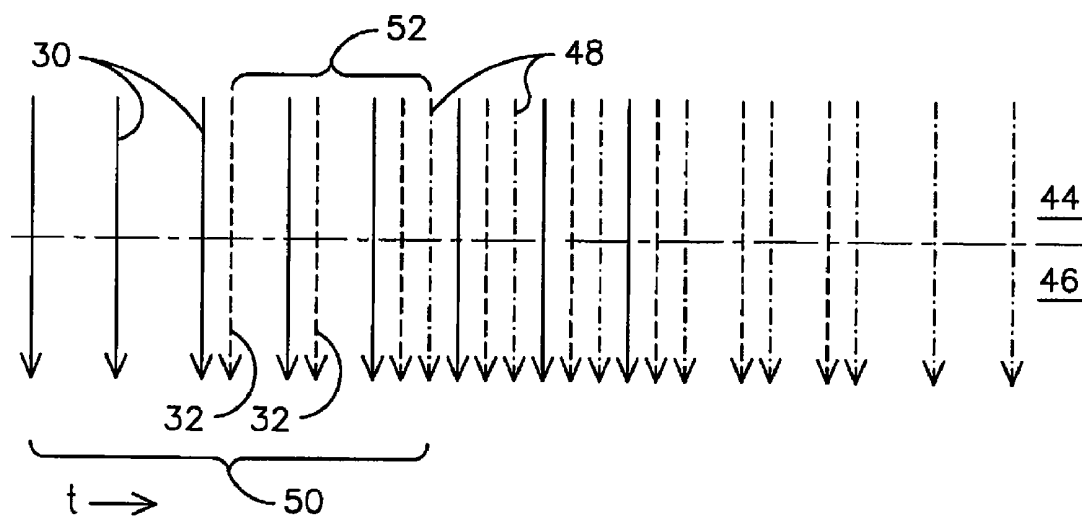
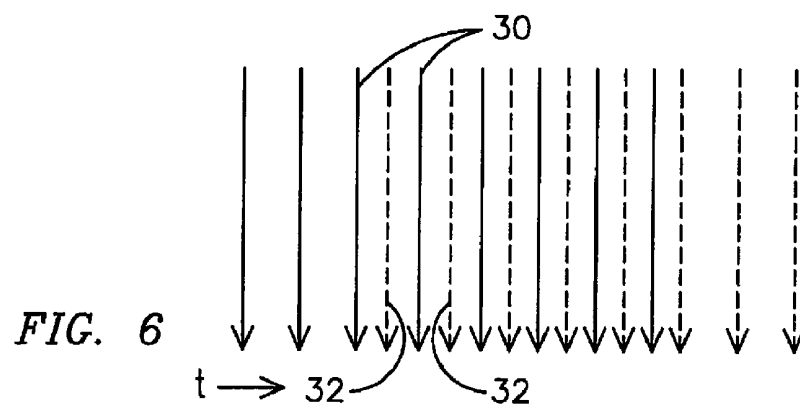
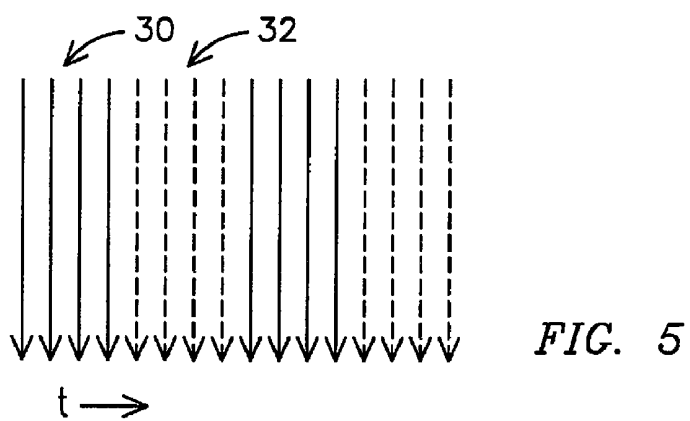


FIG. 4



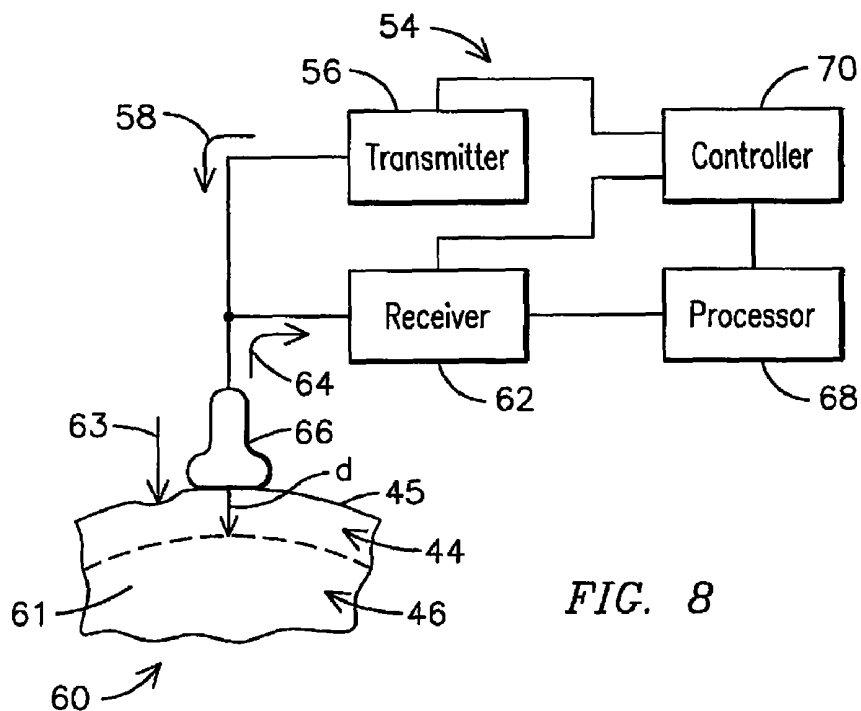


FIG. 8

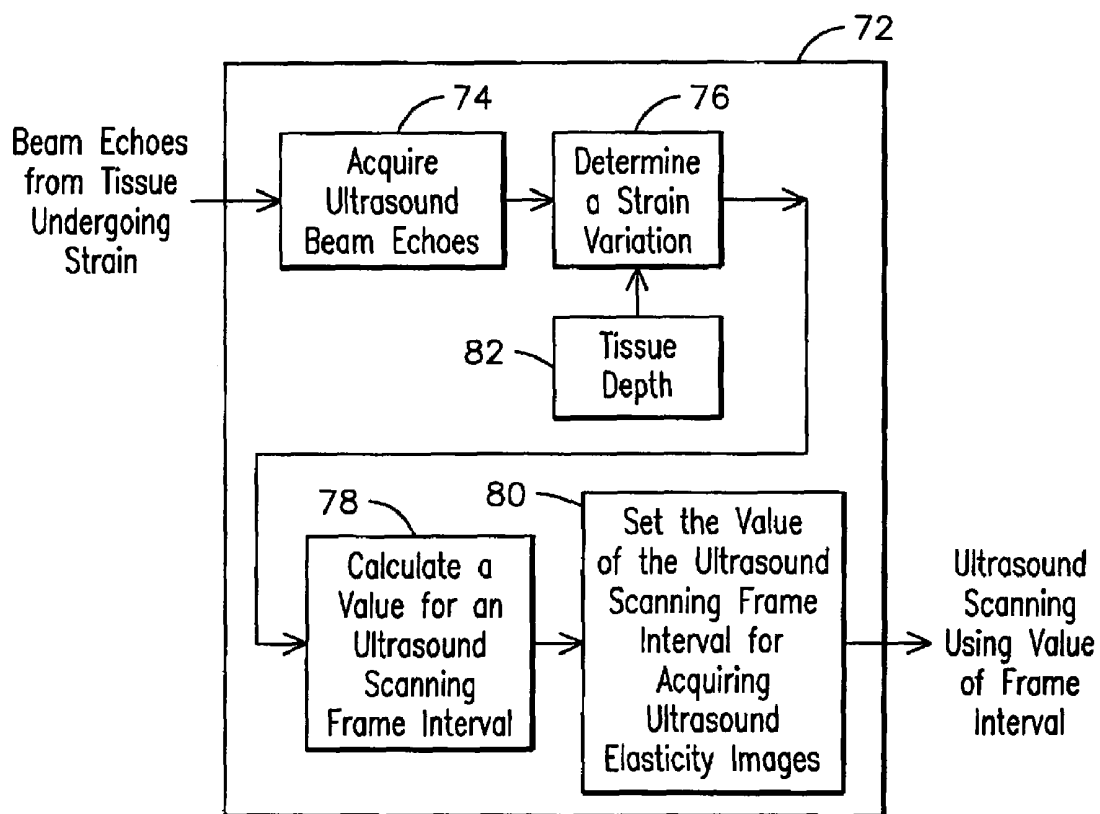


FIG. 9

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APPARATUS, SYSTEM, AND METHOD FOR ADAPTIVELY CONTROLLING A FRAME INTERVAL BETWEEN ULTRASOUND SCANNING FRAMES FOR AN ULTRASOUND ELASTICITY IMAGING SCAN

FIELD OF THE INVENTION

Embodiments of the present invention are generally related to imaging systems, and, more particularly, to adaptively controlling a frame interval between ultrasound scanning frames for an ultrasound elasticity imaging scan.

BACKGROUND OF THE INVENTION

Ultrasound elasticity imaging is useful for distinguishing tissues having different elastic properties. To perform ultrasound elasticity imaging of tissue in a desired region of interest (ROI), the tissue is excited, or palpated, by an external force, such as by manual palpitation, vibrational devices, and/or ultrasound beams. Alternatively, tissue may be excited by internal forces, such as forces resulting from a heart beat or blood vessel pulsation. Tissue deformation responsive to the excitation may be detected by directing ultrasound beams at the excited tissue and monitoring ultrasonic pulse echoes from the tissue at different times during excitation to obtain strain information related to elasticity of the tissue. Because strain is a function of a derivative of displacement, at least two time separated imaging frames received from the deformed tissue are required for each estimate of strain. Accordingly, elasticity imaging relies on sensing tissue deformation between two imaging frames to obtain strain information.

In conventional ultrasound elasticity imaging, a time interval between imaging frames to be compared for obtaining strain information is typically fixed a constant value. The fixed time interval is typically selected based on a general knowledge about the strain force being applied, such as a frequency and/or amplitude of the force. However, there may be times during elasticity imaging when there is no displacement, or only rigid displacement between frame intervals. Consequently, strain information may be difficult, if not impossible, to obtain. Conversely, when a deformation during a frame interval is too great, the resulting echoes may be insufficiently correlated to enable a reliable strain estimation.

BRIEF DESCRIPTION OF THE INVENTION

In an example embodiment, the invention includes a method for adaptively controlling a frame interval between ultrasound scanning frames of an ultrasound elasticity imaging scan, each frame including a plurality of ultrasound beams. The method includes acquiring a plurality of ultrasound beam echoes from tissue undergoing strain and processing the acquired plurality of ultrasound beam echoes to determine a strain variation of the tissue undergoing strain. The method also includes calculating a value for an ultrasound scanning frame interval adapted for imaging the tissue undergoing the determined strain variation and setting the value of the ultrasound scanning frame interval for acquiring ultrasound elasticity images of the tissue undergoing the determined strain variation.

In another example embodiment, the invention includes a method for adaptively controlling a frame interval between ultrasound scanning frames for an ultrasound elasticity imaging scan. The method includes positioning a source of ultrasound beams proximate a subject for performing an ultrasound elasticity imaging scan of tissue of the subject

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undergoing strain and acquiring a plurality of ultrasound beam echoes from the tissue. The method includes processing the acquired plurality of ultrasound beam echoes to determine a strain variation of the tissue undergoing strain based on a distance of the tissue from the source. The method also includes calculating a value for an ultrasound scanning frame interval adapted for imaging the tissue undergoing the determined strain variation and setting the value of the ultrasound scanning frame interval for acquiring ultrasound elasticity images of the tissue undergoing the determined strain variation.

In another example embodiment, the invention includes an apparatus for adaptively controlling a frame interval between ultrasound scanning frames of an ultrasound elasticity imaging scan. The apparatus includes a first module for acquiring a plurality of ultrasound beam echoes from tissue undergoing strain and a second module for processing the acquired plurality of ultrasound beam echoes to determine a strain variation of the tissue undergoing strain. The invention also includes a third module for calculating a value for an ultrasound scanning frame interval adapted for imaging the tissue undergoing the determined strain variation and a fourth module for setting the value of the ultrasound scanning frame interval for acquiring ultrasound elasticity images of the tissue undergoing the determined strain variation.

In another example embodiment, the invention includes a system for adaptively controlling a frame interval between ultrasound scanning frames of an ultrasound elasticity imaging scan. The system includes a transmitter for transmitting ultrasound beams to a subject during an ultrasound elasticity imaging scan and a receiver for receiving ultrasound beam echoes from the subject responsive to transmitted ultrasound beams. The invention also includes a processor for processing a plurality of the ultrasound beam echoes to determine a strain variation of the tissue undergoing strain, calculating a value for an ultrasound scanning frame interval adapted for imaging the tissue undergoing the determined strain variation, and setting the value of the ultrasound scanning frame interval for acquiring ultrasound elasticity images of the tissue undergoing the determined strain variation.

In another example embodiment, the invention includes computer readable media containing program instructions for adaptively controlling a frame interval between ultrasound scanning frames of an ultrasound elasticity imaging scan. The computer readable media includes a computer program code for acquiring a plurality of ultrasound beam echoes from tissue undergoing strain and a computer program code for processing the acquired plurality of ultrasound beam echoes to determine a strain variation of the tissue undergoing strain. The computer readable media also includes a computer program code for calculating a value for an ultrasound scanning frame interval adapted for imaging the tissue undergoing the determined strain variation and a computer program code for setting the value of the ultrasound scanning frame interval for acquiring ultrasound elasticity images of the tissue undergoing the determined strain variation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a block diagram of an example method for adaptively controlling a frame interval between ultrasound scanning frames for an ultrasound elasticity imaging scan.

FIG. 2 is a schematic timing diagram showing an example frame interval between two ultrasound scan frames.

FIG. 3 shows an example scanning sequence for an ultrasound elasticity scan according to an embodiment of the invention.

FIG. 4 shows an example scanning sequence for an ultrasound elasticity scan according to another embodiment of the invention.

FIG. 5 shows an example scanning sequence for an ultrasound elasticity scan according to another embodiment of the invention.

FIG. 6 shows an example scanning sequence for an ultrasound scan according to another embodiment of the invention.

FIG. 7 shows an example scanning sequence for an ultrasound elasticity scan for different tissues depths according to an embodiment of the invention.

FIG. 8 shows a schematic diagram of an example system for performing a scanning sequence for an ultrasound elasticity scan according to an embodiment of the invention.

FIG. 9 shows a schematic diagram of an example apparatus for performing a scanning sequence for an ultrasound elasticity scan according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The inventors have recognized that improved elasticity imaging may be achieved by adaptively adjusting an ultrasound elasticity imaging frame interval responsive to a strain variation of tissue being imaged. FIG. 1 shows a block diagram 10 of an example method for adaptively controlling a frame interval between ultrasound scanning frames for an ultrasound elasticity imaging scan. The method may include positioning a source of ultrasonic beams proximate a subject for performing an ultrasound elasticity imaging scan of tissue of the subject undergoing strain 12. The method may then include acquiring a plurality of ultrasound beam echoes from tissue undergoing strain 14, for example, for at least two ultrasound scan frames.

FIG. 2 is schematic timing diagram 22 showing an example frame interval 24 between two ultrasound scan frames 26, 28 having a frame length 38 useful for explaining certain aspects of the invention. Each ultrasound scan frame 26, 28 may include a number of ultrasound scanning beams 30, 32 fired during the frame 26, 28 according to a desired scan sequence. In an embodiment, a reduced number of ultrasound beams than normally used for ultrasound scanning, i.e., detective beams 34, 35, 36, may be used during a strain variation determination process, for example, independently of beam scan frames used for normal imaging. The detective beams 34, 35, 36 may be equally spaced in time and may have a different pulse repetition interval (PRI) than a PRI that is used for normal scan frames, such as scan frames 26, 28. The detective beams 34, 35, 36 may be interleaved inside a frame, or may be used in an inter-frame region 25. In an embodiment, the detective beams 34, 35, 36 may be asynchronous with respect to normal scan frames.

Returning to FIG. 1, the ultrasound echo beams acquired in step 14 may be responsive to detective beams, such as detective beams 34, 35, 36, directed at the tissue undergoing strain. The detective beams, such as detective beams 34, 35, 36, may be fixed at predetermined positions within a ROI of a subject. In one example embodiment, the detective beams may be configured to be equally distributed in a ROI. In another embodiment, a time interval between the detective beams 34, 35, 36 may be predetermined. By limiting a number of beams used to acquire the ultrasound beam echoes in step 14, a processing requirement and a corresponding processing time may be reduced compared to having to process all beams of a normal scan frame.

After the beam echoes, for example, from at least the detective beams, are acquired for at least two frames, the

method may include processing the acquired plurality of ultrasound beam echoes to determine a strain variation of the tissue undergoing strain 16. In one example embodiment, an average strain between frames may be determined for use as an estimate for strain variation. Average strain may be calculated as a function of tissue depth using known techniques, such as direct strain estimation, and then averaging the strain along the depth. In another example embodiment, displacements at certain depths may be estimated using, for example, a known cross correlation method. The corresponding strains may then be calculated by dividing the displacements by the corresponding depths and averaging the resulting strains.

After a strain variation has been determined, the method may include calculating a value for an ultrasound scanning frame interval that is adapted for imaging the tissue undergoing the determined strain variation 18. In an aspect of the invention, calculating this value may be performed based on at least one of the determined strain variation, the predetermined time interval of detective beams, and a desired amount of strain, such as an optimal amount of strain. An optimized ultrasound scanning frame interval value may correspond to acquiring beam echoes at time intervals when strain has a desired profile, such as desired average strain.

A strategy for calculating a value of a frame interval may be different depending on how an external force is applied during elasticity scanning. For example, when using free hand palpation, the strain variation may be comparatively slow, so that a desired value of a frame interval may be derived directly from an average determined strain variation. Accordingly, a frame interval may be calculated according equation 1:

$$T = \frac{St}{s} \quad 1)$$

where s represents the average strain, t represents a predetermined time interval of detective beams, S represents a strain variation corresponding to a preferred strain profile, and T represents the desired ultrasound scanning frame interval.

When a vibrational device is used to impart an external force, the resulting strain variation is typically periodic. Accordingly, a history of the average strain may be used to estimate a period and a phase of the variation. A desired ultrasound scanning frame interval may be selected to synchronize beam echo acquisition with the periodic strain variation.

Once a value for a frame interval has been calculated, the method may include setting the value of the ultrasound scanning frame interval for acquiring ultrasound elasticity images of the tissue undergoing the determined strain variation 20. In an aspect of the invention, steps 14-20 may be sequentially repeated while imaging the tissue undergoing strain so that the frame interval is dynamically adapted, for example, in real time, or near real time, to ensure that beam echoes are acquired at a frame interval that is desired for improved elasticity imaging compared to a fixed frame interval.

In an aspect of the invention, the determined strain variation may affect the frame length and/or a scanning sequence used within the frame to acquire elasticity images. A nominal frame length may be determined by a number of beams in a tissue ROI and an allowable minimum time interval between ultrasound beams. The minimum time interval between ultrasound beams may be limited by a distance between a source of ultrasound beams from the tissue ROI and an acoustic attenuation of the tissue. For example, as shown in FIG. 3,

with reference to FIG. 2, when a value of a frame interval 24 is greater than a frame length 38 of an ultrasound scanning frame, a blank interval 40 may be inserted between the ultrasound scan frames 26, 28.

However, when a value of the ultrasound scanning frame interval 24 needs to be less than a length 38 of an ultrasound scanning frame, scanning sequences of the beams 30, 32 may need to be modified to accommodate a frame interval 24 less than a frame length 38. For example, a number of beams in a frame may be reduced to fit within a frame length 38 less than or equal to a frame interval 24. Reducing a number of beams to fit within a frame interval 24 may include truncating at least one of the beams in at least one of two frames and then concatenating the remaining beams of the two frames so that at least some beams of each of the two frames are scanned during the frame interval 24. As shown in FIG. 4, beams 30 from one frame (indicated by continuous lined arrows) and beams from another frame 32 (indicated by dashed lined arrows) are concatenated in a single frame 42.

In another example embodiment, interleaving of beams may be used to ensure that beams from different frames fit within a frame length 38 less than or equal to a frame interval 24, such as by interleaving beams of a first frame with beams of a second frame so that at least some beams of each of the first and second frames are scanned during a frame interval 24. Interleaving may include grouping beams from each of the frames into respective beam groups and then interspersing the beam groups of the first frame between beam groups of the second frame. As shown in FIG. 5, a group of beams 30 from one frame (indicated by continuous lined arrows) and a group of beams 32 from another frame (indicated by dashed lined arrows) are interleaved so beams from both frames are scanned during a frame interval 24.

In another example embodiment, a smooth interleaving scheme may be used to reduce motion artifacts compared to group interleaving. As shown in FIG. 6, beams 30 (indicated by continuous lined arrows) of a first frame may be interleaved with beams 32 (indicated by dashed lined arrows) of a second frame so that at least some beams of each of the first and second frames are scanned during a frame interval 24. Interleaving in this manner may be accomplished by interspersing beams 30 from the first frame between beams 32 of the second frame.

In another aspect of the invention, processing the acquired plurality of ultrasound beam echoes to determine a strain variation of the tissue undergoing strain may be based on a distance of the tissue from an ultrasound source. For example, as shown in FIG. 8, a distance (d) may include a depth of the tissue 61 from an ultrasound probe 66 applied to a surface 45 of a subject 60 undergoing an ultrasound elasticity scan. An amount of deformation required for strain estimation may be different for tissue that is relatively close to the probe 66, such as less than about 2 centimeters (cm) (i.e., in a near field) compared to tissue that is relatively far from the probe 66, such as more than about 2 cm (i.e., in a far field) Ultrasound echoes from far field tissue may be more likely to be decorrelated, because the propagation path through the deformed tissue is much longer than for ultrasound echoes signals from near field tissue. Consequently, the strain may have a different quality if the same frame interval is used for signals at the near field and the far field.

Accordingly, a desired scanning value may be determined based on a tissue depth. An expected strain and/or displacement value may be assigned to different depth regions, such as near field and far field regions. The frame interval for desired strain/displacement for each region may be independently estimated based on its assigned strain or displacement

value. In addition, in some elasticity imaging situations, such as when using manual compression scanning, optimal strain/displacement for different tissue depths may occur at different times. Rather than wait until an average strain and/or displacement occurs, images at each depth may be updated independently to achieve a faster frame rate perception. Consequently, different pulse repetition intervals between beams of different frames may be used depending of tissue depth. For example, beam echoes may be processed at a longer pulse repetition interval of the beams for tissue being imaged at a shallower depth than tissue being imaged at a deeper depth. Conversely, beam echoes may be processed at a shorter pulse repetition interval for tissue being imaged at a deeper depth than tissue being imaged at a shallower depth.

FIG. 7 shows example beam scanning sequences that may be used to perform a strain variation estimation based on depth of the tissue. As shown in FIG. 7, strain in the near field 44 may be obtained by comparing beam echoes from solid lined beams 30 with beam echoes from dashed dotted line beams 48 at a pulse repetition interval 50 of fourteen, for example. Strain in the far field 46 may be obtained by comparing beam echoes from dash lined beams 32 with beam echoes from dashed dotted line beams 48 at a pulse repetition interval 52 of seven, for example. Accordingly, far field strain estimation may be obtained more quickly than near field estimation.

FIG. 8 shows a system 54 for performing a scanning sequence for an ultrasound scan, such as one or more of the example scanning sequences described above. The system 54 may include a transmitter 56 for transmitting ultrasound beams 58 to tissue 61 of a subject 60 during an ultrasound scan. The system 54 may also include a receiver 62 for receiving beam echoes 64 from the subject 60 responsive to the transmitted ultrasound beams 58. An ultrasound probe 66 may be configured for receiving the ultrasound beams 58 from the transmitter 56 and providing beam echoes 64 from the subject 60 to the receiver 62.

The system 54 may also include a processor 68 for processing a plurality of the echoes signals 64 to determine a strain variation of the tissue 61 undergoing strain as a result of force 63, for example, calculating a value for an ultrasound scanning frame interval adapted for imaging the tissue 61 undergoing the determined strain variation, and setting the value of the ultrasound scanning frame interval for acquiring ultrasound elasticity images of the tissue 61 undergoing the determined strain variation. The system may also include a controller 70 in communication with the processor 68 for controlling an operation of the transmitter 56 according to the value of the ultrasound scanning frame. The controller 70 may be in communication with the transmitter 56 for controlling the transmitter 56 to transmit beams according to a desired frame interval and/or beam scanning sequence. The controller 70 may also be in communication with the receiver 62 to process received beam echoes 64 according to the frame interval and/or scanning sequence.

FIG. 9 shows an example apparatus 72 for adaptively controlling a frame interval between ultrasound scanning frames of an ultrasound elasticity imaging scan is shown. The apparatus may include a first module 74 for acquiring a plurality of ultrasound beam echoes from tissue undergoing strain and a second module 76 processing the acquired plurality of ultrasound beam echoes to determine a strain variation of the tissue undergoing strain. The apparatus may also include a third module 78 for calculating a value for an ultrasound scanning frame interval adapted for imaging the tissue undergoing the determined strain variation and a fourth module 80 for setting the value of the ultrasound scanning frame interval

for acquiring ultrasound elasticity images of the tissue undergoing the determined strain variation. The value of the frame interval may then be used for performing an ultrasound scan to achieve improved ultrasound elasticity imaging results. The apparatus 72 may also include a fifth module 82 for providing tissue depth information to the second module 76 to be used for processing the acquired plurality of ultrasound beam echoes.

Based on the foregoing specification, the invention may be implemented using computer programming or engineering techniques including computer software, firmware, hardware or any combination or subset thereof, wherein the technical effect is to adaptively control a frame interval between ultrasound scanning frames of an ultrasound elasticity imaging scan. Any such resulting program, having computer-readable code means, may be embodied or provided within one or more computer-readable media, thereby making a computer program product, i.e., an article of manufacture, according to the invention. The computer readable media may be, for instance, a fixed (hard) drive, diskette, optical disk, magnetic tape, semiconductor memory such as read-only memory (ROM), etc., or any transmitting/receiving medium such as the Internet or other communication network or link. The article of manufacture containing the computer code may be made and/or used by executing the code directly from one medium, by copying the code from one medium to another medium, or by transmitting the code over a network.

One skilled in the art of computer science will easily be able to combine the software created as described with appropriate general purpose or special purpose computer hardware, such as a microprocessor, to create a computer system or computer sub-system embodying the method of the invention. An apparatus for making, using or selling the invention may be one or more processing systems including, but not limited to, a central processing unit (CPU), memory, storage devices, communication links and devices, servers, I/O devices, or any sub-components of one or more processing systems, including software, firmware, hardware or any combination or subset thereof, which embody the invention.

While certain embodiments of the present invention have been shown and described herein, such embodiments are provided by way of example only. Numerous variations, changes and substitutions will occur to those of skill in the art without departing from the invention herein. Accordingly, it is intended that the invention be limited only by the spirit and scope of the appended claims.

What is claimed is:

1. An apparatus to adaptively control a frame interval between ultrasound scanning frames of an ultrasound elasticity imaging scan comprising:

- a first module configured to acquire a plurality of ultrasound beam echoes from tissue undergoing strain, wherein some of the beam echoes are generated in response to a number of detective beams directed to determine a strain variation of the tissue undergoing strain, the detective beams comprising a reduced number of ultrasound beams relative to a number of ultrasound beams normally used to perform an ultrasound elasticity imaging scan of the tissue undergoing strain;
- a second module configured to process the acquired plurality of ultrasound beam echoes resulting from the detective beams to determine the strain variation of the tissue undergoing strain;
- a third module configured to calculate a value for an ultrasound scanning frame interval adapted to image the tissue undergoing the determined strain variation,

wherein the calculated value is based at least on the determined strain variation of the tissue; and

a fourth module configured to set the value of the ultrasound scanning frame interval for acquiring ultrasound elasticity images of the tissue undergoing the determined strain variation.

2. The apparatus of claim 1, further comprising a fifth module to provide tissue depth information to the second module to be used to process the acquired plurality of ultrasound beam echoes resulting from the detective beams.

3. A system to adaptively control a frame interval between ultrasound scanning frames of an ultrasound elasticity imaging scan comprising:

- a transmitter configured to transmit ultrasound beams to a subject during an ultrasound elasticity imaging scan, some of the ultrasound beams comprising a number of detective beams directed to determine a strain variation of the tissue undergoing strain, the detective beams comprising a reduced number of ultrasound beams relative to a number of ultrasound beams normally used to perform an ultrasound elasticity imaging scan of the tissue undergoing strain;

- a receiver configured to receive ultrasound beam echoes, some of the ultrasound beam echoes resulting from the detective beams; and

- a processor configured to process the ultrasound beam echoes, which result from the detective beams to determine the strain variation of the tissue undergoing strain, the processor further configured to calculate a value for an ultrasound scanning frame interval to image the tissue undergoing the determined strain variation, wherein the calculated value is based at least on the determined strain variation of the tissue, and to set the value of the ultrasound scanning frame interval to acquire ultrasound elasticity images of the tissue undergoing the determined strain variation.

4. The system of claim 3, further comprising a controller in communication with the processor to control an operation of the transmitter according to the value of the ultrasound scanning frame interval.

5. The system of claim 4, wherein the processor is further configured to instruct the controller to direct the reduced number of ultrasound beams.

6. The system of claim 3, wherein the processor is further configured to process the acquired plurality of ultrasound beam echoes, which result from the detective beams based on a distance of the tissue from a source of ultrasound beams.

7. A non-transitory computer readable storage media containing program instructions, which when executed by a processor allows to adaptively control a frame interval between ultrasound scanning frames of an ultrasound elasticity imaging scan, the computer readable storage media comprising:

- a computer program code to acquire a plurality of ultrasound beam echoes from tissue undergoing strain, wherein some of the beam echoes are generated in response to a number of detective beams directed to determine a strain variation of the tissue undergoing strain, the detective beams comprising a reduced number of ultrasound beams relative to a number of ultrasound beams normally used to perform an ultrasound elasticity imaging scan of the tissue undergoing strain;
- a computer program code to process the acquired plurality of ultrasound beam echoes resulting from the detective beams to determine the strain variation of the tissue undergoing strain;
- a computer program code to calculate a value for an ultrasound scanning frame interval to image the tissue under-

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going the determined strain variation, wherein the calculated value is based at least on the determined strain variation of the tissue; and

a computer program code to set the value of the ultrasound scanning frame interval to acquire ultrasound elasticity images of the tissue undergoing the determined strain variation.

8. The system of claim 3, wherein, when the calculated value of the ultrasound scanning frame interval is less than a predetermined length of an ultrasound scanning frame of the ultrasound elasticity imaging scan, the processor is configured to truncate at least one ultrasound beam in at least one of two successive scanning frames, and to concatenate the two frames so that at least some ultrasound beams of each of the two scanning frames are scanned during the frame interval.

9. The system of claim 3, wherein, when the calculated value of the ultrasound scanning frame interval is less than a predetermined length of an ultrasound scanning frame of the

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ultrasound elasticity imaging scan, the processor is configured to interleave ultrasound beams of a first scanning frame with ultrasound beams of a succeeding second scanning frame so that at least some ultrasound beams of each of the first and second frames are scanned during the frame interval.

10. The system of claim 3, wherein, when the calculated value of the ultrasound scanning frame interval is greater than a predetermined length of an ultrasound scanning frame of the ultrasound elasticity imaging scan, the processor is configured to insert a gap interval between two successive scanning frames.

11. The apparatus of claim 2, wherein the second module is configured to process the beam echoes resulting from the detected beams at a shorter pulse repetition interval for tissue being imaged at a deeper depth than tissue being imaged at a shallower depth.

* * * * *

专利名称(译)	用于自适应地控制超声扫描帧之间的帧间隔以进行超声弹性成像扫描的装置，系统和方法		
公开(公告)号	US8123692	公开(公告)日	2012-02-28
申请号	US11/567285	申请日	2006-12-06
[标]申请(专利权)人(译)	林峰 危险CHRISTOPHER ROBERT 赛义德BOLORFOROSH MIRSAID HILTAWSKY KARSTEN 吴哲		
申请(专利权)人(译)	林枫 危险CHRISTOPHER ROBERT 赛义德 - BOLORFOROSH MIRSAID HILTAWSKY KARSTEN 吴哲		
当前申请(专利权)人(译)	通用电气公司		
[标]发明人	LIN FENG HAZARD CHRISTOPHER ROBERT SEYED BOLORFOROSH MIRSAID HILTAWSKY KARSTEN WU ZHE		
发明人	LIN, FENG HAZARD, CHRISTOPHER ROBERT SEYED-BOLORFOROSH, MIRSAID HILTAWSKY, KARSTEN WU, ZHE		
IPC分类号	A61B8/00		
CPC分类号	A61B8/08 A61B8/485 G01S7/52085 A61B8/0858 G01N29/041 G01N29/043		
代理机构(译)	阿斯穆斯，SCOTT J.		
助理审查员(译)	阮HIEN		
其他公开文献	US20080139935A1		
外部链接	Espacenet USPTO		

摘要(译)

一种用于自适应地控制超声弹性成像扫描的超声扫描帧之间的帧间隔的装置，系统和方法。该系统包括：发射器，用于在超声弹性成像扫描期间将超声波束发射到受试者；以及接收器，用于响应于发射的超声波束从受试者接收超声波束回波。该系统还包括处理器，用于处理多个超声波束回波以确定经受应变的组织的应变变化，计算适于对经历所确定的应变变化的组织进行成像的超声扫描帧间隔的值，并设定该值。超声扫描帧间隔用于获取经历所确定的应变变化的组织的超声弹性图像。

