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Rapid Multidimensional Strain Imaging for Cardiac, Abdominal and Other Applications

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Technology description

Elastography is an imaging technique that uses ultrasound to assess tissue stiffness by comparing the displacement of the tissue under deformation. When tissue is compressed, stiffer tissue will displace or deform less than more flexible tissue. Stiffness properties of the imaged tissue then can be used to detect breast cancer or other pathological changes that alter tissue stiffness.

To assess stiffness, images of the tissue before and after it is compressed are obtained using ultrasound. Then portions of the images are analyzed along a series of one-dimensional kernels extending along the axis of compression, and the signal in each kernel in the pre-compression image is compared to the corresponding post-compression signal.

To accurately measure strain, the displacement must be measured in multiple dimensions. However, in multi-dimensional elastography the kernels encompass more data and must be cross-correlated in two or three dimensions, increasing the computational burden and acquisition time. The computation is complicated further because in many ultrasonic scanning systems the ultrasonic beam spreads outward in a fan beam. The fan beam must be modified to use conventional methods to track lateral tissue displacement. A new technique for computing two- and three-dimensional tissue displacement is needed that requires no modifications to current ultrasonic equipment while providing high resolution images with low acquisition times. UW-Madison researchers have developed an improved method of accurately and rapidly providing an elastographic image of tissue strain. This method estimates axial, lateral and elevational displacements for data acquired using an ultrasonic beam in a phased array, sector or fan-shaped geometry.

Pre- and post- deformation data in the radial direction are acquired using ultrasound. These data are processed from a coarse-to-fine scale, on the pre- and post-deformation echo signals. This approach improves the spatial resolution of the displacement and strain estimates as well as the computational efficiency.

Coarse displacement estimates guide the tracking and estimation of fine displacement estimates on radiofrequency echo signals, typically performed in two to four stages. The signals from pre-deformation data segments in the radial direction are correlated to corresponding post-deformation echo signals to indicate movement during deformation. Pre-deformation echo-signals from each radial line also are compared to those lines laterally or elevationally adjacent to them.

Then displacements from the segment pairs with the maximum correlation are defined as the displacement peak, and sub-sample displacement estimates are obtained by interpolating the displacements about the peak, using a sector or phased array grid to estimate displacement vector images. That image may incorporate a color scale and can represent either tissue displacement or tissue strain.
The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing an elastographic imaging system that provides axial, lateral and elevational strain measurements that can improve two- and three-dimensional elastography.

Application area

Imaging applications that use ultrasound, such as cardiac imaging.

Advantages

Increases image resolution by improving the spatial resolution of the displacement and strain estimates
Displays fine resolution for axial, lateral and/or elevational displacement or strain
Improves computational efficiency
Reduces the number of lines that must be analyzed
Requires no modification to ultrasound hardware

Institution

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