Electromechanical Wave Imaging of the Cardiovascular System

Technology #1781

This technology allows physicians and medical professionals to assess the viability and integrity of cardiac muscle by imaging both its mechanical properties and its electrical conductivity. The technology uses electromechanical wave imaging to measure vibrations of the myocardium (which are believed to be caused by the opening and closing of the mitral and aortic valves). Previous technology measured the delayed contraction through the propagation of the electrical wave. This technology images the coupling between the electrical activation and the mechanical contraction in a non-invasive way and only requires basic ultrasound scanning technology. Measuring the properties of the propagating mechanical (shear) wave, gives all the required information. Furthermore, the speed of the shear wave may help pinpoint the underlying properties of the myocardium changes that occur in patients with ischemia or myocardial infarction.

Highly sensitive cardiovascular imaging improves discovery of cardiovascular complications

Vital diagnostic information can be obtained by analyzing the local motion of cardiovascular tissues over the course of an entire cardiac cycle. This transient motion is generated within a very short time (on the order of milliseconds) and cannot be acceptably imaged with conventional imaging systems, due to their limited temporal resolution. This technology is able to image the rapid transient motion of tissues and propagating mechanical vibrations for cardiovascular applications. The technique combines data gathered across multiple cardiac cycles into a single, high frequency (8000 frames/second) sequence, capable of detecting interframe displacements of less than one micrometer. The pulse wave velocity can easily be measured and the local elasticity of a vessel wall can be derived for the purposes of further diagnostic analysis.

Animal and human experiments have established the relationship between the electrical conduction wave and the mechanical wave observed on the displacement images as well as the potential for using the properties of the mechanical wave for assessment of the mechanical properties of the muscle.
Lead Inventor:

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Applications:

- Non-invasive technology
- Does not require expensive equipment investment
- Viability of the heart muscle can be assessed
- Creating images that can detect myocardial ischemia in patients with and without visible symptoms
- Assessing the viability of the heart muscle through information obtained by imaging both the mechanical property and electrical conductivity of the muscle
- Mapping myocardial stiffness which could lead to the early diagnosis of heart disease
- Imaging the propagation of the pulse wave through the aorta in order to detect abdominal aneurysms in a mouse model
- Detecting vascular diseases such as atherosclerosis.
- Determining electrical propagation in the myocardium of a subject for achieving an effective positioning of a pacemaker in the subject
- Assisting in surgical interventions

Advantages:

- Provides a dynamic picture of mechanical changes in heart tissue at much higher temporal resolution (up to 125 us/frame) than traditional methods
- Small tissue displacements on the order of 1um can be detected between consecutive frames
- Does not require an external source of mechanical waves
- Imaging of the coupling between electrical activation and mechanical contraction can be done noninvasively
- Easily implemented with conventional ultrasound scanners, particularly with the software-based (ECG-free) method
- Respiratory gating can be added to the acquisition system to remove slow and large motion artifacts induced by respiration

Patent information:

Patent Pending (US 20070049824)

Tech Ventures Reference: IR CU1781

Related Publications:

Inventors

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