Non-Contact Laser Ultrasound (NCLUS) – An Imaging System that Remotely Creates and Controls Photoacoustic Energy for Biomedical Diagnostics

Technology #16423-16424-18576

Applications

This non-contact laser ultrasound system (NCLUS) generates ultrasound images without making physical contact with the patient. It is an improvement upon current ultrasound applications in the medical setting such as bone imaging, traumatic brain injury detection, surgical guidance, internal bleeding detection, and bone health imaging. NCLUS is compact and lightweight, making it useful in field settings such as during combat or patient evacuation transport. The non-contact feature of the NCLUS makes it attractive for situations in which standard contact ultrasound systems would cause contamination or discomfort. For example, this system may be used to image injured body regions, open wounds during surgery, and in delicate procedures such as those involving the eye.

Problem Addressed

Current ultrasound imaging systems rely on mechanical transducers and receivers in contact with the skin where coupling gels act as an interface to reduce the impedance between the device and the skin. They produce images with inconsistent resolution due to the variability in operator hand pressure. The NCLUS limits operator variability by using non-contact ultrasound techniques to produce high resolution images.

Additionally, current ultrasound imaging systems produce images by delivering photoacoustic energy in an omni-directional fashion. This yields two-dimensional images that suffer from a lack in resolution, and have a penetration depth of centimeters. The NCLUS delivers a very strong near surface wave propagating in a single direction along the surface of the patient. This allows for three-dimensional imaging, improved resolution, and a penetration depth of inches.

Technology

The NCLUS system utilizes photoacoustics to create a directed source of acoustic energy within the body. To accomplish this, it uses a pulsed near infrared source (Q-switched laser) to scan ultrasonic elastic waves at the speed of sound along a surface of the body. By moving the source of ultrasonic elastic waves at the speed of the propagating acoustic wave, the system creates a coherent directional wavefront to probe structures within the patient. The directionality of the NCLUS produces higher quality spatial information, reducing the distortion observed with contact sensing deformation. It also provides an amplitude that is significantly larger than that of current omni-directional techniques. This results in a penetration depth of a few inches rather than a few centimeters.

The elastic waves propagate into the body and reflect back to the skin surface, where they are measured using laser Doppler vibrometry developed specifically for the NCLUS. These measurements can be processed to form an image of the interior body based on elastic wave impedance contrast.

Advantages

- Non-contact
- Limits operator variability in hand pressure
- Better and more consistent image resolution
- 3D spatial imaging
- Deeper imaging penetration depth of inches rather than centimeters
- Safe for use on eyes and sensitive skin
- Compact and lightweight, therefore useful in field settings

Categories For This Invention:

Lincoln Laboratory
Medical Devices
Other (Medical Devices)
Life Sciences
Instrumentation
Other (Instrumentation)

Intellectual Property:

System and method for analyzing tissue using shear waves
US Patent Pending
2015-0148675
System and method for non-contact ultrasound with enhanced safety
Issued US Patent
System and method for non-contact ultrasound with enhanced safety
PCT
2017-160858
System and method for non-contact ultrasound with enhanced safety
Issued US Patent

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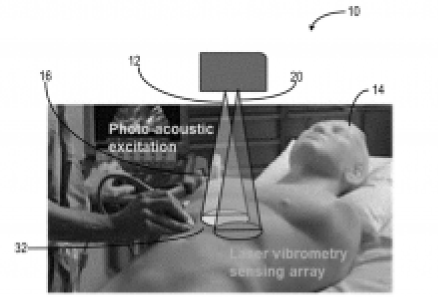

FIG. 2

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