Noncontact Laser Ultrasound for Medical Imaging (NCLUS)

In the portable noncontact laser ultrasound system, a flexible "arm" (center) is used to position an optical head (right) housing a miniaturized laser source and receiver, optical fibers, mirrors, and a camera.

Researchers from MIT Lincoln Laboratory and their collaborators at Massachusetts General Hospital's Center for Ultrasound Research and Translation are developing the Noncontact Laser Ultrasound (NCLUS) with the goal of generating high-resolution images of organs, fat, muscle, tendons, and blood vessels. This dual-laser system offers key new advantages that overcome 50-year limitations of conventional medical ultrasound systems, which rely on sonographers who manually acquire the imagery.

KEY FEATURES

- In tracking tumor or disease progression, mitigates image distortion and error caused by a variety of sonographers operating handheld probes at different times
- Provides a fixed reference frame that can be repeated to monitor changes in tissue features over time
- Enables pain-free imaging of interior tissue, standoff imaging of contagious patients, and imaging of difficult-to-access body regions
- Eliminates the need for a highly skilled sonographer, thereby allowing a minimally trained operator to take the ultrasound image in nonhospital settings such as clinics and field sites

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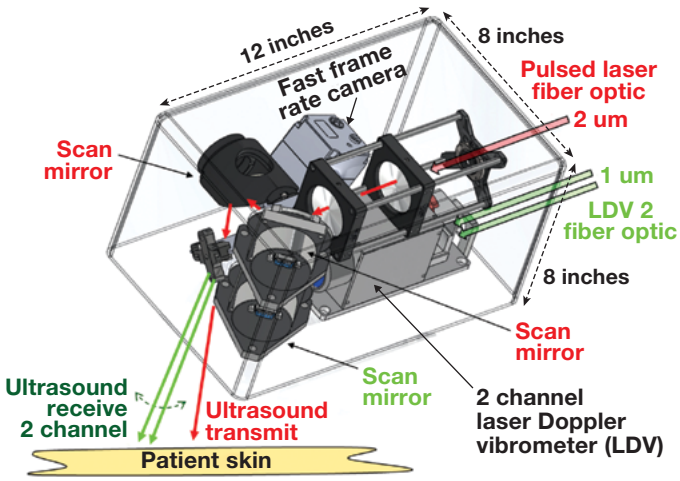
Motivation

Ultrasound is the most commonly used method for imaging soft tissue with many advantages: it has no harmful effects; is extremely portable, ranging from handheld devices to cart systems; and measures blood flow and elastography of tissue and organs. However, despite their size and cost, magnetic resonance imaging (MRI) and computerized tomography (CT) are the dominant technologies for tracking disease progression because they provide referenced imagery of tissue over time. Ultrasound results manually acquired at different times often vary, so an ultrasound device that can provide low-variability imagery suitable for assessing disease progression would be a welcome, innovative alternative to MRI and CT systems.

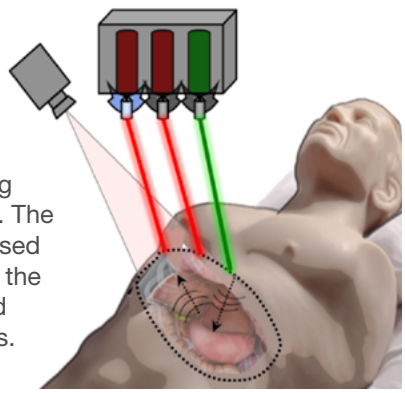
NCLUS Solution

The NCLUS system provides this breakthrough in medical imaging through its dual-laser methodology. The first laser emits short optical pulses absorbed in the skin surface that cause instantaneous thermoelastic expansion and generates ultrasound signals. The second laser, a laser Doppler vibrometer, measures the probing ultrasound echoes from the tissue interior that return to the skin surface. Any line-of-sight skin or open tissue can become a viable ultrasound source or receiver.

The system's programmable laser positioning provides a vast range of acquisition array compositions that control acoustic beam shaping and directivity for many diverse applications in medical imaging. Applications range from standard B-mode synthetic aperture imagery of soft tissue to ultrasound refraction surveys of bone and musculoskeletal injuries. Using skin fiducials, i.e., markers, NCLUS can yield a fixed reference or registered image and has the potential to offer capabilities comparable to MRI or CT. With vastly lower cost than those large imaging units, NCLUS could transform medical imaging both in and out of hospitals.



NCLUS optical system houses a miniaturized laser source and receiver, flexible optical fibers, mirrors, and a camera.



An optical head containing an excitation source and laser-sensing receiver scans the body. The optical source emits pulsed infrared light that enters the skin's surface layers and creates ultrasonic waves.

U.S. PATENTS
#10,456,044; 10,602,931; and 10,835,202

More Information

X. Zhang, et al., "Full Noncontact Laser Ultrasound: First Human Data," *Nature, Light: Science & Applications*, vol. 8, December 20, 2019.

This technology is an R&D 100 Award Winner

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