Handheld Force-controlled Ultrasound Probe for Improving Quantitative Ultrasonography

Technology #14088-15782

Applications

- Improved usability and diagnostic capabilities of ultrasound imaging

Problem Addressed

In current medical practice, the ultrasound probe acquisition state (position, orientation, and contact force of the probe) is manually controlled by an ultrasonographer, and therefore, the acquisition state at any given time is not repeatable at a later time, making ultrasound imaging difficult to reproduce. This can lead to imaging variations; hence, clinicians may not be able to determine, for instance, whether a tumor has grown larger over time or the change is due to the variations in the acquisition state. In addition, clinicians performing a biopsy must pay attention to the ultrasound probe force, the image display, and the needle in hand, so additional challenges caused by fluctuating contact force can lead to incorrect placement of the biopsy needle. Controlling the acquisition state through real time feedback leads to more consistent ultrasound images and safer medical procedures.

Technology

This invention, a group of related cases, presents an ergonomic, handheld, force-controlled ultrasound probe for medical imaging applications. The device, which consists of an ultrasound probe mounted to a backlash-free ball screw actuator and driven by a compact servo motor, maintains a prescribed contact force between the ultrasound probe and the patient's body. A control system, which combines both a position controller and a force controller, enables ergonomic operation by keeping the actuator centered within its range of motion and permits the repeated making and breaking of probe-patient contact. By controlling ultrasound probe contact force and consequently the amount of tissue deformation, the system enhances the repeatability, usability, and diagnostic capabilities of ultrasound imaging.

Advantages

- Maintains a constant contact force between the ultrasound probe and patient's body
- Improved repeatability and diagnostic capabilities; eliminates image variations with controlled acquisition state
- Easier to control & more user friendly
- Provides the user with visual and audio feedback, informing them the position, orientation, and contact force of the device
- Provides pushbuttons on the device itself, enabling the user to initiate events (e.g., data recording, zeroing the angle) without needing to interact with a computer; hence users can focus on the device rather than the computer screen.
- Fits comfortably in an ultrasound technician's hand

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Categories For This Invention:

Medical Devices
Life Sciences
Clinical Applications
Radiology
Imaging
Ultrasound

Intellectual Property:

Ultrasound scanning system
Issued US Patent
9,456,800
Handheld force-controlled ultrasound probe
Issued US Patent
8,333,704
Handheld force-controlled ultrasound probe
Issued US Patent
8,328,725

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Publications:

Force and Position Control System for Freehand Ultrasound
IEEE Transactions on Robotics
August 2015
Evaluating the Clinical Relevance of Force-correlated Ultrasound
Biomedical Imaging (ISBI), IEEE 11th International Symposium
2014
Accessing Duchenne Muscular Dystrophy with Force-controlled Ultrasound
Biomedical Imaging (ISBI), IEEE 11th International Symposium
2014
An Ergonomic, Instrumented Ultrasound Probe for 6-axis Force/torque Measurement
Engineering in Medicine and Biology Society (EMBC), 35th Annual International Conference of the IEEE
July 2013
Ergonomic Control Strategies for a Handheld Force-controlled Ultrasound Probe
IEEE/RSJ International Conference on Intelligent Robots and Systems
October 2012
Impedance-controlled Ultrasound Probe
Proceedings of SPIE Medical Imaging Conference

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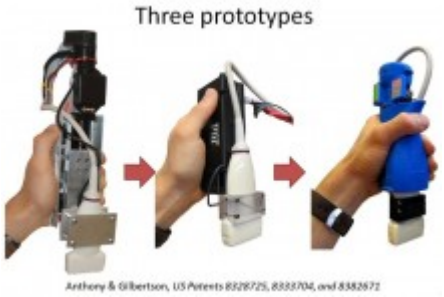
March 2011
Sharper Ultrasound Images Could Improve Diagnostics
MIT News
June 18, 2012

External Links:

Lincoln Laboratory
http://www.ll.mit.edu/
Device Realization, Computational Instrumentation@MIT
https://devicerealization.mit.edu/

Image Gallery:



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