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Adaptive Refocusing of Ultrasound Arrays Using Synthetic Aperture Imaging Data

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Adaptive Image-Based Refocusing for Focused Ultrasound

An adaptive image-based refocusing algorithm uses synthetic-aperture imaging data for safe and effective focused ultrasound in imaging and treating tissue abnormalities in complex media. The refocusing technology, designed for ultrasound arrays with transmit-receive capabilities, is well-suited for any imaging array with transmit-receive capability (in particular, for large-aperture arrays capable of operating in therapeutic and imaging modes, like dual-mode ultrasound arrays (DMUAs)). The array is capable of imaging in both synthetic aperture (SA) and single-transmit focus (STF) modes, and imaging provides real-time feedback for quality refocusing. The algorithm can be implemented on any existing imaging system with software or hardware access to pre-beamformed raw element data and contains hardware features for efficient real-time adaptive refocusing as new system architecture.

Combines Synthetic Aperture and Single-Transmit Focus Echo Data

Ultrasound imaging arrays are increasingly being used in pulse-echo imaging of complex media (e.g., transcranial imaging of the brain, breast, large-aperture trans-thoracic cardiac imaging), and non-invasive high-intensity focused ultrasound may even be used for deep-brain stimulation (instead of electrical stimulation via embedded electrodes). However, bone causes beam distortions and defocusing, a major hindrance of using focused ultrasound successfully in these applications. This new adaptive refocusing method offers imaging interspersed within energy bursts/shots and combines synthetic aperture (SA) and single-transmit focus (STF) echo data and performs the optimization in multiple bands in order to maximize the focusing gain.

BENEFITS AND FEATURES:

- Imaging capability in synthetic aperture (SA) and single-transmit focus (STF) modes

- Large-aperture arrays
- Imaging arrays with transmit-receive capability
- Enhanced ability to aim, minimized collateral damage, reduced treatment time

APPLICATIONS:

- Deep-brain stimulation
- Ultrasound imaging
- Existing imaging systems with software or hardware access to pre-beamformed raw element data
- Transcranial applications of focused ultrasound (neuromodulation, blood brain barrier)

PHASE OF DEVELOPMENT:

Preliminary animal data in rats, ex vivo human skulls.
The refocusing algorithm has been demonstrated in transcranial focusing in rat brain.

Researchers

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Publications

Wideband transskull refocusing of ultrasound beams using dual-mode ultrasound arrays: Ex vivo results
The Journal of the Acoustical Society of America, 143, 1731 (2018)

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