Ultrafast Doppler and fUltrasound Imaging

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Abstract

In the last fifteen years, the concept of plane wave transmissions rather than line by line scanning beams broke the conventional limits of ultrasound imaging. By using such large field of view transmissions, the frame rate reaches the theoretical limit of physics dictated by the ultrasound speed and an ultrasonic map can be provided typically in tens of micro-seconds ($>$ 1000 frames per second). Interestingly, this leap in frame rate is not only a technological breakthrough offering completely new ultrasound imaging modes and open new application, but at such frame rates, it becomes possible to track in real time transient vibrations – known as shear waves – propagating through organs and provides quantitative maps of tissue stiffness whose added value for diagnosis has been recently demonstrated in many fields of radiology.
For blood flow imaging, ultrafast Doppler permits high-precision characterization of complex vascular and cardiac flows. It also gives ultrasound the ability to detect very subtle blood flow in very small vessels. In the brain, such ultrasensitive Doppler paves the way for fUltrasound (functional ultrasound imaging) of brain activity with unprecedented spatial and temporal resolution compared to fMRI. Examples will emphasize the potential of this new imaging modality.
fUS technology could open new avenues in neuroscience. For therapy, localizing the epileptic focus using fUS during surgery could be a major application. Functional imaging on newborns will also be of major interest in order to increase our knowledge in cognitive science. Beyond clinical application, it will be a fantastic tool for people in neuroscience working on small animals. This technology should help them answer unsolved questions.

Keywords: Ultrafast Doppler, fUltrasound, epilectic, newborn, small animals

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