Application for Round 3 QIBA Project Funding

Title of Proposal: Numerical Simulation of Shear Wave Speed Measurements in the Liver		
QIBA Committee/Subgroup: US SWS System Dependencies Subcommittee		
NIBIB Task Number(s) which this project addresses:		
Project Coordinator or Lead Investigator Information:		
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e-mail:	Tel #:	
Institution/Company: Duke University		
Amount Requested:		

Project Description

Field II and FOCUS, coupled with mechanical simulation tools, enable simulation of ultrasonic imaging of the static and dynamic tissue response to applied forces, including static loading and impulsive acoustic radiation forces. This project will focus on developing open-source finite difference / finite element method (FEM) simulation tools that will allow the impact of system and material properties to be evaluated systematically on shear wave speed imaging. The model will have the ability to simulate different: (1) Acoustic radiation force beam excitations (e.g., excitation frequency, excitation duration, F/#, focal depths), (2) Acoustic attenuations, and (3) Elastic, viscoelastic and nonlinear (hyperelastic) materials.

These models being developed for homogeneous liver tissue can then be extended to introduce more complicated structural boundaries, such as vessels or the liver capsule, and expand to different organs, such as the breast. Future efforts would also include the development of phantoms with structures to validate these more complicated models, which might be performed as a separate or subsequent project.

Primary goals and objectives

By leveraging freely available software resources (i.e. VMTK [geometry creation], Tetgen [mesh generation], FEBio[1] [FEM]), one of our objectives is to develop a freely available shear wave imaging simulation tool. Concurrently, a finite-difference code base will be developed in OpenCL that can be run with less computation overhead. These mechanical simulation tools will be coupled with the freely-available acoustic simulation tools, Field II and FOCUS, to simulate acoustic radiation force excitations and ultrasonic displacement tracking. Further development will be focused on streamlining FEA simulations of shear wave propagation in the liver through a simple text file passing mechanism.