Background

• Focused ultrasound (FUS) refers to ultrasound that is focused via a transducer, lens, or phased array.
• The pressure induced by FUS is highest at the focus and minimal elsewhere, so tissue outside the focus is not damaged during treatment.
• FUS offers a non-invasive way to treat small targets (mm in size) deep inside the body and brain.
• For example, the thalamus of the brain is targeted for FUS-based treatment of essential tremor and Parkinson’s tremors.

Objectives

We aimed to calculate the position and orientation of an ultrasound focus for a given position and orientation of the transducer, as well as assess whether the transducer would be able to transmit ultrasound through the skull at a given point.

Methods

• Collect MRI data for the following:
  - Multiple subjects wearing transducer
  - Transducer alone
  - Subjects with fiducial (small object used as a reference point) on side of head

• Import MRI data into MATLAB
• Fit surface to skull, calculate normal vectors at surface
• Use linear static analysis to calculate location of ultrasound focus
• Translate and rotate focus for different positions of transducer
• Assess curvature of skull based on normal vectors

Results

MRI data was collected with the Siemens MAGNETOM Prisma MRI machine at 3T.

• The MRI data were analyzed in MATLAB.
• The MRI image was processed to show only the surface of the subject’s head.
• This full head surface was cropped to show only the part of the surface where the transducer would be placed.

• The fit was calculated for a head surface with a fiducial (small vitamin pill) attached to the head as a placeholder for the transducer.
• Thus, it was necessary to remove the voxels representing the fiducial.

Conclusions

• Calculating the location of the ultrasound beam in the individual’s brain is an important first step in using FUS for neuromodulation.
• Future work will determine the accuracy of our model in calculating the location of the ultrasound focus through comparison with experimental values.

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References