Ultrasound interaction with bone: simulations and experiment

Masters Project for APh, BME and ME students
Multi Scale Mechanics (CTW) and *Biomedical Photonic Imaging (TNW) groups*

Goals

To study the interactions of ultrasound with bone-like structures with a view to recognizing and interpreting ultrasound signals that have propagated through bone or were reflected by the bone.

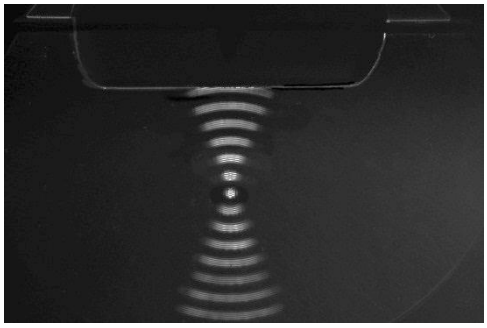
Your profile

- You have the interest in computer simulations of particulate and heterogeneous systems, and/or
- You have the interest in performing experiments related to ultrasound interaction in bone.

Background

For photoacoustic imaging of the finger joints for diagnosis of rheumatoid arthritis, a detailed understanding of ultrasound interaction with bone is required. The porosity and irregularity of bone can lead to distortion of the transmitted and scattered time-domain signals. We aim to understand the acoustic transmission through the bone skeleton of finger joints and the interface between bone and soft tissue.

DEM simulation of pressure-wave propagating in a lattice



Schlieren image of a focused ultrasound wave

Plan

1) *Experiments on ultrasound transmission and reflection*
   Bone samples will be procured and fashioned to perform ultrasound transmission experiments. You will be helped to setup experiments comprising ultrasound transmitter and detector with sample in a test tank. You will perform fast Schlieren imaging experiments to visualize the reflection and transmission of ultrasound with the bone samples.
2) *Numerical simulations with Discrete Element Method (DEM)*
   With an open source Discrete Element code numerical samples reproducing different kinds of bones will be created. Small perturbation will be applied to the samples, resembling acoustic waves that propagate through the material. The dependence of the signal (path, velocity, etc) on the internal structure of the "numerical bone" will be studied.

What will you learn?

You will work in a group which conducts pioneering work in the field of multiscale computer simulations, and will learn the basics of working with discrete simulations code as well as advanced data-processing methods.
You will work in a group which conducts pioneering work in the field of photoacoustics. Specifically you will learn to use and understand ultrasound measurement and imaging equipment.

Contact

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