



Tutorial 4: Elastography and photoacoustic imaging - towards more effective imaging for diagnosis, staging, and surgical interventions

Organizers

Dr. Abbas Samani, Western University, Canada

Dr. Hassan Rivaz, Concordia University, Canada

Dr. Mohammad Mehrmohammadi, Wayne State University, USA

Overview

This tutorial provides an overview of recent developments in the two emerging fields of elastography and photoacoustic imaging. Elastography involves imaging the mechanical properties of tissue. Photoacoustic imaging uses tunable light sources to acquire functional and molecular diagnostic information from the tissue. These imaging techniques can be utilized for effective disease (e.g. cancer) diagnosis, staging, and surgical interventions.

In the tutorial, we will present essential elements of theory, computational modelling and experimentation, including data acquisition involved in elastography and photoacoustic imaging. Elastography utilizes an imaging modality (e.g. MRI or ultrasound) to acquire tissue deformation data as it is subjected to an internal or external mechanical excitation. In the elastography part, the two major techniques of harmonic and quasi-static elastography in conjunction with MRI or ultrasound imaging will be presented. The presentation will include methods of mechanical stimulation, data acquisition and processing and finally data inversion algorithms used for image reconstruction. Strengths and limitations of each of the two techniques will be discussed. Finally, recent advances of elastography in breast cancer and prostate cancer diagnosis will be presented and discussed. In the photoacoustic imaging part, the following topics will be discussed: physics of photoacoustics, optical-resolution vs. acoustic resolution photoacoustic imaging, development of combined ultrasound and photoacoustic/spectroscopic imaging systems, applications of photoacoustic imaging by using endogenous tissue contrast, exogenous photoacoustic contrast agents for cellular and molecular imaging, and recent advancements in pre-clinical applications and clinical translation of photoacoustic imaging.

Topics

1. Introduction
2. Elastography imaging
 - a. Principles and theoretical background
 - b. Magnetic resonance elastography
 - c. Ultrasound elastography
 - d. Tissue motion estimation techniques
 - e. Image reconstruction algorithms
 - f. Applications
3. Photoacoustic imaging
 - a. Principles and theoretical background
 - b. Photoacoustic imaging system components
 - c. Methods of data acquisition
 - d. Image reconstruction
 - e. Applications
4. Summary and conclusions

Audience

The intended audience for this tutorial include researchers (including graduate students and trainees) with interest in medical imaging. The audience are expected to have basic background in a relevant Engineering or Physics discipline. The tutorial does not assume knowledge in areas specific to elastography or photoacoustic imaging theory, computation or experimentation.