Doctoral thesis - Monitoring thermal ablations using real-time MRI in interventional radiology

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Duration: 3 years

Director: Afshin Gangi, Professor of Radiology, Head of the Radiology Department, Strasbourg Hospital
Co-Director: Jonathan Vappou, Associate Research Scientist at CNRS, ICube Engineering laboratory
Co-Supervisor: Elodie Breton, Research Engineer at CNRS, ICube Engineering laboratory

Summary

Minimally-invasive and non-invasive surgical procedures are increasingly used thanks to decreased morbidity and increased patient comfort associated with them. The Department of Interventional Radiology of Strasbourg Hospital is a renowned center of excellence in Magnetic Resonance Imaging (MRI)-guided interventional procedures.

The general context of this project is the monitoring of HIFU (High Intensity Focused Ultrasound) ablations. HIFU is a non-invasive, non-ionizing method for the ablation of cancerous tissues. During HIFU treatment, an ultrasound beam is focused within the region to be treated. The absorption of the acoustic energy yields localized tissue heating, and subsequent necrosis. One of the major challenges in HIFU therapy is its monitoring. The physician must ensure that the whole cancerous tissue has been ablated while the surrounding healthy tissue does not suffer from any significant damage. The objective of this PhD thesis is to develop and use new methods for the monitoring of HIFU therapy in real-time, based on Magnetic Resonance Elastography (MRE) and MR Thermometry.

MRE allows obtaining biomechanical contrast in soft tissues through the mapping of their mechanical properties. Conventional MRE is only used for diagnosis, based on the fact that tumors are generally stiffer than healthy tissue. The objective of this project is to develop an « interventional » MRE method, as a continuation of a project initiated in 2013 by the Medical Robotics team of the ICube engineering laboratory [1], which was awarded the First prize of the MRE study group at ISMRM 2015. This method differs from conventional MRE in that it involves more advanced excitation systems, ultrafast MRI pulse sequences and reconstruction algorithms that provide elasticity maps in real-time. This multidisciplinary thesis will involve the following fields/ skills: Interventional Radiology (from a clinical point-of-view); Medical Imaging, and MRI in particular (physics and pulse sequence programming); Biomechanics and wave propagations; Inverse problems; Image processing.

Environment

The primary location for this thesis is the Medical robotics team of the ICube laboratory. This research team is composed of about 10 faculty members and about 10 PhD students, and covers a large variety of research activities revolving around Medical Imaging and Robotics. The MRI environment for this project is exceptional: members of this team have access to two identical MRI platforms (one preclinical, one clinical within the Department of Interventional Radiology), and this project benefits from a direct collaboration with the MRI manufacturer (Siemens Healthcare). Strasbourg is the second capital of Europe after Brussels. It is a very pleasant, highly international, middle-sized city with a major world-renowned university. The laboratory and the Department of Radiology are located at the heart of the central Hospital, in the city center.

Requirements

The candidate should have a MS degree in engineering or in applied physics. He/She should want to work in a highly biomedical environment and should have excellent general scientific skills ranging from basic physics to programming. Previous experience with medical imaging is a plus.

To apply, please send a CV, contact information of 2-3 references, and a cover letter to Jonathan Vappou, jvappou@unistra.fr and Elodie Breton ebreton@unistra.fr