IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Multi-physics numerical modelling for bio-effects mapping and controlled delivery of ablation dosage in Oncological applications**	
Project Number	**IMURA0422**	
Monash Main Supervisor (Name, Email Id, Phone)	Prof. Sunita Chauhan; sunita.chauhan@monash.edu	*Full name, Email*
Monash Co-supervisor(s) (Name, Email Id, Phone)	NA	
Monash Head of Dept. (Name,Email) chris.davies@monash.edu	Prof. Chris Davies chris.davies@monash.edu	*Full name, email*
Monash Department:	Department of Mechanical & Aerospace Engineering	
Monash ADRT (Name,Email)	Professor Emanuele Viterbo Emanuele.Viterbo@monash.edu	*Full name, email*
IITB Main Supervisor (Name, Email Id, Phone)	Prof. Atul Srivastava; atulsr@iitb.ac.in; +91-22-25767531	*Full name, Email*
IITB Co-supervisor(s) (Name, Email Id, Phone)		
IITB Head of Dept (Name, Email, Phone)	Prof. R.P. Vedula; head.me@iitb.ac.in; +91-22-25767500	*Full name, email*
IITB Department:	Department of Mechanical Engineering	

Research Academy Themes:

Highlight which of the Academy's Theme(s) this project will address?

(*Feel free to nominate more than one. For more information, see www.iitbmonash.org)*

1. Advanced computational engineering, simulation and manufacture
2. Infrastructure Engineering
3. Clean Energy
4. Water
5. Nanotechnology
6. Biotechnology and Stem Cell Research

The research problem

Define the problem

The proposed research problem is concerned with multi-physics modelling for understanding the mechano-biology for mass-heat transport and fluid flow phenomena in representative multi-layer tissues, under given thermal dosages. The work is significantly important in the areas of thermal therapies and thermal ablation wherein ablative modalities such as high power lasers, RF and

ultrasound sources are employed for raising the tissue temperatures. While an optimum amount of temperature rise localized to the region of embedded abnormal cells e.g. cancerous cells/tumors is desired, extreme care needs to be demonstrated to prevent the surrounding normal cells getting damaged due to the thermal damage. The tissue damage is a result of both thermal and mechanical stress mechanisms; the contribution of either factor, however, depends on the input intensities and heating rate. At high intensities used in ablative procedures, it is very difficult to separate the two mechanisms. In this context, the work proposed becomes critically important as the literature available addressing these issues is very limited and most of the studies are empirical in nature only. In view of this, it becomes imperative to perform systematic fundamental studies on theoretical investigation and quantitative evaluation of localized bio-effect thresholds in the targeted biological tissues. The study will aid in calculated and controlled selective destruction using pre-computed heat dose for safer and efficacious outcomes. If proven successful, it could have a significant impact on oncological treatment.

Project aims

Define the aims of the project

Specific aims of the project include multi-physics modelling of phenomena associated with thermal therapy and thermal ablation in order to understand the mechano-biological concepts of mass-heat transport and fluid flow in multi-layered tissues. The work involves numerical modelling of radiative transport equation coupled with continuity, momentum and energy equations for understanding the thermal response of the tissues under the effects of thermal dosage.

Expected outcomes

Highlight the expected outcomes of the project

Successful completion of the objectives defined in the project include a detailed in-house developed numerical model for understanding the mass-heat transport and fluid flow phenomena in representative multi-layer tissues, under given thermal dosages. This would be one of the few theoretical/numerical studies available in the literature in this context and is expected to have a significant impact on oncological treatment.

How will the project address the Goals of the above Themes?

Describe how the project will address the goals of one or more of the 6 Themes listed above.

The proposed project is important in the context of Bioengineering and Biotechnology as a detailed numerical investigation on thermal and mechanical responses of biological tissues subjected to laser/RF ablation would provide useful information in deciding the safe laser/RF parameters required for inducing the optimum thermal damage in selective targets while maintaining no/minimum harm to the overlying tissues.

Capabilities and Degrees Required

List the ideal set of capabilities that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities.

The interested candidates should have knowledge/skills in two or more of the following domains:

1. Sound knowledge of fluid flow and heat transfer.
2. Skills in numerical/theoretical modelling.
3. Code development and data analysis.
4. Desirable background: Mechanical, Chemical, Materials Engineering

Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.

Potential collaborators have already been identified:
Prof. Sunita Chauhan, Monash University
Prof. Atul Srivastava, IIT Bombay.