IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**An Immersed-Boundary method based fluid-structure interaction (FSI) solver with application in biomedical flows**
Project Number	**IMURA0505**

Monash Main Supervisor (Name, Email Id, Phone)	Mark Thompson mark.thompson@monash.edu	*Full name, Email*
Monash Co-supervisor(s) (Name, Email Id, Phone)		
Monash Department:	Mechanical & Aerospace Engineering	
IITB Main Supervisor (Name, Email Id, Phone)	Rajneesh Bhardwaj rajneesh.bhardwaj@iitb.ac.in	*Full name, Email*
IITB Co-supervisor(s) (Name, Email Id, Phone)	Prof.Salil S.Kulkarni	
IITB Department:	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

The flow-induced deformation of soft structures has several applications in biological systems; examples include, flow-induced vibration of vocal folds in human larynx during phonation, contraction/relaxation of the heart, pathologies of aneurysms and deformation of insect wings/fish fins during propulsion. The modeling of the flows in above systems generally involves complex three-dimensional moving solid-fluid and fluid-fluid interfaces, and flow-induced deformation of a soft structure. The flow in many of the above applications is highly unsteady and the modeling of the structure also involves geometric and material nonlinearities including viscoelastic effects. Due to the nonlinear interaction between highly deformable structures and flowing fluids, FSI usually leads to complex system behaviors, like surface morphing, bifurcation, chaotic vibrations, lock-on and resonance etc. While modeling of the flow and the structure are challenging in their own right, the coupled fluid-structure interaction raises the challenge to an even higher level. The goal of this project is to develop an in-house immersed-boundary method based FSI solver to investigate the viscoelastic effects during FSI. The flow solver will be employed to simulate challenging moving boundaries problems in complex 3D geometries in biomedical engineering. Numerical simulations will be corroborated with published data in order to validate the model. Since the measurements of flow fields in above applications is not trivial, the proposed computation tool will provide detailed insights in the respective biophysics. The parallel scalability of the FSI solver will be tested on multi-cores in-house high performance computer.

Project aims

The aims of this project are the following:

- Develop a FSI solver for biomedical applications.
- Understand the flow physics using the developed solver

Expected outcomes

We expect the following outcomes from this project

- A state-of-the-art, FSI solver.
- Quality Ph.D. graduate with ability and skills to understand and model FSI incompressible flows in complex geometries.

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

The target of the project is to model FSI incompressible flows and understand flow physics via advanced computational techniques. Thus, the project will address the goals of above theme (Advanced computational engineering, simulation and manufacture).

Capabilities and Degrees Required

The student for this project will require the following skills

- Sound background in fluid mechanics and numerical methods.
- Some experience with computer programming preferably with FORTRAN and C++. If not, a willingness to learn is essential.
- Good written and communication skills.

Potentia 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.