IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Numerical analysis of control for plate problems**	
Project Number	**IMURA0812**	
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Research Clusters:

Highlight which of the Academy's CLUSTERS this project will address?
*(Please nominate JUST **one.** For more information, see www.iitbmonash.org)*

1	*Material Science/Engineering (including Nano, Metallurgy)*
2	*Energy, Green Chem, Chemistry, Catalysis, Reaction Eng*
3	*Math, CFD, Modelling, Manufacturing*
4	*CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control*
5	*Earth Sciences and Civil Engineering (Geo, Water, Climate)*
6	*Bio, Stem Cells, Bio Chem, Pharma, Food*
7	*Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng*
8	*HSS, Design, Management*

Research 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*
7	*Humanities and social sciences*
8	Design

The research problem

Define the problem

Plate models are specific form of elasticity equations that describe the behaviour, under external forces, of thin elastic materials. These models are linear when only small deformation are accounted for, and non-linear if large deformations have to be considered. Too much force applied to a plate leads to damage – which changes the elastic behaviour of the material – or even breakdown – in which case the model needs to account for fractures of the material. If the external forces considered is provided by the environment, or exerted by a user to achieve a certain result, then we talk about *control* of the model.

Obtaining accurate numerical simulations of all the possible behaviour of these models is already challenging, and even more when control is involved, as the corresponding system size increases. Additionally, the treatment of damage or fracture usually requires non-conforming methods, that is, methods that approximate a seemingly continuous model with non-continuous functions. The non-conformity can also come from specific meshes considered to discretize the model.

Project aims

Define the aims of the project

We aim to develop numerical techniques for the control of plate models. We will design schemes – for conforming or non-conforming schemes, for linear or non-linear models – that are flexible enough to properly capture extreme behaviour of the plate, up to its fracture. This will be obtained by using a combination of techniques, based on discontinuous Galerkin or hybrid high-order methods with relaxed continuity constraints, and/or by enrichments of these methods.
The convergence analysis of the schemes will also be conducted, using both error estimates techniques and convergence by compactness.

Expected outcomes

Highlight the expected outcomes of the project

- New numerical schemes for plate problems, that account for fractures
- Rigorous numerical analysis of non-linear plate models
- Simulations to analyse which kind of control situation lead to possible fractures.

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.

This project addresses the theme *Advanced computational engineering, simulation and manufacture.* The novel and robust numerical methods for plate problems and their control will give accurate tools to simulate engineering problems associated to the manufacture and usage of plates. Additionally, the rigorous mathematical and numerical analysis carried out in the project will give us certainty on the simulation outcomes, and their usability in engineering situations.

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.

- Basic theory of elliptic partial differential equations

- Functional analysis
- Knowledge of some classical Finite Element Method

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.

Select up to **(4)** keywords from the Academy's approved keyword list **(available at http://www.iitbmonash.org/becoming-a-research-supervisor/)** relating to this project to make it easier for the students to apply.

Computational Fluid Dynamics and Mechanics
Maths
Computer Simulation