IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	Discretization techniques and numerical analysis of non-linear models in elasticity	
Project Number	**IMURA0688**	
Monash Main Supervisor (Name, Email Id, Phone)	Dr. Jerome Droniou, jerome.droniou@monash.edu,	*Full name, Email*
Monash Co-supervisor(s) (Name, Email Id, Phone)		
Monash Head of Dept/Centre (Name,Email)	Prof. Philip Hall, phil.hall@monash.edu	*Full name, email*
Monash Department:	School of Mathematical Sciences, Faculty of Sciences	
Monash ADRT (Name,Email)	A/Prof Peter Betts Peter.Betts@monash.edu	*Full name, email*
IITB Main Supervisor (Name, Email Id, Phone)	Prof. Neela Nataraj, neela@math.iitb.ac.in	*Full name, Email*
IITB Co-supervisor(s) (Name, Email Id, Phone)		*Full name, Email*
IITB Head of Dept (Name, Email, Phone)	Prof. Neela Nataraj, neela@math.iitb.ac.in	*Full name, email*
IITB Department:	Mathematics	

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*

The research problem

Define the problem

The project aims at exploring efficient discretisation techniques for nonlinear models in elasticity. Elastic solid materials are frequently encountered in industrial applications and a detailed study of the behaviour of these materials under the effect of external forces is both important and interesting. Depending on the application, the behaviour of these materials under the effect of external load can be modelled by either by linear and nonlinear partial differential equations. While the linear models have been studied extensively, there is not much literature on the study of efficient discretization techniques available for the nonlinear models for which the exact solutions are usually unknown. The nonlinearity and higher order nature of the partial differential equations make the problem quite challenging.

In this project, we aim to first identify a few nonlinear elasticity models which are relevant in applications. The first goal is to design theoretically robust and computationally efficient discretization schemes for this models. The next goal would be to apply the discretisation schemes to optimal control problems governed by these nonlinear partial differential equations and study the convergence analysis.

Project aims

Define the aims of the project

We aim to:

(i) identify a few nonlinear elasticity models relevant in applications;
(ii) develop efficient discretisation schemes;
(iii) develop the theoretical error estimates and perform numerical studies;
(iv) extend the theoretical and numerical analysis to optimal control problems governed by nonlinear elasticity models;
(v) develop efficient numerical algorithms for both the state equation and the control problem.

Expected outcomes

Highlight the expected outcomes of the project

(a) Quality international research publications;
(b) Joint supervision of a Ph.D. student from India which will help to boost the research in Numerical Analysis in the country;
(c) Continue the already existing collaborative research work between Monash University and IIT Bombay in the broad area of numerical analysis and scientific computing.

Novel and robust numerical methods for engineering problems.

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.

Advanced computational engineering, simulation and manufacture

We would be addressing the first and second components in the above mentioned theme. Computational PDEs is an extremely active topic internationally. The proposed project aims at providing tangible progress in the direction of the growth of the topic.

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.

Candidates should

1. have a strong mathematical background in post graduation;
2. should have a MASTER's degree in Mathematics;
3. have done courses in Partial differential Equations & Functional Analysis in Masters level,

knowledge and aptitude in computer languages – like Matlab, Fortran90, C or C++ – is essential.

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 www.iitbmonash.org)** relating to this project to make it easier for the students to apply.

Numerical Methods, Adaptive methods, Convergence Analysis, Implementation