IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Modelling and Control strategies for Soft robotic actuation**	
Project Number	**IMURA0915**	
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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

Robots made with 'soft' or deformable materials are well-suited for safe interactions with other objects, or people in the environment. The motion of these robots is usually governed by partial differential equations, as compared to ordinary differential equations that describe the dynamics of conventional robotic manipulator.

This project aims to discretize the soft robot structure, and represent the dynamics of using a set of ordinary differential equations. To reduce the degrees of freedom in this model, model simplification using model order reduction methods will be done.

The resulting model can then be used to understand the controllability of the robot, and design motion control algorithms using existing techniques. Use of adaptive control strategies can also be explored to address the issues associated with change in material properties of time.

Project aims

- Development of a discretized model for soft robots
- Model simplification and validation
- Design and experimental verification of the control algorithms for positioning and motion control
- Use of adaptive control techniques for robustness

Expected outcomes

- Kinematics and dynamical analysis for compliant soft-robotic mechanisms;
- New control algorithms for compliant gripper behaviour and real-time feedback;
- Publications related to modelling and control of soft robots.

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

The project aims to develop mathematical tools for modelling and control of soft robots. Such robots are expected to replace conventional robots in manufacturing industry for fragile object handling, manipulation and packaging etc. in the future.

Capabilities and Degrees Required

The student should have a Bachelors/Masters in Mechanical/Mechatronics/Aerospace/Electrical/Controls engineering (or equivalent) with a keen interest in working with robotic mechanisms/mechatronic systems. As the project involves mathematical modelling, simulations and experiments, a solid background in applied mathematics, programming and hands-on-experiments is required. Prior exposure to control design, microcontroller programming and finite element analysis is desirable.

Potential Collaborators

Prof. Sunita Chauhan, Monash University
Prof. Abhishek Gupta

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.

Robotics, Mechatronics, Modelling and Simulation, Systems Analysis and Control