

An Indian-Australian research partnership

<b>Project Title:</b>	<b>Testbed for Controlling a Lunar Lander</b>	
<b>Project Number</b>	IMURA0987	
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### Research Clusters:

### Research Themes:

Highlight which of the Academy's CLUSTERS this project will address? <i>(Please nominate JUST <b>one</b>. For more information, see <a href="http://www.iitbmonash.org">www.iitbmonash.org</a>)</i>		Highlight which of the Academy's Theme(s) this project will address? <i>(Feel free to nominate more than one. For more information, see <a href="http://www.iitbmonash.org">www.iitbmonash.org</a>)</i>	
1	Material Science/Engineering (including Nano, Metallurgy)	1	Advanced computational engineering, simulation and manufacture
2	Energy, Green Chem, Chemistry, Catalysis, Reaction Eng	2	Infrastructure Engineering
3	Math, CFD, Modelling, Manufacturing	3	Clean Energy
4	CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control	4	Water
5	Earth Sciences and Civil Engineering (Geo, Water, Climate)	5	Nanotechnology
6	Bio, Stem Cells, Bio Chem, Pharma, Food	6	Biotechnology and Stem Cell Research
7	Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng	7	Humanities and social sciences
8	HSS, Design, Management	8	Design

## The research problem

### *Define the problem*

There is significant thrust now in India to fly missions to the Moon and Mars, while also developing landing capabilities. One of the key aspects of such missions where we have had trouble in the past is the landing phase. This begins when the lander separates from the orbiter and then ends with vertical touchdown on the surface of the moon. The non-availability of a localization system such as GPS and high-speed manoeuvres close to the planet or moon's surface make this a particularly difficult phase to control.

The aim of this project is to develop algorithms for flight and control of the lander while accounting for uncertainties. This will include trajectory design and tracking controller development that is robust to these uncertainties. We also want to develop a testbed platform to evaluate the capabilities of these algorithms here on Earth, in order to assess failure modes before actual flight. The test platform along with the newly developed algorithms will be a great asset to future inter-planetary space missions and more specifically the lunar lander mission.

## Project aims

### *Define the aims of the project*

The aims of the project are as follows:

1. Design and develop an experimental testbed for verification of lander trajectory estimation and tracking algorithms reliably.
2. Develop algorithms for optimal flight of lander from separation phase to vertical engine-off landing phase.
3. Design and test observers based on optical/terrain navigation over the Moon surface.
4. Design and test tracking controllers for lander flight.

## What is expected of the student when at IITB and when at Monash?

### *Highlight how the project will gain from the students stay at IITB and at Monash*

IITB – The student is expected to design and develop the lander platform while at IITB. He/she is also expected to learn algorithm development for guidance, navigation and control aspects of the mission.

Monash – The student is expected to learn mechatronics aspect of the lander testbed design at Monash and finalize the prototype design with the aid of expertise available in Hoam's laboratory.

## Expected outcomes

### *Highlight the expected outcomes of the project*

1. Hardware for a lander testbed to be developed at IITB.
2. Algorithms for guidance, navigation and control tasks to be implemented on the lander.
3. Experimental validation of the developed control algorithms.

## 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 project falls under the Design theme and involves direct design and development of a novel robotic platform for testing implementation of control, guidance and navigation schemes for landers.

## 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.*

1. Masters degree in Aerospace/Mechanical/Electrical engineering
2. Conversant with design software such as Solidworks, ProE, should have implemented projects in the same.
3. Coding experience – C++, Python, MATLAB, ROS
4. 3D printing experience – should have printed own designs with 3D printing services or machine, experience using slicing softwares etc.
5. Robotics hardware knowledge – RPi, PixHawk, Arduino, Gazebo or relevant microcontroller platforms, should have some experience with robot development with motors, microcontrollers, sensors interfacing etc.

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, UAVs, Systems Analysis and Control