

An Indian-Australian research partnership

Project Title: **Integrated Robotic System for Inspection of Railway Infrastructure**

Project Number **IMURA0638(a)**

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IITB Department: Systems and Control Engineering Group

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
7. Humanities and Social Sciences

The research problem

The rapid growth for freight, passenger and heavy haul railway across the world introduces the challenges of increased costs of upgrading railway infrastructure and increased demand for enhanced efficiency and performance. Integration of robotics and smart communication technologies presents opportunities to develop rail into a more commercially sustainable industry.

One of the important rail infrastructure management activities involves regular inspection of track conditions and overhead signal network (power and communication), which is labour intensive and could be potentially augmented with robotics.

At present, mobile railway inspection systems are available with camera links installed on railcars or mobile service vehicles to detect damage to the components of railway track. The image feeds from camera are converted to compliant video streams, aggregated onto a single network, and transmitted to a vehicle based workstation for analysis. Such railcars occupy the tracks for an elongated period and suspend the logistic scheduling of the trains. Alternatively, speed constraint (low resolution) data is gathered using on-board wagon workstations for post-collection data analyses. This is restricted to vision (camera systems) and indirect stress-strain analysis on the rolling stock (extrapolated from the effect not the direct cause).

The proposed project would address *in situ* data collection and communication by introducing novel dedicated robotic system for automated inspection of railway tracks using vision as well as non-vision sensors. A series of such robotic configuration design concepts are being developed by the Monash main supervisor's group. The PhD project would involve optimization and integration of hardware and software for the dedicated application.

Project aims

Define the aims of the project

The proposed project aims to address the above stated problem by introducing novel dedicated robotic system for automated inspection of railway tracks integrated with data uptake (localization and coarse inspection) from instrumented rolling stock. Integrated system design and control strategies are required for this purpose for easy deployment (and detachment) of the system synchronized with scheduling constraints. Also a good communication and coordination between the robot and central control room is required with minimal unskilled manual assistance in telemetry and *in situ* remote data collection.

Expected outcomes

Highlight the expected outcomes of the project

The efficient deployment of resources for remote *in situ* data collection by devising a novel dedicated autonomous robotic inspection system and wireless coordination with central control room is addressed in this project. It aims to provide solution of placing fixed and mobile sensors (vision and non-vision) on a known/structured localization graph.

- Hardware-software integration for a dedicated robotic system for automated inspection of railway tracks;
- Data acquisition (localization and coarse inspection), efficient and fault tolerant exploration, communication and coordination strategies for data collection and analyses;
- Publications in peer-reviewed journals and conferences.

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 is related to modelling and optimizing robotic configurations and control strategies for efficient and fault tolerant exploration of rail infrastructure.

Capabilities of the system would be investigated by extensive system design and control simulations, offline/online and decentralized/centralized techniques for data collection and communication.

The above mentioned research activities thus fall under the two main themes of the research academy, viz. Advanced computational engineering, simulation and manufacture and Infrastructure Engineering as highlighted in that section.

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.

B.E. or M.Tech in relevant branch of engineering with strong knowledge and aptitude in mechatronics design involving mathematical and computational methods; object oriented programming, coding and interface with hardware; robotics and motion/path planning.

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.

Potential collaborators have already been identified:
Professor Sunita Chauhan and Mr. Ravi Ravitharan, Monash University and
Prof. Leena Vachhani at IITB

Please provide a few key words relating to this project to make it easier for the students to apply.

Mechatronics approach, dedicated system design, sensor network, telemetry and communication.