Mishal Assif P K

Curriculum Vitae

Hostel 7, IIT Bombay
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Research Interests

- Geometric optimal control, with emphasis on computationally tractable constrained control techniques.
- Applications of probability to control theory.

Education

2014–Present **IIT Bombay**, *B.Tech + M.Tech: Mechanical Engineering*.
GPA: 8.26/10.00

2014 **CBSE**, *All India Senior School Certificate*.
Score: 95.2%

2012 **CBSE**, *All India Secondary School Certificate*.
GPA: 10.0/10.0

Research

Title **Measure of Quality of nonlinear systems**

Supervisor Prof. Debasish Chatterjee

Description A measure of quality of a control system is a quantitative extension to the notion of controllability of a system. It provides a notion of one controllable system being "more controllable" than another one. We define such a measure of quality for control affine nonlinear systems with analytic drift and control vector fields.

Title **Scenario approach for non-convex robust optimization problems**

Supervisor Prof. Debasish Chatterjee, Prof. Ravi N Banavar

Description We provide performance bounds for the scenario approach when applied to a class of non-convex robust optimization problems where the uncertainity set is a metric space.

This is a work in progress

Title **Discrete time Pontryagin maximum principle on smooth manifolds**

Supervisor Prof. Debasish Chatterjee, Prof. Ravi N Banavar

Description We establish a geometric Pontryagin maximum principle for discrete time optimal control problems on finite dimensional smooth manifolds under the following three types of constraints: a) constraints on the states pointwise in time, b) constraints on the control actions pointwise in time, c) constraints on the frequency spectrum of the optimal control trajectories.

Submitted to Automatica. [arXiv preprint]

Title **Variational Collision Avoidance Problems on Riemannian Manifolds**

Supervisor Prof. Ravi N Banavar

Description We introduce a variational approach to collision avoidance of multiple agents evolving on a Riemannian manifold. We find necessary conditions satisfied by trajectories that minimize an energy functional that depends on the velocity, covariant acceleration and an artificial potential function used to prevent collision among the agents.

Accepted for presentation at the 57th IEEE CDC 2018. [arXiv preprint]

Teaching

Spring 2018 **Differential Geometric Methods in Control**, Teaching Assistant.

- Course contents: Primer on topology, Introduction to Differentiable Manifolds, Tangent vectors, Tangent bundle, Vector fields, Lie bracket of vector fields, Lie groups, Feedback Linearization, Lyapunov stability on manifolds.
- Posed and graded test problems and conducted weekly tutorial sessions.

Fall 2018 **Microprocessors and Automatic control**, Teaching Assistant.

- Course contents: Introduction to feedback control, block diagrams, LTI systems, Fourier and Laplace transform, Impulse response, Transfer functions, Bode plots, Stability, Linear control design.
- Assisted in grading test problems and conducting weekly tutorial sessions.

Presentations

July 2018 Presented a short talk on "Geometric Pontryagin Maximum Principle for discrete time optimal control problems" at the **12th International ICMAT Summer School on Geometry, Mechanics and Control** held at Universidade de Santiago de Compostela, Spain.

Course Projects

Spring 2018 **Variational integrators and the Newmark Algorithm**.

ME 6106: Computational structural dynamics

- Reviewed the theory of Discrete Lagrangian mechanics, the construction of Variational integrators and their structure preserving properties.
- Observed that the Newmark family of integrators, widely used in computational structural dynamics, are variational in nature.
- Validated through numerical simulations that the Newmark family of integrators exhibit excellent energy behaviour for conservative systems as expected from a Variational integrator.

Spring 2018 **Adaptive control under input constraints**.

SC 617: Adaptive control

- Reviewed two adaptive control techniques that can handle input constraints:
  1. Positive mu-modification method for linear systems with bounded magnitude inputs,
  2. An adaptive tracking controller for a class of control affine systems with both magnitude and rate constraints on the input.
- Validated the performance of the two control laws through numerical simulation for a 1D system with a single input.

Technical Projects

2015 - 2016 **Autonomous Underwater Vehicle team (AUV-IITB)**, Software team.

- Developed and tuned a PID controller for controlling a 4 DOF AUV.
- Wrote drivers for a Doppler Velocity Log (DVL) and an Inertial Measurement unit (IMU).
- Developed a half-duplex robust communication protocol for inter board communication.
- Secured 2nd place at the International AUVSI Robosub competition 2016.

Academic Achievements

2017 Awarded an AP grade in *Probability and Random Processes* for distinctive performance.

2016 Awarded an AP grade in *Differential Geometric Methods in Control* for distinctive performance.

2014 Secured All India rank 967 in JEE Advanced 2014.

Software Skills

Programming Languages: C++, Python, Matlab

Other tools: LaTeX, ROS, Gazebo, OpenCV

Key Courses

- Sparsity methods in Control
- Probability and Random Processes
- Physics and Control
- Nonlinear Control
- Systems Theory
- Stochastic models
- Behavioural Theory of Systems
- Optimization
- Adaptive Control
- Differential Geometric Methods in Control

References

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