Soham **Shanbhag**

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Research Interests

- Differential Geometric Control
- Nonlinear Control

Education

Indian Institute of Technology, Bombay
August 2019 (Expected)

B.Tech + M.Tech in Mechanical Engineering, CGPA: 8.17

Pace Junior Science College, Thane
June 2014

Intermediate, Maharashtra State Board, Percentage:89%

Lok Puram Public School, Thane
May 2012

Matriculation, Central Board of Secondary Edication, CGPA: 10.0

Honors & Awards

2017 **Undergraduate Research Award**, Indian Institute Of Technology, Bombay *IIT Bombay*

Research Projects

Design of a discrete observer for a dynamical system on SO(3)
March 2018 - Present

Guide: Prof. Ravi Banavar, Systems and Control Engineering, IIT Bombay

Usually, systems are modelled as continuous time systems. However, the measurement of their states, using any kind of device, is performed in discrete time. The effect of this discretization is seen when the measurements are sparse. Hence, we intend to develop a discrete time observer for a continuous time system on the SO(3), with the system dynamics as the rotation dynamics.

- Studied various existing continuous time observers and discrete time observers for the system on the manifold
- Studied various discretization techniques for dynamical systems evolving on manifolds

Design of a capacitive sensor
December 2015 - December 2016

Guide: Prof. Abhishek Gupta, Department of Mechanical Engineering, IIT Bombay

The intention of this project was to detect the number of capsules or tablets passing through a given point in the commercial line and measure the amount they were filled non-invasively and without disrupting the flow of the manufacturing system.

- Used mechanical design tools like solidworks for designing sensor and implemented it for solid, liquid filled capsules, and tablets.
- Designed faraday cage for compactness, reducing noise by 90% and implemented an aray for multiple lines of sensors.

Simulation and Control of Purcell Swimmer
December 2016

Guide: Prof. Ravi Banavar, Systems and Control Engineering, IIT Bombay

- Simulated a 2D purcell swimmer in Python following different gaits for pure translation along individual axes and pure rotation

Internship

Automation of Tool and Component Design
May 2017 - July 2017

Design Intern, NRB bearings Limited

Designed software to reduce time required to draw proposal drawings of bearing components by 6 hours.

- Designed software in Visual Basic with user friendly GUI to automate technical drawing generation of commonly used bearings
- Increased productivity by decreasing designing time of proposal drawings (pre-confirmation of orders) per bearing by 4-8 hours
- Learnt and developed template files in PTC Creo modelling software to automate new design creations
- Documented procedure to automate new designs and other products and presented live demonstration to the design team

Course Projects

Adaptive Control under Input Constraints
January 2017 - April 2017

Course: Adaptive Control Theory, Instructor: Prof. Sukumar Srikant, Systems and Controls Engineering

- Studied paper (Positive μ- modification for stable adaptation in the presence of input constraints) of μ-modification proposed by Eugene Lavretsky and Naira Hovakimyan for Input constraints
- Studied paper (Adaptive tracking for nonlinear systems with control constraints) by Alexander Leonessa, Wassim M Haddad, and Tomohisa Hayakawa for input saturation and input rate saturation constraints
- Performed simulation of both the papers on a system in GNU Octave
- Compared results between both of them listing pros and cons of the strategies

Active Noise Cancellation - Coding LMS and Modified LMS Methods

January 2017 - April 2017

Course: Acoustics and Hearing, Instructor: Prof. Sripriya Ramamoorthy, Department of Mechanical Engineering

- Studied various types of noise cancellation algorithms, specifically Least Mean Square algorithm used for active noise cancellation using two microphones. LMS and Modified LMS methods were implemented in GNU Octave for performing simulations
- Voice samples of students mess, engine sounds, songs, white noise(computer generated), and recorded voice were used to look at the attenuation. Attenuation of upto 19 dB was observed in simulation of random noise. The results of both the algorithms were compared

Paper Review, Optimal Control

January 2017 - April 2017

Course: Geometric and Analytic Aspects of Optimal Control, Instructor: Prof. Ravi Banavar, Systems and Controls Engineering

- Studied paper (A Simple Proof of the Pontryagin maximum principle) by Dong Eui Chang and prepared a report of the same
- Studied paper (Time-optimal control of a 3-level quantum system and its generalization) by Dong Eui Chang and presented it.

Passive Walking Assist Device

July 2017 - November 2017

Course: Machine Design, Instructor: Prof. Shantanu Tripathi, Department of Mechanical Engineering

- Designed a device which would assist people with weaker thigh muscles or injury to walk without any external energy source
- Studied energy required in different parts of the human gait using openly available medical data and simulated it in MSC ADAMS
- Designed a catch and release mechanism to release spring when the foot would do negative work to minimise strain on user
- Fabricated the design made in solidworks of the said mechanism using laser cutting and made a working prototype

Design of a Spherical Robot

July 2017 - November 2017

Course: Design of Mechatronic Systems, Instructor: Prof. Prasanna Gandhi, Department of Mechanical Engineering

- Designed in a team of two a spherical robot in SolidWorks with rotation and stability based on gyroscopic effect and calculated specifications required for various actuators used in the robot for specified values of velocity
- Fabricated the bot interior using Laser Printing and achieved desired speed of the bot by open loop control controlling it through bluetooth by developing a bluetooth control system using motor drivers, ATmega32 microcontroller chip and bluetooth module

FEA of Drilling of CFRP Polymers

July 2016 - November 2016

Course: Manufacturing Processes, Instructor: Prof. Ramesh Singh, Department of Mechanical Engineering

Studied drilling of orthotropic composite fibre reinforced polymers and performed FEA simulation in ABAQUS. Matched value of delamination with that available in literature at various feed rates and thrust forces

Relevant Courses

Systems and Control	Systems Theory, Introduction to Probability and Random Processes, Control of Nonlinear Dynamical Systems, Analytical and Geometric Dynamics, Optimization Techniques, Geometric and Analytic Aspects of Optimal Control, Differential Geometric Methods in Control, Adaptive Control Theory
Mechanical Engineering	Design Optimization, Design of Mechatronic Systems, Computer Aided Simulation of Machines, Acoustics and hearing, Computational Structural Dynamics, Computer Graphics and Product Modeling, Machine Design
MOOCs	Introduction to Computer Science and Programming Using Python (MITx - 6.00.1x), Foundation of Data Structures (IITBombayx - CS213.1x)
TEQIP	Geometry, Robotics and Control

Skills

Programming	C/C++, Embedded C, Java, Android, MATLAB, Octave, Arduino, Python, Visual Basic, Bash
Web	HTML, CSS, Javascript, Bootstrap
Engineering software	SolidWorks, AutoCAD, Abaqus, PTC Creo
Others	LaTeX, Eagle, Simulink
Fabrication Tools	CNC, 3D Printing, Laser Cutting, Power tools, Welding

Leadership and Mentorship

Manager, Robotics Club

April 2016 - March 2017

Students' Technical Activities Body, IIT Bombay

- Incharge of organising various events pertaining to robotics for freshmen and managing a budget of INR 2L for various events
- Organised the institute's biggest technical competition, XLR8, a remote controlled car making competition for over 500 students
- Organised Institute wide summer project platform to develop self ideated projects. Saw participation from 300 sophomores
- Developed robotics club website/blog which had over 15000 pageviews in the initial 2 months after launch
- Organised the first ever technical workshop in Indian Institute of Technology Goa, with a 100% completion of projects rate

Student Mentor

July 2018 - Present

Institute Student Mentor Program, Indian institute of Technology, Bombay

Selected among 92 mentors from amongst 290 applicants based on strong peer reviews and rigourous interview to help 11 freshmen acclimatise to campus life and helped them with their problems

Teaching Assistant

July 2018 - Present

Course: Microprocessors and Automatic Control, IIT Bombay, Instructor: Prof. Shashikant Suryanarayanan

Assisted the professor in conducting weekly Tutorials and conducted and evaluated quizzes for a class of 80 third year undergraduate students. The topics in the course included laplace transform, bode plots, frequency respone, pole placement, designing control systems, and basics of microprocessors.

Volunteer

July 2014 - December 2015

National Service Scheme, IIT Bombay

- Taught students of standard sixth to ninth Maths, Science and english as part of different NGOs in and around IIT Bombay Campus
- Taught mess workers and security of IIT Bombay as a part of NGO Computer Learning Program

Industrial Visits and Workshops

Nov 2018	**Recent Innovations in Predictive Control**, Attended lectures by various speakers in the field of deterministic and stochastic predictive control	*IIT Bombay*
Jan 2016	**Tata Motors Manufacturing Facility**, Visited Tata motors Manufacturing facility, viewing various production lines and interacted with the technical and HR team	*Pune, Maharashtra*
May 2016	**Fun in Fabrication, Tata Centre for Technology and Design**, Attended workshop on various modern fabrication tools like power tools, TIG welding, 3D printers, Laser cutters and PCB printers	*IIT Bombay*