Pulkit Katdare

Contact

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Interests

My primary interests lie in the intersection of Control Theory and Optimization.

Education

Indian Institute of Technology Bombay, Mumbai, India *July 2013 – Present*

Final Year, Dual Degree(Bachelor & Masters in Technology), Mechanical Engineering
Specialization : Computer Aided Design and Automation (CADA)

- **Major CGPA:** 8.24/10
- **Minor Degree:** Department of Mathematics

Publications

S.Kadam, K.Joshi, N.Gupta, P.Katdare & R.Banavar, *Trajectory Tracking Using Motion Primitives for the Purcell's Swimmer*, Proc. International Conference on Intelligent Robots and Systems, 2017

Research Projects

Formation Control Strategy for Swarms of Micro-swimmer *Masters Thesis*
Guide: Prof. Ravi Banavar, SC & Prof Salil Kulkarni, ME, IITB *May 2017 -*
Formation control theory deals with coordination of multiagent systems to achieve a common desired objective. In this work we formulate a control strategy to achieve a circular type of formation for a two agent Purcell's micro-swimmer. We further demonstrate the Stability of this control formulation by using the Lyapunov's theorem. We further plan on generalizing this control strategy for a N-agent Purcell swimmer and deploy them in our in-house fabricated prototype of Purcell's swimmer. Report here

Design and fabrication of micro-robot
Guide:Prof. Ravi Banavar, SC IITB *May 2017 -*
In this work we are trying to fabricate a micro-swimmer also popularly called as the micro-scallop. Lithography methods are generally used for fabricating these types of swimmers whose length scale are in order of few micro-meters. We propose to actuate this swimmer using an external magnetic field which is generated using time varying magnetic field using a Helmholtz coil. Report here

Modelling and Control of a Shape Altering Micro-Swimmer *Bachelor's thesis*
Guide: Prof. Ravi Banavar, SC IITB *July 2016 – April 2017*
In this bachelor's thesis, we attempt to formulate a control theoretic model for a shape altering micro-swimmer whose locomotion was inspired by observing the motion of amoeboid. Using low Reynolds approximation along with Stokes law hypothesis, we were able to come up with a control-affine equations for this shape altering swimmer. We later go on to prove notions on controllability. Report here

Trajectory tracking using motion primitives for the purcell's swimmer
Guide: Prof. Ravi Banavar, SC, IITB *July 2016 – April 2017*
Motion primitives is an infinite time control algorithm to maneuver a controllable system from one point in the state space to another. In this work we demonstrate the motion primitives algorithm approximately converges at moderately sufficient time on an in-house fabricated prototype of Purcell's swimmer. We also show that the algorithm can also be used to track a smooth trajectory in state space. Paper here

Dust Characterization of Keyboard Connector *College Park, USA*
Guide: Prof. Diganta Das & Prof. Carlos Morillo, CALCE *Summer 2016*
CALCE is the largest electronic products and systems research center focused on electronics reliability. In this 10 week research internship work, I was involved in modeling the effect of dust particles on keyboard connector performance degradation. We later verified our findings by comparing the effect of the size of dust particles on the performance of the keyboard connector

Learning via Chemical Reaction Networks

Guide: Prof. Manoj Gopalkrishnan, EE, IITB *July 2016 – April 2017*

Chemical Reactions in a way epitomizes the functioning of any living organism. In this work, we developed learning algorithms by observing the dynamics of a Chemical Reaction Networks.

Understanding Reinforcement learning Algorithms

Self-Initiated Project *July 2016 – April 2017*

A self-exploratory project undertaken to realize the intricacies behind the theories of various Reinforcement learning algorithm and it's implementation. Implementation algorithms include Dynamic programming, DQN, DDPG, TRPO implementations. Code Here.

The IITB Mars Rover Project

Guide: Prof. P.J, Guruprasad *May 2015 – Present*

The IITB Mars Rover project is a student initiative at IIT Bombay to build a prototype Mars rover to participate in the University Rover Challenge at the Mars Desert Research Station, Utah. I am currently working with a team of 8 people to design and fabricate a mars rover with an attached 3 DOF robotic arm. The systems design of this mars rover will be integrated on ROS framework to enable a smoother integration all subsystems in our rover. Report Here.

Course Projects

Kinematic Design Optimization of Automobile suspension *Design Optimization*

Guide: Prof. Salil Kulkarni, ME, IITB *Autumn 2016-17*

Optimized the design parameters of a double-wishbone suspension system to maximize the traversable obstacle height possible by the suspension. The optimization was driven by purely geometric consideration and used Sequential Quadratic Programming (SQP) algorithm for optimization. Report Here.

Statistical v/s Neural Machine Translation *Advanced Machine Learning*

Guide: Prof. Sunita Sarwagi, CSE, IITB *Autumn 2016-17*

Trained the Neural Machine Translation model with embedded attention mechanism for transliteration. Compared the alignments probabilities computed using Statistical Machine Translation (SMT) and Neural Machine Translation. Report Here.

Design of a Continuously Variable Transmission System *Machine Design*

Guide: Prof. Tanmay Bhandakkar, ME, IITB *Autumn 2016-17*

Designed the model of the system in SolidWorks. Analysed the durability of the belt and the pulley mechanism using ANSYS. Selected suitable material and optimal machine element parameters like size of belt, pulley etc. through repeated iteration. Report Here.

Character Recognition using Unsupervised SNNs *Neuromorphic Engineering*

Guide: Prof. Bipin Rajendran, EE, IITB *Autumn 2015-16*

Designed an unsupervised learning algorithm along with lateral inhibition using spiking neural networks(SNNs) for digit recognition on MNIST database. The database achieved an accuracy of 37%, which could be further improved by using genetic algorithms.

Using Vanishing Points for Camera Calibration *Computer Vision*

Guide: Prof. Ajit Rajawade, CSE, IITB *Spring 2015-16*

Calibrated a DSLR and a mobile camera using the geometric concepts of mutually perpendicular vanishing points. Reference: "Using Vanishing Points for Camera Calibration". Further developed functionalities to automatically detect the vanishing points. Code Here.

Automatic Laser Etching Machine *Advanced Manufacturing Processes*

Guide: Prof. Ramesh Singh, ME, IITB *Autumn 2015-16*

Designed and fabricated a 2 DOF laser etching on the lines of a 3D Printer along with an interactive GUI. Achieve an accuracy of the etching machine to 0.1mm. Report Here.

Camera Stabilizer *Institute Technical Summer Project*

Guide: STAB, IIT Bombay *Summer 2014*

Conceptualised and designed a gimble stabiliser which counterbalances a standard DSLR camera. Designed a feedback controller for this 3 DOF gimbal using STM-32 microcontroller to stabilize the camera from jerky movements

Achievements and Awards

- Secured all-India rank 306 in the IIT-JEE Advanced 2013 amongst half a million candidates
- Secured all-India rank 1809 in the IIT-JEE Mains 2013 amongst 1,400,000 candidates
- Secured an Gujarat State Rank of 20 in GHSEB examinations 2013 among 150,000 candidates
- Nominated for the **INSPIRE** Scholarship by the Government of India for higher studies
- Completed a Green belt certification course on the **Six Sigma** methodology organised by KPMG
- Awarded an **AP** grade for an exceptional performance in the course Numerical Analysis

Mentoring Experience

Teaching Assistant for IITB Courses

PH 107: Quantum Physics	Prof. U.Shankar *&* Prof. S.Prasad	*Summer 2017*
MA 214: Numerical Analysis	Prof S.Baskar *&* Prof S.Ganesh	*Spring 2016-17*
ME311: Microprocessors and Automatic Control	Prof P.Gandhi *&* Prof. V.Sangwan	*Autumn 2017-18*

Abhyasika, Community Service Teacher *July 2016 –*
Currently Teaching a group of Disadvantaged kids elementary mathematics and algebra to help them get ahead in their schooling

Key Coursework

Computer Sciences Engineering
Computer Vision, Advanced Machine Learning, First Course in Optimization, Science of Information Statistics and Learning, Introduction to Neuromorphic Engineering, Statistical Physics*
Mathematics and Control Courses
Introduction to Numerical Analysis, Real Analysis, Complex Analysis, Basic Algebra, Fourier Analysis, Analytical Methods in Engineering Applications, Advanced Calculus, Differential Equations, Linear Systems, Micro-processors and Automatic Control, Differential Geometric Methods in Control, Games and Information, Control Systems, Control of Non-linear Dynamical Systems
Mechanical Engineering Courses
Machine Design, Kinematics and Dynamics of Machines (course & lab), Computer Aided Simulation of Machines, Introduction to Bio-fluid Mechanics, Industrial Engg & Operations Research, Computational Fluid Dynamics and Heat Transfer*

Technical Skills

Programming	C/C++, Python, Matlab, Scilab, mongoDB, LaTeX
Software Packages	ROS/Gazebo, OpenCV, The Point Cloud Library, Design, SolidWorks, AutoCAD, LabView
Science Software	Python packages: NumPy, SciPy and Matplotlib, GNUPlot Machine Learning: Theano, Tensorflow, Keras, Scikit-learn

References

Prof. Ravi Banavar, SC
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Prof. Diganta Das, ME
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