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Education

- **Indian Institute of Technology (IIT), Kharagpur, India** **Current CGPA: 8.13/10.0**
B.Tech in Electrical Engineering + M.Tech in Control System Engineering, *2014-2019 (expected)*

Publications

- **Modeling and Control of an Autonomous Three Wheeled Mobile Robot with Front Steer**
IEEE International Conference on Robotic Computing, Taiwan - 2017
- **Low Cost Autonomous Navigation and Control of a Mechanically Balanced Bicycle with Dual Locomotion Mode [15ITEC-0224]**
IEEE International Transportation Electrification Conference, Chennai - 2015.

Research Experience/Projects

- **Autonomous Ground Vehicle (AGV) Research Group** **IIT Kharagpur**
Control Systems and Computer Vision Researcher *Feb 2015–Present*
Guide: *Prof. Debashish Chakravarty, Department of Mining Engineering*
 - Planned and implemented a robust control system and developed the vision based obstacle detection pipeline for Eklavya 5.0, a ROS based front-driven and front-steering autonomous electric vehicle built entirely in IIT Kharagpur.
 - Also worked on vision based traffic sign recognition, Stereo SLAM, real-time vision based road bumper detection, odometry/localization using a custom built velocity sensor data and communication networks.
 - Selected as an undergraduate representative for the university for Intelligent Ground Vehicle Competition 2016.
 - Also building a self-driving car for Mahindra Rise Driverless Car Challenge, where the group was selected among top 13 teams in the final round, out of the 600+ that applied for the same.
- **Visual Odometry and Monocular Loop Closures for SLAM** **Carnegie Mellon University**
Perception Research Intern *May 2017–Jul 2017*
Guide: *Prof. Nathan Michael, RASL, The Robotics Institute*
 - Worked on an implementation of a keyframe-based robust visual odometry framework using RGBD sensors, with a focus on accurate and robust loop closures for trajectory optimization.
 - Implemented the entire framework in C++ from scratch, including Robust Loop Closures using bag of words, Trajectory Estimation via Graph Optimization, Perspective n-points solving using optimization and Dense Visual Tracking.
 - Also worked on building custom embedded Linux distributions using bitbake, especially for Intel Aero Drones. Cross compiled libraries like Ceres, Eigen, Sophus for use on the Intel Aero platform.
 - Presently working remotely to produce an improved work based on robust feature trails, using regular monocular cameras instead of RGBD and high-frequency inertial readings for scale estimation.
- **SKALA: A stair climbing mobile robot** **IIT Kharagpur**
Embedded Systems and Computer Vision Team Captain *Nov 2016–April 2017*
 - Led the development of a large robot to carry people up and down stairs while also being able to move on floors.
 - Worked on an autonomous vision-based control system using real time object tracking, EEG signal based control, voice control, touch interface development, mechanical design and overall embedded design.
 - Recipient of the Gold medal in the inter-hall hardware exhibition 2017 at IIT Kharagpur.
- **THAWR (Teachable Human Augmentation Workstation Robot)** **IIT Kharagpur**
Embedded Systems and Computer Vision Team Member *Jan 2016–April 2016*
 - Developed a large scale industrial mobile robot with 4-DOF arms capable of storing and replicating human actions.
 - Worked on control of high torque actuators, computer vision for object recognition on a Raspberry Pi 2, multi-sensor interfacing and voice recognition.
 - Recipient of the Silver medal in the inter-hall hardware exhibition 2016 at IIT Kharagpur.

- i-Bike : Low-Cost Autonomous Bicycle with Dual Locomotion Mode** **IIT Kharagpur**
 Embedded Systems and Control Team Member *Jan 2015–April 2015*

 - Built a low cost, modular and user friendly three-way hybrid bicycle [Manual, Electric, Autonomous] for the visually impaired and partially disabled people by modifying an ordinary bicycle.
 - Worked on sensor interfacing, motor control and implementation of motion planning on a network of Arduinos.
 - Recipient of the Gold medal in the inter-hall hardware exhibition 2015 at IIT Kharagpur.

- 3D Homing for quadcopters using visual servoing** **IIT Bombay**
 Vision and Control Intern *Dec 2016–Jan 2017*
 Guide: Prof. Leena Vachhani, Systems & Control Engineering

 - Implemented a bearing-only homing method under a visual servoing implementation on Parrot AR Drone v2.
 - Extracted image features, simulated the convergence of the algorithm, programmed the motion planner and developed the ROS architecture as a part of a month-long internship. Github Repository Link.

- Retina² : Navigation and Tracking System for Visually Impaired** **IIT Kharagpur**
 Team Leader and Developer *Aug 2016–Apr 2017*
 Guide: Prof. Debdoot Sheet, Department of Electrical Engineering

 - Top 10 Finalist of Analog Devices Inc.'s fully funded Anveshan 2016 Internet-of-things student developer challenge.
 - Developed a geo-navigation and tracking system for the visually impaired using computer vision for obstacle avoidance, Kalman filters for sensor fusion, haptic touch control and actual human gait analysis.

Course Projects

- **Soft Computing Tools in Engineering:** Developed a fuzzy logic based, parallel obstacle-avoidance and path-planning algorithm for mobile robots. Performed MATLAB simulations and also demonstrated the algorithm on a real differential-driven robot. Github Repository Link
- **Computational Neuroscience:** Simulated neuron-level learning on MATLAB by using computer-generated spiking data from 4 neurons. Used analysis of Spike triggered averages, evaluated output nonlinearities of model and performed pruning on trained models. Github Repository Link.
- **Embedded Systems Laboratory:** Developed a human motion mimicker autonomous mobile robot using digital compasses and accelerometers. Developed the communication pipeline and programmed a proportional controller to make the robot follow the direction and steps of a subject.

Research Interests

- Autonomous Robots, Computer Vision, Graph Optimization, Control Systems, Embedded Systems

Technical Skills

The number in brackets: (1) = Proficient (2) = Competent (3) = Beginner

- **Programming Languages:** C (1), Python (1), C++ (1), MATLAB (2), Lua (3), Java (3), L^AT_EX(3)
- **Hardware Programming:** Arduino and ATmega microcontrollers (1), Raspberry Pi & BeagleBone (1)
- **Specialized Libraries & Environments:** ROS (1), OpenCV (1), GTSAM (2), Git (2), PCL (3), Gazebo (3)
- **Robotics Specializations:** Control Systems (1), Computer Vision (1), Localization (2), Motion Planning (3)

Academic Achievements

- **2010:** Awarded National Talent Search Examination Scholarship by Government of India (99.96 percentile)
- **2013:** Awarded KVPY Fellowship by Dept. of Science & Technology, Government of India (99.67 percentile)
- **2014:** Qualified JEE Main and Advanced for science & engineering education entrance in India with percentiles of 99.98 (score 313/360) and 99.2 (All India Rank 1178) respectively.
- **2013:** Finished in top 1% in National Standard Examination(s) in Physics and Astronomy (NSEP and NSEA) in state of Delhi and qualified for Indian National Chemistry Olympiad (INChO).

Relevant Coursework

• University

Control Systems Engineering
Programming & Data Structures
Control Theory
Estimation of Signals & Systems
Soft Computing Tools in Engineering
Linear Algebra
Computational Neuroscience

Convex Optimization in Control
Computer Architecture & Operating Systems
Embedded Systems
Data Communication
Signals & Networks
Probability & Stochastic Processes
Analog Electronic Circuits

• Online

Artificial Intelligence for Robotics
Robot Mapping
Machine Learning

Visual Navigation for Flying Robots
Control of Mobile Robots
Multiple View Geometry

Other Activities

- **Technology Robotix Society** **IIT Kharagpur**
 - *Head (Since Feb '16)* *Aug 2014–Jul 2016*
 - As part of the university's official robotics and hobby maker group, conducted the largest robotics related events in India, namely Robotix 2015 and 2016. Prototyped 4 robots for the events.
 - Also mentored several workshops on Autonomous robotics in IIT Kharagpur and other universities in eastern India.
 - **Azad Hall of Residence Hardware Exhibition team** **IIT Kharagpur**
 - *Captain* *Jul 2016–Apr 2017*
 - Led a team of 40+ for over 9 months to a gold medal in the inter hall hardware exhibition 2017. See SKALA project.
 - **Personal Hardware Projects**
 - *Hardware Hacker/Hobby Robotacist*
 - Built more than 10 hardware projects for learning the concepts of robotics and programming.
 - Bronze medal recipient at IEEE IIT Kharagpur Hardware Hackathon 2015.
 - Built a 3D printed ROS-compatible rangefinder using a Raspberry Pi 2 on my own and presented it at IBM Day 2016.