

# Siddharth S. Jha

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## Education

- Indian Institute of Technology (IIT), Kharagpur, India CGPA: 8.12/10.0
  - B.Tech in Electrical Engineering + M.Tech in Control System Engineering, 2014-2019

## Publications

- Siddharth Jha, Debashish Chakravarty, and Alok Kanti Deb "Coordinated 3-D UAV-UGV exploration with failure recovery" [Submitted Manuscript](#) to ICRA 2020
- Siddharth Jha, Aashay Anil Bhise, Debashish Chakravarty, and Alok Kanti Deb "Optimal visual servoing of a ground robot following an aerial object using a Pan-Tilt (PTZ) camera" [Submitted Manuscript](#) to ICAPS 2019
- Het Shah, Siddhant Haldar, Rohit Ner, Siddharth Jha, and Debashish Chakravarty. "Ground vehicle odometry using a non-intrusive inertial speed sensor." in IEEE ICIT 2019, Melbourne, Australia [IEEE Xplore](#)
- Siddharth Jha, Himanshu Chaudhary et al. "Design, Analysis & Prototyping of a Semi-Automated Staircase-Climbing Rehabilitation Robot." in ACM ICMRE 2018, Valenciennes, France [ACM Digital Library](#)
- Ayush Pandey, Siddharth Jha, and Debashish Chakravarty. "Modeling and Control of an Autonomous Three Wheeled Mobile Robot with Front Steer." in IEEE IRC 2017, Taichung, Taiwan [IEEE Xplore](#)
- Ayush Pandey, Subhamoy Mahajan, Adarsh Kosta, Dhananjay Yadav, Vikas Pandey, Saurav Sahay, Siddharth Jha et al. "Low cost autonomous navigation and control of a mechanically balanced bicycle with dual locomotion mode." In IEEE ITEC 2015, Chennai, India [IEEE Xplore](#)

## Work Experience

- Black Coffee Robotics** Secunderabad
  - Motion Planning & Localization Intern Oct 2019–Present
    - Working on ROS-enabled coverage motion-planning and SLAM for 2 different mobile robots, as a part of a deep-tech start-up. Also working on mobile robot control, simulation and embedded systems (STM32).

## Research Experience/Projects

- Autonomous Ground Vehicle (AGV) Research Group** IIT Kharagpur
  - Control Systems and Computer Vision Researcher Feb 2015–Jun 2019
    - Guide: Prof. Debashish Chakravarty, Department of Mining Engineering
    - Developed non-trivial control systems ([Publication](#)), a factor-graph based localization stack ([Accepted Preprint](#)), lane detection and navigation for a unique 3-wheeled ground robot.
    - Worked on a visual SLAM pipeline, road bumpers & traffic sign detection, and embedded systems/CAN communication architecture for a self-driving car. [Group website](#) | [Project Details](#)
    - Represented the team at Intelligent Ground Vehicle Competition (IGVC) 2016 and led it to the 2<sup>nd</sup> position worldwide in 2018, both held in Oakland University, Michigan, USA. [Competition Website](#) | [Report \(2016\)](#) | [Report \(2018\)](#)
- Coordinated exploration using autonomous aerial and ground robots** IIT Kharagpur
  - Master's Thesis Project Aug 2018–Sep 2019
    - Guide: Prof. Alok Kanti Deb, Department of Electrical Engineering
    - Worked on local motion planning of a ground robot following a flying object, by using a pan-tilt camera and a LiDAR rigidly mounted on the robot, solved novelly using a single optimization problem.
    - Submitted aforementioned part of the research as a manuscript to the International Conference on Automated Planning and Scheduling (ICAPS) 2019, Berkeley, USA. [Submitted Manuscript](#)
    - Developed an RRT-based, online unknown area exploration-cum-failure-recovery software stack with 6DoF Visual SLAM as backend, demonstrated results on ROS-based Gazebo simulations, as well as in real world, with a Clearpath Husky and a custom quadcopter built from scratch.
    - Submitted the complete research as a manuscript to ICRA 2020. [Submitted Manuscript](#) | [Thesis](#)
- Analysis of visual state estimation for high speed vision-based flight** Carnegie Mellon University
  - Summer Research Intern May 2018–Jul 2018
    - Guide: Prof. Nathan Michael, RISLab, The Robotics Institute
    - Worked on fusion of dense RGBD and feature track-based monocular visual odometry algorithms in a pose graph stack
    - Developed a ROS wrapper for Microsoft AirSim simulator, added capability of data collection on low-spec systems.
    - Researched observability analysis and dynamic camera resource sharing for a multi-camera visual-inertial odometry problem, and developed algorithms to avoid state degradation in degenerate environments, like featureless straight walls.

- Monocular Visual Odometry and Loop Closures for SLAM**

Carnegie Mellon University  
May 2017–Jul 2017
  - Summer Research Intern*

**Guide:** Prof. Nathan Michael, RISLab, 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 closure detection for drift recovery.
      - Implemented the entire framework in C++ from scratch, including robust loop closures using bag-of-words, trajectory estimation via graph optimization and perspective n-points, and dense (direct) visual tracking.
      - Continued this work as my bachelor's thesis project (Aug 2017–Apr 2018), to produce an improved version of the algorithm, based on robust feature trails, using monocular cameras and IMU preintegration. [Report](#)
  - SKALA: A stair climbing mobile robot**

IIT Kharagpur  
Nov 2016–April 2017
    - Embedded Systems and Computer Vision Team Captain*
      - 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 architecture. [Details](#)
        - Recipient of the Gold medal in the inter-hall hardware exhibition 2017 at IIT Kharagpur.
    - THAWR (Teachable Human Augmentation Workstation Robot)**

IIT Kharagpur  
Jan 2016–April 2016
      - Embedded Systems and Computer Vision Team Member*
        - 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, object recognition, sensor interfacing and voice recognition. [Details](#)
          - 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  
Jan 2015–April 2015
        - Embedded Systems and Control Team Member*
          - 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. [Details](#)
            - Recipient of the Gold medal in the inter-hall hardware exhibition 2015 at IIT Kharagpur.
        - 3D Homing for quadcopters using visual servoing**

IIT Bombay  
Dec 2016–Jan 2017
          - Vision and Control Intern*
            - 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](#)
          - Retina<sup>2</sup> : Navigation and Tracking System for Visually Impaired**

IIT Kharagpur  
Aug 2016–Apr 2017
            - Team Leader and Developer*
              - Guide:** Prof. Debodoot 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

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- **Robotics:** Developed a visual servoing framework for a 4DoF robotic arm. Built and assembled the arm, programmed real-time inverse kinematics and autonomous target following on a RPi 2. [Report](#) | [Details](#)
- **Computer Graphics** Developed an algorithm for segmenting 3D OBJ meshes based on geodesic and angular distance of triangle surface normals, and using k-means clustering [Github Repository](#)
- **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](#)
- **High Performance Parallel Programming:** Developed an efficient CNN inference engine using CUDA, and analysed the effect of thread coarsening on AlexNet feedforward pass times. [Report](#) | [Github Repository](#)
- **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. [Report](#) | [Github Repository](#)
- **Embedded Systems Laboratory:** Developed a human motion mimicker autonomous mobile robot using digital compasses and accelerometers. Developed the communication pipeline and programmed a PI controller to make the robot follow the direction and steps of a subject.

## Research Interests

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- Robotics, Geometric Computer Vision, Nonlinear Optimization, Control Theory, Embedded Systems

# Technical Skills

- The number in brackets: (1) = Proficient (2) = Competent (3) = Beginner
- o **Programming Languages:** C (1), Python (1), C++ (1), MATLAB (1),  $\LaTeX$ (2), Lua (3), Java (3),
  - o **Hardware Programming:** Arduino and ATmega microcontrollers (1), Raspberry Pi & BeagleBone (1)
  - o **Specialized Libraries & Environments:** ROS (1), OpenCV (1), GTSAM (1), Ceres (1), Gazebo (1), Eigen (2), Git (2), CUDA (2), AirSim (2), numpy (2), scikit (3), OpenMP (3), PCL (3)
  - o **Robotics Specializations:** Control Systems (1), Computer Vision (1), Localization (1), Motion Planning (2)

# Notable Achievements

- o **2010:** Awarded **National Talent Search Examination Scholarship** by Government of India (99.96 percentile)
- o **2013:** Awarded **KVPY Fellowship** by Dept. of Science & Technology, Government of India (99.67 percentile)
- o **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) (top 0.2%).
- o **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.
- o **2018:** GRE & TOEFL scores of 330/340 (V:160, Q:170, AWA:5.0) & 112/120 (R:30, L:30, W:27, S:25).
- o **2019:** IIT Kharagpur institute order of merit for contributions to technology & research.

# Relevant Coursework

## • University

Robotics	Optimal Control
Control Systems Engineering	Computer Graphics
Convex Optimization in Control	Nonlinear Control
Digital Control	Cyber Physical Systems
Programming & Data Structures	Computer Architecture & Operating Systems
Control Theory	Embedded Systems
Estimation of Signals & Systems	High Performance Parallel Programming
Soft Computing Tools in Engineering	Signals & Networks
Linear Algebra	Probability & Stochastic Processes

## • Online

Artificial Intelligence for Robotics	Visual Navigation for Flying Robots
Control of Mobile Robots	Machine Learning

# Other Activities

- o **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.
- o **Kharagpur Robotics and Artificial Intelligence Group** **IIT Kharagpur**  
*Instructor* *Jul 2015–Dec 2016*
  - Taught freshers and sophomores the basics of robotics in a series of lectures, often attracting participation of 200+.
  - Mentored a 7-day long autonomous robotics workshop in December 2016. Introduced 20+ freshers and sophomores to microcontroller programming and helped them build a step following autonomous robot.
- o **Personal Hardware Projects**  
*Hardware Hacker/Hobby Roboticist*
  - Built more than 10 personal 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.
  - Additional details about these projects are available on [my blog](#).
- o **National Cadet Corps** **1 Bengal EME Coy NCC**  
*Cadet* *Jul 2014–Apr 2016*
  - Volunteer cadet for NCC for a period of 2 years, successfully obtained the B-certificate. Acquired leadership, discipline, basic first-aid, firefighting and target practice skills.
  - Attended a 7-day long training camp held in Kharagpur, won gold medal in tent-pitching competition.