Siddharth S. Jha

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Education

Indian Institute of Technology (IIT) Kharagpur **Current CGPA: 8.18/10.0**
M.Tech in Control Systems Engineering (Dual Degree) 2017-2019
B.Tech in Electrical Engineering 2014-2018

Research Interests

Robotics, Geometric Computer Vision, Nonlinear Optimization, Control Theory

Conference Publications

- **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-Zoom (PTZ) camera" in ICAPS 2019, Berkeley, USA *Manuscript under review, Available upon request*
- 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 Arxiv Preprint
- **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

Research Experience

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*

• 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^{nd} position worldwide in 2018, both held in Oakland University, Michigan, USA. Competition Website | Report (2016) | Report (2018)

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 trail-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**
Summer Research Intern *May 2017–Jul 2017*
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 regular monocular cameras instead of RGBD, and IMU preintegration.

Coordinated exploration using autonomous aerial and ground robots **IIT Kharagpur**
Master's Thesis Project *Aug 2018–Present*
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. Work submitted to ICAPS 2019.
• Working towards unknown area exploration using a light autonomous aircraft being followed by an autonomous ground robot, communicating with each other, localizing each other and mapping the environment together. Github Repository

- **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.
  - Simulated the convergence of the motion planning algorithm, developed a C++ visual servoing codebase from scratch, and developed the ROS architecture as a part of a month-long internship. Reference Paper
  - Work still being used in the lab as a motion planning/localization codebase Github Repository

Projects

Systems Design Projects

- **SKALA: A stair climbing mobile robot** Developed a large semi-autonomous rehabilitation robot to carry people up and down stairs, and also capable of moving on flat ground. Worked on mechanical design, image-based visual servoing & embedded design. Project Details | Publication
- **THAWR: Human replicating industrial robot** Developed a large-sized industrial mobile robot with 4-DoF load bearing arms, capable of memorizing and replicating human actions. Worked on forward kinematics, sensor interfacing, embedded system design and feedback control. Project Details
- **i-Bike : Low-Cost Autonomous Bicycle with Dual Locomotion Mode:** Developed a low-cost autonomous bicycle for the visually impaired and partially disabled people, by modifying an ordinary bicycle. Worked on motor control, dynamic obstacle avoidance, sensor interfacing and embedded system design. Project Details | Publication
- **Retina^2 : Navigation and Tracking System for Visually Impaired**: 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. Project Details | Github Repository

Course Projects

- **Robotics:** Developed a visual servoing framework for a 4DoF robotic arm. Built and assembled the arm, programmed inverse kinematics calculation 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:** Developed a fuzzy logic-based, parallel obstacle-avoidance and motion-planning algorithm for mobile robots. 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
- **Cyber Physical Systems:** Developed a multi-car platooning simulation using a feedforward PI speed and bearing control strategy, demonstrated on TORCS and MATLAB. Details

Technical Skills

Programming Languages: C, C++, Python, MATLAB
Libraries: ROS, OpenCV, Ceres, GeorgiaTech Smoothing And Mapping (GTSAM), Point Cloud Library, Gazebo
Hardware: Arduino, ATMega, Raspberry Pi & other SBCs, Pixhawk, Xilinx FPGA

Academic Honours

- **KVPY Scholar, 2012:** Awarded by Dept. of Science and Technology, Govt. of India for scientific aptitude.
- **NTSE Scholar, 2010:** Awarded by NCERT, Govt. of India for academic excellence.

Other Activities

- Mentored 5 technical workshops as a part of Kharagpur Robotics and AI Group, for freshers and sophomores.
- Was responsible for conduction of technical fests Robotix 2015 and 2016, saw combined footfall of 1500+.
- Captained Azad Hall of Residence, IIT Kharagpur for Inter Hall Hardware Exhibition, 2017 (SKALA Project).
- Avid keyboard and harmonium player. Played the harmonium at Inter-hall dramatics 2015 at IIT Kharagpur.