SIDDHARTH SAHA

Mumbai, India

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Education

Examination	University	Institute	Year	GPA
M.S.	Carnegie Mellon	Robotics Institute	2022 - 2024	-/4.00
Graduation	IIT Bombay	Indian Institute of Technology Bombay	2017 - 2021	9.43/10.00

Undergraduate Degrees: B.Tech. with Honors in Mechanical Engineering, IIT Bombay
Minor in Computer Science and Engineering, IIT Bombay

Conference Talks & Working Papers

- Ravit Anand, Siddharth Saha, Prasanna Gandhi, **Equilibrium states of Rotary Ultra-flexible Inverted Pendulum**, *Working Paper*
- Siddharth Saha, Leena Vachhani, **Dynamic OctoMap: Mapping Regions of Dynamic Activity & Building Dynamic-free 3D Occupancy Maps**, *Lightning Talk at ROS Conference 2021* Video
- Siddharth Saha, P. Vanjani, S. Gokhale, **Google Summer of Code '21: ROS2 RADI & pick-and-delivery warehouse exercise in web-based template**, *Lightning Talk at ROS Conference 2021* Video

Scholastic Achievements

- Ranked **top 5** in batch of 150 students on merit of GPA | Secured **perfect 10.0** GPA in 7^{th} & 8^{th} semesters ['21]
- Bagged the **Technical Citation**, 2^{nd} highest award for excellence in technical activities at IIT Bombay ['21]
- Conferred **AP grade** (3/188 students) in Statistical Machine Learning course for exceptional performance ['20]
- Endowed with the **Economic Times Campus Star Award** from over 49,000 candidates across India ['20]
- Awarded the SSP scholarship (among 15 students from India) by **Japan Science & Technology** Agency ['19]

Research Experience

Equilibrium states of Rotary Ultra-flexible Inverted Pendulum | IIT Bombay Jul'21 - Present

Guide: Prof. Prasanna Gandhi

- Applied the **assumed modes method** to mathematically model equations of motion for the flexible beam
- Assembled **lab setup** and captured static equilibrium shapes of Be-Cu beam for varied fixed angles & tip masses
- Compared observed shapes against simulation predictions & validated with potential energy vs initial state q plots

Mapping Regions of Dynamic Activity & Building Dynamic-free 3D Occupancy Maps | Demo

Bachelor's Thesis — Guides: Prof. Leena Vacchani, Prof. Abhishek Gupta Jun'20 - Jul'21

- Proved the occupancy & dynamic activity probabilities in an octree map to **form a field** in the range (0,1)
- Designed & implemented novel clustering algorithm in **ROS OctoMap** to reject nodes with high dynamic activity

Hiroshima University, Japan | Special Auditing Student Jun'19

- Assimilated ongoing research in the **Cybernetics Laboratory** under the *Sakura Research Exchange Programme*

Work Experience

Google Summer of Code – JdeRobot, Student Developer | Final Report Jun'21 - Aug'21

JdeRobot develops framework based on ROS, Docker & Django to simplify learning robotics & computer vision

- Built the RADI-4.0 (Robotics Academy Docker Image) for **ROS2 Foxy**, and VNC-based RViz2 web template
- Implemented BT (**Behavior Tree**) Navigator | Extended pick-and-delivery exercise to ROS2 web-based template

Goldman Sachs, Quantitative Summer Analyst | Bengaluru May'20 - Jun'20

- Ideated and implemented **payment structuring** ideas for mortgage-backed securities to **maximize arbitrage**
- Achieved **sharp improvement** of 1.62% profits by optimizing cash-flows through different derivative instruments

Technical Projects

Quadruped Robot | RoboCup Rescue League Challenge Dec'19 - May'21

Founding member & Team Lead of two-tiered team with 15 members, overseeing technical budget of ~14K USD

- Explored **impedance control** to create virtual leg compliance | Simulated **gait trajectories** inside Gazebo
- Generated foot trajectory by modulating length and height of control points for a **11-order Bézier curve**
- Implemented **sensor fusion** of *MPU6050* with *Intel RealSense D435* PointCloud2 data to demonstrate SLAM

Robot Vision Scene Understanding Challenge | CVPR '21, Report & Source Mar'21 - Apr'21

Robot traversing environment to build an object-based semantic map using RGBD sensor & odometry measurements

- Trained & compared 3D object detection techniques using VoteNet, Group Free 3D, Votenet ensemble learning
- Executed YOLOv4 in parallel with 3D detection techniques to achieve higher confidence through consensus
- Applied **3D NMS** algorithm to obtain semantic map of environment with bounding boxes around detected objects

F1/10$^{\text{th}}$ – Autonomous Grand Prix | IROS '20, Las Vegas, Source Oct'20

International autonomous racing contest with standardized hardware simulated in ROS/Gazebo

- Used **Bernstein polynomial** based local trajectory planner & MPC for Ackermann steering in 4-membered team
- Acquired global optimal path using **OSQP solver** | Implemented obstacle detection | Composed Docker submission

Hilti SLAM Challenge | IROS '21, Prague Sep'21

Estimation of position from ROS bag files utilizing sensor combinations among images, IMU, and LIDAR

- Understood **visual inertial odometry** and applied *VINS-Fusion* on monocular camera and IMU sensor feed
- Calibrated Kannala-brandt camera model using datasheet & IMU noise parameters using `imu_utils` on bag files

Multi-robot Capture of Non-adversarial Target | Documentation & Source Mar'21 - Apr'21

Paper implementation of 'MILP Models for Multi-Robot Non-Adversarial Search' from the ground up

- Implemented graph-represented environment using `networkx` | Modeled the optimization problem using `gurobipy`

Two-wheeled Self-Balancing Bot | Documentation & Demo Aug'20 - Nov'20

- Stabilized Arduino bot using PD control and applied **complementary filter** on gyroscope & accelerometer output

More projects...

Competition Achievements

Winner | **International Micromouse Challenge** | Source & Demo Dec'20

Team Leader in Maze-solving challenge to program an autonomous bot simulated in ROS/Gazebo

- Implemented *online breadth-first planner* for optimal path & **omni-wheel** based drive to reduce steering latency

Winner | **Off-Track Bot** | Innerve '20, Delhi Nov'20

Autonomous bot simulated in Webots to produce given pattern on ground, minimizing number of blocks kept as cues

- Innovated vision-based **object detection in C** to sharply prune number of cues required by navigation algorithm

Winner | **Operations GC** | General Championship '21, IIT Bombay, Source Feb'21

- Devised optimization solutions in MathProg using the **GLPK Optimizer** | Solved machine learning challenges

Vision Based Obstacle Avoidance Drone | 9^{th} Inter IIT Tech Meet, Source Mar'21

*Team Leader of IIT Bombay in autonomous drone challenge inside ROS/Gazebo with **Ardupilot SITL***

- **Ranked 6$^{\text{th}}$** across India | Designed and implemented resilient navigation pipeline to recover from dead ends

RoboCon, Team IIT Bombay | ABU RoboCon '19 Ulaanbaatar, Mongolia Oct'18 - Apr'19

Competition to construct a manual bot with throwing capability & an autonomous walking bot

- Bagged **9$^{\text{th}}$ position** among 50+ national teams in stage-1 | Designed Solidworks model of **robotic gripper arm**

Positions Of Responsibility

Summer of Science Mentor | Maths and Physics Club, IIT Bombay Apr'20 - Jun'20

- Guided **4 mentees** to proficiency in *Data Structures & Algorithms* with **conceptual aid** and meticulous roadmap

Teaching Assistant | Student Mentorship Program, IIT Bombay — Apr-May'18 / Jan-Apr'19

- *Physical Chemistry*: **Only student from freshmen year** appointed to guide class of **15 students** in tutorials
- *Electricity & Magnetism*: Conducted tutorial sessions for **52 students** focusing on the academically weak students

Convener | Electronics and Robotics Club, IIT Bombay — Apr'18 - Mar'19

Part of a two-tiered team of 70 members constituting the Institute Technical Council of IIT Bombay

- Guided over **600 freshmen** participants of XLR8 2018 to make their first remote-controlled wheeled robots
- Organized bootcamps and **delivered talks** on Arduino and Image Processing, attended by **200+ enthusiasts**

Community Service & Volunteering

- Heading JdeRobot's ROS2 Working Group as an **open-source contributor** — Mar'21 - Present
- Mentoring 4 female undergraduates from low-income backgrounds under iWE (**Indian Women in Engineering**), an initiative by Goldman Sachs — Sep'21 - Present
- Tutored a high-school junior under **Abhyasika**, a student initiative at IIT Bombay for upliftment of economically disadvantaged children — Nov'18 - May'19
- Facilitated **Juhu Beach Cleanup Drive** under IIT Bombay E-Cell's Swacch initiative — Oct'17

Technical Skills

Programming & Scripting	Python, C, C++, Java, R, x10, Bash, Sed, Awk, Perl, RegEx, CMake, SQLite
Frameworks	Git, Vim, Docker, OpenCV, PyTorch, TensorFlow, Tesseract-OCR, LaTeX
Optimization	GNU MathProg, GLPK, Gurobi, PuLP, Ipopt, OSQP
Robotics tools	ROS1, ROS2, Gazebo, Webots, MRPT, Pinochhio, TSID, Crocoddyl
Controllers & Modules	Arduino, Raspberry Pi, Tiva C, NodeMCU, MPU6050, Intel RealSense D435

Relevant Courses

Computer Science	Computer Vision, **Reinforcement Learning**, Data Structures and Algorithms, Design and Analysis of Algorithms, Digital Image Processing, Statistical Machine Learning
Robotics	Advanced Topics in Mobile Robotics, **Design of Mechatronic Systems**, Microprocessors & Automatic Control, Kinematics & Dynamics of Machines, Machine Design, Robotics
Optimization	Optimization from Fundamentals, Optimization for Engineering Design, Operations Research
Certifications	**Advanced Methods for Planning & Control of Legged Robots**, ROS: Localization, Navigation & SLAM, Using GPUs to Scale & Speed-up Deep Learning

Extra Curricular Activities

Competition	• First runners-up in Aerial Path Planning GC, IIT Bombay (Source) ['21]
Public Speaking	• Participated in **Model United Nations** by WeSpeak, IIT Bombay ['17] • Received **Special Mention** among **35 participants** in English Debate, IIT Bombay ['17]
Journalism	• **Curated article** in Mechanical Media Newsletter with a **reach of 700+** students ['17]
Sports	• Completed inter-hostel Crossy General Championship and the Cyclothon by TechFest ['17]
Leadership	• Headed **150+ students** as **House Captain** in 10^{th} & Vice-Captain in 9^{th} grade ['14,'15]