

# Siddharth Bhurat

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## EDUCATION

**University of Michigan, Ann Arbor, MI**

*Master of Science in Robotics (GPA 4/4)*

**August 2022 – April 2024**

**Graduate student Instructor** for Robotic Systems Laboratory (ROB550)

**Maharashtra Institute of Technology, World Peace University, Pune, India**

*Bachelor of Technology in Robotics and Automation (CGPA 9.61/10)*

**May 2022**

## TECHNICAL SKILLS

*Programming languages:* Python, C, C++

*Framework/ Libraries:* Robot Operating System (ROS1 & ROS2), Pytorch, OpenCV

*Version Control:* Git, Docker

*Operating systems:* Windows, Linux

*Microprocessors and Microcontrollers:* Raspberry pi, Jetson Nano, tinkercard, NodeMCU, Arduino mega

*Software & Manufacturing:* Matlab, Gazebo Simulator, RViz, Robo-analyzer- Robot Kinematics, 3D – Printing, Fusion360

*Communication Protocols:* UART, USART, I2C, SPI, MQTT

*Key Skills:* Strong hold in Sensor Fusion, Localization, Computer Vision(Depth Cameras), Sensor and Actuator and Control, Deep Learning, EKF, graph optimization and bundle adjustment, Visual Odometry, SLAM, Moveit, Move Base

## PROFESSIONAL EXPERIENCE

**Milwaukee Electric Tool Corporation, Brookfield, Wisconsin**

**May 2023 – August 2023**

*Robotics Engineering Intern – Autonomous Lawn Mower*

- Formulated a localization algorithm by interfacing sensors like camera, RTK GPS, Imu, wheel encoders and was able to achieve accuracy of +-3cm. Incorporated the udev rules for the communications which are over USB
- Interfaced the motors over ROS and programmed a differential drive controller for autonomous navigation
- Implemented “pure pursuit” based closed loop robust line following algorithm along with arc following
- Programmed the functionality of gradual speed-up and speed-down when starting from a point and approaching the goal, ensuring a smoother motion for the robot
- Integrated lidar for obstacle “stop and go” behavior and mapping
- Engineered a robust mapping algorithm for the robot to create a detailed map of its surroundings
- Incorporated the frontier detection algorithm, empowering the autonomous robot to explore its environment

**Barton Research Group @ University of Michigan**

**January 2023 – April 2023**

*Research Assistant - Heterogenous Multi Robot Integration for End to End Automation in Manufacturing*

- Deployed multiple robots like Toyota HSR, Kuka Kmr & Kawasaki Duaro with single master controller and having shared sensing among all the robots along with path planning for mobile robots using ROS
- Each of these robots can be programmed separately for their particular tasks, wherein Kuka Kmr and Toyota HSR are mobile robots with robotic arm but with different configurations and different applications like placing the object in the CNC machine chuck or removing the object from a 3D printer, Kawasaki is just a dual Scara robotic arm which can resemble doing an assembling operation
- Once programmed, they are integrated together using ROS over network to have single controller and shared sensing

**Biped Robotics Lab @ Michigan**

**October 2022 – April 2023**

*State Estimation on Digit Robot Platform by implementing Invariant Extended Kalman Filter*

**Itech Robotics and Automation pvt Ltd., Pune, India**

**October 2021 – February 2022**

*Intern | Autonomous Mobile Robot Developer*

- Added an extra axis to their robotic arm and integrated it with their controller to be further used to teaching the arm using teach pendant. Used structured text programming
- Developed an autonomous mobile robot for use in operations such as movement of raw material
- Built a completely new driver for ft servo motors to work with ROS, this has led to achieve the autonomous navigation with a very optimized communication rate
- Implemented g-mapping, monte-carlo localization and used move-base navigation framework with ROS for SLAM
- Utilized 2D-RPLidar with Nvidia Jetson Nano to build map of the surrounding
- Fused sensor data from imu and wheel encoder to get precise odometry

**Iotiot (iotiot.in), Pune, India**

**June 2019 – November 2020**

*Intern | Embedded Developer and Computer Vision Developer*

- Devised sensor libraries using C++ for sensors like soil moisture sensor SHT3X, temperature sensor and stereo cameras to interface them with their custom operating system “Shunya OS” and to be used for IOT and Industrial Automation applications
- Led a team to fabricate a computer vision application capable of detecting motion of a patient, sending automated signal to avail medical aid immediately in hospitals with shortage of trained nurses

## PROJECT EXPERIENCE

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### **Model Predictive Control Based Path Following and Obstacle Avoidance for a Drone** August 2023 – December 2023

- Modeled the drone dynamics in MATLAB using Newton's equations of motion
- Formulated a constrained nonlinear optimization problem based on the drone dynamics, considering requirements for the shortest path from start to goal and obstacle avoidance
- Implemented nonlinear model predictive control for the defined problem using MATLAB

### **Distributed Control, Scheduling and Planning of Multi Robot System** August 2023 – December 2023

- Worked on converting a centralized multi robot control and scheduling into a decentralized systems where all the different robot capabilities intermittently/continuously communicate with each other try to gain as much information about the environment as possible and by doing this, at some point in time, every robot will have information of the complete environment
- This type of system which is decentralized will help in reducing the communication requirements of all the robots from a central system

### **Loop Closure Detection using CLIP | Mobile Robotics Course Project | Team Project** March 2023 – April 2023

- Leveraging the vision-language model CLIP, we were able to achieve better accuracy in visual place recognition, surpassing the state-of-the-art (SoTA) performance
- Integrated our highly effective semantic loop closure detection system into a SLAM (Simultaneous Localization and Mapping) setup, elevating its performance

### **MBot | Robotics Systems Lab Course Project | Team Project** October 2022 – December 2022

- Fabricated an autonomous robot completely from scratch, starting with interfacing different sensors and motors with Raspberry Pi, and then writing the controller for controlling these motors
- Wrote the complete SLAM algorithm in C++, including localization, mapping, and autonomous navigation
- Incorporated the path planning algorithm like A\* to enhance the robot's capabilities
- Solved the kidnapped robot problem by incorporating OpenCV's feature matching algorithm. This allowed us to match the incomplete map with the complete map and then localize the robot

### **ArmLab | Robotics Systems Lab Course Project | Team Project** August 2022 – October 2022

- Employed the Interbotix Robotic (6 DOF) Arm to create a pick and place application using a depth camera
- Computed DH parameters and executed forward and inverse kinematics using Python alongside ROS
- Devised a block detection algorithm by segmenting blocks using computer vision techniques and calculating their coordinates in the real world using camera intrinsic and extrinsic matrices
- Utilized the determined world coordinates to guide the end effector of the robotic arm, enabling it to reach the blocks and perform various operations, such as pick and place, stacking, and more

### **Developed software for a drone to cater people who are stuck during a natural calamity using ROS**

- Implemented PID Control algorithm to stabilize a drone, navigating it in a defined environment through overhead camera using ROS framework and Python as part of the E-Yantra Robotics Competition, Indian Institute of Technology, Bombay in 2019-2020.
- Upscaled the drone by integrating functionalities that help distribute necessities to people in remote areas during a natural calamity

### **Autonomous Robot for Outdoors | Personal Project** December 2020- May-2022

- Engineered a bot capable of traversing to a destination autonomously outdoors, by getting multiple waypoints to form a straight-line path, extracted using Google map API, can be used for deliveries and agriculture
- Localized robot using sensor fusion of magnetometer and GPS, used ultrasonic distance sensors to avoid obstacles
- Implemented iterative closest point algorithm along with ego-motion to estimate depth from monocular camera using python, tensorflow and to be used for motion planning in autonomous navigation using visual servoing
- Utilized Raspberrypi 4, Arduino mega, raspi-cam, motor drivers along with sensors and python programming

### **Autonomous Maze Solving and Floor Cleaning Robot | Personal Project** January 2022 – June 2022

- Programmed, assembled, and prototyped a robot to solve the maze by integrating 2 infrared sensors to detect the maze and devised an algorithm to implement the right-(hand)wall rule based on the path denoted by white strips
- Upscaled the project to perform autonomous floor cleaning application by using ROS with full coverage path planner
- Configured Arduino, Raspberry Pi, Infrared sensors, motor drivers, YD-Lidar X-2 and used C/Python programming to develop the algorithm

### **Home Automation** April 2019- February 2020

- Engineered a home automation device to control appliances like water tank monitoring, light control