

# Sahib Singh Dhanjal

Linkedin: [sahibdhanjal](#) | Github: [sahibdhanjal](#) | Portfolio: [sahibdhanjal.github.io](#) | Email: [sdhanjal@umich.edu](mailto:sdhanjal@umich.edu) | Phone: (734) 239 2285

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## Education

MS: Robotics, Automation and Mechatronics (GPA - 3.55/4.0) - University of Michigan, Ann Arbor

Sep 17 – Apr 19 (expected)

B.E(Hons): Mechanical Engineering (GPA – 9.05 /10) (Ranked top 10 in batch) – BITS, Pilani (#5 in India)

Aug 12 – Jun 16

## Skills

**Languages:** Python, C/C++, JavaScript (Proficient); MATLAB, Java, HTML, CSS, Latex (working knowledge)

**Technologies:** Git, Tensorflow/Keras, ROS, OpenCV, Android Studio, Django, Linux, PyTorch, GTSAM

**Software:** Solidworks, ANSYS, Fritzing, Adobe Creative Suite, Microsoft Office Suite, Processing

**Hands-on:** TurtleBot v2, Fetch, AION R1 Rover, Crazyflie 2.0, Velodyne HDL32, Flir Ladybug 5, Kinect, Hololens, Oculus Rift

**Fabrication:** Skilled in mechanical design, fabrication and prototyping. Comfortable in circuit design and testing procedures.  
*Strong implementation skills (have solved 500+ problems on various online judges)*

## Work Experience

ExxonMobil Chemicals | Sales Assistant – South Asia

Jun 16 – Jul 17

- Handled India and subcontinent operations for EM's largest global distributor. Managed portfolio of 12 customers
- Implemented custom dashboard which led to increase in sales performance by 15% and the analytics efficiency by 65%

PEPL Lab, University of Michigan | Search Engine Optimization

Oct 17 – Nov 17

TATA Steel | Quality Control Intern

May 14 – Jul 14

## Ongoing Projects

Visual-Radio-Inertial SLAM

Aug 18 – Current

- Developed a system for fusing Visual Odometry from ORB-SLAM, IMU Readings and WiFi RSSI data for GPS Denied Localization
- Implemented Deep Neural Network in Keras to classify LOS/NLOS packets to validate application for Friis Free Space Model.
- Simulation of front-end algorithm using Fast SLAM v1 and back-end using GTSAM (iSAM2) built in MATLAB
- Currently implementing model on the Fetch Robot in ROS | Keywords – deep learning, WiFi localization, ORB-SLAM, Fast SLAM, sensor fusion

Multi-Agent Mapping, Task Allocation and Control

Aug 18 – Current

- Implementing Algorithms for multi-robot mapping for ground vehicles using multiple [AION R1 Rovers](#)
- Implementing multi-agent task allocation and coordination algorithms for multiple [CrazyFlies](#) and [AION R1 Rovers](#) for surveillance and mapping
- Keywords – Multi-Agent Mapping, LiDAR, ROS, Multi-Agent Control

## Research and Projects

Deep Learning based Vehicle Classification and 3D Bounding Box Regression

Oct 18 – Dec 18

- Implemented 20-Layer SE-ResNet deep neural network in PyTorch for vehicle classification on the GTA 10k dataset (accuracy ~73%)
- Developed a 3D Bounding Box Regression algorithm using YOLO v3 to produce segmented images with corresponding 2D/3D bounding boxes
- Placed #5 (out of 41) in the competition | Keywords – SE ResNet, object detection, GTA 10k dataset, PyTorch, YOLO

SLAM and Object Detection for an Autonomous Surface Vessel

Jan 18 – Oct 18

- Developed Software Framework for sensor fusion between Spatial Dual GPS/IMU module, Flir Ladybug 3 and 2 Velodyne HDL-32E
- Implemented Robot Control Algorithms and YOLO based marker detection system (as per competition guidelines)
- Worked on Multi-Lidar and Camera Calibration using 3D-3D point correspondences [algorithm](#)
- Implemented SLAM Framework in ROS using gmapping, costmap-2d, and amcl library
- Keywords – deep learning, SLAM, sensor fusion, lidar/camera calibration, ROS, OpenCV, YOLO, Velodyne, GPS

Unsupervised Learning of Assistive Camera Views in Augmented Reality Multitasking Environments

Jul 18 – Sep 18

- Devised an unsupervised learning algorithm by which an aerial co-robot streamed assistive camera views which are unknown a-priori
- Research work submitted for the ICRA 2019 Conference
- Keywords – multi-agent control, Expectation Maximization, AR, ROS, OptiTrack, rViz, Gazebo

### NASA Astronet - A human centric network of Astrobbee robots

May 18 – Aug 18

- Bayesian inferred control algorithms for local and global multi-agent coverage of a confined space
- Each agent (Astrobbee) capable of operating autonomously, and manually as per gesture commands
- VR environment of the International Space Station with multiple robots created. Operator capable of walking inside and operating robots
- Keywords – autonomous exploration, multi-agent control, NASA Astrobbee, Oculus Rift, ROS, VR, OptiTrack, rViz, Gazebo

### Deep Learning in Localization and Mapping (PoseNet + SfM)

Feb 18 – Apr 18

- Deep Learning based structural motion generation algorithm used to automatically label mobile camera input
- PoseNet is trained on the above labeled data and is used as the sensor model. GPS/Odometry data used as action model
- Simulation on GTSAM and implementation on a differential drive mobile robot
- Keywords – SLAM, Deep Learning, PoseNet, Structure from Motion, OpenCV, TensorFlow, GTSAM

### Mask R-CNN based Online Pedestrian Tracking System

Feb 18 – Apr 18

- Transfer learning on Matterport Mask R-CNN for pedestrian detection
- Particle Filtering based on optical flow used to track the trajectory of each of the pedestrians
- Keywords – Localization, Deep Learning, Mask R-CNN, TensorFlow, Keras, OpenCV

### Robot Kinematics Simulator and Motion Planner

Sep 17 – Dec 17

- Forward kinematics using matrix stack & DH convention implemented based on URDF structure of the robot (model for Fetch available)
- Inverse Kinematics simulated using cyclic coordinate descent and gradient descent using manipulator jacobian implemented
- RRT/ RRT-Connect/ RRT-Star planner implemented for high dimensional motion/ trajectory planning
- Keywords – Serial Manipulation, Trajectory Planning, Simulator, Fetch

### SLAM and autonomous exploration in differential drive robot

Oct 17 – Dec 17

- Implemented the occupancy grid mapping algorithm, action model, sensor model, and particle filter for SLAM (in C/C++)
- Implemented Yamauchi's autonomous exploration algorithm on the robot
- Localization results within 5% accuracy of the ground truth. Keywords – SLAM, LiDAR, Mapping, Localization, LCM

### Vision based autonomous 4-DOF dynamixel robotic manipulator

Sep 17 – Oct 17

- Developed a block detection system in OpenCV on images and depth-maps streamed from an overhead Microsoft Kinect
- Processed data was used to manipulate a 4-DOF dynamixel arm autonomously to complete tasks such as block stacking based on color and building 5-level pyramids | Keywords – OpenCV, Kinect, LCM, serial manipulation, Object Detection

### Path planning and multi-robot autonomous exploration on Turtlebot

Dec 15 – May 16

- Path Planning / Navigation stack developed for Turtlebot on ROS Indigo
- Python simulator developed for simulation of multi-robot autonomous exploration and path planning algorithms
- Simulation of autonomous multi-robot exploration in Gazebo. Project was sponsored by DRDO, India
- Keywords – ROS, navigation, exploration, multi-robot, path planning, A\*, JPS, Yamauchi, Burgard exploration

### Formula Student – FSAE Italy

Oct 12 – Sep 14

- Responsible for design and fabrication of a suspension package for a formula student prototype
- Worked on bell crank geometry, double wishbone suspension design, dynamic roll center migration, spring and roll rates for the car, anti-dive and anti-squat parameters for the car
- Team achieved a global 8<sup>th</sup> place in Design out of 47 teams in FSAE Italy 14 | Keywords – Suspension design, SolidWorks, ANSYS, Msc Adams

### Gesture controlled robotic arm

Oct 14 – Dec 14

- Gesture controlled 4-DOF serial manipulator fabricated to augment human capability
- The arm was controlled using 2 Arduino UNOs, IMUs for gesture tracking and an XBee module for wireless communication

### Design/ Fabrication of an autonomous white-board cleaner

May 15 – Jun 15

- Autonomous serial manipulator fabricated which was capable of wiping boards of numerous sizes
- Research paper on this work presented at IEEE UPCON 15

### SVM based spam-mail classifier

Oct 15 – Dec 15

- Spam mail classifier based on Support Vector Machine modeled in MATLAB with accuracy in classification of 96.3%

### Coursework

**Graduate/ Undergraduate:** Design & Analysis of Algorithms, Foundations of Computer Vision, Mobile Robotics, Machine Learning, Robot Kinematics & Dynamics, Machine Learning, Artificial Intelligence, Self-Driving Cars, Data Structures and Algorithms, Image Processing, Deep Learning

## Publications/ Conferences

Unsupervised Learning of Assistive Camera Views in Augmented Reality Multitasking Environments: ICRA 19 (submitted)

Design and development of board cleaning serial manipulator: IEEE UPCON 15

## Positions of Responsibility

### CoStAA ( Techfest Coordinator )

Mar 14 – Apr 15

- 1 of 7 people solely responsible for managing APOGEE, BITS Pilani's Annual TechFest (2nd largest in Asia)
- Managed and coordinated the work of 50+ clubs and departments comprising of 2200+ student members
- Raised funding of 20 lakh INR for sponsorship of all events
- Witnessed participation of 5000+ students from through out India

### Festival Coordinator - Aarohan

Mar 14 – Apr 15

- Gesture controlled 4-DOF serial manipulator fabricated to augment human capability
- The arm was controlled using 2 Arduino UNOs, IMUs for gesture tracking and an XBee module for wireless communication

### Department Coordinator - Department of Visual Media

Dec 13 – Apr 15

- Gesture controlled 4-DOF serial manipulator fabricated to augment human capability
- The arm was controlled using 2 Arduino UNOs, IMUs for gesture tracking and an XBee module for wireless communication

### Marketing and Vehicle Dynamics Lead - Formula Student Team

July 13 – Sept 14

- Raised sponsorship of 5 lakh INR for fabricating vehicle
- Designed, printed and sold over 2500 T-shirts as an effort of securing funds for the team
- Responsible for designing and sending out monthly newsletters and sponsorship brochures to sponsors
- Managed a brilliant team of 15 student engineers, who designed the whole suspension system of the vehicle : from the wheel hubs to pushrod suspension system

## Achievements

- Won Track-O-Mania, Junkyard Wars, iStrike (vision based autonomous robot competition), APOGEE '14
- Won the Google Udacity Scholarship for Android Development
- Won iBOSM '14 soccer and volleyball tournaments
- Represented East Singhbhum district soccer team

## Extra - Curricular

- Taught Robotics, Algorithms, and Mechanical Engineering on Chegg Tutors
  - Front-end developer - APOGEE '15 | Aarohan '15 | Inspired Karters | Department of Visual Media
  - Lead animator and web-designer, Department of Visual Media, BITS Pilani
  - 2<sup>nd</sup> in BITS Premier Soccer League
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