

# Sahib Singh Dhanjal

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## Education

MS: Robotics, Automation and Mechatronics (GPA - 3.56/4.0) - 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

**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

- Modifications to ORB-SLAM in order to output odometry in ROS, which is then fused with IMU and WiFi RSSI data for FAST SLAM front-end
- Conceptualized Deep Learning Model to classify LOS/NLOS packets to validate application for Friis Free Space Model.
- Simulation of front-end algorithm using FAST SLAM and back-end using GTSAM (iSAM2) built in MATLAB
- Currently implementing model on the Fetch Robot in ROS
- Keywords – Bayesian Filtering, WiFi Localization, ORB-SLAM, GTSAM, Android, ROS, Visual SLAM, Sensor Fusion, MATLAB, FAST SLAM

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

## Projects

3D Bounding Box Regression and Image Classification

Oct'18 – Dec'18

- Implemented 20-layer SE ResNet architecture for Image Classification on the GTA V dataset on Kaggle (classification accuracy ~93%)
- Implementing 3D Bounding Box Regression [algorithm](#) to regress the coordinates of detected vehicles on the GTA V dataset
- Placed #5 (out of 38) in the competition Keywords – SE ResNet, Deep Learning, Object Detection, GTA V dataset

AUVSI RobotX - Autonomous Surface Vessel Competition

Jan'18 – Oct'18

- Architected Software Framework for Sensor Fusion, ROS Network/ Communication and base control system
- Sensor fusion between Spatial Dual GPS/IMU module, FLiR Ladybug 3 and 2 Velodyne HDL-32E
- YOLO v3 based marker detection system (object+color+distance/heading) (as per competition guidelines)
- Multi-Lidar and Camera Calibration using 3D-3D point correspondences [algorithm](#)
- SLAM Mapping Module (using gmapping, costmap-2d, and amcl library) integrated into framework
- Path Planning (A\* algorithm) package implemented based on Occupancy Grid
- Keywords – Deep Learning, SLAM, Sensor Fusion, Calibration, Path Planning, ROS, OpenCV, YOLO

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, Computer Vision, Mobile Robotics, Machine Learning, Robot Kinematics & Dynamics

**Online/ Self:** Deep Learning, Self-Driving Cars, Data Structures and Algorithms, Intro to Networks, Artificial Intelligence

## 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 Dynamic 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

- Placed 8<sup>th</sup> in ACM ICPC Amritapuri Regional '13 and 12<sup>th</sup> in ACM ICPC Calcutta Regional '14
- Won Track-O-Mania, Junkyard Wars, iStrike (vision based autonomous robot competition), APOGEE '14
- Won iBOSM '14 soccer and volleyball tournament and 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
  - Animator and web-designer, Department of Visual Media, BITS Pilani
  - 2<sup>nd</sup> in BITS Premier Soccer League
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