Saurabh Belgaonkar

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EDUCATION

Texas A&M University Aug. 2023 – Present
Ph.D., Mechanical Engineering | CGPA: 4.0/4.0 *College Station, TX*
– **Coursework:** Control Systems, Intelligent Systems & Robotics, Convex Optimization, Reinforcement Learning

Indian Institute of Science (IISc) Bangalore Oct. 2020 – Jul. 2022
M.Tech, Mechanical Engineering | CGPA: 9.2/10 *Bangalore, India*

National Institute of Technology (NIT) Warangal Aug. 2015 – May 2019
B.Tech, Mechanical Engineering | CGPA: 8.92/10 *Warangal, India*

RESEARCH PROJECTS

Energy-Aware Path Planning for Hybrid UAVs Feb. 2024 – Jan. 2025
Graduate Research Assistant | Texas A&M University *College Station, TX*

– Developed a continuous-space planner for a series-hybrid UAV in **noise-restricted zones**, jointly optimizing route and **fuel/electric mode switching** under battery constraints to minimize fuel.
– Formulated the problem as a **Mixed-Integer Convex Program** solved with **Gurobi**, achieving a 10× speedup vs. SOTA.
– Designed a heuristic for a **TSP** variant achieving near-optimal (within 2%) results with significantly lower computation.

Exact Algorithm for Load-Dependent Traveling Salesman Problem (LD-TSP) Mar. 2025 – Oct. 2025
Graduate Research Assistant | Texas A&M University *College Station, TX*

– Developed a **load-dependent** energy model and proved the energy-optimal tour is equivalent to a TSP tour up to constant factor.
– Implemented a novel **branch-and-cut MILP** solver where ordering variables both enforce visit sequence and subtour elimination, reducing the need for explicit subtour cuts.
– Solved instances up to 50 targets to optimality in < 1 minute and achieved $\leq$10% optimality gap on 70-target instance.

Multi-Robot Path Planning via Difference-of-Convex Algorithm (DCA) Nov. 2025 – Aug. 2025
Graduate Research Assistant | Texas A&M University *College Station, TX*

– Built a **DCA**-based multi-robot planner by encoding collision avoidance as DC constraints and solving a sequence of **convex QP** subproblems (Python + Gurobi).
– Added penalty terms and an active-set strategy to scale collision constraints; used visibility-graph initialization for obstacle scenarios.
– Validated collision-free trajectories and scaled to 160 robots with ∼245–265s runtime on a workstation.

Formation Control with Vision-based Collision Avoidance Mar. 2020 – Jul. 2022
Graduate Research Assistant | IISc Bangalore *Bangalore, India*

– Developed a **vision-based formation control** algorithm using a **super-twisting** controller (finite-time convergence) that maintained formation and avoided obstacles using only visual feedback, without inter-robot communication.
– Implemented and validated the controller on physical robots in **Python/ROS**, matching performance benchmarks from MATLAB simulations, demonstrating scalable and communication-free coordination.

EXPERIENCE

SAE AutoDrive Challenge Oct. 2023 – Present
Vice Captain; Perception Lead *College Station, TX*
SAE AutoDrive Challenge is a multi-year collegiate competition where university teams develop and demonstrate Level-4 autonomous driving on urban courses.

– Led the perception team and delivered a real-time **camera–LiDAR perception stack** (object, lane, traffic-light detection; fusion; tracking) in **C++/ROS2**, providing accurate environment understanding for planning and **obstacle avoidance**.
– Led a team to write the **Software Requirements and Specification (SRS)** for **perception, planning, and control** modules and supervised testing to ensure compliance, improving system reliability and integration.
– As Vice Captain, coordinated cross-team efforts and managed project timelines, validation testing, and deliverables across perception, planning, and controls, resulting in **2nd** (2024) and **3rd** (2025) overall finishes.

Atlas Copco India Aug. 2022 – Jul. 2023
Data Scientist *Pune, India*

- Built end-to-end **ML pipelines** for **machine health monitoring** using **CNNs, GANs**, and signal-processing techniques, reducing manual inspection effort and enabling early fault prediction.
- Engineered data workflows using **SQL** and **Azure Databricks** to extract and transform equipment data; built dashboards and analytics pipelines that improved diagnostic visibility and predictive maintenance accuracy across monitored assets.

PUBLICATIONS

[1] J. Keshavan, **S. Belgaonkar**, S. Murali, "Adaptive Super-Twisting Control of a First-Order Sliding Mode with an Output Constraint," *IEEE Access*.

[2] **S. Belgaonkar**, D. Kumar, S. Rathinam, S. Darbha, T. Bihl, "A Path Planning Algorithm for a Hybrid UAV Traveling in Noise Restricted Zones," *IEEE Transactions on Aerospace and Electronic Systems*.

PERCEPTION & PLANNING PROJECTS

Real-time Perception stack Feb. 2024 - Dec 2024
Texas A&M University *College Station, TX*

- Fine-tuned **YOLO** on custom dataset (15 classes, e.g., pedestrians, traffic signs/lights, barrels etc) achieving **mAP = 0.85** and deployed in **C++/ROS2** via **OpenVINO** for real-time inference on Intel GPU.
- Processed LiDAR point clouds with ground removal, voxel filtering, and Euclidean clustering to form 3D object clusters; used a **Kalman** filter for multi-object tracking to support speed estimation and obstacle-aware planning.
- Calibrated Camera–LiDAR extrinsics and projected clustered 3D LiDAR points onto the image plane and matched them with 2D detections via **IoU** to assign class labels and recover object distances.

Obstacle Avoidance Behavior Planning Jan. 2024 – May 2024
Texas A&M University *College Station, TX*

- Integrated perception outputs (object class, pose, velocity) into an **HD-map**–derived **local semantic map**, providing a unified view of the driving environment for planning.
- Built a layered **occupancy grid** combining **static** (barricades, barrels) and **dynamic** (pedestrians, vehicles) obstacles with class-aware motion prediction, enabling the planner to generate safe, lane-respecting paths.
- Modeled **dynamic actors** (pedestrians, vehicles) with short-horizon motion prediction and class-aware behavior to anticipate movement and support proactive obstacle avoidance.

Speed Estimation of a Compressor using Vibration Data Aug. 2022 – Nov. 2022
Data Scientist *Atlas Copco, Pune*

- Built a vibration data-based speed estimator to replace manual estimation on machines lacking sensors.
- Computed the **FFT** of vibration signals to derive harmonic peaks and generate likely speed candidates; used **1D CNN** spectral–temporal features and a **LightGBM** binary verifier (correct/incorrect) per candidate; at inference, scored all candidates and chose the highest-probability speed.
- Trained and deployed on **Databricks** (**Spark**/**PySpark**); achieved **99.5%** accuracy (597/600) on ∼500 labeled datasets.

Locomotion of Non-Anthropomorphic Bipedal Robot Apr. 2021 – June. 2021
Graduate Research Assistant *Bangalore, India*

- Developed a locomotion controller for a non-anthropomorphic biped using **Model Predictive Control (MPC)** for trajectory tracking and gait stabilization, enabling dynamic and balanced walking.
- Implemented **Augmented Random Search (ARS)** reinforcement learning to learn locomotion policies for improved adaptability across terrains; validated performance in **Gazebo** and **MuJoCo** simulations.

SKILLS

- **Languages/Frameworks:** Python, C++, ROS2, PyTorch, MuJuCo, CUDA, OpenCV, Databricks, Spark, Linux
- **Perception:** Object detection, Segmentation, Multi-object tracking, Camera calibration, LiDAR clustering
- **Optimization:** Gurobi, Mixed Integer Programming, MDP, Dynamic programming, Reinforcement Learning

HONORS and AWARDS

- Overall 2nd (2024) and 3rd (2025) in SAE AutoDrive Challenge .
- S. V. Sastry Memorial Gold Medal, IISc, 2022.