Sugheerth Sreedharan

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EDUCATION

Doctor of Philosophy, Computer Science Fall 2025 – Present
University at Buffalo (SUNY), DRONES Lab – Advisor: Dr. Karthik Dantu *Buffalo, NY*
Focus: Safe motion planning, trajectory generation using diffusion models, and sim-to-real transfer for highly articulated robotic manipulators and autonomous systems.

Master of Science, Engineering Science: Robotics Aug 2023 – Aug 2025
University at Buffalo (SUNY) *Buffalo, NY*

Bachelor of Technology, Mechanical Engineering May 2018
SASTRA Deemed University – GPA: 7.96/10 *Tamil Nadu, India*

SKILLS

Robotics and Simulation: ROS2 (Actions, Services, Lifecycle Nodes), Gazebo, MoveIt2, Nav2, URDF, XACRO, RViz
Planning, Control & Dynamics: Safe Motion Planning, Multi-DoF Kinematics/Dynamics, Control Barrier Functions (CBF), Control Lyapunov Functions (CLF), Quadratic Programming (QP), Constrained Optimization, CasADi, RRT, A-star, AMCL, Diffusion-based Planners
Machine Learning and Perception: Generative Learning, Diffusion Models, Deep/Reinforcement Learning, Sim-to-Real Transfer, PyTorch, PointNet, Vision Transformer (ViT), MMDetection3D, 3D Point Cloud Segmentation, State Estimation
Programming: Python, C++, C, Java, Go, MATLAB **Tools:** Git, Docker, Linux, gRPC, Protobuf, PostgreSQL

EXPERIENCE

PhD Researcher and Research Assistant, DRONES Lab May 2024 – Present
University at Buffalo (SUNY) *Buffalo, NY*

- **Safe Planning for Robotic Manipulators:** Developing collision-free trajectory generation for multi-DoF robot arms using Control Barrier Functions (CBF) and Control Lyapunov Functions (CLF) with arm kinematics and workspace constraints like collision points; formulating CLF-CBF-QP for real-time safe reactive control via CasADi; extending from 2-DoF planar arms to full 3D multi-DoF configurations; exploring learning-based and generative methods, especially, diffusion-based planners for safe trajectory generation.
- **Diffusion-based Planning and Safe Sampling:** Developing trajectory-level constraint-aware safe sampling methods that integrate closed-form CBF corrections into diffusion-model sampling updates for fast, safety-aware planning; designing diffusion planners for hydraulic excavators with learned forward and inverse LSTM dynamics models over joint angles, velocities, pressures, and control inputs.
- **Learned Dynamics for Excavator Trajectory Generation:** Using learned inverse dynamics to convert MoveIt state trajectories into observation-control demonstrations and forward-dynamics guidance to promote physically coherent Gazebo and hardware execution for hydraulic excavators.
- **EARTH – Excavation Autonomy with Resilient Traversability and Handling** (droneslab.github.io/EARTH): Serving as Field and Software Lead for EARTH, a three-year Moog-funded project developing autonomous excavators. Contributed to Nav2-based differential drive navigation, and MoveIt2 multi-link arm trajectory planning. Validated dynamics in Gazebo and deployed using optimized waypoints on physical hardware via ROS2 lifecycle node management and CAN bus interfacing.

Member Technical Staff, Software Development Engineer Sep 2018 – Aug 2023
Zoho Corporation *Chennai, India*

- Led end-to-end development of Zoho's Cloud Repository Management System; engineered search pipeline achieving low latency retrieval and reduced API response time by 60 percent via asynchronous scheduling.
- Integrated polyglot microservices via gRPC and Protobuf reducing max latency by over 200 percent; redesigned database architecture reducing data redundancy by 70 percent.

ONGOING RESEARCH

A Constraint Aware Framework For Safe Sampling

- Developing a deterministic safe sampling framework that integrates a closed-form trajectory-level CBF correction directly into diffusion-model sampling updates for fast, safety-aware trajectory generation.
- Formulated a single smooth, trajectory-level CBF by aggregating obstacle- and waypoint-level constraints through nested softmin approximations, enabling a closed-form safety correction that applies weighted updates across waypoints according to their relative safety.
- Derived a first-order DPM-Solver discretization of the safety-augmented probability-flow ODE and delayed CBF corrections until the final denoising steps to reduce local-trap formation.
- Demonstrated 100% trajectory safety across the evaluated Maze2D settings and a 91% safe-success rate in the dense PointMass2D environment, while generating trajectories in 0.05–0.07 seconds.

Diffusion-based Trajectory Planning for Excavators with Learned Dynamics Models

- Designing a diffusion-based trajectory generation framework with learned dynamics models to generate dynamically coherent observation-control trajectories for hydraulic excavators.
- Engineered forward and inverse LSTM dynamics models over rolling histories of joint angles, joint velocities, hydraulic pressures, and control inputs for boom, arm, and bucket motion.
- Using learned inverse dynamics to convert MoveIt state trajectories into observation-control demonstrations and forward-dynamics guidance to promote physically coherent Gazebo and hardware execution.

PUBLICATIONS

Y. Turkar, C. Aluckal, **S. Sreedharan**, Y. Dighe, Y. Kim, J. Gemerek, K. Dantu. "Excavation Autonomy with Resilient Traversability and Handling." *ICRA Workshop on Field Robotics (WFR)*, 2025. [PDF]

COURSE PROJECTS

3D Point Cloud Segmentation – PointNet, MMDetection3D, PyTorch, SemanticKITTI Aug – Dec 2024

- Implemented PointNet for LiDAR-based outdoor semantic segmentation; benchmarked against MMDetection3D baselines; explored attention mechanisms and loss combinations (focal, dice, Jaccard); achieved 71 percent training and 62 percent test accuracy on SemanticKITTI.

Object Detection with Vision Transformer (ViT) – PyTorch, Caltech-101 Jan – May 2024

- Implemented Vision Transformer with Patch Embeddings for object detection; achieved mean IoU of 88.4 percent on Caltech-101 airplanes dataset.

Robotics Algorithms and Autonomous Racing – ROS2, F1TENTH Aug – Dec 2023

- Implemented motion planning (RRT, A-star, Dijkstra), localization (AMCL, Particle Filter, Pure Pursuit), and Gap Follow for autonomous racing; secured 2nd place in gap follow race; implemented stereo visual odometry for state estimation.