

Rwik Rana

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RESEARCH INTERESTS

My research focuses on unifying controls and perception. I design algorithms that combine model-based controls with model-free learning and use representation learning to capture task-relevant state for control. The goal is autonomy in unstructured settings—particularly off-road and field robotics—where dynamics, terrain, and sensing can be highly variable. I am also interested in whole-body control for humanoids and high-DoF mobile platforms.

EDUCATION

The University of Texas at Austin

Ph.D in Computer Science

Austin, TX, USA

Aug 2024 - Present

Researcher @ [Autonomous Mobile Robotics Laboratory \(AMRL\)](#), Prof. Joydeep Biswas

University of Washington, Seattle, WA, USA

M.S in Mechanical Engineering

Seattle, WA, USA

Sep 2022 - Jun 2024

Research Assistant @ [Robot Learning Lab\(RLL\)](#), Prof. Byron Boots

Indian Institute of Technology (IIT) Gandhinagar

B.Tech. in Mechanical Engineering, Double Minor in CSE and Robotics

Gandhinagar, Guj, India

Aug 2018 - Jul 2022

Undergraduate Researcher @ [IITGN Robotics Lab](#), Prof. Harish PM

EXPERIENCE

The University of Texas at Austin, Research Assistant

Aug 2024 - Present

Planning from Satellite Imagery using Natural Language — ARL SARA

Prof. Joydeep Biswas

- Engineered **OVSeeC**, a training-free system using LLMs and VLMs to generate robot costmaps directly from satellite imagery and natural language commands.
- Designed a modular “Interpret, Locate, Synthesize” pipeline and deployed it via a web-based GUI for interactive, prompt-conditioned global planning.

Terrain Aware Forward Kinodynamics Modelling for Close Loop Optimal Control

Prof. Joydeep Biswas

- Developed a terrain-aware forward dynamics model to predict complex vehicle behavior, including wheel-terrain contact and airborne maneuvers, surpassing point-mass assumptions.
- Improved model robustness for MPC/MPPI controllers by training with adversarial methods (RL, UED) in simulation and fine-tuning on real-world data.

Designing Hardware and Software of Mobile Robot Fleet

Prof. Joydeep Biswas

- Designed and built the complete hardware/software stacks for two autonomous vehicle platforms: **Omega-truck** (1/16th scale) and **Alphatruck** (1/5th scale).
- Integrated systems ranging from Raspberry Pi to high-performance Jetson Orin AGX, LiVOX LiDAR, VN-100 IMU, and RealSense cameras for robust navigation.

University of Washington, Seattle, Research Assistant

Oct 2022 - May 2024

Uncertainty Estimation for BEV Segmentation — UW DARPA Racer

Prof. Byron Boots

- Enhanced Birds-Eye-View segmentation by developing an aleatoric uncertainty-aware BEVNet to handle occlusions and reduce overconfident predictions.
- Achieved an **18% performance improvement** in the local path planner by providing more reliable, uncertainty-aware semantic maps.

Fast BEV Costmap generation from Image Space — UW DARPA Racer

Prof. Byron Boots

- Built a multi-camera object detection and tracking pipeline for off-road hazards using YOLOv7, the Hungarian Algorithm, and a Kalman Filter.
- Optimized the C++/Python implementation to achieve **42 FPS**, enabling real-time BEV costmap generation for high-speed navigation.

Software Engineering and Robot Deployment — UW DARPA Racer

Prof. Byron Boots

- Developed core infrastructure, including camera alignment visualization tools and ROS packages, to deploy perception modules on a full-scale robotic platform.
- Managed code repositories and led algorithm deployment and testing on the DARPA RACER Polaris RZR in collaboration with Overland AI.

DATT : Deep Adaptive Trajectory Tracking for Quadrotor Control

Prof. Guanya Shi & Prof. Byron Boots

- Developed **DATT**, a novel hybrid controller combining model-free RL and L1 adaptive control to track aggressive trajectories and resist wind disturbances.
- Outperformed MPPI by **54%** on infeasible paths and **34%** under perturbations, delivering a complete sim-to-real hardware/software stack.

Deep Model Predictive Optimization

Prof. Guanya Shi & Prof. Byron Boots

- Created a residual-based framework to learn the MPPI optimizer via Reinforcement Learning, drastically reducing sample and memory requirements.
- Achieved a **27% performance increase** and **4.3× memory reduction**, enabling agile drone flips with **8× fewer samples** (128 vs. 1024) than MPC.

Johns Hopkins University, Summer Research Intern

May 2021 - Aug 2021

Super Resolution of data from low cost tactile-sensors

Prof. Nitish V. Thakor

- Designed a VAE-based spatio-temporal architecture to perform super-resolution on low-cost 4x4 tactile sensor grids.
- Increased effective data resolution by **4×**, generating human skin-like pressure maps to enhance robotic manipulation.

- Developed an end-to-end racing algorithm by training a VAE-based policy on expert trajectories generated by a genetic algorithm.
- Demonstrated zero failures in the CARLA simulator and constructed a physical F1/10th scale race car with a Jetson Nano and RealSense camera.

Memory Guided Road Detection

Prof. Shanmughanathan Raman

- Solved the accuracy-vs-speed trade-off in road segmentation by developing a framework that interleaves large and small networks with a shared memory.
- Achieved a $3\times$ **increase in inference speed** with a negligible drop in accuracy, enabling real-time performance on embedded hardware.

Impedance Control on Flexible Manipulators

Prof. Harish and Prof. Madhu Vadali

- Designed, fabricated, and tested a custom 2-R flexible manipulator with integrated series and parallel compliance.
- Implemented and validated an impedance controller on the hardware, analyzing its step, impulse, and frequency responses.

Multi-Robot Global Planning

Prof. Madhu Vadali

- Improved the RRT* algorithm for multi-robot swarms to generate paths that preserve formation constraints.
- Developed a complete ROS pipeline and a prioritized tracking controller for deployment on Turtlebot and Firebird VI robot platforms.

PUBLICATIONS & PATENTS

1. **OverSeeC-Open-Vocabulary CostMap Generation from Satellite Images and Natural Language**
Rwik Rana, Jesse Quattrociochi, Dongmyeong Lee, Christian Ellis, Amanda Adkins, Adam Uccello, Garrett Warnell, Joydeep Biswas,
Robotics: Science and Systems 2025 Workshop on Resilient Off-road Autonomous Robotics [link](#)
2. **BEV-Patch-PF: Particle Filtering with BEV-Aerial Feature Matching for Off-Road Geo-Localization**
Dongmyeong Lee, Jesse Quattrociochi, Christian Ellis, **Rwik Rana**, Amanda Adkins, Adam Uccello, Garrett Warnell, Joydeep Biswas,
Robotics: Science and Systems 2025 Workshop on Resilient Off-road Autonomous Robotics [link](#)
3. **Deep Model Predictive Optimization**
Jacob Sacks, **Rwik Rana**, Kevin Huang, Alex Spitzer, Guanya Shi, and Byron Boots,
International Conference for Robotics and Automation (ICRA) 2024, CoRL Workshop 2023 [link](#)
4. **DATT: Deep Adaptive Trajectory Tracking for Quadrotor Control**
Kevin Huang*, **Rwik Rana***, Alex Spitzer, Guanya Shi, Byron Boots,
Conference on Robot Learning (CoRL) 2023 [link](#)
5. **FF-RRT*: A Sampling-Based Planner for Multirobot Global Formation Path Planning**
Suraj Borate, **Rwik Rana**, Praveen Venkatesh, Madhu Vadali,
Journal of Mechanisms and Robotics [link](#)
6. **Impact of Added Passive Compliance on the Performance of Tip-actuated Flexible Manipulators**
Barat S, **Rwik Rana**, Sushrut Surve, Madhu Vadali, Harish J. Palanthandalam Madapusi,
ASME Journal of Dynamic Systems, Measurement, and Control [link](#)
7. **Memory Guided Road Detection**
Rwik Rana*, Praveen Venkatesh*, Varun Jain*,
21st International Conference on Image Analysis and Processing (ICIAP) 2021 [link](#)
8. **An end-to-end optimization system to streamline meetings and study sessions**
Rwik Rana*, Pranshu Kumar*, Dhruv Menon*, Prankush Agarwal*, Udit Bhatia,
Indian Patent 202221002873 [link](#)

ACHIEVEMENTS

1. OverSeeC wins **second prize** at ROAR Workshop @ RSS 2025
2. Received **Dean's List** in 6 Semesters for securing more than 8.5 CGPA per semester at IIT Gandhinagar
3. Received **Institute's Silver Medal** for Excellent Academic Performance at IIT Gandhinagar
4. Received **Director's Silver Medal** for Outstanding Overall Performance at IIT Gandhinagar
5. Awarded **Explorer Fellowship** for covering 16 states in India for 40 days with only 500\$.