Sumanth Tangirala

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RESEARCH INTERESTS

Data-driven reachability analysis for verifying robot controllers, especially black-box learned policies such as RL and behavior cloning policies. Related interests include uncertainty quantification, conformal prediction, and planning and control for robots with complex dynamics.

EDUCATION

Rutgers, the State University of New Jersey, New Brunswick — NJ, USA

PhD in Computer Science | Advisor: Kostas E. Bekris — 2024 – 2029 (expected)

MS in Computer Science, GPA: 3.97/4 — 2022 – 2024

- Thesis: "Safety and Efficiency for High-dimensional Robots: Integrating Learning, Planning, and Control"

Dhirubhai Ambani University (formerly DA-IICT) — Gandhinagar, India

BTech in Information and Communication Technology — 2016 – 2020

EXPERIENCE

Graduate Researcher, PRACSYS Lab — Feb 2023 – Present

Rutgers, the State University of New Jersey — *New Brunswick, NJ, USA*

- Researching methods to estimate where black-box robot controllers reach their goals without failing under stochastic dynamics, so learned policies can be trusted without a model of the policy or the system.
- Mentoring students, including on building a YOR mobile manipulator and a UR5e-actuated cartpole.
- Helped build the lab's external perception system for training closed-loop policies on MuSHR robots.

Prediction Intern (Research) — Jun 2025 – Sep 2025

Zoox — *Foster City, CA, USA*

- Owned a project to reduce how much simulation it takes to validate the autonomy stack, by estimating its performance metrics from a subset of the logged scenarios.
- Modeled each metric as a Gaussian process over scenario embeddings and used Bayesian optimization to sample the rare events the metrics depend on, then compared this approach with stratified sampling.
- Found a negative result and identified the cause. Embeddings rich enough to predict the metrics were too high-dimensional for GPs, and compressed embeddings lost the signal.

Software Engineer (Intern, then Full-time) — Jan 2020 – Jul 2022

Tekion — *Bangalore, India*

- Led development of dealership management modules, including the repair-order Kanban and vehicle history.
- Led product-wide frontend changes, coordinating across multiple teams, that enabled global expansion.
- Trained 25+ interns and mentored junior developers in React and Redux.

Research Intern — May 2019 – Aug 2019

Indian Space Research Organisation (ISRO) — *Ahmedabad, India*

- Classified groundnut and cotton fields in radar (PolSAR) satellite imagery with an RNN-LSTM at 91.2% accuracy, and collected the ground truth in the field.

Research Assistant, Smart City Lab — Sep 2018 – Dec 2019

Dhirubhai Ambani University (formerly DA-IICT) — *Gandhinagar, India*

- Developed deep-learning methods for classifying radar (PolSAR) images, published at PReMI 2019.

PUBLICATIONS

Under Review

[1] Sumanth Tangirala*, Dhruv Metha Ramesh*, Ewerton R. Vieira, Abdeslam Boularias, Ying Hung, Kostas E. Bekris, "Uncertainty-Aware Reach-Avoid Estimation with Statistical Guarantees", *Learning for Dynamics and Control Conference (L4DC), 2027.*
Predicts reach-avoid outcomes or abstains, with finite-sample bounds on the error rates of its predictions.

[2] Sumanth Tangirala*, Dhruv Metha Ramesh*, Ewerton R. Vieira, Abdeslam Boularias, Ying Hung, Kostas E. Bekris, "`GRAPE`: Generative Reach-Avoid Probability Estimation for Black-Box Robot Controllers under Stochastic Dynamics", *IEEE International Conference on Robotics and Automation (ICRA), 2027.*
Estimates reach-avoid probabilities under stochastic dynamics from a flow-matching terminal-state model.

Conference Papers

[3] Kostas E. Bekris, Joe Doerr, Patrick Meng, Sumanth Tangirala, "Integrating Explicit and Implicit Models for Robot Motion Generation", *International Symposium of Robotics Research (ISRR), 2026.*
Taxonomy of methods that combine explicit models with learned ones, ordered by how tightly they couple.
My role: Co-wrote the taxonomy of integrative methods and proposed new splits within it.

[4] Edgar Granados, Sumanth Tangirala, Kostas E. Bekris, "Kinodynamic Trajectory Following with `STELA`: Simultaneous Trajectory Estimation & Local Adaptation", *Robotics: Science and Systems (RSS), 2025.*
Tracks planned trajectories under noisy observations, deviating from the plan when needed to avoid obstacles.
My role: Implemented the STEAP (Simultaneous Trajectory Estimation and Planning) baseline.

[5] Kostas E. Bekris, Joe Doerr, Patrick Meng, Sumanth Tangirala, "The State of Robot Motion Generation", *International Symposium of Robotics Research (ISRR), 2024.*
Survey of robot motion generation, organized by reliance on explicit versus learned, implicit models.
My role: Co-wrote the sections on explicit planning and control, RL, and behavior cloning.

[6] Aravind Sivaramakrishnan, Sumanth Tangirala, Edgar Granados, Noah R. Carver, Kostas E. Bekris, "Roadmaps with Gaps over Controllers: Achieving Efficiency in Planning under Dynamics", *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2024.*
Speeds up planning under dynamics by linking learned controllers through a roadmap with gaps.
My role: Trained the quadrotor RL policy and built the RL-only baseline.

[7] Ewerton R. Vieira*, Aravind Sivaramakrishnan*, Sumanth Tangirala, Edgar Granados, Konstantin Mischaikow, Kostas E. Bekris, "`MORALS`: Analysis of High-Dimensional Robot Controllers via Topological Tools in a Latent Space", *IEEE International Conference on Robotics and Automation (ICRA), 2024.* ***Best Paper Award Finalist (Automation)****.*
Estimates regions of attraction of high-dimensional controllers using topology in a learned latent space.
My role: Proposed and implemented the label-based contrastive training variant.

[8] Tushar Gadhiya, Sumanth Tangirala, Anil K. Roy, "Stacked Autoencoder Based Feature Extraction and Superpixel Generation for Multifrequency PolSAR Image Classification", *International Conference on Pattern Recognition and Machine Intelligence (PReMI), 2019.*
PolSAR land-cover classification from stacked-autoencoder features and superpixels.

Preprints

[9] Aravind Sivaramakrishnan, Sumanth Tangirala, Dhruv Metha Ramesh, Edgar Granados, Kostas E. Bekris, "`KRAFT`: Sampling-Based Kinodynamic Replanning and Feedback Control over Approximate, Identified Models of Vehicular Systems", *arXiv:2409.11522, 2024.*
Safe trajectory execution over approximate, identified vehicle models via replanning and contingency checks.
My role: Co-developed the method, proposed and implemented its contingency-checking safety mechanism, and ran the MuSHR hardware experiments.

* Equal contribution

PROFESSIONAL ACTIVITIES

- Reviewer for IEEE RA-L, IEEE T-ASE, ICRA (2025, 2026, 2027), IROS (2024, 2025), and L4DC (2027).

SKILLS

Methods: Reachability analysis, statistical verification, conformal prediction, active learning, generative models (flow matching, diffusion), reinforcement learning, behavior cloning

Frameworks: PyTorch, Stable-Baselines3, scikit-learn, OpenCV, TensorFlow, ROS, MuJoCo, Isaac Gym

AWARDS

- Best Paper Award Finalist (Automation), ICRA 2024
  For MORALS
- NSF-NRT Fellowship, SOCRATES Program 2024 – 2026
  Two years of funding for interdisciplinary research in socially cognizant robotics
- Outstanding Project Award & Outstanding Publication Award 2024
  Department of Computer Science, Rutgers University, for MORALS