Apurva Patil

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Education

The University of Texas at Austin
PhD, Mechanical Engineering (Robotics Portfolio Program) *Aug 2021 - May 2025 (expected)*
Specialization: Controls, Autonomy and Robotics
Advisor: Takashi Tanaka, Luis Sentis, GPA: **4.0/4.0**

MS, Mechanical Engineering (Robotics Portfolio Program) *Aug 2019 - May 2021*
Advisor: Takashi Tanaka, Luis Sentis, GPA: **3.97/4.0**

College of Engineering Pune, India
BTech, Mechanical Engineering; GPA: **9.39/10** (Class Rank: **2/185**) *Aug 2013 - May 2017*

Research Interests

I am broadly interested in the intersection of control theory, robotics, and learning theory to solve problems in decision-making under uncertainty. Recent topics I have worked on include risk-aware motion planning, learning-based control, risk analysis of motion plans, and stochastic dynamic games.

Research Projects

***PhD Thesis*: Stochastic Optimal Control via Path Integral Approach**
Advisor: Prof. Takashi Tanaka and Luis Sentis, UT Austin *May 2021 - Present*

- Developing theoretical frameworks and algorithms to solve stochastic optimal control problems such as **risk-constrained motion planning**, **stochastic dynamic games**, **deceptive control** and **hierarchical control** via the **path integral** control approach (an approach to synthesize optimal control policies **on-the-fly** using online Monte-Carlo simulations)
- Working on analyzing the **sample complexity** of path integral to understand the interplay between the **achievable control performance** and sample size

***Master's Thesis*: Risk-Aware Motion Planning in Uncertain Environments**
Advisor: Prof. Takashi Tanaka and Luis Sentis, UT Austin *Aug 2019 - May 2021*

- Developed algorithms to estimate **end-to-end collision probabilities** of **motion plans** for autonomous agents with discrete and continuous-time dynamics, navigating in **uncertain environments**
- Incorporated the developed risk estimation framework in motion planners to generate **optimal safe trajectories** in the presence of uncertainties

Reinforcement Learning Based Risk-Bounded Motion Planning
Advisor: Prof. Peter Stone and Scott Niekum, UT Austin *Jan - May 2022*

- Proposed an extension of **semi-gradient SARSA** and **TD(0)** algorithms to solve **risk-bounded motion planning** and end-to-end **risk estimation** problems for autonomous vehicles in continuous-space. The proposed model allows the user to adjust the **risk-averse level** of the autonomous agent.

Collision Detection for Motion Planning in Stochastic Environments
Advisor: Prof. Takashi Tanaka, UT Austin *Jan - May 2020*

- Developed an **interior-point optimization** algorithm for **efficient collision detection** to speed up motion planning in stochastic environments. This algorithm is significantly faster than the off-the-shelf SemiDefinite Programming (SDP) solvers like sdpt3.

***Bachelor's Thesis*: Design and Development of a Humanoid Torso**
Advisor: Prof. Shantipal Ohol, College of Engineering Pune, India *Aug 2016 - May 2017*

- Built a humanoid torso to **pick and place** objects by obtaining visual and audio data via **Microsoft Kinect**
- Designed **5 DOF robot arms** and **multi-finger adaptive grippers**, established a real-time control of the robot arms to attain the desired position and orientation of the end-effectors

Professional Experience

Amazon Robotics Seattle, WA
Applied Scientist II Intern *May - Aug 2024*

- Developed a real-time motion planning algorithm for an 8 DOF manipulator, a key component of their system for efficiently stowing items within storage pods—what they refer to as the "beautiful problem"

Cruise San Fransisco, CA
Motion Planning Intern *Sep - Dec 2023*

- Worked on making the trajectories of autonomous vehicles safer and more comfortable during **remote assistance**, **auto parking and unparking**

Apptronik Austin, TX
Software and Controls Intern *May - Aug 2020*

- Developed a **sampling-based, real-time motion planning** algorithm Hierarchical Dynamic Roadmap (HDRM) for Apptronik's robotic manipulators
- Benchmarked the algorithm on **6 DOF manipulators** with the virtual workspace developed in **Gazebo**

Skills

Languages: Python, C++, **Tools and software packages**: MATLAB/Simulink, PyTorch, TensorFlow, ROS, OpenCV, NuSMV, Slugs, PRISM, LabVIEW, AutoCAD, SolidWorks, ANSYS, ParaView, MeshLab, Git, Isaac Sim

Publications and Manuscripts (Google Scholar)

- **A. Patil**, A. Duarte, F. Bisetti, T. Tanaka, "Strong Duality and Dual Ascent Approach to Continuous-Time Chance-Constrained Stochastic Optimal Control", *submitted to Transactions on Automatic Control (TAC)*.
- **A. Patil**, R. Funada, T. Tanaka, L. Sentis "Task Hierarchical Control via Null-Space Projection and Path Integral Approach", *submitted to American Control Conference (ACC)*, 2025.
- M. Baglioni, **A. Patil**, L. Sentis, A. Jamshidnejad, "Achieving multi-UAV best viewpoint coordination in obstructed environments", *submitted to L-CSS and American Control Conference (ACC)*, 2025.
- **A. Patil**, G. Hanasusanto, T. Tanaka, "Discrete-Time LQR via Path Integral Control and Its Sample Complexity Analysis", *IEEE Control Systems Letters (L-CSS)*, 2024.
- **A. Patil**, M. Karabag, T. Tanaka, U. Topcu, "Simulator-Driven Deceptive control via Path Integral Approach", *IEEE Conference on Decision and Control (CDC)* 2023. [Paper]
- **A. Patil**, Y. Zhou, D. Fridovich-Keil, T. Tanaka, "Risk-Minimizing Two-Player Zero-Sum Stochastic Differential Game via Path Integral Control", *IEEE Conference on Decision and Control (CDC)* 2023. [Paper]
- **A. Patil**, T. Tanaka, "Upper and Lower Bounds for End-to-End Risks in Stochastic Robot Navigation", *IFAC World Congress*, 2023. [Paper]
- **A. Patil**, A. Duarte, A. Smith, F. Bisetti, T. Tanaka, "Chance-Constrained Stochastic Optimal Control via Path Integral and FDM", *IEEE Conference on Decision and Control (CDC)*, 2022 [Paper]
- **A. Patil**, T. Tanaka, "Upper Bounds for Continuous-Time End-to-End Risks in Stochastic Robot Navigation", *European Control Conference (ECC)*, 2022. [Paper]
- **A. Patil**, M. Kulkarni, A. Aswale, "Analysis of the inverse kinematics for 5 DOF robot arm using D-H parameters", *IEEE International Conference on Real-time Computing and Robotics*, 2017. [Paper]

Positions, Awards, and Achievements

- **Reviewer**: TAC, CDC-2021, ACC-2022, ACC-2023, ECC-2022, IFAC WC-2023
- **CDC 2022 Student Travel Support Award**, IEEE Control System Society *2022*
- **H. Grady Rylander Excellence in Teaching Fellowship**, UT Austin *2020*
- **TCS Best Student Award**, College of Engineering Pune, India *2017*
- **Best Bachelor's Project Award**, College of Engineering Pune, India *2017*
- **S. N. Bose Fellowship** for a research internship in the USA (1 in 47 students across India) *2016*
- **National Robocon**: Winner *'17* [video], Runners-up *'16* [video], Best Innovative Design *'15* [video]