

Ali Reza Pedram

POSTDOCTORAL FELLOW | GEORGIA INSTITUTE OF TECHNOLOGY

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RESEARCH INTERESTS

Autonomy and Robotics, Decision Making and Motion Planning under Uncertainty, Generative and Diffusion Models, Deep RL, Optimization, Sampling-based Algorithms, Information Theory, Multi-agent Systems and Game Theory, Estimation and SLAM, Stochastic Optimal Control, and Formal Methods.

EDUCATION

PhD in Mechanical Engineering & Certificate of Expertise in Robotics 2017 - 2023
University of Texas at Austin Austin, TX
Dissertation: Information-Theoretic Path Planning and Navigation [\[Link\]](#)
Advisors: Prof. Takashi Tanaka and Prof. Luis Sentis

MSc in Mechanical Engineering: Robotics and Control 2015 - 2017
Sharif University of Technology Tehran, Iran
Max Planck Institute for Intelligent Systems (Joint program) Stuttgart, Germany
Dissertation: Fabrication and Optimal Control of Neutrally-buoyant Magnetic Microrobots
Advisors: Prof. Metin Sitti and Prof. Hossein Nejat

BSc in Mechanical Engineering & BSc in Applied Physics (dual-major degree) 2010 - 2015
Sharif University of Technology Tehran, Iran
Dissertation: Development of a Coarse-grained Molecular Dynamics Method for Biological Systems
Advisors: Prof. Hossein Nejat

SOFTWARE

C++, Python, PyTorch/TensorFlow, OpenCV, ROS, Gazebo, OMPL, CVX/CVXPY, Gurobi, MATLAB/Simulink

EXPERIENCE

Postdoctoral Fellow 2023 – Present
Dynamics and Control Systems Laboratory | Georgia Institute of Technology Atlanta, GA

Graduate Research Assistant 2018 – 2023
Networked Control Systems Laboratory | The University of Texas at Austin Austin, TX

Guest Researcher 2016 - 2017
Department of Physical Intelligence | Max Planck Institute for Intelligent Systems Stuttgart, Germany

Undergraduate Researcher 2015 – 2016
Micro-Nano Robotics Laboratory | Sharif University of Technology Tehran, Iran

INVITED TALKS

RTX Technology Research Center | AI Systems Engineering Team Nov. 2024
Optimal Steering of Probability Distributions in Dynamic Systems: Theory and Applications in Autonomy

Georgia Institute of Technology | Decision and Control Laboratory Seminar Feb. 2023
Information-Theoretic Approach to Belief Space Motion Planning for Minimum Sensing Navigation

KTH Royal Institute of Technology | Division of Robotics: Perception and Learning Apr. 2023
Chance-constrained Motion Planning with Continuous-time Safety Guarantees (online)

Rice University | Kavradi Labratory May 2023
Random Matrix Sampling and Rapidly-exploring Random Trees in Uncertain Configuration Space

AWARDS AND ACHIEVEMENTS

Professional Development Award, UT Austin 2023

ACC Student Travel Award, IEEE Control System Society 2023

Awarded admission to the 3rd Summer School on Cognitive Robotics, University of Southern California 2019

Cockrell School of Engineering Scholarship, UT Austin 2017

Max Planck Institute Visiting Scholarship 2016

Iranian National Elite Foundation Scholarship 2015

Merit-based admission to the MSc program as an outstanding undergraduate student, Sharif University of Technology 2015

Ranked in the **top 0.1%** of 320,000 students in the nation-wide Entrance Exam for Iranian universities 2010

Selected as a semi-finalist (**top 1%**) for the Iranian National Olympiads of **Mathematics, Computer Science, Physics, Chemistry, and Linguistics and Literature.** 2009

- [P1] **A. R. Pedram**, E. Psomiadis, D. Maity, P. Tsiotras, “Communication-Aware Map Compression for Online Multi-agent Path-Planning”, **IEEE Transactions on Robotics**, 2025, under review. [\[Manuscript available upon request\]](#)
- [P2] G. Rapakoulias, **A. R. Pedram**, P. Tsiotras, “Go With the Flow: Fast Diffusion for Gaussian Mixture Models”, **The Thirty-Ninth Annual Conference on Neural Information Processing Systems**, 2025, Under review. [\[Paper\]](#)
- [J1] G. Rapakoulias, **A. R. Pedram**, P. Tsiotras, “Steering Large Agent Populations using Mean-Field Schrödinger Bridges with Gaussian Mixture Models”, **IEEE Control Systems Letters** and **IEEE Conference on Decision and Control**, 2025. [\[Paper\]](#)
- [J2] **A. R. Pedram**, R. Funada, T. Tanaka, “Gaussian Belief Space Path Planning for Minimum Sensing Navigation”, **IEEE Transactions on Robotics**, vol. 39, no. 3, pp. 2040-2059, 2023. [\[Paper\]](#)
- [J3] V. Zinage, **A. R. Pedram**, T. Tanaka, “Optimality of Sampling-based Belief Space Planners”, **The International Journal of Robotics Research**, 2024, Under review,. [\[Paper\]](#)
- [J4] H. Jung, **A. R. Pedram**, T. Cuvelier, T. Tanaka, “Optimized Data Rate Allocation for Dynamic Sensor Fusion over Resource Constrained Communication Networks”, **International Journal of Robust and Nonlinear Control**, 2023. [\[Paper\]](#)
- [J5] A. Govindarajan, A. Kiaghadi, HS. Rifai HS, **A. R. Pedram**. “Source apportionment of polychlorinated dibenzo-p-dioxins and dibenzofurans in the sediments of an urban estuary”. **Environmental Monitoring and Assessment**, 2023. [\[Paper\]](#)
- [J6] T. Tanaka, E. Nekouei, **A.R. Pedram**, KH. Johansson, “Linearly Solvable Mean-Field Traffic Routing Games”, **IEEE Transactions on Automatic Control**, vol. 66, no. 2, pp. 880-887, 2021. [\[Paper\]](#)
- [J7] **A. R. Pedram**, H. Nejat Pishkenari, M. Sitti, “Optimal Controller Design for 3D Manipulation of Buoyant Magnetic Micro-robots via Constrained LQR Approach”, **Journal of Micro-Bio Robotics**, 15(2): 105-117. [\[Paper\]](#)
- [J8] **A. R. Pedram**, H. Nejat Pishkenari, “Smart Micro/Nano-robotic Systems for Gene Delivery”, **Current Gene Therapy**, 17(2): 73-79. [\[Paper\]](#)
- [C1] E. Psomiadis, **A. R. Pedram**, D. Maity, P. Tsiotras, “Communication-Aware Iterative Map Compression for Online Path-Planning: A Rate-distortion Approach”, **IEEE Conference on Robotics and Automation (ICRA)**, 2025. [\[Paper\]](#)
- [C2] **A. R. Pedram**, T. Tanaka, “Smoothing Algorithm for Minimum Sensing Path Plans in Gaussian Belief Space”, **Annual American Control Conference (ACC)**, 2023. [\[Paper\]](#)
- [C3] **A. R. Pedram**, R. Funada, T. Tanaka, “Dynamic Allocation of Visual Attention for Vision-based Autonomous Navigation under Data Rate Constraints”, **IEEE Conference on Decision and Control (CDC)**, 2021. [\[Paper\]](#)
- [C4] **A. R. Pedram**, J. Stefan, R. Funada, T. Tanaka, “Rationally Inattentive Path-Planning via RRT*”, **Annual American Control Conference (ACC)**, 2021. [\[Paper\]](#)
- [C5] **A. R. Pedram**, T. Tanaka, “Closed-loop Parameter Identification of Linear Dynamical Systems through the Lens of Feedback Channel Coding Theory”, **Annual American Control Conference (ACC)**, 2020. [\[Paper\]](#)
- [C6] **A. R. Pedram**, T. Tanaka, “Linearly-Solvable Mean-Field Approximation for Multi-Team Road Traffic Games”, **IEEE Conference on Decision and Control (CDC)**, 2019. [\[Paper\]](#)
- [C7] **A. R. Pedram**, T. Tanaka, M. Hale, “Bidirectional Information Flow and the Roles of Privacy Masks in Cloud-Based Control”, **IEEE Information Theory Workshop (ITW)**, 2019. [\[Paper\]](#)
- [C8] **A. R. Pedram**, T. Tanaka, “Some Results on the Computation of Feedback Capacity of Gaussian Channels with Memory”, **56th Annual Allerton Conference on Communication, Control, and Computing (Allerton)**, 2018. [\[Paper\]](#)
- [W1] **Texas Robotics Seminar**, May 2022 at University of Texas at Austin, TX, USA.
- [W2] **8th Midwest Workshop on Control and Game Theory (MWCGT)**, April 2019 at Washington University in St. Louis, MO, USA.
- [W3] **3rd Summer School on Cognitive Robotics**, July 2019 at the University of Southern California, CA, USA.

PROFESSIONAL AND OUTREACH SERVICES

Session Chair: Multi-Robot Exploration, IEEE International Conference on Robotics and Automation (ICRA), 2025

Journal Reviewer: IEEE Transactions on Robotics, The International Journal of Robotics Research, IEEE Transaction on Automatic Control, Automatica, IEEE Transactions on Information Theory, IEEE Transactions on SMC: Systems, and IEEE Robotics and Automation Letters. (over 20 reviews)

Conference Reviewer: International Conference on Robotics and Automation (ICRA), International Conference on Intelligent Robots and Systems (IROS), IEEE Conference on Decision and Control (CDC), Annual American Conference (ACC), and European Control Conference (ECC). (over 30 reviews)

Proposal Reviewer: PURA Salary Award for Georgia Tech Undergrad students, Spring 2024.

Volunteer: Collaborated on the Research Experience for Undergraduates (REU) outreach, Research Experience in Autonomy and Control Technologies (REACT), at the Center for Autonomy, UT Austin, 2023.

Volunteer: Session support staff at IEEE Conference on Decision and Control (CDC), 2021.

MENTORSHIP EXPERIENCE

- **Evangelos Psomiadis** (Graduate Student, Georgia Tech) Sept. 2023 - Present
Provided training in estimation theory and information theory, led research ideation, and collaborated on source code development and paper publication.
- **George Rapakoulis** (Graduate Student, Georgia Tech) Sept. 2023 - Present
Provided training in deep diffusion models and optimal transport theory, contributed to research ideation, and collaborated on source code development and paper publication.
- **Vrushabh Zinage** (Graduate Student, UT Austin) Sept. 2022 - Aug. 2023
Provided training in belief space path planning and sampling-based algorithms, contributed to research ideation, and collaborated on source code development and paper publication.
- **Tyler Dean** (Undergraduate Student and intern, UT Austin) June 2023 - Aug. 2023
Assisted in learning and utilizing ROS, and guided experiments with the Dingo robot from ClearPath Robotics.
- **Emily Liu** (Undergraduate Student and intern, UT Austin) Jan. 2022 - May 2022
Mentored in trajectory optimization techniques and implementing SDP solver using the CVX library.
- **Pete Lealiieej** (Undergraduate Student, UT Austin) Sept. 2021 - Dec. 2021
Collaborated on high-fidelity simulation of the VOXL drone from ModalAI using C++ and Gazebo.
- **Dong Kyu Kim and Chinmay Senapathi** (Undergraduate Students, UT Austin) June 2021 - Aug. 2021
Provided training in the use of ROS, Vicon system, Crazyflies drones, and Qbot ground robots, and facilitated hands-on learning experiences.
- **Samuel Faulkner** (Undergraduate Student, UT Austin) Jan. 2019 - May 2019
Mentored in game theory and co-developed Python code for linearly solvable MDPs.
- **Research Mentor, Glue Program**, UT Austin 2019 - 2023
Mentored undergraduate students in research processes, ideation, and academic writing.

TEACHING EXPERIENCE

- **Fundamentals in Teaching and Learning for Postdocs**, Georgia Tech, Spring 2024
Completed a 10-week course aimed at preparing postdoctoral scholars for teaching in higher education.
- **Inclusive Classrooms Leadership Seminar (Certified)**, UT Austin, Spring 2020
Trained in inclusive teaching strategies to enhance classroom leadership.
- **Teaching Fellow** of Mechatronics Lab, UT Austin, Fall 2017 and Spring 2018
Course: ME 140L | Prof. Glenn Masada
Led instruction on selected topics and provided hands-on training for laboratory experiments.
- **Teaching Assistant** for Automatic Control, Sharif University of Technology, Spring 2016
Course: ME 28-416 | Prof. Hossein Nejat
Held office hours and evaluated MATLAB-based projects for control systems coursework.
- **Teaching Assistant** for Materials Engineering Lab, Sharif University of Technology, Fall 2015
Course: ME 28-701 | Prof. Mohsen Asghari
Supervised laboratory work, including tensile testing and phase diagram analysis.

FUNDING EXPERIENCE

- **Neural Optimal Distribution Steering for Robotic AI Tasks**, Amazon Consumer Robotics, 2024
PI: Panagiotis Tsiotras
Contribution: Assisted in conceptualizing the proposal and contributing to the writing process.
- **Distributed and Collaborative Intelligent Systems and Technology**, ARL Continuing grant DCIST CRA, 2024
PI: Panagiotis Tsiotras.
Contribution: Assisted in conceptualizing the proposal and contributing to the writing process.

RESEARCH PROJECTS

Information-theoretic Map Compression for Online Path-Planning in Unknown Environments

Advisor: Prof. Panagiotis Tsiotras, Dynamics and Control Systems Laboratory, Georgia Tech

- Developed a communication framework for optimizing information exchange among robot teams, introducing task-driven map compression. Designed the compression generation process [P1] and implemented the compression selection method [C2], achieving significant data reduction while maintaining planning efficiency.

Neural Optimal Distribution Steering for Robotic AI Tasks

Advisor: Prof. Panagiotis Tsiotras, Dynamics and Control Systems Laboratory, Georgia Tech

- Developed a framework for optimizing distribution steering using deep neural networks and solving the stochastic optimal controller via Kantorovich duality and a neural solver for forward-backward SDEs. Applied the proposed method to generative modeling and robotic control with integrated safety measures [P2].

- Proposed an analytic parametrization for Schrödinger Bridges to steer dynamical systems between Gaussian Mixture Models, solving the optimal policy with a low-dimensional linear program, outperforming state-of-the-art methods in Entropic Optimal Transport problems [C1]-[J1].

Minimum Perception Effort Motion Planning and Autonomous Navigation

Advisor: Prof. Takashi Tanaka, Networked Control Systems Laboratory, UT Austin

- Developed an information-theoretic framework to quantify the expected perception effort in safe navigation of uncertain systems and incorporated this effort into motion planning problem [C5].
- Proposed optimal information-geometric rapidly-exploring random tree (IG-RRT*) algorithms, a new class of sampling-based stochastic algorithms to find motion plans traceable with moderate perception effort. Developed and tested the source codes for IG-RRT* implementation [J2].
- Proved the IG-RRT* algorithms almost surely (i.e., probability one) find the global minima of the non-convex minimum perception effort motion planning problem [J3].
- Developed and implemented a scalable trajectory optimization algorithm for path smoothing in uncertain configuration space using CVX solvers. Proposed a new method to impose safety in continuous-time for uncertain systems [C3].
- Devised and implemented a task-dependent attention allocation mechanism to reduce perception effort in computer vision tasks [C4] and sensor networks [J4].

Capacity of Dynamic Communication Channels: Implications in Autonomy

Advisor: Prof. Takashi Tanaka, Networked Control Systems Laboratory, UT Austin

- Investigated optimal control of dynamic communication channels [C9], demonstrating its relevance in various aspects of autonomous systems, including cloud-based control [C8] and parameter identification in dynamic systems [C6], revealing significant practical implications.

Linearly Solvable Mean-Field Traffic Routing Games

Advisor: Prof. Takashi Tanaka, Networked Control Systems Laboratory, UT Austin

- Proposed a penalty based on the logarithm of route usage in a dynamic traffic routing game, showing that the mean-field equilibrium (MFE) can be solved through a linearly solvable Markov decision process. Demonstrated that the MFE is strongly time-consistent, linked it to a class of fictitious play [J6]. Extended the results to a multi-team setting [C7].

Fabrication and Optimal Control of Magnetic Microrobots

Advisor: Prof. Metin Sitti, Physical Intelligence Department, Max Planck Institute for Intelligent Systems

- Proposed a new method to design and build a hollow magnetic microrobot that is neutrally buoyant for drug/gene delivery applications, and tested it in a Helmholtz coil setup [J8].
- Performed dynamic modeling and proposed a control scheme using an LQR controller with linear constraints [J7].

ACADEMIC COURSEWORK

- **Estimation/Control:** Signal Processing, Digital Control, Estimation Theory, Stochastic Estimation and Control, Nonlinear and Optimal Control, Multi-variable and Robust Control, Networked Control Systems and Information Theory, Fuzzy Control, Linear System Theory and Control.
- **Machine Learning/Optimization/Advanced Mathematics:** Reinforcement Learning, Deep Learning, Linear Algebra, Convex Optimization, Large Scale Optimization for Learning, Advanced Statistics, Stochastic Process I, Gaussian Processes, Cyber-Physical Intelligent Systems.
- **Robotics/Mechatronics:** Advanced Robotics and Lab, Algorithms for Sensor-Based Robotics, Robot Mechanism Design, Advanced Mechatronics and Lab, Advanced Dynamics.
- **Other Courses:** Computational Fluid Dynamics (CFD), Finite Element Methods (FEM), Micro-fabrication, Statistical Thermodynamics, Quantum Mechanics, Electromagnetism and Electrodynamics.