

Taha Shafa

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EDUCATION

University of Illinois Urbana-Champaign

Ph.D. in Aerospace Engineering

Urbana-Champaign, IL

Jan. 2021 – May 2025 (expected)

Arizona State University

Master of Science in Electrical/Computer Engineering

Tempe, AZ

summa cum laude, GPA 3.85

Master of Science in Engineering (Robotics Track)

Aug. 2018 – June 2020

Drexel University

Bachelor of Science in Electrical Engineering

Philadelphia, PA

Aug. 2010 – June 2015

TECHNICAL SKILLS

Languages: Python, C++, MATLAB/Simulink, Java

Developer Tools: pytorch, ROS, MuJoCo, Linux, Git, Neovim

Relevant Coursework: Nonlinear Control, Machine Learning, Convex Optimization, Real Analysis, Random Signals, Differential Geometry, Geometric Control Theory, Optimal Control, Robust Control, Multivariable Control, Abstract Linear Algebra, Dynamics and Vibrations

PROFESSIONAL EXPERIENCE

Research and Teaching Assistant — University of Illinois Urbana-Champaign

Urbana-Champaign, IL

Provably Reachable Controller Synthesis for Nonlinear Systems with Unknown Dynamics

Jan. 2021 - Present

- **Invented a novel method** for calculating a **provably optimal** underapproximation of a system's reachable set under significant uncertainties in the system dynamics.
- Generalized theoretical results to include systems operating on a complete **Riemannian manifold**
- **Developed a novel control algorithm** capable of autonomous navigation to provably attainable states utilizing guaranteed reachable sets without knowledge of the system dynamics
- Utilized **Koopman learning** and **functional analysis** techniques to **rigorously prove** how sampled trajectories known a priori can help identify control methods for autonomous systems without knowledge of their dynamics
- Formulated a novel method of **system identification** through proof using solely a system's reachable sets

Applied Safety-Critical Control and Robotics

March 2024 - Present

- Applied my novel, derived control algorithm to **autonomously navigate** a vehicle around obstacles to reach some final state within a theoretically guaranteed time **without knowledge of the system dynamics**
- Utilized **physics-informed neural networks** augmented with **nonlinear control algorithms** to introduce **model-based control** capabilities with heightened performance for soft robotics platforms

Teaching Assistant for Aerospace Dynamical Systems (AE 352)

Jan. 2023 - May 2023

- Led weekly hour-long lecture during recitations solving 3D Newtonian and Lagrangian dynamics problems

Research Scientist: Machine Learning for Uncertainty Quantification

May 2024 – August 2024

Lawrence Livermore National Laboratory

Livermore, CA

- Performed **uncertainty quantification** using both frequentist and **Bayesian** methods which utilized **Gaussian processes** and **Monte Carlo simulations** techniques for parameter estimation
- Utilized **pytorch** to predict the parameters of metals under extreme stress with **limited information**

Research Scientist: Controls and Automation

May 2023 – August 2023

MIT Lincoln Laboratory

Lexington, MA

- Utilized **Lyapunov methods** to derive a provably stable adaptive control law for fixed-wing and quadrotor UAV to compensate for actuator degradation
- Simulated theoretical results on an in-house **physics engine using C++** to validate calculations
- Contributed major edits to implement an adaptive control algorithm on a **large scale ROS-based C++** program designed to execute flight trajectories that best track a requested path

Robotics Research Engineer

June 2020 – Sep. 2021

Construction Engineering Research Laboratory (CERL)

Champaign, IL

- Developed **LQR-I controller** to reduce high frequency noise vibrations for a medical evacuation robot
- Programmed 6-DoF robotic arm to interface with **ROS** and execute specific trajectories in unknown environments
- Developed **path planning algorithm** using optimal control concepts for automated ground vehicles

JOURNAL PUBLICATIONS

Shafa, T., Ornik, M. (2021). Reachability of Nonlinear Systems with Unknown Dynamics. IEEE Transactions on Automatic Control (TAC).

JOURNAL SUBMISSIONS

Shafa, T., Ornik, M. (2024). Guaranteed Reachability on Riemannian Manifolds for Unknown Nonlinear Systems. IEEE Transactions on Automatic Control (TAC).

Meng, Y., **Shafa, T.**, Wei, J., Ornik, M. (2024) Online Learning and Control Synthesis for Reachable Paths of Unknown Nonlinear Systems. IEEE Transactions on Automatic Control (TAC).

PEER-REVIEWED CONFERENCE PUBLICATIONS

Shafa, T., Dong, R., Ornik, M. (2023). Identifying Single-Input Linear System Dynamics from Reachable Sets. IEEE Conference on Decision and Control (CDC) 2023.

Shafa, T., Ornik, M. (2022). Maximal Ellipsoid Method for Guaranteed Reachability of Unknown Nonlinear Systems. IEEE Conference on Decision and Control (CDC) 2022.

El-Kebir, H., **Shafa, T.**, Purushottam, A., Ornik, M., Soylemezoglu, A. High-Frequency Vibration Reduction for Unmanned Ground Vehicles on Unstructured Terrain. NATO Modeling and Simulation for Autonomous Systems Conference (MESAS21).

Shuch, B. D., **Shafa, T.**, Rogers, E., Aukes, D. M. (2019, August). Design of a Two DOF Laminate Leg Transmission for Creating Walking Robot Platforms. In International Design Engineering Technical Conferences and Computers and Information in Engineering Conference (Vol. 59247, p. V05BT07A046). American Society of Mechanical Engineers.

ADDITIONAL CONFERENCE PUBLICATIONS

Puthumanaillam, G., Vora, M., **Shafa, T.**, Li, Y., Mitra, S., Ornik, M. Assured Collision Avoidance for Learned Controllers: A Case Study of ACAS Xu. American Institute of Astronautics and Aeronautics (AIAA) SCITECH 2024.

FELLOWSHIPS AND GRANTS

MAVIS Future Faculty Fellow, *University of Illinois Urbana-Champaign*, 08/2023 - 05/2024 – awarded for outstanding research and qualifications to succeed as future faculty

GAANN Fellowship, *University of Illinois Urbana-Champaign*, 08/2021 - 08/2022 – awarded for academic excellence in a field of national need

Engineering Graduate Fellowship, *Arizona State University*, 08/2018 - 04/2019 – awarded for extraordinary academic and research achievement

KEEN Research Grant, *Arizona State University*, 01/2019 - 04/2019 – granted for outstanding research exemplifying the entrepreneurial mindset

PROFESSIONAL SERVICE AND LEADERSHIP ROLES

Reviewer – Two journal papers for IEEE Transactions on Automatic Control

Diversity Ambassador, *University of Illinois Urbana-Champaign*, 08/2022 - 05/2024 – Organize outreach events for prospective underrepresented students and help transition accepted students from all countries to the University of Illinois Urbana-Champaign graduate culture

AeroGSAC Student Government, *University of Illinois Urbana-Champaign*, 08/2022 - 05/2024 – Help organize events for the aerospace engineering graduate community such as outreach events for grades K-12 and collaboration efforts within the University of Illinois engineering community