

# Taha Shafa

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## EDUCATION

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### 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*

*Master of Science in Engineering (Robotics Track)*

Tempe, AZ

*summa cum laude*

*Aug. 2018 – June 2020*

### Drexel University

*Bachelor of Science in Electrical Engineering*

Philadelphia, PA

*Aug. 2010 – June 2015*

## TECHNICAL SKILLS

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**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

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### 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

*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

*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

*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

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

## JOURNAL SUBMISSIONS

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**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

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**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

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Puthumanaim, 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

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**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

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**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