

# AKASH HARAPANAHALLI

408-515-9157 ◇ Atlanta, GA ◇ San Ramon, CA ◇ US Citizen ◇ [akash.harapanahalli@gmail.com](mailto:akash.harapanahalli@gmail.com) ◇ [akashhara.com](http://akashhara.com)

## SUMMARY

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Passionate second-year PhD student with interests in the intersection of control theory and machine learning. Strong educational background in mathematics, controls, and signals. Demonstrated research experience through (i) ongoing work into safety verification of learning-enabled control theory, studying a reachability and invariance perspective; (ii) award-winning undergraduate results for a dual-arm manipulator robot. Demonstrated professional experience through an industry internship. Won several awards in competitive settings with innovative designs and collaboration.

## EDUCATION

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**Ph.D. Machine Learning** - Georgia Institute of Technology, GPA: 4.00 Aug 2022 - 2027  
**M.S. Mathematics** - Georgia Institute of Technology, GPA: 4.00 Aug 2022 - Dec 2024  
**B.S. Computer Eng. with Highest Honor** - Georgia Institute of Technology, GPA: 4.00 Aug 2019 - May 2022

## RESEARCH AND PROFESSIONAL EXPERIENCE

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**Graduate Research Assistant** - [FACTS Lab](#), Georgia Tech Aug 2022 - Present

- Proving formal guarantees for the safety of uncertain controlled systems with learning-based methods in-the-loop.
- Developed a framework for certifying parallelepiped forward invariant sets in neural network controlled systems.
- Developing a novel, efficient library called **ReachMM** for online reachable set analysis of closed-loop nonlinear dynamical systems with neural network controllers to guarantee safety during runtime.
- Created [npinterval](#), an interval analysis extension module for **numpy** using natural inclusion functions.
- Supported by an NSF grant dedicated to finding formal assurances for learning-enabled assistive driving.

**Graduate Teaching Assistant** - School of ECE, Georgia Tech Aug 2022 - Dec 2022

- Developed teaching and vocational skills while sharpening technical abilities in related fields.

**Athena Controls Lead** - Laboratory for Intelligent Decision and Autonomous Robots Jan 2020 - May 2022

- Led and mentored a subteam of 8 undergraduates to design manipulator planning and control solutions for a humanoid robot using position, velocity, and force approaches.
- Guided peers through a ramping process to understand complex math and background theory.
- Used the DRAKE C++ toolbox to simulate dynamic physical conditions and validate control methods.
- Designed impedance controller for robust, compliant task space position and force robot manipulation.

**Applications Engineering Intern** - Texas Instruments Jun 2021 - Aug 2021

- Designed a modern Over-The-Air update process for Wi-Fi network processors using embedded C with RTOS.
- Analyzed customer feedback to optimize the design for utility, functionality, and practicality.
- Developed interpersonal professional skills while learning about product lifecycle and post-market strategies.

## PUBLICATIONS

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\* indicates equal contribution

- [7] **A. Harapanahalli**, S. Jafarpour, S. Coogan, “**Forward Invariance in Neural Network Controlled Systems**,” *preprint journal submission*, 2023. [[arXiv](#)]
- [6] L. Baird, **A. Harapanahalli**, S. Coogan, “**Interval Signal Temporal Logic from Natural Inclusion Functions**,” *preprint journal submission*, 2023. [[pdf](#)]
- [5] S. Jafarpour\*, **A. Harapanahalli\***, S. Coogan, “**Efficient Interaction-Aware Interval Analysis of Neural Network Feedback Loops**,” *preprint journal submission*, 2023. [[arXiv](#)]
- [4] **A. Harapanahalli**, S. Jafarpour, S. Coogan, “**A Toolbox for Fast Interval Arithmetic in numpy with an Application to Formal Verification of Neural Network Controlled Systems**,” *2nd Workshop on Formal Verification of Machine Learning, ICML*, 2023. [[arXiv](#)] [[github](#)]
- [3] **A. Harapanahalli**, S. Jafarpour, S. Coogan, “**Contraction-Guided Adaptive Partitioning for Reachability Analysis of Neural Network Controlled Systems**,” *IEEE Conference on Decision and Control*, 2023. [[arXiv](#)]

- [2] S. Jafarpour\*, **A. Harapanahalli\***, S. Coogan, “**Interval Reachability of Nonlinear Dynamical Systems with Neural Network Controllers,**” *Learning for Dynamics and Control Conference*, 2023. [extended [arXiv](#)]
- [1] **A. Harapanahalli\***, E. Muly\*, H. Welch\*, ... , Y. Zhao, “**Towards a Biomimetic and Dexterous Robot Avatar: Design, Control, and Kinematics Considerations,**” *IEEE/ASME International Conference on Advanced Intelligent Mechatronics*, 2020. (poster) **Award: Best Latest Breaking Results Poster.** [[pdf](#)]

## HONORS AND AWARDS

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<b>ECE Senior Scholar Award (4.00 Cumulative GPA)</b> - School of ECE, Georgia Tech	Apr 2022
<b>Faculty Honors (every semester)</b> - Georgia Tech	Fall 2019 - Spring 2022
<b>Best Overall Hack</b> - HackGT Horizons 2022	Mar 2022
<b>Best Hardware Hack</b> - HackGT 8	Oct 2021
<b>First Place</b> - 2021 Georgia Tech VIP Innovation Competition (Hardware, Devices & Robotics)	Apr 2021
<b>Best Latest Breaking Results Poster</b> - 2020 IEEE/ASME Intl. Conf. on Adv. Int. Mechatronics	Jul 2020
<b>Best in Show</b> - HackGT Horizons 2020	Feb 2020
<b>Second Place, Best TI Integration</b> - The Invention Studio's Hack-A-Thing 2020	Jan 2020
<b>State Tournament Champion</b> - 2019 California VEX VRC High School State Championship	Mar 2019

## OTHER EXPERIENCE

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<b>Data Acquisition Technician</b> - GT Off-Road (BAJA SAE) [ <a href="#">github</a> ]	Jan 2020 - May 2022
<ul style="list-style-type: none"> <li>GT Off-Road designs and manufactures a car to compete in the BAJA SAE competition cycle.</li> <li>Rebuilt embedded software infrastructure with a custom dynamic communications protocol using C++ to streamline data transfer in a mesh network of microcontrollers communicating over wired and wireless regimes.</li> <li>Designed and programmed a dashboard for a driver to read critical measurements using Solidworks and Eagle.</li> <li>Built a closed-loop control algorithm for an Electronic Continuous Variable Transmission (eCVT) in C++.</li> </ul>	
<b>Hardware Lead</b> - Grand Challenges Team Reflex	Aug 2019 - Aug 2021
<ul style="list-style-type: none"> <li>Grand Challenges tackles the real-world societal challenges of today through STEM-oriented applications.</li> <li>Learned key business principles, identified unmet needs, and conducted primary research with customers.</li> <li>Pursued the idea of using drones to send life-saving equipment before EMS, cutting emergency response time.</li> </ul>	

## OTHER PROJECTS

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<b>Voxel</b> - ECE Senior Capstone [ <a href="#">expo</a> ] [ <a href="#">report</a> ]	Aug 2021 - May 2022
<ul style="list-style-type: none"> <li>Created the world's first fully volumetric high-density holographic persistence of vision display.</li> <li>Designed an algorithm to convert arbitrary mesh files to a custom cylindrical 3D display video format.</li> <li>Wrote critical embedded system code in C++ and SystemVerilog to encode and decode custom 3D video format.</li> </ul>	
<b>StepDance</b> - HackGT Horizons 2022 - Best Overall Hack [ <a href="#">devpost</a> ] [ <a href="#">github</a> ]	Mar 2022
<ul style="list-style-type: none"> <li>Designed an interactable piano using stepper motor vibrations to generate music with computer vision features.</li> <li>Personally wrote all embedded C++ code to take inputs, schedule, and control stepper motors.</li> </ul>	
<b>Zen</b> - HackGT 8 - Best Hardware Hack [ <a href="#">devpost</a> ] [ <a href="#">github</a> ]	Oct 2021
<ul style="list-style-type: none"> <li>Repurposed an old 3D printer as a data visualization tool and art piece under strict time constraints.</li> <li>Personally designed the system and mounts in Onshape and wrote embedded C++ to control stepper motors.</li> </ul>	
<b>OxySpool</b> - Tikum Olam Makers (TOM) at GT Makeathon 2021 - Second Place [ <a href="#">project</a> ] [ <a href="#">github</a> ]	May 2021
<ul style="list-style-type: none"> <li>TOM is a service organization that sponsors open source solutions to the real challenges of underserved people.</li> <li>Created a low force motor-powered oxygen cord reel designed for patients with COPD to avoid tripping hazards.</li> <li>Personally helped design/manufacture using Onshape, and wrote embedded C++ to control the device.</li> </ul>	
<b>TrashTalker</b> - HackGT Horizons 2020 - Best in Show [ <a href="#">devpost</a> ] [ <a href="#">github</a> ]	Feb 2020
<ul style="list-style-type: none"> <li>Integrated art and technology by engineering a music instrument out of trashed beer bottles.</li> <li>Personally modeled mounts and connections in Solidworks, wrote embedded Arduino software using MATLAB.</li> </ul>	
<b>Industrial Screw Sorter</b> - Hack-a-Thing - Second Place, Best TI Integration [ <a href="#">github</a> ]	Sep 2019 - Jan 2020
<ul style="list-style-type: none"> <li>Competed in a five-month-long competition to create an industrial screw sorting apparatus.</li> <li>Personally worked on its design and on reusable embedded C++ for its TI MSP-432 using Energia.</li> </ul>	