

## EDUCATION

### PhD Electrical Engineering

Vanderbilt University, Nashville, TN  
Minored in Computer Science

Expected Graduation: June 2022

Research Area: Safe Reinforcement Learning and Deployment on Real-World Control Systems

Preliminary paper: [PDF]

### M.S. Electrical Engineering

Vanderbilt University, Nashville, TN  
Minored in Computer Science

May 2020

Coursework: Adv Image Processing, Adv Real-Time Systems, Automated Verification, Control Systems, Discrete Event Systems, Hybrid/Embedded Systems, Machine Learning Verification, Random Processes, Solid State Effects & Devices I, Systems Theory

### BSc. Electrical and Computer Engineering

Lipscomb University, Nashville, TN

May 2017

Minored in Pure Mathematics and Computer Science with a 3.98 GPA (*Summa Cum Laude*)

Honors Received: Provost's List (Fall 2013, Fall 2014 - Spring 2017), Honor Roll (Spring 2014), Who's Who (2016-2017)

## HONORS AND AWARDS

National Defense Science and Engineering Graduate (NDSEG) Fellowship, Department of Defence

2019 — 2022

The Outstanding Student in Electrical and Computer Engineering, Lipscomb University EECE

May 2017

Presidential Scholarship, Lipscomb University

2013 — 2017

## WORK HISTORY

### Graduate Research Assistant

Vanderbilt University Institute for Software Integrated Systems, Dr. Taylor Johnson

May 2017 - Present

My research has primarily focused on the training safe, robust, adaptive, and optimal control policies using Safe Reinforcement Learning. I have been involved in DARPA's Assured Autonomy project, that seeks to assure learning enabled components in autonomous cyber-physical systems. Additionally, I have participated and lead teams in the following competitions:

- F1Tenth Autonomous Racing Competition ([f1tenth.org](http://f1tenth.org)) April 2019, December 2019, and April 2020
- 2018 and 2019 NSF CPS-VO Challenge focused on autonomous drone search-and-rescue

### Autonomy Technology Research Center (ATRC) Summer Internship

Air Force Research Laboratory (RYZA), Dr. Kerianne Hobbs

Summer 2021

Completed a Distribution C project involving a deeper look into how run time assurance impacts the safety and robustness of learning-enabled controllers trained via reinforcement learning. The internship ended with multiple write-ups that are in the process of becoming public release.

### Autonomy Technology Research Center (ATRC) Summer Internship

Air Force Research Laboratory (RYAY), Dr. Chad Waddington

Summer 2020

Completed a Distribution C project involving Opposition-Based Learning and its potential applications in Safe Reinforcement Learning. The internship ended with multiple write-ups that are in the process of becoming public release.

### Autonomy Technology Research Center (ATRC) Summer Internship

Air Force Research Laboratory (RYAY), Dr. Chad Waddington

Summer 2019

Completed a Distribution C project involving Deep Reinforcement Learning and Transfer Learning. The internship ended with a write-up, a poster and a publication [C2].

### NSF REU Research Assistant

University of Arizona ECE, Dr. Jonathan Sprinkle

Summer 2016

Designed, implemented, and tested an autonomous velocity controller for the Cognitive Autonomous Test Vehicle (CATVehicle). The fuzzy-logic controller used a front-mounted lidar sensor to measure the distance from a preceding vehicle and determined their relative velocities. Using those values as inputs, the controller determined how fast the autonomous car should travel in order to avoid collision, maintain a desired velocity, and potentially reduce traffic waves created in stop-and-go traffic.

### IT Help Desk Aide

Lipscomb University

January 2015 - May 2017

Learned how to problem solve and troubleshoot various technical issues effectively, work with networks, and how to work directly with customers in distress.

## PROJECTS

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### Formula 1/10 Autonomous Racing

March 2019 — Present

Vanderbilt University EECS, Dr. Taylor Johnson

Built a 1/10 scale autonomous vehicle testbed equipped with a LIDAR, stereo camera, and inertial sensors. The testbed's sensors and actuators mimic full scale solutions and allow us to pursue research in perception, planning, control, and networking. Additionally, we have competed in official racing competitions at CPS-IoT Week in Montreal, Canada and at Columbia University using a potential field control strategy. We have also designed and implemented strategies involving Simultaneous Localization and Mapping, Path Planning, Reinforcement Learning, Imitation Learning, and End-to-End Learning.

### 2019 NSF Student CPS-VO Challenge

May 2019

Vanderbilt University EECS, Dr. Taylor Johnson

The goal of the challenge was to use a quadrotor aircraft with downward facing camera and other sensors to scan an area for a lost aircraft and recover it autonomously. My roles involved being the team leader and software architect.

### 2018 NSF Student CPS-VO Challenge

May 2018

Vanderbilt University EECS, Dr. Taylor Johnson

The goal of the challenge was to use a quadrotor aircraft with downward facing camera and other sensors to scan an area for a lost aircraft and recover it autonomously. While the other teams had months to prepare, my team only had 1 week to design and write the code we used in the competition. However, we were still able to achieve a 3<sup>rd</sup> place ranking in the competition. My roles involved being the team leader and software architect.

### Senior Design Project

Aug. 2016 - April 2017

Lipscomb University EECE, Dr. Greg Nordstrom

Worked in a group of six engineering students to design and build an autonomous robot for competing in the 2017 IEEE SoutheastCon Hardware Competition, the schools first time competing in such a competition. We earned 14<sup>th</sup> place out of 42 teams, ranking higher than almost all of the other TN teams. My roles involved being the software architect and navigation system designer.

## PUBLICATIONS

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### Journal Articles

- [J3] Fangyu Wu, Raphael E. Stern, Shumo Cui, Maria Laura Delle Monache, Rahul Bhadani, Matt Bunting, Miles Churchill, **Nathaniel Hamilton**, R'mani Haulcy, Benedetto Piccoli, Benjamin Seibold, Jonathan Sprinkle, Daniel B. Work, "Tracking Vehicle Trajectories and Fuel Rates in Phantom Traffic Jams: Methodology and Data", *Transportation Research Part C: Emerging Technologies*, February 2019. [PDF]
- [J2] Weiming Xiang, Patrick Musau, Ayana A. Wild, Diego Manzananas Lopez, **Nathaniel Hamilton**, Xiaodong Yang, Joel Rosenfeld, and Taylor T. Johnson, "Verification for Machine Learning, Autonomy, and Neural Networks Survey", *arXiv*, October 2018. [PDF]
- [J1] Raphael E. Stern, Shumo Cui, Maria Laura Delle Monache, Rahul Bhadani, Matt Bunting, Miles Churchill, **Nathaniel Hamilton**, R'mani Haulcy, Hannah Pohlmann, Fangyu Wu, Benedetto Piccoli, Benjamin Seibold, Jonathan Sprinkle, and Daniel B. Work, "Dissipation of stop-and-go waves via control of autonomous vehicles: Field experiments", *Transportation Research Part C: Emerging Technologies*, April 2018. [PDF]

### Conference Papers

- [C3] Hoang-Dung Tran, Neelanjana Pal, Patrick Musau, Diego Manzananas Lopez, **Nathaniel Hamilton**, Xiaodong Yang, Stanley Bak, Taylor T Johnson, "Robustness verification of semantic segmentation neural networks using relaxed reachability", *International Conference on Computer Aided Verification (CAV)*, July 2021
- [C2] **Nathaniel Hamilton**, Lena Schlemmer, Christopher Menart, Todd Jenkins, Chad Waddington, and Taylor T. Johnson, "Sonic to Knuckles: Evaluations on Transfer Reinforcement Learning", *Proc. SPIE 11425, Unmanned Systems Technology XXII*, 114250J, April 2020; <https://doi.org/10.1117/12.2559546>
- [C1] Hoang-Dung Tran, Luan Viet Nguyen, **Nathaniel Hamilton**, Weiming Xiang, and Taylor T. Johnson, "Reachability Analysis for High-Index Linear Differential Algebraic Equations", *International Conference on Formal Modeling and Analysis of Timed Systems (FORMATS)*, August 2019. [https://link.springer.com/chapter/10.1007/978-3-030-29662-9\\_10](https://link.springer.com/chapter/10.1007/978-3-030-29662-9_10)

### Workshop Papers

- [W2] Diego Manzananas Lopez, Patrick Musau, **Nathaniel Hamilton**, Hoang-Dung Tran, and Taylor T. Johnson, "Case Study: Safety Verification of an Unmanned Underwater Vehicle", *2020 IEEE Security and Privacy Workshops (SPW)*, May 2020. [PDF]
- [W1] Daniel B. Work, Raphael E. Stern, Fangyu Wu, Miles Churchill, Shumo Cui, Hannah Pohlmann, Benjamin Seibold, Benedetto Piccoli, Rahul Bhadani, Matt Bunting, Jonathan Sprinkle, Maria Laura Delle Monache, **Nathaniel Hamilton**, and R'mani Haulcy, "Controlling for Unsafe Events in Dense Traffic Through Autonomous Vehicles: Invited Talk Abstract", *International Workshop on Safe Control of Connected and Autonomous Vehicles (SCAV)*, April 2017. [PDF]

## PRESENTATIONS

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### Invited Presentations

[IT1] Presented “Improving the Sample Complexity and Performance of Safe Reinforcement Learning Using Kaleidoscope Experience Replay” for the [IEEE Aerospace Electronic Systems \(AES\) Society Dayton Chapter Virtual Speaker Event](#), October 13, 2021

### Poster Presentations

[P3] **Nathaniel Hamilton**, Lena Schlemmer, Chad Waddignton, Christopher Menart, and Todd Jenkins, “Deep, Reinforcement, and Transfer Learning Applied to Sonic the Hedgehog”, Autonomy Technology Research Center’s Summer Review, August 2019.

[P2] Lena Schlemmer, **Nathaniel Hamilton**, Christopher Menart, Todd Jenkins, and Chad Waddignton, “Exploration in Reward Shaping”, Autonomy Technology Research Center’s Summer Review, August 2019.

[P1] **Nathaniel Hamilton**, and Taylor T. Johnson, “Architecture for An Indoor Distributed Cyber-Physical System Composed of Mobile Robots and Fog Computing Nodes”, Air Force Research Laboratory’s Safe & Secure Systems and Software Symposium (S5), July 2017. [\[PDF\]](#)

## REVIEWING AND SCHOLARLY COMMUNITY SERVICE

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### Journal Reviewer

IEEE TCPS [IEEE Transactions on Cyber-Physical Systems](#), 2022

### Conference Reviewer

HSCC’22 [ACM International Conference on Hybrid Systems: Computation and Control](#), 2022

ICCPs’22 [ACM/IEEE International Conference on Cyber-Physical Systems](#), 2022

IROS’21 [IEEE/RSJ International Conference on Intelligent Robots and Systems](#), 2021

HSCC’21 [ACM International Conference on Hybrid Systems: Computation and Control](#), 2021

ICCPs’21 [ACM/IEEE International Conference on Cyber-Physical Systems](#), 2021

NFM’20 [NASA Formal Methods Symposium](#), 2020

HSCC’20 [ACM International Conference on Hybrid Systems: Computation and Control](#), 2020

ICCPs’20 [ACM/IEEE International Conference on Cyber-Physical Systems](#), 2020

HSCC’19 [ACM International Conference on Hybrid Systems: Computation and Control](#), 2019

ICCPs’19 [ACM/IEEE International Conference on Cyber-Physical Systems](#), 2019

## SKILLS

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**Programming Languages** Arduino, C, C++, Java, MATLAB, Python

**Tools & Frameworks** Git,  $\text{\LaTeX}$ , Markdown, NumPy, Pandas, Pytorch, ROS, Seaborn

**Quantitative Research** mathematical optimization, mathematical modeling

**AI Background** Behavior Cloning, Deep Reinforcement Learning, Imitation Learning, Machine Learning, Neural Network Control, Safe Reinforcement Learning

**Embedded Hardware** Arduino, JetsonTX2, pixhawk, RaspberryPi