

YUCHEN WU

Toronto, Ontario, Canada
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<https://cheneyuwu.github.io/>

EDUCATION

MASc in Aerospace Science and Engineering

University of Toronto, Institute for Aerospace Studies

CGPA: 4.00/4.00

Supervisor: Prof. Timothy D. Barfoot

Thesis: *VT&R3: Generalizing the Teach & Repeat Navigation Framework*

September 2020 - November 2022

Toronto, Canada

BASc in Engineering Science (Robotics)

University of Toronto

CGPA: 3.94/4.00 (High Honours)

Supervisors: Prof. Florian Shkurti and Prof. Jonathan Kelly

Thesis: *Combining Reinforcement Learning and Imitation Learning through Reward Shaping for Continuous Control*

September 2015 - June 2020

Toronto, Canada

EMPLOYMENT

Nuro

Senior Software Engineer

Working on synthetic sensor data generation and closed-loop simulation:

- Developing generative models (NeRF, 3D Gaussian Splatting, and diffusion models) for synthetic sensor data generation from reconstructed 4D spatial-temporal scenes.
- Improving self-driving perception models with synthetically generated camera and lidar data.
- Building a closed-loop simulation pipeline for end-to-end self-driving model evaluation and system validation.

May 2024 - Present

Toronto, Canada

Nuro

Software Engineer

Worked on self-driving vehicle sensor calibration & calibration validation:

- Developed offline calibration pipelines for Nuro's self-driving vehicles that calibrate the intrinsic and extrinsic parameters of camera, lidar, radar, and IMU using structured indoor or unstructured outdoor sensor data.
- Developed machine learning calibration validation models for real-time online validation of the extrinsic parameters between camera and lidar.
- Developed sensor simulation and visualization tooling for sensor FoV, scan pattern, and blindspot analysis.

November 2022 - April 2024

Toronto, Canada

Intel Corporation

Software Engineer Intern

Contributed to the development of *Intel HLS Compiler* and *Intel FPGA SDK for OpenCL*:

- Intel HLS Compiler: a high-level synthesis (HLS) tool that takes in untimed C++ code and generates production-quality register transfer level (RTL) code optimized for Intel FPGAs.
- Intel FPGA SDK for OpenCL: development environment that enables software developers to accelerate applications by targeting heterogeneous platforms with Intel CPUs and FPGAs.

May 2018 - May 2019

Toronto, Canada

SKILLS

Communication

Chinese (Mandarin), English

Programming

C/C++, Python, JavaScript

Software/Libraries

MATLAB, Robot Operating System (ROS), OpenCV, PyTorch, TensorFlow

AWARDS

Vector Scholarship in AI, Vector Institute	2020
CRA Outstanding Undergraduate Researchers Honorable Mentions	2020
University of Toronto Dean's Honours List	2015 - 2020
University of Toronto Excellence Awards (UTEA)	2019
Garnet W. McKee - Lachlan Gilchrist Scholarship, UofT	2017

EXTRACURRICULAR ACTIVITIES

UofT aUToronto Team, Student Advisor,	September 2021 - June 2022
<ul style="list-style-type: none">1st place overall in the first competition of the four-year SAE AutoDrive Challenge Series II.	
ROB310 Mathematics for Robotics, Teaching Assistant	Fall 2021
University of Toronto, Research Assistant	May 2019 - September 2019
<ul style="list-style-type: none">Supervisor: Prof. Florian Shkurti at the Department of Computer ScienceWorked on reinforcement and imitation learning for control.	
UofT Machine Intelligence Student Team, Academic Lead	September 2018 - May 2019
<ul style="list-style-type: none">Built a machine learning community for undergrad students.Organized MIST101, a workshop on machine learning fundamentals.	
University of Toronto, Research Assistant	May 2017 - September 2017
<ul style="list-style-type: none">Supervisor: Prof. Jianwen Zhu at the Department of Electrical and Computer EngineeringWorked on accelerating the training and inference of deep CNN on multi-core CPU.	
National University of Singapore, Research Assistant	May 2016 - July 2016
<ul style="list-style-type: none">Supervisor: Prof. Shailendra Joshi at the Department of Mechanical EngineeringWorked on computational modeling and analysis of nano/micro lattice structure.	

PUBLICATIONS

Along Similar Lines: Local Obstacle Avoidance for Long-term Autonomous Path Following

Jordy Sehn, **Yuchen Wu**, Timothy D. Barfoot

Conference on Robots and Vision (CRV), 2023

Supported by Natural Sciences and Engineering Research Council of Canada (NSERC) and Vector Institute

Picking Up Speed: Continuous-Time Lidar-Only Odometry using Doppler Velocity Measurements

Yuchen Wu, David J. Yoon, Keenan Burnett, Soeren Kammel, Yi Chen, Heethesh Vhavle, Timothy D. Barfoot

IEEE Robotics and Automation Letters (RA-L), 2023

Supported by Natural Sciences and Engineering Research Council of Canada (NSERC)

Boreas: A Multi-Season Autonomous Driving Dataset

Keenan Burnett, David J. Yoon, **Yuchen Wu**, Andrew Zou Li, Haowei Zhang, Shichen Lu, Jingxing Qian, Wei-Kang Tseng, Andrew Lambert, Keith Y.K. Leung, Angela P. Schoellig, Timothy D. Barfoot

International Journal of Robotics Research (IJRR), 2023

Supported by General Motors, Amazon (via Amazon Open Data Sponsorship Program), and Natural Sciences and Engineering Research Council of Canada (NSERC)

Are We Ready for Radar to Replace Lidar in All-Weather Mapping and Localization?

Keenan Burnett*, **Yuchen Wu***, David J. Yoon, Angela P. Schoellig, Timothy D. Barfoot

IEEE Robotics and Automation Letters (RA-L), 2022

Supported by Natural Sciences and Engineering Research Council of Canada (NSERC) and General Motors

Shaping Rewards for Reinforcement Learning with Imperfect Demonstrations using Generative Models

Yuchen Wu, Melissa Mozifian, Florian Shkurti

IEEE International Conference on Robotics and Automation (ICRA), 2021

Supported by Natural Sciences and Engineering Research Council of Canada (NSERC)

MASC THESIS

Title: VT&R3: Generalizing the Teach & Repeat Navigation Framework

Supervisor: Timothy D. Barfoot, Professor at the University of Toronto

Funding Source: Natural Sciences and Engineering Research Council of Canada (NSERC) and Vector Institute

Abstract:

Visual Teach & Repeat (VT&R) achieves long-range and long-term autonomous path following through visual topometric mapping and localization. The system requires only a stereo camera for sensing, making it well-suited for many mobile robot applications involving GPS-denied environments. In this thesis, we present VT&R3, a new version of VT&R that generalizes its underlying teach and repeat navigation framework to work with lidar, radar, and possibly any rich sensor. We develop lidar and radar topometric mapping and localization pipelines that enable lidar/radar-based teach and repeat. We further extend the lidar pipeline with the ability to detect obstacles in changing environments, making obstacle avoidance during path following possible. We validate our pipelines through extensive evaluation using real-world datasets, including runtime analysis showing their online operation capability. Our results demonstrate surprising accuracy and robustness of lidar localization across varying weather and seasonal conditions, while radar localization remains competitive and has advantages in computation and storage requirements.

PDF: <https://cheneyuwu.github.io/data/thesis/masc.pdf>

BASC THESIS

Title: Combining Reinforcement Learning and Imitation Learning through Reward Shaping for Continuous Control

Supervisor: Jonathan Kelly, Associate Professor at the University of Toronto

Co-Supervisor: Florian Shkurti, Assistant Professor at the University of Toronto

Funding Source: Natural Sciences and Engineering Research Council of Canada (NSERC)

Abstract:

The potential benefits of reinforcement learning to real robotics systems are limited by its uninformed exploration that leads to lack of sample efficiency. To address this drawback, we propose a method that combines reinforcement and imitation learning by shaping the reward function with a state-action dependent potential that is learned from demonstrations. The shaping potential specifies high-value areas of the state-action space that are worth exploring first and help accelerate the policy learning. In particular, we use deep generative models to represent the shaping potential and optimize the policy using off-policy actor-critic style RL algorithms, such that our method can apply to continuous state and action spaces. We evaluate our methods on a wide range of simulated manipulation tasks and show that our method significantly improves the sample efficiency of reinforcement learning. More crucially, unlike the majority of existing methods that incorporate demonstrations as hard constraints on policy optimization, our approach only uses the demonstration data to bias exploration and thereby does not suffer from sub-optimal demonstrations.

PDF: <https://cheneyuwu.github.io/data/thesis/basc.pdf>