

Richard (Han) Hu

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Experiences

PX Robotics

Jan. 2022 - Present

Senior Machine Learning Engineer, Motion Control Center

- **Innovation** Led biomimetic gait controller projects using reinforcement learning, surpassing state-of-the-art (SOTA) methods in all metrics, including 1.5x enhanced disturbance rejection and doubled maximum velocity, with successful adaptation to new rough terrains and tasks. Two patents pending.
- **Locomotion** Developed a quadruped robot locomotion controller combining reinforcement learning with model-based control, achieving state-of-the-art disturbance rejection.
- **Optimization** Devised an analytical method to iterate reinforcement learning reward function, cutting model iterations by up to 70%.
- **Infrastructure** Overhauled the reinforcement learning pipeline with a modular approach, spearheading MLOps tool development for cloud model sharing, automated testing, and data analysis, resulting in an 80% reduction in manual tasks.
- **Strategy** Examined state-of-the-art machine learning techniques for quadruped control, large language models, manipulators, and embodied AI, offering strategic insights for departmental product development.

Autonomous System and Biomechatronics Lab

Sep. 2018 - Aug. 2021

Developer, Master Thesis

- **Deep Learning** Directed and **published** a novel sim-to-real pipeline in Pytorch for end-to-end reinforcement learning in rough terrain navigation, achieving an 87% real world and 90% simulation success rate, marking a 72% improvement over against benchmarks.
- **Development** Created a distributed robot system using ROS, C++, Python, and SolidWorks, encompassing a simulator, LiDAR and VIO SLAM, position controller, hardware driver, reinforcement learning framework, 3D reconstruction, sensor interfaces, and teleoperator.
- **Analysis** Conducted real-world navigation, comparison, and ablation studies, proving the pipeline's efficacy with an 87% real-world success rate from a 90% simulation success rate, representing up to a 72% improvement over existing methods.
- **Publication** Published in 1) IEEE Robotics and Automation Letters 2021 and 2) IROS 2021 Conference.

Huawei Noah's Ark Lab

May. 2020 - Jan 2021

Developer, Autonomous Driving Division

- **Path Planning** Developed, **published**, and **patented** an innovative Delaunay Triangulation-based algorithm for mapless autonomous vehicle navigation in dynamic settings, resulting in an 18% improvement in navigation success and a 28% rise in valid planning compared to conventional methods.
- **Simulation** Involved in CARLA simulator development, focusing on automating the map generation process using real-world datasets.
- **Publications** Published in 1) IROS 2021 Conference and 2) US Patent Application No. 17/515,522.

Projects

Parallel Proximal Policy Gradient in Pytorch

Nov. 2019

Personal Project

- **Development** Implemented parallel agent for faster experience collection and training for proximal policy gradient in Pytorch

Apprenticeship Learning with Inverse Reinforcement Learning Implementation

Mar. 2019

Developer, Course Project

- **Development** Implemented the Apprenticeship Learning algorithm using traditional Q-Learning algorithm in Python
- **Lecture** Lectured students on the algorithm using a version implemented in Google Colab

aUToronto - SAE AutoDrive Challenge (Winner 2018-19)

Sep. 2018 - Oct. 2019

Planning and Control Team Member, University of Toronto Team

- **Collaboration** Aim to develop a level 4 autonomous vehicle using ROS and C++ in a team of 30+ students
- **Localization** Implemented real-time kinematics GPS using NovAtel's SPAN for centimeter level localization
- **Mapping** Automated the semantic map layer's lane to centerline association process using Python, QGIS, and Open Street Map

Toward Smart Cities: Road Accident Prevention

Sep. 2018 - Dec. 2018

Developer, Course Project

- **Collaboration** Data-driven accident prediction using Scikit-learn in Python; within a team of 5 students
- **Data Engineering** Data collection, visualization, feature engineering, and negative sampling
- **Machine Learning** Trained and benchmarked 3 supervised learning models: Random Forest, SVM, and MLP Network

Autonomous Turtlebot

Jan. 2018 - Sep. 2018

Developer, Course Project

- **Path Planning** Developed robot coverage and exploration algorithm using ROS and C++
- **Computer Vision** Object detection and identification using OpenCV library
- **Control** Implemented person-following and emotional model for human-robot interaction

Autonomous Maze Navigation Rover Design

Sep. 2017 - Dec. 2017

Developer, Course Project

- **Development** Designed the software and hardware architecture for autonomous payload pick-up and delivery robot in a maze
- **Path Planning** Designed and implemented localization, collision avoidance, and path planning algorithm in MATLAB and Arduino

Publications

A Sim-to-Real Pipeline for Deep Reinforcement Learning Autonomous Navigation in Cluttered Rough Terrain

Hu. H, Kaicheng Zhang, Aaron Hao Tan, Michael Ruan, Christopher Agia, and Goldie Nejat

RAL and IROS2021

- Devised a pipeline for transferring complex rough terrain navigation policies from simulation to real-world applications, utilizing high-fidelity simulation, abstract observation space, and domain randomization.
- The pipeline achieved an 87% real-world navigation success rate, based on a 90% success rate in simulation.
- The pipeline has up to a 72% increase in navigation success compared to existing methods, along with faster travel times and shorter distances.

Spatial Constraint Generation for Motion Planning in Dynamic Environments

Hu. H, Peyman Yadmellat

Patent and IROS2021

- Proposed using triangulation mesh to generate spatial constraints for long-term mapless path planning in dynamic environments.
- Resolved the limitations of static triangulation mesh assumption and object masking issues prevalent in existing methods.
- Attained up to an 18% improvement in navigation success rate and a 28% increase in valid plans compared to existing methodologies.
- Patent pending.

Optimization and System Identification of a Variable Pico-Scale Hydro Turbine for Pressure Regulation

Yu. SM, Ko. Y, Hu. H, Seo. J, and Bilton. AM

ASME

- Engaged in the design and prototyping of the turbine and its experiment rig using SolidWorks, machining, and 3D printing.

Education

University of Toronto

Toronto, Canada

Master of Applied Science, Mechanical Engineering

Sep. 2018 - Aug. 2021

- **Specialization** Deep Reinforcement Learning, Machine Learning, Mobile Robotics; GPA (4.00/4.00)

University of Toronto

Toronto, Canada

Bachelor of Applied Science, Mechanical Engineering

Sep. 2013 - Apr. 2018

- **Specialization** Robotics and Mechatronics Minor; Dean's Honor List for all terms; GPA (3.81/4.00)

Honors & Awards

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| 2019-20 | MIE Teaching Assistant Award , University of Toronto | Toronto, Ontario |
| 2013-18 | Dean's Honor List , University of Toronto | Toronto, Ontario |
| 2018 | Best Undergraduate Poster Presentation , CFD Society of Canada Conference | Winnipeg, Manitoba |
| 2015 | University of Toronto Excellence Award , University of Toronto | Toronto, Ontario |
| 2015 | Shell Canada Limited Engineering Scholarship , University of Toronto | Toronto, Ontario |
| 2015 | Best Innovation Award and Best Prototype Award , U of T Engineering Competition Junior Design | Toronto, Ontario |