

# Richard Hu

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## Experience

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### Huawei Noah's Ark Lab Autonomous Driving Division

Toronto, Ontario

Support Researcher

Sep. 2018 - Present

- **Algorithm** Developed a novel spatial constraint generation algorithm for autonomous driving using triangulation mesh
- **Simulator** Engaged in an autonomous driving simulator development using real-world datasets
- **Publications** Paper accepted to IROS 2021; provisional patent approved

### Autonomous System and Biomechatronics Lab

Toronto, Ontario

Researcher, Master Thesis

Sep. 2018 - Present

- **Machine Learning** Developed a novel deep reinforcement learning network and virtual-to-real transfer pipeline in Pytorch
- **Localization** Implemented LiDAR and visual SLAM for real time pose estimation
- **Deployment** Performed system level testing with autonomous point to point navigation, comparison studies, and ablation studies
- **Architecture** Designed ROS based decentralized computing robot architecture in ROS and C++
- **Hardware** Enhanced a robot with auxiliary computing units and sensors with components designed using SolidWorks
- **Control** Designed and optimized cascade PID controller for rough terrain navigation
- **Publication** Published in IEEE Robotics and Automation Letters and International Conference on Intelligent Robots and Systems

### MIE443 Mechatronics Systems: Design & Integration

Toronto, Ontario

Head Teaching Assistant/Tutorial Teaching Assistant

Jan. 2018 - Apr. 2020

- **Lecture** Prepared and lectured students on ROS based robot navigation and SLAM methods
- **Mentorship** Mentored students on ROS based autonomous robot algorithm development, vision sensor, and OpenCV
- **Award** Recipient of UofT MIE 2019-20 Teaching Assistant Award

### Conavi Medical - Novasight Hybrid System

Toronto, Ontario

Mechanical Engineer Intern

May. 2016 - Aug. 2017

- **Research** Investigated potential design hazards and risks of catheter rotary assembly
- **Manufacturing** Streamlined an efficient assembly and calibration work instruction for intravascular catheter
- **Organization** Established an inventory system with full traceability for FDA 510k submission validation
- **Project Management** Directed technical design reviews with senior leadership, accelerated the exit of the project phase
- **Design** Designed imaging and rotary assembly for a intravascular catheter using MATLAB and SolidWorks

### Multiphase Flow and Spray Systems Lab

Toronto, Ontario

Researcher

Jun. 2015 - Sep. 2015

- **Design** Developed Arduino based camera to fluid pipeline synchronization system for data collection automation
- **Research** Analyzed and classified novel air-droplet fluid impingement shattering pattern

## Projects

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### Parallel Proximal Policy Gradient in Pytorch

Toronto, Ontario

Personal Project

Nov. 2019

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

### Apprenticeship Learning with Inverse Reinforcement Learning Implementation

Toronto, Ontario

Developer, Course Project

Mar. 2019

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

### aUToronto - SAE AutoDrive Challenge (Winner 2018-19)

Toronto, Ontario

Planning and Control Team

Sep. 2018 - Oct. 2019

- **Autonomy** Aim to develop a level 4 autonomous vehicle using ROS and C++ in a team of 30+ students
- **Localization** Implemented real-time kinematics GPS for precision localization
- **Planning** Optimize trajectory planner for real time performance
- **Simulation** Evaluation of planning and control system using kinematics and dynamics model
- **Mapping** Processed semantic map using Python, QGIS and Open Street Map for level 3 autonomy vehicle

## Toward Smart Cities: Road Accident Prevention

Toronto, Ontario

Developer, Course Project

Sep. 2018 - Dec. 2018

- **Smart City** 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 Deep Neural Network

## Pico-Scale Hydro Turbine Design

Toronto, Ontario

Mechanical Design

Jan. 2018 - Sept. 2018

- **Design** Designed a variable guide vane for pico-scale hydro turbine using Solidworks
- **Research** Evaluated the guide vane failure mode with fluid pressure test, mechanical stress test, and finite element analysis
- **Prototype** Prototyped the pico-scale turbine and an experiment pipeline using SLA 3D printing and machining techniques

## Autonomous Turtlebot

Toronto, Ontario

Developer, Course Project

Jan. 2018 - Sept. 2018

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

## Autonomous Maze Navigation Rover Design

Toronto, Ontario

Developer, Course Project

Sep. 2017 - Dec. 2017

- **Mechatronics** Engaged in the design and prototyping of the autonomous robot
- **Autonomy** Designed and implemented localization, collision avoidance, and path planning algorithm in MATLAB and Arduino
- **Control** Designed architecture for autonomous payload pick-up and delivery in a maze

## Open Architecture Quadcopter Design

Toronto, Ontario

Mechanical Design

Sep. 2017 - Apr. 2018

- **Mechanical** Designed mechanical features of quadcopter using SolidWorks and prototyped using 3D printer
- **Structure** Evaluated failure mode of designed components using ANSYS Explicit Dynamics Analysis

## Publication

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### Spatial Constraint Generation for Motion Planning in Dynamic Environments

Hu. H, Peyman Yadmellat

Accepted into International Conference on Intelligent Robots and Systems (IROS) 2021

Provisinal Patent filed

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

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

IEEE Robotics and Automation Letters (RAL), vol. 6, no. 4, pp. 6569-6576, Oct. 2021, doi: 10.1109/LRA.2021.3093551.

Accepted into International Conference on Intelligent Robots and Systems (IROS) 2021

### 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 2020 Power Conference. Virtual, Online. August 4–5, 2020. V001T08A020. ASME. <https://doi.org/10.1115/POWER2020-16902>

## Education

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### University of Toronto

Toronto, Canada

Master of Applied Science, Mechanical Engineering

Sep. 2018 - Expected 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	<b>MIE Teaching Assistant Award</b> , University of Toronto	<i>Toronto, Ontario</i>
2013-18	<b>Dean's Honor List</b> , University of Toronto	<i>Toronto, Ontario</i>
2018	<b>Best Undergraduate Poster Presentation</b> , CFD Society of Canada Conference	<i>Winnipeg, Manitoba</i>
2015	<b>University of Toronto Excellence Award</b> , University of Toronto	<i>Toronto, Ontario</i>
2015	<b>Shell Canada Limited Engineering Scholarship</b> , University of Toronto	<i>Toronto, Ontario</i>
2015	<b>Best Innovation Award and Best Prototype Award</b> , U of T Engineering Competition Junior Design	<i>Toronto, Ontario</i>