# Richard (Han) Hu

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## Experiences

**Autonomous System and Biomechatronics Lab** *Sep. 2018 - Aug. 2021*

Researcher, Master Thesis

- **Deep Learning** Developed and published a novel sim-to-real transfer pipeline for robot navigation in Pytorch, achieved 87% real world success rate given a 90% simulation success rate
- **Development** Developed a ROS based decentralized software and hardware robot architecture using C++ and Python
- **Localization** Implemented LiDAR and visual SLAM on a mobile robot for real time pose estimation
- **Control** Designed and optimized a cascade PID controller for global position and wheel control in rough terrain
- **Analysis** Analyzed the pipeline with autonomous navigation experiments, comparison studies, and ablation studies

**Huawei Noah's Ark Lab** *May. 2020 - Jan 2021*

Support Researcher, Autonomous Driving Division

- **Path Planning** Developed, published, and patented a novel spatial constraint generation algorithm for autonmous driving in python
- **Simulation** Engaged in an autonmous driving simulator development using real-world datasets

**MIE443 Mechatronics Systems: Design & Integration** *Jan. 2018 - Apr. 2020*

Head Teaching Assistent

- **Lecture** Lectured on ROS based robot navigation and SLAM methods
- **Mentorship** Guided students on ROS based autonomous robot algorithm development, vision sensor, and OpenCV

**Water and Energy Research Laboratory** *Jan. 2018 - Sep. 2018*

Researcher, Pico-Scale Hydro Turbine Design

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

**Conavi Medical** *May. 2016 - Aug. 2017*

Mechanical Engineer Intern, Novasight Hybrid System

- **Analysis** 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
- **Management** Directed technical design reviews with senior leadership, accelerated the exit of the project phase
- **Mechanical** Designed imaging and rotary assembly for a intravascular catheter using MATLAB and SolidWorks

**Multiphase Flow and Spray Systems Lab** *Jun. 2015 - Sep. 2015*

Researcher

- **Development** Developed Arduino based camera to fluid pipeline synchronization system to speed up data collection by 85%
- **Analysis** Classified 13 novel air-fluid impingement shatter pattern using statistical analysis

## 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 Devleoper

- **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 for precision localization
- **Simulation** Evaluated 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** *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

**Open Architecture Quadcopter Design** *Sep. 2017 - Apr. 2018*

Mechanical Designer

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

# Publications

**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 Application Number: 63/108,348

**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

- 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

**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* |