Richard (Han) Hu

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Experiences

XPENG Robotics
Jan. 2022 - Present

Machine Learning Engineer, Motion Control Center

- **Deep Learning** Developing and deploying a locomotion controller for legged robots that combines reinforcement learning and traditional model-based control to increase robot stability
- **Infrastructure** Building and refactoring a containerized, distributed and scalable reinforcement learning pipeline using IsaacGym, Pytorch and Raylib.

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

Developer, Master Thesis

- **Deep Learning** Led the development and **published** a novel sim-to-real transfer pipeline for rough terrain navigation in Pytorch
- **Sim-to-Real** Researched, designed, and implemented a high fidelity Gazebo simulator and domain randomization
- **Development** Developed a decentralized software and hardware robot architecture using ROS, 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** Led real-world navigation, comparison, and ablation experiments to demonstrate that the pipeline achieved 87% real world success rate given a 90% simulation success rate; up to 72% increase against existing methods
- **Hardware** Enhanced a robot with auxilliary computing units and sensors with components designed using SolidWorks
- **Publication** Published in 1) IEEE Robotics and Automation Letters and 2) International Conference on Intelligent Robots and Systems

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

Developer, Autonomous Driving Division

- **Path Planning** Developed, **published**, and **patented** a Delaunay Triangulation based spatial constraint generation algorithm for mapless autonomous vehicle navigation in a dynamic environment
- **Development** Implemented a Python based path planning simulator and the algorithm's modules for fast development iterations
- **Algorithms** Implemented Hybrid A* and Funnel algorithm for path planning in triangulation mesh
- **Simulation** Engaged in simulator development using CARLA by automating map generation process from real-world datasets
- **Publications** Published in 1) IROS 2021 Conference and 2) US Patent Application No. 17/515,522

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

Head Teaching Assistent

- **Lecture** Lectured 4th year engineering students on ROS based robot navigation and SLAM methods
- **Mentorship** Guided students on ROS based autonomous robot algorithm development, vision sensor, and OpenCV
- **Award** Recipient of UofT MIE 2019-20 Teaching Assistant Award

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

Developer, Pico-Scale Hydro Turbine Design

- **Mechanical** Designed and published 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 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 centermeter 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 (RAL, IROS2021)

Hu. H, Kaicheng Zhang, Aaron Hao Tan, Michael Ruan, Christopher Agia, and Goldie Nejat
- Proposed a pipeline to transfer challenging rough terrain navigation policy from simulation to the real-world using high fidelity simulation, abstract observation space, and domain randomization
- The pipeline acheived a 87% real world navigation success rate given a 90% simulation success rate
- The pipline has up to 72% increase in navigation success along with a faster travel time and shorter distance against existing methods

Spatial Constraint Generation for Motion Planning in Dynamic Environments (IROS2021, Huawei Patent)

Hu. H, Peyman Yadmellat
- Proposed to generate spatial constraint using triangulation mesh for long-term mapless path planning in a dynamic environment
- Overcame the static triangulation mesh assumption and the object masking issue that existing methods have
- Achieved up to 18% increase in navigation success rate and up to 28% increase in valid plans compared to existing methods

Optimization and System Identification of a Variable Pico-Scale Hydro Turbine for Pressure Regulation (ASME2021)

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

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*