Richard (Han) Hu

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Experiences

XPeng 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 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

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

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*