

# HARVEY MERTON

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## Summary

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As a robotics engineering Master's researcher at MIT, I specialize in the development of autonomous systems. My expertise encompasses artificial intelligence across computer vision, navigation, estimation, task and trajectory planning, multi-agent coordination, control systems (including reinforcement learning), and machine learning. With a Bachelor's degree in Mechatronics engineering, I am equally well-versed in robotic cognitive intelligence and physical embodiment (mechanical design and electronics).

## Education

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### Massachusetts Institute of Technology (MIT)

Sept 2022– Present

*S.M. Mechanical Engineering - Autonomous Systems and Robotics*

GPA: 5.0/5.0

- **Relevant Coursework:** Principles of Autonomy and Decision Making, Underactuated Robotics, Visual Navigation for Autonomous Vehicles, Introduction to Robotics, Parallel Computing and Scientific Machine Learning

### The University of Auckland (UoA)

Mar 2018– Nov 2021

*BE(Hons) Mechatronics Engineering - First class honours*

GPA: 8.91/9.0 (ranked first in class)

## Experience

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### Master's Researcher - Multiagent Robotic Systems

Sept 2022– Present

*Bioinstrumentation Laboratory MIT*

*Boston, Massachusetts*

- Ground-up software development using Ubuntu, ROS2, gazebo, PX4 autopilot, python, openCV, drake, C++ and julia.
- Devised novel Kalman Filter formulations for visual pose estimation for a multiagent slung load system.
- Developing universal differential equations and machine learning techniques for novel cable dynamics modelling.

### Embedded Control Systems Engineer

Nov 2021– Jul 2022

*EnergyBank*

*Auckland, New Zealand*

- Ground-up concept design and optimization of an ultra-low wear linear winch system at this seed-stage start-up.
- Built a fully-functioning prototype with STM32 microcontrollers and open-source ESCs.
- Control system design in Matlab/Simulink for this multiple-input, torque-sharing system.

### Researcher - Reinforcement Learning

Mar 2021– Nov 2021

*Drone Technology Research Group UoA*

*Auckland, New Zealand*

- Used OpenAI Gym, Python and ROS to develop a full reinforcement learning training pipeline for track following of an autonomous racecar.
- Successfully selected and trained Pytorch-implemented reinforcement learning algorithms.
- Optimized learning hyper parameters based on real-world and simulation inference results.

### Chief Engineer, Autonomous Researcher and Driveline Leader

Mar 2018– Nov 2021

*UoA Formula:Society of Automotive Engineers Team*

*Auckland, New Zealand*

- Lead the 50-strong Auckland University F:SAE team to design and build a \$200,000 single-seater electric race car for an annual international competition (F:SAE – A).
- Systems-level concept design, top-down modelling in Autodesk Inventor (with PDM), TIG welding, precision metal manufacture, carbon-fibre layup, Ansys CFX fluid simulations, nTopology FEA and topology optimization.
- Leadership responsibilities included: vision setting, leading integration across subteams, coordinating with various stakeholders, project management, leading meetings and maintaining team morale over COVID-19.

### Additive Manufacturing and Image Analysis Engineer

Nov 2020– Feb 2021

*Zenith Tecnica*

*Auckland, New Zealand*

- Independently developed an image analysis method using ImageJ macros to measure porous 3D printed structures from CT scans.
- Performed topology optimization, structural simulation, and design for additive manufacture in nTopology and Solidworks on a variety of parts.
- Ran the full titanium 3D printing (EBM) production process from launch through complete post-processing and 3D scanning to generate compliance reports against GD&T specifications.

## Bruce McLaren Engineering Intern

*McLaren Automotive*

**Dec 2019– Feb 2020**

*Woking, United Kingdom*

- Involved a rotation around different departments following an automobile's development from conception to manufacture and testing.
- Provided a broad exposure to the engineering and business industries and experience communicating with many different people in an international and professional setting.
- Mini-projects on Hyperworks crash simulation, Arduino sound production and technology prediction data analysis.

## General Engineering Design and Manufacture

*E.G. Whiter*

**Nov 2018– Feb 2019**

*Auckland, New Zealand*

- Manual milling, turning, grinding, honing and use of hand and power tools to manufacture steel parts according to engineering drawings.
- Mazak CNC mill programming, setting and operation.
- Custom designed a variety of parts, modelled in Creo Parametric, devised optimal manufacture methods and manufactured according to customer specifications.

## Skills

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- **Robotics and drones:** kinematics and dynamics, task planning, behavior coordination, path and trajectory planning, mathematical programming, multiagent coordination, computer vision and visual pose estimation, PDDL, ROS(2), PX4 autopilot, Gazebo, Ubuntu, Drake, OpenCV, ImageJ.
- **Machine learning:** universal differential equations, reinforcement learning, Pytorch, OpenAI Gym, Julia's automatic differentiation and machine learning packages.
- **Control:** Simulink, classical, modern and digital control.
- **Software:** Object oriented programming in Python, Matlab, C#, C++/C, Julia, embedded development, git.
- **CAE:** Onshape, Solidworks, Ansys CFX (CFD), nTopology (FEA and topology optimisation).
- **Manufacturing:** 3D printing (EBM/SLM and FDM), lasercutting, manual and CNC mill, manual lathe, standard rough cutting machines, grinding, honing, hand and power tools.
- **Electronics:** Verilog HDL, LT Spice, digital and analogue design (including basic power electronics), embedded C for microcontrollers and real-time programming.

## Publications and Presentations

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- H. Merton, Z.Q. Huang and I.W. Hunter, "Multi-UAV Slung Load Carrying for Methane Emissions Measurement," presentation at Workshop on Robotics in Agriculture, International Conference on Robotics and Intelligent Systems, Detroit, MI, USA, Oct. 2023.
- H. Merton, T. Delamore, K. Stol, and H. Williams, "Deep Reinforcement Learning for Local Path Following of an Autonomous Formula SAE Vehicle," in Australasian Conference on Robotics and Automation, Sydney, Australia: Australian Robotics and Automation Association, Dec. 2023. ISBN 978-0-6455655-2-2, ISSN: 1448-2053. Available: [https://ssl.linklings.net/conferences/acra/acra2023-proceedings/views/at\\_a\\_glance.html](https://ssl.linklings.net/conferences/acra/acra2023-proceedings/views/at_a_glance.html).

## Selected Awards and Achievements

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William Georgetti Fellowship (2022-2024); Elite Robotics and Entrepreneurship Summer School (2023); Fulbright Science and Innovation Graduate Award - alternative candidate (2022); Senior Scholar Engineering (2021); Kupe Leadership Scholarship (2021); top in class – COMPSYS 726 robotics and intelligent systems (2021), MECHENG 313 real time programming (2020); Sir Colin Maiden Scholar (2020); AUEA Ardmore Scholarship (2020); Robert Horton Award (2018).