Thomas O'Brien

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SUMMARY

PhD student with a deep interest in general-purpose humanoid robotics. My academic and research endeavors have been centered around the development of control and state estimation techniques to enable robots to navigate (**locomotion**) and interact (**manipulation**) with their environment. I have extensive experience in developing software and hardware for robotics applications in both simulation and the real world. I am also a robot soccer enthusiast.
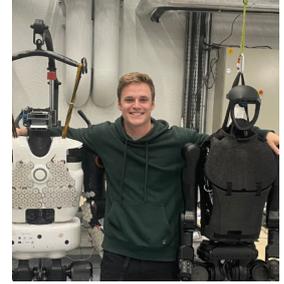
EDUCATION

PhD in Mechanical Engineering	2022 – Present
Control Strategies for Contact-Rich Robotic Systems	University of Newcastle
Bachelor (Honours) of Mechatronics Engineering	2018 – 2021
Class 1 Honours with a 89.2 WAM (GPA 6.6/7.0) + College Medal	University of Newcastle

EXPERIENCE

Software Engineer - 4AI Systems   2024 – Present

- Developed computer vision detection systems for rail network operations, improving precision and recall over prior architecture [`TensorFlow, PyTorch`]
- Refactored data playback system enabling post-operation analysis and seamless replay of robotics datasets through the complete software pipeline, increasing playback time by 5× [`C++`]

Research Associate - University of Newcastle   2025 – Present

- Developed computer vision systems, autonomous path planning algorithms, and state estimation techniques for drone operations achieving safety critical mission success rate of 100% [`ROS + Python`]

Robotics Researcher - NUbots   2020 – Present

- Led a multi-disciplinary team to achieve **3rd place** globally at RoboCup 2025, overseeing the development of the complete software and hardware stack
- Developed humanoid locomotion control stack using standard MPC + Inverse Kinematics and modern reinforcement learning approaches [`JAX + MuJoCo`]
- Implemented humanoid state estimation techniques leveraging nonlinear optimisation for odometry & localisation reducing pose error by over 30%
- Built computer vision pipelines for both object detection and semantic segmentation in dynamic, real-world environments achieving real-time performance (15.15ms iGPU inference) [`PyTorch + OpenVino`]

Visiting Researcher - LAAS-CNRS   2025

- Developed novel Policy-guided MPC controller leveraging GPU-parallelized simulation, improving task performance by 81% over baseline policy [`JAX + MuJoCo`]

Visiting Researcher - Prisma Lab   2025

- Explored novel combination of energy-based control with reinforcement learning for whole-body humanoid control

Research Assistant - University of Newcastle   2023

- Real-time point cloud data analysis using LiDAR for rail localization and state estimation [`Eigen3`]

Mechatronics Engineer - Varley Group   2021 – 2022

- Designed and developed novel drain camera technology featuring advanced IMU-based image levelling in extremely hazardous environments [`Python`]
- Selected and tested PCB-preserving resin for device encapsulation, which ensured operating temperature was kept below $70°C$
- Developed user-facing application for device control and visualization [`Android Studio + Java`]

ACHIEVEMENTS

- **World Robot Humanoid Games 2025 Beijing:** 5th Place - RCAP Beijing Masters *(Team Leader)*
- **RoboCup 2025 Salvador:** 3rd Place - Humanoid League *(Team Leader)*
- **RoboCup 2024 Eindhoven:** 4th Place - Humanoid League *(Team Leader)*
- **RoboCup 2023 Bordeaux:** Quarterfinalist - Humanoid League
- **RoboCup 2022 Thailand:** Quarterfinalist - Humanoid League
- **Warman Competition 2020:** 1st Place - University of Newcastle

TEACHING

Teaching Assistant - University of Newcastle   2022 – Present

- AERO3600 - Embedded Control Systems: Assisted students with microcontroller programming, real-time systems, and control theory implementation
- MCHA3500 - Mechatronics Design: Guided students through integrated mechanical, electrical (Custom PCB), and embedded-software system (STM32) design projects

Supervisor - University of Newcastle   2024 – Present

- ENGG4801 - Final Year Project: Supervised undergraduate engineering students in honours thesis
- SCIE3002 - Work Integrated Learning: Mentored students in industry placement projects

AWARDS

2021	College Medal, College of Engineering Science and Environment	Univ. of Newcastle
2021	College Commendation List	Univ. of Newcastle
2018–2021	Faculty Commendation List (2018–2021)	Univ. of Newcastle
2017	Vice-Chancellor's Award for Academic Excellence in Year 12	Univ. of Newcastle

PUBLICATIONS

[J1] Thomas O'Brien, Joel Ferguson, Alejandro Donaire, "Orbital Stabilization of Hybrid Mechanical Systems - A port-Hamiltonian Approach," Preprint, 2025.

[J2] Fadi Gebrayel, Thomas O'Brien, Martin Mujica, Patrick Danès, "Point Cloud Based Visual Planning and Servoing for Autonomous Vine Pruning," RAL, 2026.

[C1] Thomas O'Brien "Sampling-based Predictive Control for Non-prehensile Manipulation," Australasian Conference on Robotics and Automation (ACRA 2025), Perth, Australia, 2025.

[C2] Will Burgin, Thomas O'Brien "Real-Time Humanoid State Estimation with IMU, Kinematic Odometry, and Visual SLAM," Australasian Conference on Robotics and Automation (ACRA 2025), Perth, Australia, 2025.

[C3] Thomas O'Brien, Joel Ferguson, Alejandro Donaire, "A port-Hamiltonian formulation of mechanical systems with switching contact constraints," 2025 European Control Conference (ECC), Thessaloniki, Greece, 2025.

[C4] Thomas O'Brien, Joel Ferguson, Alejandro Donaire, "Exponentially Stable Regulation of Mechanical Systems to a Path," 2023 IFAC World Congress, Yokohama, Japan, 2023.

[C5] Thomas O'Brien, Ysobel Sims, "Exploring GPT-4 for Robotic Agent Strategy with Real-Time State Feedback," 2023 Australasian Conference on Robotics and Automation (ACRA), Sydney, Australia, 2023.

[C6] Ysobel Sims, Trent Houliston, Thomas O'Brien, et al., "SoS: A Semi-Synthetic RoboCup Soccer Dataset for Visual Segmentation," RoboCup Symposium 2024, Eindhoven, Netherlands, 2024.

[C7] Khaled Saleh, Thomas O'Brien "Efficient Sequence Model for Early Fall Detection of Humanoid Robots," RoboCup Symposium 2024, Eindhoven, Netherlands, 2024.

[C8] Ysobel Sims, Trent Houliston, Thomas O'Brien, "The Director: A Composable Behaviour System with Soft Transitions," RoboCup Symposium 2024, Eindhoven, Netherlands, 2024.

[W1] Thomas O'Brien, "Humanoid State Estimation in RoboCup," 2024 IEEE-RAS International Conference on Humanoid Robots (Humanoids), Nancy, France, 2024.

PROJECTS

Software:

- NUbots (2023) – Control, locomotion, state estimation, vision, behaviour software for humanoid robots
- NUbook (2025) – The NUbots team handbook and documentation
- NUWebots (2025) – Webots simulation environment for NUbots robots
- tinyrobotics (2023) – Lightweight, versatile C++ robotics dynamics/kinematics library
- tinympc (2025) – A lightweight implementation of MPC and NMPC in C++ using Eigen3
- urdf-visualizer (2023) – Web-based robotics visualiser developed using three.js

Hardware:

- NUgus (2023) – Design and development of small-sized humanoid robot platform
- NUsense (2025) – Development of humanoid subcontroller for interfacing with actuators (Dynamixel) and sensors (IMU, force sensors, battery monitoring, fan control) using RS485 and Intel NUC over USB

REVIEWING ACTIVITIES

- IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)   2025