Finn Wilson

Robotics, Systems & Control Engineer · Mechatronics and Physics

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Oct – Dec 2026: full-time research sabbatical; available January 2027. I work on both the hardware and the theory: a 30,000-line C++ stack that flies a 10-drone flock, a braid-group safety certificate for tethered drone swarms with its own frictional-contact solver, and certified bounds on controlling organised systems. On sabbatical I'm finishing three papers, building a GPU physics engine, and researching and writing about AI, physics and robotics.

Research

UAV flock herding (Ferroflock) Sep 2024 – Present

University of Sydney, Unmanned Aerial Systems Researcher to Dec 2025; independent since, with Z. Wang

- Built a **30,000-line C++** autonomy stack for a 10-drone Tello/OptiTrack testbed and flew it as a flock, herded live in the lab (control walkthrough, all videos). A **50 Hz** Kalman filter keeps position through tracking dropouts, and setup tooling cut lab setup from half a day to **ten minutes**.
- Knowing the flock's current shape gives most of the herding benefit; predicting individual birds only pays off for a single fast drone. Herding from the flock's edge keeps it together, which a rigid-body flock model can't capture.

Tethered drone swarms: a braid-group safety certificate Jul 2026 – Present

Independent research

- Proving that drones tethered to a shared collar can move without tangling, with a safety certificate built on the **braid group** and control barrier functions keeping the swarm in a forward-invariant safe set.
- In a discrete-elastic-rod simulator, fixed endpoints don't determine a crossing's state once it slides (**0.53 µm** vs **5.9 mm** slip under the same probe), but the hitch position does. Found three silent defects in the DisMech solver and submitted fixes upstream; the first is merged.
- Built a frictional-contact solver for the certificate that reproduces the thick-cable capstan law, where MuJoCo's default contact holds a ratio of only **1.01–1.14** against an ideal of **6.6**. Now porting it to a **batched CUDA** engine benchmarked against MuJoCo.

Identifiability in automated drilling Feb 2024 – Present

With A. Melkumyan and A. J. Hill (University of Sydney); began at the Rio Tinto internship

- Drilling planners that chase lower predicted uncertainty can stop collecting the close sample pairs they need, and nothing in their scores flags it. From sparse starts, **54%** of first batches left the Gaussian-process range unidentified. Traced it to vanishing Fisher information, built a per-batch guard that fixes it without losing accuracy, and checked it against **2,939** Western Australian drilling campaigns.

The cost of keeping a system organised 2026

With Z. Wang

- A system can hold its structure up to a deadline at no cost yet be unable to hold it afterwards, so requiring it to stay organised past the deadline costs real performance. Interval-certified examples in a 3D bird flock, a power-grid generator and a superconducting condensate.

AI research 2026 – Present

Independent research

- **Is slop load-bearing?** Testing whether the stylistic habits of LLM output carry calibration and honesty or are vestigial, by suppressing fourteen families of AI-isms and measuring calibration, abstention and sycophancy. Grew out of Tacita's agent systems and an essay series (first essay published).
- **Tally: do coding agents understand, or recall?** The test is a made-up language that looks exactly like Python but works differently in nine places. Frontier agents got through; a smaller open model kept writing Python.

Camera simulation for long-range drone detection 2026

Independent research

- Physics-based synthetic data to predict how a trained detector performs on cameras it was never tuned on, so a camera can be designed before it's built. In early tests on an unseen camera, simulation-trained detectors found far more drones than ones trained on real footage from another camera.

Also: *Superconductivity:* for picosecond current pulses, the safe drive is set by the gap's minimum *after* the pulse, not at its end; in a certified model, the end-of-pulse view overstates it by at least 20%. *Wind waves:* a first-principles model of how wind feeds ocean waves, with no tuned constants, matching 25 published simulation growth rates within a median factor of 1.2; GPU spectral-element simulations (NekRS) to test it.

Experience

Tacita Pty Ltd May 2025 – Sep 2026

Founder & AI Systems Architect · Blackbird Giants founder program (2026)

- **Legal AI.** An on-premise platform over **500k+ documents**. Delivered a **5,000-email eDiscovery matter** end-to-end in **under a week**, replacing months and A$30–40k of manual work (lawyer estimate), with staged adversarial verification of the outputs.
- **Ingestion at scale.** Indexing had silently slowed from 800 to 20–30 documents a minute while the pipeline reported success, putting the database load at months. Fixed the root causes and gated completion on store-versus-source counts; a 200k-document load now takes **an afternoon**.
- Also built **Substrate**, an agent-native systems engineering platform for long-horizon human and agent work; **Episteme**, a Bayesian belief engine that treats sources like sensors in a state estimator; and **Altus**, property feasibility with correlated Monte Carlo.

Raytheon Australia Sep 2024 – Apr 2025

Systems Engineer

- Automated Australian Defence Air Traffic System engineering workflows, saving **500+ hours a year** across a five-person team. Systems architecture in DOORS, Windchill and Cameo; held baseline security and export clearances.

Rio Tinto Centre for Mining Automation Feb 2024 – Aug 2024

Mechatronics Intern

- Adaptive sampling on Pilbara drill-core data, cutting sampling density **30%** in sandbox experiments with **up to 50% more information per sample** than uniform sampling.

University of Sydney 2020 – 2024

Tutor and Research Scholar

- Tutored Sensors and Signals (2024). Australian Centre for Field Robotics Research Scholar on neural underwater change detection (2022–23). Physics Special Studies Program research projects (by invitation): piezoelectric nanofibres (2021), and MOF-glass perovskite solar cells with Anita Ho-Baillie's group (2023), including device fabrication and characterisation.

Publications and manuscripts

F. Wilson, A. Melkumyan, A. J. Hill. *Variance-Reduction Infill Sampling Can Leave the Variogram Unidentifiable: A Per-Batch Diagnostic and Guard for Automated Drilling.* For *IEEE T-ASE*; preprint soon.

F. Wilson, Z. Wang. *Performance Bounds and the Cost of Continuation under State Constraints.* Preprint soon.

F. Wilson, Z. Wang. *When Does Flock Prediction Help UAV Herding? Shape, Speed, and Execution Limits.* For *IEEE RA-L*; in preparation.

F. Wilson (2024). *The value of information in ML-based mine geology modelling.* Honours thesis, First Class.

Education

University of Sydney 2020 – 2024

BE (**Honours Class I**), Mechatronics/Space Engineering; BSc, Advanced Physics.

Selected marks: Aerospace Engineering Project 3 (95), Mechatronics 3 (92), Physics Interdisciplinary Project (91).

Projects: SLOSHSat CubeSat fluid-slosh payload, where I designed the custom PCBs for sensing, localisation, experiment control and magnetorquer actuation, wrote the firmware on FreeRTOS, and 3D-printed the structure in carbon-fibre polycarbonate (PC-CF); quadrotor autonomous landing on a moving ground vehicle; TurtleBot SLAM.

Leadership and awards: led the 25-person Sydney University Rover Team through critical design review; executive of the Physics and Engineering societies; Dean's List (2024); Australian Centre for Field Robotics Research Scholar (2022–23); 1st place, AIAA Aerohack; Raytheon GradX, Engineering Sydney Industry Placement and Sydney Innovation Program scholarships; LSAT 174; GRE 334 (169 verbal, 165 quant, 5.5 writing); Optiver Quant Test 80/80.

Technical skills

Languages and tools: C, C++, Python, CUDA, Verilog (FPGAs), MATLAB, PyTorch, TensorFlow, ROS, Docker, Linux, Git, SysML

Hardware: PCB design, embedded firmware, real-time operating systems, 3D printing and CAD

Simulation and physics: physics simulation, multibody and contact dynamics, numerical methods, sim-to-real

Control and estimation: state estimation, Kalman filtering, sensor fusion, model predictive control, optimal control, control barrier functions, Lyapunov analysis, decentralised multi-agent control

ML and verification: Gaussian processes, Bayesian inference, computer vision, reinforcement learning, LLM agents and evaluations, interval-arithmetic verification