

Nathaniel Simon

PhD Candidate in Mechanical & Aerospace Engineering, Princeton University

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In my post-graduate career, I aim to enable transformative capabilities in autonomous systems. I am seeking full-time research and engineering roles in robotics spanning perception, planning, and controls.

My dissertation research enhances aerial vehicle performance in the real world with high-dimensional sensors (e.g. cameras, flow sensors) and machine learning. During my PhD, I invented an omnidirectional flow sensor for UAVs (See: Patent) and developed a wind-aware flight controller capable of navigating wind gusts (See: FlowDrone). In addition, I advanced state-of-the-art micro aerial vehicle navigation through learning-based monocular depth estimation and 3D reconstruction to enable high-speed exploration in unseen cluttered environments (See: MonoNav).

Education

Ph.D. Candidate in Mechanical & Aerospace Engineering, Princeton University 2022 - 2025
Advisors: Anirudha Majumdar (IRoM Lab), Marcus Hultmark (FAST Group)

Master of Arts, Mechanical & Aerospace Engineering, Princeton University Conferred 2022

Master of Science, Mechanical Engineering, Stanford University Conferred 2020

Bachelor of Science, Mechanical Engineering, Stanford University (GPA: 3.94) Conferred 2019
Activities: Tau Beta Pi, US Air Force ROTC, Hacking for Defense.

Research Experience

Flight Research Software and Controls PhD Intern, Joby Aviation, Santa Cruz, CA Summer 2024
Joby's Flight Research team develops novel aerospace technology. On the software and controls team, I extended the flight controller to novel aircraft designs (in C++), wrote tests and tools to monitor vehicle performance (in Python), and led a research effort in GPS-denied aircraft localization (with ML).

Project Lead: MonoNav, Princeton University [website](#), [paper](#), [code](#) Nov 2022 - Present
I created MonoNav, a state-of-the-art monocular navigation stack enabling micro aerial vehicles to explore unseen environments through simultaneous mapping and navigation. MonoNav is a modular stack that uses pre-trained depth estimation, off-the-shelf fusion, and a library of fast motion primitives.

Project Lead: FlowDrone, Princeton University [website](#), [paper](#) Sep 2020 - Nov 2022
I created FlowDrone, an experimental quadrotor testbed for wind-aware control in gusty conditions. FlowDrone uses MAST, our novel high-speed omnidirectional flow sensor, and a wind-aware controller learned in simulation (via reinforcement learning), to outperform baseline controllers in real-world gusts.

Publications

Distributed feather-inspired flow control mitigates stall and expands flight envelope.

Girguis Sedky, [Nathaniel Simon](#), Ahmed K. Othman, Hannah Wiswell, Aimy Wissa.

In Press: Proceedings of the National Academy of Sciences, 2024.

MonoNav: MAV Navigation via Monocular Depth Estimation and Reconstruction.

[Nathaniel Simon](#) and Anirudha Majumdar. *International Symposium on Experimental Robotics, 2023.*

Best Paper Award: *Learning Robot Super Autonomy Workshop (IROS), 2023.*

Online Learning for Obstacle Avoidance.

David Snyder, Meghan Booker, Nathaniel Simon, Wenhan Xia, Daniel Suo, Elad Hazan, and Anirudha Majumdar. *Conference on Robot Learning*, 2023.

FlowDrone: Wind Estimation and Gust Rejection on UAVs Using Fast-Response Hot-Wire Flow Sensors. Nathaniel Simon, Allen Z. Ren, Alexander Piqué, David Snyder, Daphne Barretto, Marcus Hultmark, and Anirudha Majumdar. *International Conference on Robotics and Automation*, 2023.

Fast-Response Hot-wire Flow Sensors for Wind and Gust Estimation on UAVs.

Nathaniel Simon*, Alexander Piqué*, David Snyder, Kyle Ikuma, Anirudha Majumdar, and Marcus Hultmark, *Measurement Science and Technology*, 2022. (* Equal Contribution)

Patents

Omnidirectional flow sensor.

Nathaniel Simon, Alexander Piqué, David Snyder, Kyle Ikuma, Anirudha Majumdar, and Marcus Hultmark. *Publication Number: US20240200997A1*, 2024. View: patents.google.com

Awards and Honors

- **Finalist, Amazon Robotics PhD Communication Competition** \$5,000 award. 2024
- **Best Paper Award: MonoNav** 2023
Learning Robot Super Autonomy Workshop, International Conference on Intelligent Robots and Systems (IROS).
- **Crocco Award for Teaching Excellence** 2023
\$1,000 award for teaching excellence in MAE 345/549: Introduction to Robotics.
- **Robotics and Automation Society Student Travel Grant** 2023
\$1,300 for travel to the International Conference on Robotics and Automation in London, UK.
- **Outstanding Presentation Award, Princeton Research Day** 2023
\$1,500 prize for my video presentation: *Improving Drone Performance in Wind with Novel, Fast, Sensors*.
- **Guggenheim Second Year Fellowship, Princeton University** 2021
- **National Science Foundation Graduate Research Fellowship Program (NSF GRFP)** 2020-2025

Invited Talks

MonoNav: MAV Navigation via Monocular Depth Estimation and Reconstruction

- Amazon Robotics Research Symposium & PhD Communication Competition, Boston, MA. Oct 2024
- GRASP Lab Group Meeting, University of Pennsylvania, Philadelphia, PA. Mar 2024
- International Symposium on Experimental Robotics, Chiang Mai, Thailand. Nov 2023
- SSR Lab Group Meeting, Princeton University, Princeton, NJ. Oct 2023

FlowDrone: Wind Estimation and Gust Rejection on UAVs Using Fast Hot-wire Flow Sensors

- PX4 Developer Summit, New Orleans, LA. Oct 2023
- Google Deepmind Princeton, Princeton, NJ. Mar 2023

Fast-response hot-wire flow sensors for wind and gust estimation on UAVs

- Thousand Islands Fluid Dynamics Meeting, Ontario, Canada. Apr 2023
- 75th Annual Meeting of the Division of Fluid Dynamics, Indianapolis, IN. Nov 2022
- Mechanical & Aerospace Engineering Research Day, Princeton University, Princeton, NJ. Sep 2022

Micro Aerial Vehicles as Lagrangian Particles in the Atmospheric Boundary Layer

- AFOSR Program Review, Rome, NY (Virtual). Oct 2024
- 76th Annual Meeting of the Division of Fluid Dynamics, Washington DC. Nov 2023

Teaching Experience

- **Guest Lecturer:** Introduction to Robotics (MAE 345/549), Princeton MAE Fall 2024
Topics: Mapping, Simultaneous Localization and Mapping (SLAM)
- **Guest Lecturer:** Optimal Control and Machine Learning, USAF Test Pilot School Aug 2024
- **TA:** Aircraft Design (MAE 332), Princeton MAE Spring 2023
- **TA:** Introduction to Robotics (MAE 345/549), Princeton MAE Fall 2022
- **TA:** Introduction to Engineering Dynamics (MAE 206), Princeton MAE Spring 2022
- **Head TA:** MS&E 297: Hacking for Defense, Stanford MS&E Spring 2019, 2020
- **TA:** ME 70: Introductory Fluids Engineering, Stanford ME Winter 2020
- **TA:** MS&E 293: Technology and National Security, Stanford MS&E Fall 2019

Key Skills

- **Coding:** C++, Python, git, Bazel, Bash, **Software:** PX4, ROS, OpenCV, Open3D, TensorFlow, PyBullet.
- **Perception:** camera calibration, image transformation, depth estimation, integration.
- **Controls:** modeling, dynamics, feedback control, optimal control, learning-based control.
- **Machine Learning:** Foundation models, neural networks, reinforcement learning.
- **Hardware:** UAV and sensor design and fabrication, CAD, 3D printing, machining.
- **Electrical:** PCB design, soldering, debugging and analysis (oscilloscope/function generator).
- **Aviation:** Private Pilot (Single Engine Land, Glider), Instrument Rated, Part 107 Remote Pilot (UAS).

Industry Experience

Product Manager Intern, Somewear Labs, San Francisco, CA Summer 2019
Somewear develops satellite transceivers for off-grid communication. I led business development and field testing for Air Force customers to improve situational awareness in combat search and rescue operations.

1st Mechanical Engineer Intern, Redwood Materials, Milpitas, CA Fall 2018
Founded by JB Straubel, Redwood Materials recycles lithium-ion batteries to accelerate electrification. I modeled their early electrorefining system.

Design Engineer Intern, Boyd Corp, San Jose, CA Summer 2018
I designed and validated thermal systems (electronics cooling solutions) for customers, using Solidworks, ANSYS ICEPAK, and experimental tests.

Aviation Systems Engineering Intern, Garmin Aviation, Olathe, KS Summer 2017
Garmin is a leading provider of avionics in general aviation and corporate aircraft. I developed an integrated test bench for the TXi™ family of touchscreen flight displays.

France-Stanford Fellow, CentraleSupélec, Paris, France Summer 2016
I researched nonthermal (glow) plasma generation under the supervision of Prof. Christophe Laux.

Academic References

Ani Majumdar (Advisor)
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Aimy Wissa (Collaborator)
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Marcus Hultmark (Co-advisor)
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Additional references available upon request.