Nathaniel Simon

PhD Candidate
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My research improves aerial vehicle performance in the real world through high-dimensional sensors (e.g., vision, airflow) and machine learning. In my work, I have invented and deployed high-frequency omnidirectional flow sensors for UAVs, as well as wind-aware flight controllers to navigate unsteady flows. (See: FlowDrone, 3 min video.) I have also enabled state-of-the-art monocular, micro aerial vehicle navigation using computer vision (See: MonoNav). My goal is to enable transformative autonomy in applications such as urban air mobility, package delivery, infrastructure inspection, and ISR. I am seeking full-time engineering roles in the aerospace and robotics industries in perception, planning, and controls.

Education

Ph.D. in Mechanical & Aerospace Engineering, Princeton University 2020 - 2025
Advisors: Anirudha Majumdar (IRoM Lab), Marcus Hultmark (FAST Group)

Master of Science, Mechanical Engineering, Stanford University 2019 - 2020

Bachelor of Science, Mechanical Engineering, Stanford University 2015 - 2019

Recent 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 (C++), wrote tests and tools to demonstrate and monitor vehicle performance (Python), and led a research effort in GPS-denied aircraft localization (ML).

Project Founder: MonoNav, Princeton University website, github Nov 2022 - Present
I created MonoNav, a state-of-the-art monocular navigation stack enabling micro aerial vehicles to explore unseen environments *fast* through simultaneous navigation and reconstruction. MonoNav is a modular stack that uses pre-trained depth estimation, off-the-shelf fusion, and a library of motion primitives.

Project Founder: FlowDrone, Princeton University Sep 2020 - Nov 2022
I created FlowDrone, an experimental quadrotor testbed for wind-aware control in gusty conditions. FlowDrone uses MAST, a 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 (PNAS), 2024.

MonoNav: MAV Navigation via Monocular Depth Estimation and Reconstruction.
Nathaniel Simon and Anirudha Majumdar. *International Symposium on Experimental Robotics, 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 (MST), 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`

Key Skills

- **Software:** C++, Python, git, Bash, Bazel, PX4 Autopilot, Robot Operating System (ROS).
- **Perception:** camera calibration/modeling, image transformation, depth estimation, 3D representations, reconstruction/integration. (Tools: OpenCV, Open3D, TSDF Fusion.)
- **Planning:** motion planning, trajectory optimization (Tools: RRT*, A*, motion primitives.)
- **Control:** modeling, dynamics, feedback control (e.g., PID, LQR, MPC, INDI), learning-based control.
- **Machine Learning:** Foundation models (e.g., robot navigation), neural networks (e.g., learned sensor models), reinforcement learning (e.g., learned flight control). (Tools: TensorFlow, PyBullet, CUDA.)
- **Hardware:** UAV design and fabrication, sensor fabrication (clean room processes), Diptrace/Eagle, Solidworks/Fusion 360, 3D printing, soldering, machining.
- **Aviation:** Private Pilot (Single Engine Land, Glider), Instrument Rated, Part 107 Remote Pilot (UAS).

Awards and Honors

- **Finalist, Amazon Robotics PhD Communication Competition** 2024
- **Best Paper Award: MonoNav**. Project Website. 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
  Departmental fellowship for high-performing second year students.
- **National Science Foundation Graduate Research Fellowship Program (NSF GRFP)** 2020
  "The five-year fellowship provides three years of financial support inclusive of an annual stipend of $37,000."

Invited Talks

- AFOSR Program Review, Rome, NY (Virtual). Aug 2024
- GRASP Lab Group Meeting, University of Pennsylvania, Philadelphia, PA. Mar 2024
- International Symposium on Experimental Robotics, Chiang Mai, Thailand. Nov 2023
- 76th Annual Meeting of the Division of Fluid Dynamics, Washington DC. Nov 2023
- PX4 Developer Summit, New Orleans, LA. Oct 2023
- SSR Lab Group Meeting, Princeton University, Princeton, NJ. Oct 2023
- Google Deepmind, Princeton, NJ. Mar 2023
- Thousand Islands Fluid Dynamics Meeting, Ontario, Canada. Apr 2023
- 75th Annual Meeting of the Division of Fluid Dynamics, Indianapolis. Nov 2022
- Mechanical & Aerospace Engineering Research Day, Princeton. Sep 2022

Teaching Experience

- **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
- **TA:** Hacking for Defense (MS&E 297), Stanford MS&E Spring 2019, 2020
- **TA:** Introductory Fluids Engineering, Stanford ME Winter 2020
- **TA:** Technology and National Security, Stanford MS&E Fall 2019

Additional Experience (pre-PhD)

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.

Head Teaching Assistant, MS&E 297: Hacking 4 Defense, Stanford University Spring 2019, 2020
I taught student teams to apply lean startup principles to national security problems, taking a hands-on approach requiring close engagement with military, DoD, and other government end-users.

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.