Nathaniel Simon

Email: nsimon@princeton.edu   Homepage: natesimon.github.io

My research improves aerial vehicle performance in the real world using high-dimensional sensors (e.g., vision, airflow) and machine learning. My goal is to enable transformative autonomy in applications such as urban air mobility, package delivery, infrastructure inspection, and ISR. Specifically, I design, build, and test high-frequency omnidirectional flow sensors for UAVs, as well as flight controllers to navigate unsteady flows. (See: FlowDrone, 3 min video.) I also work on fast, monocular, micro aerial vehicle navigation using computer vision (See: MonoNav). I am actively seeking roles in the autonomous vehicle and robotics industries in perception, planning, and control.

Education

Ph.D. in Mechanical & Aerospace Engineering, Princeton University   2020 - Present
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

Experiences

Project Lead: FlowDrone, Princeton University   September 2020 - Present
FlowDrone is an experimental quadrotor for wind-aware control in gusty conditions. FlowDrone uses MAST (MEMS Anemometry Sensing Tower), a high-speed omnidirectional flow sensor, and a wind-aware controller learned in simulation, to outperform baseline controllers in lab-generated gusts.

Project Lead: MonoNav, Princeton University   Nov-Oct 2023
MonoNav is a monocular navigation stack that enables micro aerial vehicles to explore unknown environments through simultaneous navigation and reconstruction, using pre-trained metric depth estimation.

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
Student teams 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.

Publications

MonoNav: MAV Navigation via Monocular Depth Estimation and Reconstruction.
<u>Nathaniel Simon</u> and Anirudha Majumdar. *International Symposium on Experimental Robotics, 2023.*

Online Learning for Obstacle Avoidance.
David Snyder, Meghan Booker, <u>Nathaniel Simon</u>, 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.
<u>Nathaniel Simon</u>, 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.
<u>Nathaniel Simon</u>*, Alexander Piqué*, David Snyder, Kyle Ikuma, Anirudha Majumdar, and Marcus Hultmark, *Measurement Science and Technology (MST), 2022.* (* Equal Contribution)

Awards and Honors

- **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

- 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.   Oct 2023
- Robotics Student Seminar, Princeton.   Oct 2023
- Google Deepmind, Princeton.   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 Assistant Experience

- Aircraft Design (MAE 332), Princeton MAE   Spring 2023
- Introduction to Robotics (MAE 345/549), Princeton MAE   Fall 2022
- Introduction to Engineering Dynamics (MAE 206), Princeton MAE   Spring 2022
- Hacking for Defense (MS&E 297), Stanford MS&E   Spring 2019, 2020
- Introductory Fluids Engineering, Stanford ME   Winter 2020
- Technology and National Security, Stanford MS&E   Fall 2019

Academic Service

Undergraduate Students Advised

- Arthur Schmidt (COS),   Next: SpaceX   2023
- Skywalker Li (ECE)   2023
- Jimmy Tran (MAE)   2023
- Dylan Epsteingross (COS)   2023
- Daphne Barretto (COS),   Next: Microsoft & Stanford MS   2022, 2023
- David Fu (MAE)   2022
- John Wallace (MAE)   2022
- Kyle Ikuma (MAE),   Next: Skydio   2021

Organizer

- Princeton Robotics Seminar   2022-2023
- **Workshop:** Bridging the Lab-to-Real Gap: Conversations with Academia, Industry, and Government (ICRA 2023).

Key Skills

- **Topics:** Robotics (kinematics, dynamics, motion planning, feedback control),
  Computer Vision (depth estimation, reconstruction, OpenCV, Open3D),
  Sensors (design, fabrication, characterization), Fluids (weather, wind, turbulence).
- **Software:** Python, C++, MATLAB, Bash, Robot Operating System (ROS), PX4 Autopilot.
- **Hardware:** Custom UAV design and fabrication, Bitcraze Crazyflie, Unitree Go1 Quadruped, 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).

Advisor References

Ani Majumdar (Advisor)
Assistant Professor
Intelligent Robot Motion Lab
Mechanical and Aerospace Engineering
Princeton University
ani.majumdar@princeton.edu
(609) 258-0854

Marcus Hultmark (Co-advisor)
Professor
Fundamental and Applied Studies in Turbulence
Mechanical and Aerospace Engineering
Princeton University
hultmark@princeton.edu
(609) 258-5689

Additional references available upon request.