Kristen Michaelson, Ph.D.

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Estimation researcher passionate about autonomy in aerospace systems; excited to work on modeling and simulation, data assimilation, tracking, and motion planning from the ground up!

EDUCATION

Ph.D. Aerospace Engineering, The University of Texas at Austin　　　　　　　　December 2024
Dissertation: *Recursive Measurement Updates for Particle and Ensemble Filtering*

M.S.E. Aerospace Engineering, The University of Texas at Austin　　　　　　　December 2020
Master's Report: *A Multiplicative Multi-State Constraint Kalman Filter*

B.Sc. Mechanical Engineering, Brown University　　　　　　　　　　　　　　　May 2016

TECHNICAL SKILLS

- ***Engineering expertise:*** Kalman filtering, statistical estimation, data assimilation, ensemble filtering, particle filtering, modeling and simulation, Monte Carlo analysis, sensor fusion, onboard navigation, space tracking, linear covariance analysis (LinCov), laboratory testing, technical publications and conference presentations

- ***Software development skills:*** proficient in Python, MATLAB; some experience with C++, ROS, Java, and Julia; some experience with Unix/Linux and Git/Github/GitLab

- ***Selected coursework:*** Intro/Advanced Statistical Estimation Theory, Neural Networks and Deep Learning (Coursera), Linear/Nonlinear/MIMO Control Systems, Spacecraft Dynamics, Orbital Debris, Optimal Control Theory, Modeling of Multi-Agent Systems, Autonomous Robots, Aerial Robotics, Space Law

- ***Other skills and interests:*** technical writing, public speaking, mentorship, technology policy

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RESEARCH AND PROFESSIONAL EXPERIENCE

The University of Texas at Austin, Dept. of Aerospace Engineering & Engineering Mechanics
Postdoctoral Fellow　　　　　　　　　　　　　　　　　　　　　　　　　　Jan. 2025—Present
Graduate Research Assistant　　　　　　　　　　　　　　　　　　　　　　　　　2018—2024
Teaching Assistant (Aerial Robotics, Introduction to Computer Programming)　　　2021 & 2022
Advisor: Dr. Renato Zanetti

- Studied the optimality of multiple data assimilation (MDA), a recursive ensemble filter measurement update
- Concluded that MDA is an approximate maximum *a posteriori* estimator and proposed a novel adaptive MDA scheme; to our knowledge, this is the most complete discussion available on the optimality of the MDA update
- Derived a continuous formulation of the MDA update; extended to particle flow filtering for estimation in highly nonlinear systems with non-Gaussian uncertainty; in particle flow filtering, particles (i.e., samples) move from one probability distribution to another, similar to iterative refinement in diffusion models
- Designed simulation studies to test the new filters, demonstrating promising results compared to baseline methods in applications such as radar-based cislunar tracking and tracking large-scale chaotic systems
- Developed an information-based cost metric for rapidly-exploring random trees (RRT*); the metric induces navigation-friendly behaviors by drawing agents into regions where informative measurements are available
- Implemented a popular simultaneous localization and mapping (SLAM) algorithm, the multi-state constraint Kalman filter (MSCKF), with a multiplicative quaternion update in a simulated camera-IMU system

- Facilitated annual Aerial Robotics course tournament in which student teams program quadcopters to complete an obstacle course; mentored students through development of full autonomy stack (MATLAB / C++ / ROS) including state estimation, guidance, path planning; received overall "Excellent" TA rating of 5.0/5.0
- First-authored 3 journal publications and 5 conference publications
- Mentored 3 junior graduate student researchers; met regularly, shared expertise on my dissertation topic, identified relevant resources in the literature, and helped devise new research directions
- Contributed to research sponsored by Sandia National Laboratories, NASA Johnson Space Center, Air Force Office of Scientific Research (AFOSR), and the University Consortium for Applied Hypersonics

Sandia National Laboratories, Albuquerque, NM

Summer Intern, Technical Internships to Advance National Security (TITANS)/AutonomyNM   2019 & 2022
- Designed and implemented a navigation filter for a neuromorphic terrain-relative navigation technique (NeuroGrid) under development in the Sandia Center for Computing Research
- Studied observability in aided inertial navigation systems (INS); identified unobservable subspace for systems with INS + range measurements only

Saint-Gobain Performance Plastics, Wayne, NJ

R&D Engineer   2016—2018
- Carried out standard laboratory testing for automotive bearings including journal bearing testing, Instron testing, and corrosion/environmental testing
- Designed application-specific test fixtures and procedures, including for evaluation of spring-back during forming and evaluation of friction in steering applications
- Performed finite element analysis (FEA)-based forming and loading simulations in Abaqus
- Presented test results to internal and external customers, including quality engineering, sales, and global R&D

Vecna Technologies, Inc., Cambridge, MA

Summer Intern, Product Development   2015
- Designed and constructed a pressure sensor calibration system for hydraulic-powered robotic actuators, supporting adoption of low-cost components in hydraulic systems

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SELECTED PUBLICATIONS

- **K. Michaelson**, A. A. Popov, and R. Zanetti. "Multiple Data Assimilation as an Approximate Maximum A Posteriori Estimator." *Computational Geosciences*. Vol. 29, No. 17. April 2025.

- **K. Michaelson** and R. Zanetti. "Error Flow Filter." Accepted for publication in *IEEE Transactions on Aerospace and Electronic Systems.* May 2025.

- **K. Michaelson**, M. Gandhi, and R. Zanetti. "Navigation-Aware Path Planning and Multi-Agent Coordination in Challenging Environments." ION PLANS, Salt Lake City, UT. April 28-May 1, 2025.

- **K. Michaelson**, A. Popov, R. Zanetti, and K. J. DeMars. "Particle Flow with a Continuous Formulation of the Nonlinear Measurement Update." 27th Intl. Conf. on Information Fusion, Venice, Italy. July 7-11, 2024.

- **K. Michaelson**, F. Wang, and R. Zanetti. "Terrain-Relative Navigation with Neuro-Inspired Elevation Encoding." *IEEE Transactions on Aerospace and Electronic Systems*. Vol. 60, Issue 3. June 2024.

- **K. Michaelson**, A. A. Popov, and R. Zanetti. "Ensemble Kalman Filter with Bayesian Recursive Update." 26th Intl. Conf. on Information Fusion. Charleston, SC. June 27-30, 2023.

- **K. Michaelson**, A. A. Popov, and R. Zanetti. "Recursive Update Filtering: A New Approach." In AAS/AIAA Space Flight Mechanics Meeting (AAS 23-321), Austin, TX. Jan. 15-19, 2023.

- **K. Michaelson**. "A Multiplicative Multi-State Constraint Kalman Filter." Master's Report. Dec. 2020.