Michael J. Kuhlman

U.S. Citizen

PhD in Mech E.
Part 107 certified drone pilot

EDUCATION

University of Maryland, College Park, MD   December 2018
Doctor of Philosophy, Mechanical Engineering
Concentration: Robotics, 3.769 GPA

University of Maryland, College Park, MD   Fall 2012 – May 2014
Doctor of Philosophy, Electrical Engineering
Concentration: Controls, 3.583 GPA

University of Maryland, College Park, MD   May 2013
Masters of Science, Electrical Engineering
Concentration: Controls and Microelectronics, 3.5 GPA

Rensselaer Polytechnic Institute, Troy, NY   December 2009
Bachelor of Science, Electrical Engineering
Concentration: Automatic Control & Robotics
Graduated *Magna Cum Laude* with a GPA of 3.78

WORK EXPERIENCE

Lead UAV Planning and Autonomy Algorithms Developer   August 2018 – Present
AiRXOS, part of GE Aviation, Boston, MA

- Designing path planning and coordination technologies for unmanned traffic management and air mobility.
- Researching technologies enabling beyond visual line of sight (BVLOS) flight.
- Co-invented 5 patent applications.
- AiRXOS technical lead for external engagements with the FAA including Low Altitude Authorization and Notification Capability (LAANC) and BVLOS National Airspace System Evaluation project.
- Winner of the 2019 Innovation Award and the 2019 Making a Difference Award.

NRL Pathways Computer Science Student Trainee   August 2017 – August 2018
Navy Center for Applied Research in Artificial Intelligence, U.S. Naval Research Laboratory, Washington, D.C.
Underwater Vehicle Navigation Command and Control   August 2017 – August 2018
- Investigated use of Monte Carlo Tree Search and Cross Entropy Method to coordinate teams of underwater vehicles for coverage planning problems.
- Factored the ocean currents into the policy to improve system efficiency while accounting for forecast uncertainty.

Student Contractor   June 2013 – August 2017
Navy Center for Applied Research in Artificial Intelligence, U.S. Naval Research Laboratory, Washington, D.C.
Mobile Autonomous Navy Teams for Information Surveillance and Search   January 2015-August 2017
- Developed a modular, hardware agnostic, robust control architecture for quadrotors in C++ and ROS to facilitate rapid deployment of experiments. Capabilities developed included robust navigation filtering, tracking control, sample based motion planning, landing on a moving ground vehicle using visual servoing, employing test driven development practices, all of which are easily deployed to multiple platforms using a git repository.
- Developed physics-aware informative path planning algorithms in MATLAB, C++, Python and ROS to direct autonomous vehicles in persistent monitoring and target search tasks.
- Investigated mission agnostic target search strategies for teams of autonomous vehicles. Developing an advanced state of the art beta filter for sensor fusion for target tracking applications.
- Conducted target search hardware experiments with AscTec Pelican quadrotors in an indoor motion capture facility.

Meso-scale Robotic Locomotion Investigation   June 2013–May 2015
- Investigated legged locomotion techniques for an electrically powered 20kg quadruped robot.
- Extended previous forward locomotion techniques modeling a task-based central pattern generator enabling stable omnidirectional locomotion.
- Generated control software, kinematic and dynamic models using C++, Eigen and Rigid Body Dynamics Library for a real time model-based controller executing on hardware.
- Developed code still in active use (as of 2018) across three different hardware generations and is the default gait of choice.

Graduate Research Assistant   August 2010 – August 2012
Institute for Systems Research, University of Maryland , College Park
- Modeled Extended Kalman Filter and nonlinear Model Predictive Control VLSI circuit design for miniature robotic platforms.
- Developed inter-robot distance sensor implementing Time Difference of Arrival. Characterized sources of noise which lead to measurement error.
- Performed system identification of the robot chassis and developed a motion uncertainty model using a calibrated vision system.

Robotics Academy Team Lead   Summer 2010
NASA Marshall Space Flight Center, Huntsville, AL
- Led a three person team in prototyping a burrowing robotic worm for lunar exploration.
- Created senior capstone design projects pertaining to the robotic worm design for University of Alabama at Huntsville and Louisiana Tech University.

TECHNICAL SKILLS

Computer: MATLAB (8 years application), C & C++ (6 years application), Robot Operating System (ROS), Python, LaTeX, Linux, Cadence Allegro Design Entry CIS, SolidWorks, Verilog HDL, Bash, Subversion and git.

Embedded Systems & Hardware: ARM Cortex-A9 single board computers, inertial measurement units, AscTec Pelican quadrotor, Vicon Motion Capture Systems, SimLab Allegro Dog quadruped robot, Arduino microcontroller, TI MSP430 microcontroller, 3D printing.

General: Robotics, Planning, Control Theory, Machine Learning, System Identification, Electronics, Modeling and Numerical Simulation, Technical Writing and Communication, Test Driven Development, website development.

HONORS

NSF Graduate Research Fellowship Program Honorable Mention, April 2011
Dean's List, Rensselaer Medalist at Rensselaer Polytechnic Institute
Eta Kappa Nu National Electrical and Computer Engineering Honor Society, April 2008
Tau Beta Pi National Engineering Honor Society, April 2008
Eagle Rank, Boy Scouts of America, June 2006

PROFESSIONAL ACTIVITIES

FAA Part 107 drone pilot certification, January 2019
Remote control airplane and helicopter construction

PUBLICATIONS

[1] M. Kuhlman, D. Jones, D. Sofge, G. Hollinger, and S. Gupta, "Collaborating underwater vehicles conducting large-scale geospatial tasks," *IEEE Journal of Oceanic Engineering*, 2021 (to appear).

[2] M. Otte, M. J. Kuhlman, and D. Sofge, "Auctions for multi-robot task allocation in communication limited environments," *Autonomous Robots*, 2019.

[3] M. J. Kuhlman, "Trajectory planning for autonomous vehicles performing information gathering tasks," Ph.D. dissertation, University of Maryland, College Park, 2018.

[4] M. J. Kuhlman, M. W. Otte, D. Sofge, and S. K. Gupta, "Multipass target search in natural environments," *Sensors*, vol. 17, no. 11, 2017.

[5] M. W. Otte, M. J. Kuhlman, and D. A. Sofge, "Multi-robot task allocation with auctions in harsh communication environments," in *International Symposium on Multi-Robot and Multi-Agent Systems*, Dec. 2017.

[6] M. Otte, M. Kuhlman, and D. Sofge, "Competitive target search with multi-agent teams: symmetric and asymmetric communication constraints," *Autonomous Robots*, vol. 42, no. 6, Aug 2018.

[7] M. J. Kuhlman, M. W. Otte, D. A. Sofge, and S. K. Gupta, "Maximizing mutual information for multipass target search in changing environments," in *IEEE International Conference on Robotics and Automation*, May 2017.

[8] M. Otte, M. Kuhlman, and D. Sofge, "Competitive two team search game with communication symmetry and asymmetry," in *the International Workshop on the Algorithmic Foundations of Robotics at San Francisco, CA*, December 2016.

[9] D. Sofge, M. Kuhlman, N. Sydney, A. Wallar, and K. Sullivan, "Mobile autonomous navy teams for information surveillance and search (MANTISS)," *2015 NRL Review*, July 2016.

[10] M. Kuhlman, J. Hays, D. Sofge, and S. Gupta, "Stabilizing task-based omnidirectional quadruped locomotion with virtual model control," in *IEEE International Conference on Robotics and Automation (ICRA), presented at Seattle, WA*, May 2015.

[11] ——, "Central Pattern Generator Based Omnidirectional Locomotion for Quadrupedal Robotics," in *Workshop on Real-time Motion Generation & Control Constraint-based Robot Programming, held at IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2014), presented at Chicago, IL*, 2014.

[12] M. Kuhlman, P. Svec, K. Kaipa, D. Sofge, and S. Gupta, "Physics-aware informative coverage planning for autonomous vehicles," in *IEEE International Conference on Robotics and Automation (ICRA 2014), presented at Hong Kong*, May 2014.

[13] M. Kuhlman, T. Lee, and P. Abshire, "Low power analog odometry circuit for miniature robotics," in *SPIE Defense, Security & Sensing Conference*, May 2013.

[14] M. Kuhlman, "Mixed-signal sensing, estimation, and control for miniature robots," Master's thesis, University of Maryland, College Park, 2012.

[15] M. Kuhlman, E. Arvelo, S. Lin, P. Abshire, and N. Martins, "Mixed-Signal Architecture of Randomized Receding Horizon Control for Miniature Robotics," in *IEEE 55th International Midwest Symposium on Circuits and Systems (MWSCAS), presented at Boise, ID*, Aug. 2012.

[16] G. Sineriz, M. Kuhlman, and P. Abshire, "High Resolution Distance Sensing for Mini-Robots Using Time Difference of Arrival," in *IEEE International Symposium on Circuits and Systems (ISCAS)*, May 2012.

[17] C. Perkins, L. Lei, M. Kuhlman, T. Lee, G. Gateau, S. Bergbreiter, and P. Abshire, "Distance Sensing for Mini-Robots: RSSI vs. TDOA," in *IEEE International Symposium on Circuits and Systems (ISCAS)*, 2011.

[18] A. Stoica, M. Kuhlman, C. Assad, and D. Keymeulen, "Developing Humanoid Robots for Real-World Environments," in *8th IEEE-RAS International Conference on Humanoid Robots*, 2008.