

## RESEARCH INTERESTS

My work focuses on planning and control for underactuated mechanical systems. I'm interested in rigorous geometric approaches which leverage strong properties of these control systems and scale gracefully with system complexity. Such properties can inform mechanism and controller design for real-world robots and enable the deployment of robots that more closely parallel the complex biological systems that inspire us.

## EDUCATION

- PhD Student in Mechanical Engineering and Applied Mechanics** 2019 – ongoing  
*University of Pennsylvania, GRASP Laboratory* Philadelphia, PA  
 Theoretical foundations of control for underactuated multibody aerial robots. Supervised by Dr. Vijay Kumar.
- Master of Science in Engineering, Robotics** 2020  
*University of Pennsylvania* Philadelphia, PA
- Bachelor of Science in Engineering, Mechanical Engineering and Applied Mechanics** 2019  
*University of Pennsylvania* Philadelphia, PA  
 Minor in French and Francophone Studies

## EXPERIENCE

- GRASP Laboratory, University of Pennsylvania** 2015 – present  
*Research in Aerial Robotics, Dynamics and Control* Philadelphia, PA
- Contributed to onboard sensing, estimation, and motion planning pipeline enabling a quadrotor to autonomously track dynamically moving targets without violating the vehicle's coupled sensor and actuation constraints
  - Demonstrated differential flatness of underactuated aerial manipulators and developed algorithm to plan trajectories which will achieve a desired trajectory for the end effector while respecting system's underactuation
  - Achieved insight into longstanding open questions regarding the role of symmetry in differential flatness, simplifying the discovery of flat outputs and enabling efficient and effective control of underactuated robotic systems.
- SharpShooter: an Invisible Tripod via Reaction Wheels** 2018-2019  
*Senior Design Project, Mechanical Engineering at the University of Pennsylvania* Philadelphia, PA  
 Development of a novel reaction wheel stabilizer for ergonomic, handheld long-exposure still photography
- Developed motor system identification pipeline to enable precise application of corrective torques
  - Implemented gyroscope bias observer to enable accurate and precise attitude estimation during exposures
  - Packaged estimation, control, and camera integration system in tightly-integrated prototype of consumer device
  - Quantitative stabilization performance exceeded all other commercially available handheld stabilizers
- Exyn Technologies** Summer 2018  
*Robotics: Software and Algorithms Intern* Philadelphia, PA  
 Software engineering at aerial robotics startup delivering trustworthy autonomy in challenging environments
- Evaluated and integrated a variety of sensing modalities for barcode decoding and localization for autonomous robotic warehouse inventory and inspection applications
  - Contributed mission-critical modules to integrate low-level sensors with high-level software stack
  - Developed and implemented novel algorithm for extrinsic calibration of any number of rigidly connected inertial measurement units, cameras, and LIDARs using only a single physical calibration target for all modalities

## TEACHING

**MEAM 520 / CIT 520: Introduction to Robotics** Fall 2020 / Spring 2021 / Fall 2021  
*Teaching Assistant for Professors Cynthia Sung, Vijay Kumar, and M. Ani Hsieh* University of Pennsylvania  
Led development of written and laboratory assignments to achieve key pedagogical objectives across theory and practice, including forward/inverse kinematics, motion planning, a rigorous testing process, and a simulation-to-reality workflow. Worked with students in office hours, recitations, and hands-on lab sessions with industrial robot hardware. Received the Outstanding TA Award in my department for my teaching service in this course.

**MEAM 211: Engineering Mechanics, Dynamics** Spring 2021  
*Teaching Assistant for Professor Michael Posa* University of Pennsylvania  
Led interactive problem-solving recitations with undergraduates. Led development of major components of a new computational aspect of the course, in which students implement a multibody dynamics simulator via step-by-step weekly assignments, putting their conceptual understanding into practice.

## PUBLICATIONS

### PREPRINT

*The Role of Symmetry in Constructing Geometric Flat Outputs for Free-Flying Robotic Systems* 2022  
J. Welde, M. D. Kvalheim, and V. Kumar. pdf, video

### JOURNAL

*Dynamically Feasible Task Space Planning for Underactuated Aerial Manipulators* 2021  
J. Welde, J. Paulos and V. Kumar, in *IEEE Robotics and Automation Letters*. pdf, video

*Autonomous Flight for Detection, Localization, and Tracking of Moving Targets With a Small Quadrotor* 2017  
J. Thomas, J. Welde, G. Loianno, K. Daniilidis and V. Kumar, in *IEEE Robotics and Automation Letters*. pdf, video

### CONFERENCE

*Coordinate-Free Dynamics and Differential Flatness of a Class of 6DOF Aerial Manipulators* 2020  
J. Welde and V. Kumar, at the *IEEE International Conference on Robotics and Automation*. pdf, video

## MEDIA

GRASP Lab Presents: "MEAM 520 Class Breakdown" 2022  
Penn Engineering Today: "Virtual Robots: Taking Risks in an Online Classroom" 2021  
National Geographic's Breakthrough: "Game of Drones" 2017  
34th Street Magazine: "Penn Students Create Gingerbread Replica of Fisher Fine Arts Library" 2017

## HONORS AND AWARDS

Outstanding Teaching Assistant Award, Mechanical Engineering Fall 2021  
Finalist for Best Paper in Unmanned Aerial Vehicles, International Conference on Robotics and Automation 2021  
National Science Foundation Graduate Research Fellowship 2019  
Couloucoudis Prize for Best Senior Design Presentation in Mechanical Engineering 2019  
Second Place, School of Engineering Senior Design Competition, University of Pennsylvania 2019

## OUTREACH AND SERVICE

Mentoring Undergraduate Researchers  
Nicole Luna, "Aerial Manipulator Mechanical Design" Summer 2021  
Natasha Dilamani, "Dynamic Modeling of the Sphero, a Highly Nonholonomic System" Summer 2020

## Science Olympiad at the University of Pennsylvania

2017-present

Event Supervisor coordinating a team of volunteers to run an engineering challenge for high school students.

## Treasurer, Mechanical Engineering Graduate Association

2020-2021

Managed finances while planning and executing programming to support the professional, social, and engagement needs of the graduate student community in our department.

## REVIEW ACTIVITIES

- IEEE International Conference on Robotics and Automation
- IEEE International Conference on Intelligent Robots and Systems
- IEEE Robotics and Automation Letters
- IEEE Transactions on Automatic Control
- IEEE Transactions on Robotics
- Automatica

## SKILLS

Computational	C++, Python, MATLAB, ROS, Gazebo, Drake, Linux, git
Design	SOLIDWORKS, KiCad
Production	L <sup>A</sup> T <sub>E</sub> X, Digital Photography, Adobe Photoshop
Language	English (native), French (conversational)

## PERSONAL INTERESTS

My personal interests include conservation, cooking, running, and spending time outdoors, especially with my dog.