

# j a k e w e l d e

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## RESEARCH INTERESTS

My work focuses on planning and control for underactuated mechanical systems. I'm interested in rigorous geometric approaches to prove very strong properties that characterize the capabilities 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** 2019 – ongoing  
*University of Pennsylvania, GRASP Laboratory* Philadelphia, PA  
Supervised by Dr. Vijay Kumar.
- Master of Science in Engineering, Robotics** 2020  
*University of Pennsylvania* Philadelphia, PA
- Bachelor of Science in Engineering, Mechanical Engineering** 2019  
*University of Pennsylvania* Philadelphia, PA  
Minor in French and Francophone Studies

## EXPERIENCE

- Research in Aerial Robotics, Dynamics and Control** 2015 – present  
*GRASP Laboratory, University of Pennsylvania* Philadelphia, PA  
Collaborative research in planning and control for dynamic aerial robots
- Demonstrated differential flatness of underactuated aerial manipulators and developed any-time algorithm to plan dynamically feasible system trajectories which will achieve a desired trajectory for the end effector of an underactuated aerial manipulator
  - Developed geometric criteria on the mechanical structure of aerial manipulators to ensure well-behaved internal dynamics when tracking end effector trajectories
  - Contributed to onboard sensing, estimation, and motion planning pipeline to enable a quadrotor to dynamically track moving targets while respecting the vehicle's field of view, sensor, control effort, and underactuation constraints
- Intern, Robotics: Software and Algorithms** Summer 2018  
*Exyn Technologies* Philadelphia, PA  
Software engineering internship at fast-moving aerial robotics startup delivering robust, trustworthy, and safe autonomy solutions for challenging real-world problems
- Evaluated and integrated a variety of sensing modalities for barcode decoding and localization for autonomous robotic warehouse inventory and inspection applications
  - Developed system-critical software to integrate low-level sensors with high-level software stack
  - Developed and implemented novel algorithm for globally optimal extrinsic calibration of any number of rigidly connected inertial measurement units, cameras, and LIDARs, using only a single physical calibration target for all modalities, enabling rapid and accurate recalibration in challenging field environments

## TEACHING

- MEAM 520: Introduction to Robotics** Fall 2021  
*Teaching Assistant for Professor M. Ani Hsieh* University of Pennsylvania  
Led development of written and laboratory assignments to achieve key pedagogical objectives across theory and practice, including spatial geometry and kinematics, a rigorous testing process, and a simulation-to-reality workflow. Worked with students in office hours and hands-on lab sessions, supporting students from a wide range of academic backgrounds. Collaborated with teaching team to orchestrate a final competition demonstration on industrial robot hardware, integrating all concepts explored throughout the course. 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. Took on a major role in the development 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.
- CIT 520: Introduction to Robotics** Spring 2021  
*Teaching Assistant for Professor Vijay Kumar* University of Pennsylvania  
Led interactive problem-solving recitations for distance learners and provided guidance for virtual labs.
- MEAM 520: Introduction to Robotics** Fall 2020  
*Teaching Assistant for Professor Cynthia Sung* University of Pennsylvania  
Helped create a rich simulated laboratory setting in order to adapt the hands-on labs of the course to remote teaching due to COVID-19. Culminated in a livestreamed final competition where teams' autonomous robots competed head-to-head, manipulating objects to score points.
- PennX: Robotics, Dynamics and Control** Summer 2017  
*Teaching Assistant for Professors M. Ani Hsieh and Vijay Kumar* University of Pennsylvania  
Developed engaging assignments for a Massive Open Online Course (MOOC) with learners from around the world.

## PUBLICATIONS

### JOURNAL

- Dynamically Feasible Task Space Planning for Underactuated Aerial Manipulators*** April 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*** July 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

- 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
- Los Angeles Times: "They did it for the graham: Six gingerbread architectural masterpieces" 2017

## HONORS AND AWARDS

Outstanding Teaching Assistant Award, Mechanical Engineering	Fall 2021
Finalist, Best Paper in Unmanned Aerial Vehicles, International Conference on Robotics and Automation	2021
National Science Foundation Graduate Research Fellowship	2019
Couloucoundis Prize for Best Senior Design Presentation in Mechanical Engineering	2019
Second Place, School of Engineering Senior Design Competition, University of Pennsylvania	2019
Student Travel Grant Award, International Conference on Intelligent Robots and Systems	2017

## 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 schoolers interested in STEM, in which they construct and demonstrate a vehicle prototype to optimize speed and accuracy metrics.

### 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

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

## SKILLS

Computational	C++, Python, MATLAB, ROS, Drake, Linux, git
Design	SOLIDWORKS, KiCad
Production	LaTeX, 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.