Daigo Shishika

Postdoctoral Researcher
Mechanical Engineering and Applied Mechanics
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Education

2017 **Ph.D.**, *University of Maryland*, College Park, (UMD).
Aerospace Engineering
Advisor: Derek A. Paley
Dissertation title: Mosquito-inspired swarming and pursuit for autonomous rotorcraft

2015 **M.S.**, *University of Maryland*, College Park, (UMD).
Aerospace Engineering

2012 **B.S.**, *University of Tokyo*, in Aerospace Engineering.
Aerospace Engineering
Advisor: Keiji Kawachi
Bachelor's thesis: The relation between heave control and pitch-angle in Bombus terrestris flight (in Japanese)

Research Interests

Autonomous systems, Multi-agent systems, Cooperative control, Bio-inspired robotics, Animal group behavior, Game theory, Pursuit-evasion games, Nonlinear control, Networked systems

Research Experience

2017–Present **GRASP Laboratory**, *University of Pennsylvania*.
Post-doctoral Researcher advised by Vijay Kumar
- Studied multi-robot cooperation through multi-agent pursuit evasion games (perimeter defense problem)
- Collaborated on various projects including task assignment for formation control, learning communication semantics for decentralized control, and formations for network connectivity maintenance.
- Ongoing collaboration with US Army Research Lab on multi-agent games for defense applications

2012–2017 **CDCL Laboratory**, *University of Maryland*.
Graduate Research Assistant advised by Derek Paley
- Analyzed flight data of wild mosquitoes and characterized their behaviors using mechanistic particle models
- Designed bio-inspired algorithms for small and agile robotic vehicles using nonlinear control design techniques
- Conducted experimental validation using autonomous hovercraft and quadrotor testbeds

2015 **Vertical Flight Society Student Design Competition**, *University of Maryland*.
Flight Dynamics, Control Systems, and Path Planning
- Worked in a team to design a logistics system for unmanned package delivery in an urban setting
- Optimized the task allocation and vehicle routing by solving a modified traveling salesman problem
- Developed a simulation of the nonlinear vehicle dynamics and designed efficient maneuvers to transition between hover and cruise modes

2011–2012 **Kawachi Laboratory**, *University of Tokyo*.
- Obtained flight data of bumblebees in free flight responding to vertically oscillating infrared lights
- Processed the video-sequences to extract the flight kinematics and studied the frequency response of bumblebees' pitching dynamics
- Studied the relation between the heave control and the pitching motion

Journal Publications

[J6] **D. Shishika** and Vijay Kumar. "Perimeter-defense game on arbitrary convex shapes," Submitted to *Automatica*, available at `https://arxiv.org/abs/1909.03989`.

[J5] Michael Whitzer, **D. Shishika** Ani M. Hsieh, and Vijay Kumar. "DC-CAPT: concurrent assignment and planning of trajectories for Dubins cars," Submitted to *IEEE Robotics and Automation Letters*.

[J4] **D. Shishika** and Vijay Kumar. "Cooperative team strategies for multi-player perimeter-defense games," In revision for *IEEE Robotics and Automation Letters*, available at `https://arxiv.org/abs/1912.04342`.

[J3] **D. Shishika** and D. A. Paley. "Mosquito-inspired quadrotor swarming and pursuit for cooperative defense against fast intruders," *Autonomous Robots*, pp. 1-19, 2019.

[J2] **D. Shishika** J. K. Yim, D. A. Paley. "Robust Lyapunov control design for bio-inspired pursuit with autonomous hovercraft," *IEEE Transactions on Control Systems Technology*, no. 99, pp. 1-12, 2016.

[J1] **D. Shishika** N. C. Manoukis, S. Butail, and D. A. Paley. "Male motion coordination in anopheline mating swarms," *Scientific Reports*, vol. 4, pp. 1-7, 2014.

Peer-reviewed Conference Publications

[C8] X. Yu, D. Saldana, **D. Shishika**, and M. A. Hsieh. "Modular robot formation and routing for resilient consensus," Submitted to *IEEE American Control Conference*, Denver, 2020.

[C7] **D. Shishika**, J. Paulos, M. R. Dorothy, M. A. Hsieh, and V. Kumar. "Team Composition for Perimeter Defense with Patrollers and Defenders," *IEEE Conference on Decision and Control*, pp. 7325-7332, France, 2019.

[C6] J. Paulos, S. W. Chen, **D. Shishika**, and V. Kumar. "Decentralization of multiagent policies by learning what to communicate," *IEEE International Conference on Robotics and Automation*, pp. 7990-7996, Montreal, 2019.

[C5] **D. Shishika**, V. Kumar. "Local-game decomposition for multiplayer perimeter-defense problem," *IEEE Conference on Decision and Control*, pp. 2093-2100, Florida, 2018.

[C4] **D. Shishika**, K. Sherman and D. A. Paley. "Competing swarms of autonomous vehicles: intruders versus guardians," *ASME Dynamic Systems and Control Conference*, Virginia, 2017.

[C3] **D. Shishika** and D. A. Paley. "Mosquito-inspired swarming for decentralized pursuit with autonomous vehicles," *IEEE American Control Conference*, pp. 923-929, Seattle, 2017.

[C2] **D. Shishika** and D. A. Paley. "Lyapunov stability analysis of a mosquito-inspired swarm model," *IEEE Conference on Decision and Control*, pp. 482-488, Osaka Japan, 2015.

[C1] **D. Shishika**, J. K. Yim, and D. A. Paley. "Bio-inspired pursuit with autonomous hovercraft using Lyapunov-based control," *IEEE American Control Conference*, pp. 3107-3113, Chicago, 2015.

Presentations

2015 **D. Shishika** and D. A. Paley. "Motion coordination in mosquito mating swarms." Presented at *the Institute for Systems Research's 30th Anniversary Celebration*, Maryland.

2014 **D. Shishika**, N. C. Manoukis, S. Butail, and D. A. Paley. "The dynamics of malarial mosquitoes in wild mating swarms." Presented at *17th U.S. National Congress on Theoretical & Applied Mechanics*, Michigan.

Teaching

2017 **Co-instructor**, *ENAE 646*, Advanced Dynamics, UMD.

2015 **Teaching Assistant**, *ENAE 464*, Aerospace Engineering Laboratory, UMD.

2013 **Substitute Lecturer**, *ENAE 301*, Dynamics of Aerospace Systems, UMD.

Mentoring

2017–Present **Student Mentoring**, *UPenn*.
Michael Whitzer (Ph.D.)
Arjun Kumar (Ph.D.)
Vinay Senthil (B.S.)

2016–2017 **Graduate Mentor**, *UMD*.
Katarina Sherman (B.S.)
Zeyad Emam (B.S.)

2014 **Graduate Mentor for REU Program**, *UMD*.
Justin Yim (B.S. at University of Pennsylvania)

Honors and Awards

2016 Future Faculty Program Fellow, University of Maryland School of Engineering

2015 Winner of 32nd Annual AHS Student Design Competition (as a team of six students)

2012 Dean's Fellowship, University of Maryland AE dept.

2012 Minta Martin Fellowship, University of Maryland AE dept.

Academic Service

Reviewer for the *IEEE Robotics and Automation Letters*

Reviewer for *Autonomous Robots*

Reviewer for *IEEE/RSJ International Conference on Intelligent Robotics and Systems*

Reviewer for *IEEE International Conference on Robotics and Automation*

Reviewer for *IEEE Transactions on Control of Network Systems*

Reviewer for *AIAA Journal of Guidance, Control, and Dynamics*

Reviewer for *IEEE Conference on Decision and Control*

Reviewer for *IEEE American Control Conference*

Reviewer for *The European Physical Journal Special Topics*

Reviewer for *The Aeronautical Journal*