MEL 2009, 105 S Mathews Ave
Urbana, IL 61801, USA

Sheng Cheng

chengs@illinois.edu
shengcheng.web.illinois.edu

EDUCATION

Ph.D. in Electrical Engineering, Control — 08/2021
University of Maryland, College Park, MD — Advisor: Derek Paley

M.S. in Electrical Engineering, Control — 08/2018
University of Maryland, College Park, MD — Advisor: Nuno Martins

B.Eng. in Control Science and Engineering, Automation — 07/2014
Harbin Institute of Technology, Harbin, China

RESEARCH INTERESTS

robotics; adaptive control; optimization; distributed parameter systems; cooperative control;

SELECTED PUBLICATIONS

Journal articles

1. **S. Cheng** and D. A. Paley, "Cooperative estimation and control of a diffusion-based spatiotemporal process using mobile sensors and actuators," under review.

2. **S. Cheng** and D. A. Paley, "Optimal guidance and estimation of a 2D diffusion-advection process by a team of mobile sensors," Automatica, vol. 137, p. 110112, March 2022.

3. **S. Cheng** and D. A. Paley, "Optimal control of a 2D diffusion-advection process with a team of mobile actuators under jointly optimal guidance," Automatica, vol. 133, p. 109866, August 2021.

4. **S. Cheng** and N. C. Martins, "An optimality gap test for a semidefinite relaxation of a quadratic program with two quadratic constraints," SIAM Journal on Optimization, vol. 31, no. 1, pp. 866-886, March 2021.

5. A. Wolek, **S. Cheng**, D. Goswami, and D. A. Paley, "Cooperative mapping and target search over an unknown occupancy graph using mutual information," IEEE Robotics and Automation Letters, vol. 5, no. 2, pp. 1071-1078, 2020.

Conference papers

6. **S. Cheng**, M. Kim, L. Song, Z., S. Wang, N. Hovakimyan, "DiffTune: Auto-Tuning through Auto-Differentiation," under review.

7. H. Lee, **S. Cheng**, Z. Wu, N. Hovakimyan, "Geometric Tracking Control of Omnidirectional Multirotors in the Presence of Rotor Dynamics," under review.

8. Z. Wu, **S. Cheng**, K. A. Ackerman, A. Gahlawat, A. Lakshmanan, P. Zhao, and N. Hovakimyan, "$\mathcal{L}_1$ Adaptive Augmentation for Geometric Tracking Control of Quadrotors," 2022 International Conference on Robotics and Automation, pp. 1329–1336, Philadelphia, PA, 2022.

9. **S. Cheng** and D. A. Paley, "Optimal guidance of a team of mobile actuators for controlling a 1D diffusion process with unknown initial conditions," 2021 American Control Conference, pp. 1497-1502, New Orleans, LA, 2021.

10. **S. Cheng** and D. A. Paley, "Optimal guidance and estimation of a 1D diffusion process by a team of mobile sensors," 2020 IEEE Conference on Decision and Control, pp. 1222-1228, Jeju Island, South Korea, 2020.

11. **S. Cheng** and D. A. Paley, "Optimal control of a 1D diffusion process with a team of mobile actuators under jointly optimal guidance," American Control Conference, pp. 3449-3454, Denver, CO, 2020.

12. **S. Cheng** and N. C. Martins, "Reaching a target in a time-costly area using a two-stage optimal control method," American Control Conference, pp. 4903-4910, Philadelphia, PA, 2019.

RESEARCH EXPERIENCE

University of Illinois Urbana-Champaign

Safe and Agile Quadrotor Control using $\mathcal{L}_1$ Adaptive Augmentation — 09/2021--present

Advisor: Dr. Naira Hovakimyan
- Lead the theoretical development and experimentation of a safe and agile quadrotor control framework that applies the $\mathcal{L}_1$ adaptive augmentation to a geometric controller.
- Lead the development of DiffTune.
- Lead proposal development on integrating vision-based perception with the $\mathcal{L}_1$ adaptive augmentation on a quadrotor, with specific focuses on establishing a novel, uncertainty-aware, and robust framework for integrated perception, planning, and control (collaboration with Prof. Shenlong Wang from UIUC).
- Lead the ACRL quadrotor team (16 students) to integrate the low-level safe and agile quadrotor control framework with vision-based perception and planning for safe and autonomous flights.

University of Maryland, College Park

Distributed Estimation and Control of a Spatiotemporal Process with Multiple Aerial Vehicles   02/2019–08/2021

Advisor: Dr. Derek Paley
- Set up and maintaining an outdoor quadrotor swarm testbed with six quadrotors.
- Proposed a jointly optimal guidance and actuation/sensing strategy for a team of mobile actuators/sensors to efficiently control/estimate a 2D diffusion-advection process.
- Wrote a proposal to Northrop Grumman-UMD seed grant on the topic of optimal estimation and control of a 2D spatiotemporal process and won the grant.
- Validating the jointly optimal guidance and actuation/sensing strategies in experiments with the outdoor quadrotor swarm testbed.

Cooperative Mapping, Searching, and Tracking in an Uncertain Urban Environment   09/2018–06/2019

Advisor: Dr. Derek Paley
- Proposed an efficient mapping strategy that drives agents to follow waypoints generated from frontier nodes and unexplored regions.
- Proposed a path planning method that generates conflict-free and locally optimal paths over a graph-based map.
- Validated a cooperative mapping and search algorithm on the outdoor quadrotor swarm testbed.

Reaching a Target within a GPS-denied or Costly Area: a Two-stage Optimal Control Approach   08/2016–08/2018

Advisor: Dr. Nuno Martins
- Formulated a two-stage optimization problem and transformed it into a quadratic program with two quadratic constraints (QC2QP).
- Proposed a necessary and sufficient test to determine whether a globally optimal solution for a general QC2QP can be computed from that of a specific convex semidefinite relaxation.
- Implemented a controller that steers a quadrotor to reach a target within a denied area in experiments.
- Analyzed data from bat experiments (conducted by Comparative Neural Systems and Behavior Lab at JHU) and investigated bat's strategy on reaching a target within a man-made denied area.

SELECTED HONORS AND AWARDS

Student Travel Support Award, 2020 IEEE Conference on Decision and Control.	12/2020
Student Travel Award, 2020 American Control Conference.	06/2020
Future Faculty Fellow, A. James Clark School of Engineering, University of Maryland.	12/2018
George Corcoran Award, Department of Electrical and Computer Engineering, University of Maryland.	09/2016
International Teaching Fellowship, University of Maryland.	10/2015
Distinguished Teaching Assistant Award, ECE Department, University of Maryland.	05/2015
Outstanding Undergraduate Thesis Award, Harbin Institute of Technology.	07/2014

WORK EXPERIENCE

Postdoctoral Research Associate, MechSE Department, Univ. of Illinois Urbana-Champaign 09/2021–present

Lecturer, "Advanced Dynamics of Aerospace Systems" (co-teaching with Dr. Derek Paley) 01/2021–05/2021

Research Assistant, AE Department, University of Maryland. 09/2018–08/2021

Research Assistant, ECE Department, University of Maryland. 08/2016–08/2018

Teaching Assistant Training & Development Fellow, ECE Department, University of Maryland. 08/2015–05/2016

International Teaching Fellow Mentor, University of Maryland. 10/2015–05/2016

Teaching Assistant, ECE Department, University of Maryland. 08/2014–05/2016

Undergraduate Research Assistant, ME Department, University of Victoria. 06/2013–08/2013

PROFESSIONAL ACTIVITIES AND AFFILIATIONS

Journal Reviewer: Automatica, Journal of Guidance, Control, and Dynamics, IEEE Transactions on Control Systems Technology, IEEE Transactions on Industrial Informatics, IEEE Control Systems Letters.

Conference Reviewer: CoRL, ICRA, CDC, ACC, and DARS-SWARM.

Member: IEEE CSS Technical Committee on Intelligent Control.

SKILLS

Proficient in LaTeX and C/C++ and simulation software, including MATLAB and Simulink.

Intermediate in ROS, Python, and Shell script.