

Micah Corah

ACTIVE PERCEPTION · MULTI-ROBOT SYSTEMS · AERIAL ROBOTICS

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Education

Carnegie Mellon University

PH.D. IN ROBOTICS

Pittsburgh, PA

December 2020

M.S. IN ROBOTICS

December 2017

- Thesis (Ph.D.): *Sensor Planning for Large Numbers of Robots*
- Advisor: *Prof. Nathan Michael*

Rensselaer Polytechnic Institute

B.S. IN COMPUTER SCIENCE

Troy, NY

May 2015

B.S. IN MECHANICAL ENGINEERING

May 2015

Skills

Robotics Multi-robot systems, Aerial robots, Informative planning, Active sensing, Mapping, Exploration

Foundations Information theory, Control theory, Submodular optimization

Languages C++, Julia, Matlab, Python, LaTeX

Experience

Colorado School of Mines

ASSISTANT PROFESSOR OF COMPUTER SCIENCE

Golden, CO

Jan 2024–Present

- Director of the [Navigation, Aerial-robots, and Perception Planning Laboratory](#) (NAPPLab)

Carnegie Mellon University

POSTDOCTORAL FELLOW

Pittsburgh, PA

Jan 2022–Nov 2023

Advisor: *Prof. Sebastian Scherer*

- Lead an NSF-sponsored project, developing teams of drones that film and reconstruction motion of groups of dynamic actors ([link](#))
- Applications include sports videography, study of animal group behaviors, or capture of artistic and improvisational performances
- Focus on includes aerial multi-robot systems and planning and coordination for multi-robot teams
- Developed methods for planning for videography based on submodular maximization and optimizing views based on pixel densities

NASA Jet Propulsion Laboratory, California Institute of Technology

POSTDOCTORAL RESEARCHER

Pasadena, CA

Dec 2020–Dec 2021

Advisor: *Dr. Ali-akbar Agha-mohammadi*

- Member of team [CoSTAR](#), competing in the [DARPA Subterranean Challenge](#)
- Responsibilities: aerial autonomy, coverage planning, radio communication, field test scouting and planning
- Our team placed 5th (alongside very capable competition) in the DARPA Subterranean Challenge Finals

Carnegie Mellon University

RESEARCH ASSISTANT

Pittsburgh, PA

Aug 2015–Sept 2020

Advisor: *Prof. Nathan Michael*

- Developed algorithms and analysis techniques for multi-robot sensing, coverage, exploration, and target tracking based on submodular maximization, higher-order monotonicity conditions, and spatial locality
- Design and analysis of a planner for exploration at high speed (2.25 m/s) with an aerial robot in collaboration with Kshitij Goel and Curtis Boirum. This system was tested in simulation and on a hexrotor robot, outdoors, on the CMU campus
- Developed a system for multi-robot exploration combining Cauchy-Schwarz mutual information for ranging sensors, Monte-Carlo tree search for path planning, and multi-robot planning via submodular maximization
- Implemented core components of a system providing control and autonomy for aerial robots. Contributions include trajectory representation and management and a modular finite state machine

Carnegie Mellon University (Internships)

RESEARCH INTERN: PERSISTENT COVERAGE

Advisor: *Prof. Nathan Michael*

- NSF Research Experience for Undergraduates (REU)
- Implemented minimum snap, collision free, multi-vehicle trajectory generation
- Implemented controller for tracking of discretized trajectories

Pittsburgh, PA

May–Aug 2014

RESEARCH INTERN: WING ASSEMBLY

Advisor: *Prof. Reid Simmons*

- Developed a simulation of multi-robot assembly of an airplane wing-ladder
- Implemented an autonomous behavior where a mobile robot attaches and aligns to an airplane wing spar

May–Aug 2013

Rensselaer Polytechnic Institute

INDEPENDENT STUDY: ROBOTIC CATCHING

Advisor: *Prof. Jeff Trinkle*

- Modeling and simulation of contact-oriented catching of a sliding object

Troy, NY

Aug–Dec 2013

UNDERGRADUATE RESEARCHER: SCIENTIFIC COMPUTING

- Implemented threaded mesh I/O for the Parallel Unstructured Mesh Interface

Sept 2012–Dec 2013

UNDERGRADUATE TEACHING ASSISTANT (COMPUTER SCIENCE 1)

- Assisted students with lab work and graded results

Aug 2012–May 2013

Service

RSS Pioneers 2022: Organizing Committee

PROGRAM COMMITTEE MEMBER

- After participating in RSS Pioneers 2021, I am looking forward to contributing to the organization of the program for the 2022 edition

N/A

July 2021–July 2022

AAAI 2022 Student Abstract and Poster Program

PROGRAM COMMITTEE MEMBER

- As a committee member, I was responsible for reviewing several abstracts submitted by early career researchers

N/A

Fall 2021

RSS 2018: Graduate Student Volunteer

INDUSTRY RECEPTION

- Coordinated logistics and placements for the industry reception in the foyer of the Carnegie Music Hall

Pittsburgh, PA

May 2017–June 2017

First LEGO League (FLL) Championship for Western PA

JUDGE: ROBOT DESIGN

- I will be returning to judge for FLL in 2022

Pittsburgh, PA

Dec 2022

JUDGE: PROJECT

- Student groups (primary school) presented projects to judges via prepared presentations (along with posters and props) according to that year's theme, *Into Orbit*
- Deliberated with judging team and assessed projects according to notes and scoring rubric

Dec 2018

Teaching

Introduction to Artificial Intelligence (CSCI 404)

INSTRUCTOR

- Senior level undergraduate computer science course
- Textbook: *Artificial Intelligence a Modern Approach* by Stuart Russell and Peter Norvig

Mines

Spring 2024

Robot Mobility on Air, Land, & Sea (16-665)

CO-INSTRUCTOR

- Core course in the [Masters in Robotics Systems Development](#) (MRSD) program
- Gave two lectures of the *Aerial Mobility* component: *Model Predictive and Adaptive Control* and *Trajectory Generation and Tracking*
- Revised and expanded material for each lecture. Improved emphasis on concrete applications and introduced discussion of autonomy system design and safe navigation with respect to flatness-based trajectory generation
- Collaborated with TAs to port section project from Matlab to Python

CMU

Fall 2022

Mathematical Fundamentals for Robotics (16-811)

TEACHING ASSISTANT

Instructor: *Prof. Michael Erdmann*

- Course: Mathematical Fundamentals for Robotics (16-811)
- Responsibilities: grading assignments, holding office hours
- Prepared and gave a lecture on submodular maximization

CMU

Aug–Dec 2017

Mentorship

Rebecca Martin

PH.D. STUDENT, ROBOTICS

- I am advising Rebecca while she works on the multi-robot filming and reconstruction
- Currently, Rebecca is working on safe navigation for filming moving actors

Robotics Institute, CMU

Spring 2022–Present

Skyler Hughes

ROBOTICS INSTITUTE SUMMER SCHOLARS

- Skyler is an undergraduate intern from the *New Mexico Institute of Mining and Technology* working on greedy, submodular coordination for multi-robot filming

Robotics Institute, CMU

Summer 2022

Hannah Noh, Andrew (Yifan) Su

SUMMER UNDERGRADUATE RESEARCH APPRENTICESHIP

- Andrew and Hannah are rising sophomores on the multi-robot filming project. They have been developing RTK-GPS tracking backpacks that will transmit locations of actors being filmed as well as contributing to several other areas of our systems

Robotics Institute, CMU

Summer 2022

Michael Tatum

M.S. THESIS COMMITTEE

- Thesis: *Communications Coverage in Unknown Underground Environments*
- I met with Michael regularly while he performed his thesis work
- Michael's thesis developed greedy methods for placing communication nodes to maximize coverage in the DARPA Subterranean Challenge

Robotics Institute, CMU

2020

Honors & Awards

2021 **RSS Pioneers**, Research statement accepted into prestigious workshop for early-career roboticists

Virtual Workshop

Select Presentations

Talking Robotics

ACTIVE PERCEPTION AND EXPLORATION WITH TEAMS OF ROBOTS: FROM SIMULATION TO SUBTERRANEAN

- Seminar on active perception for one or more robots and lessons learned from the Subterranean Challenge. [Video](#).

Virtual

Oct 2021

Publications

THESIS

Micah Corah. **Sensor planning for large numbers of robots**. PhD thesis, Carnegie Mellon University, 2020. [Video](#).

JOURNAL

Micah Corah and Nathan Michael. **Distributed matroid-constrained submodular maximization for multi-robot exploration: theory and practice**. *Autonomous Robots*, 2019.

Micah Corah, Cormac O'Meadhra, Kshitij Goel, and Nathan Michael. **Communication-efficient planning and mapping for multi-robot exploration in large environments**. *Robotics and Automation Letters*, 2019. [Video](#).

Erik Nelson, **Micah Corah**, and Nathan Michael. **Environment model adaptation for mobile robot exploration**. *Autonomous Robots*, 2018.

CONFERENCE

Micah Corah and Nathan Michael. **Scalable distributed planning for multi-robot, multi-target tracking**. *International Conference on Intelligent Robots and Systems*, 2021. [Presentation](#).

Micah Corah and Nathan Michael. **Volumetric objectives for multi-robot exploration of three-dimensional environments.** *International Conference on Robotics and Automation*, 2021. [Presentation](#).

Hyungho Chris Choi, Inhwon Wee, **Micah Corah**, Sahand Sabet, Taeyeon Kim, Thomas Touma, David Hyunchul Shim, and Ali-akbar Agha-mohammadi. **BAXTER: Bi-modal aerial-terrestrial hybrid vehicle for long-endurance versatile mobility.** *Proc. of the Intl. Sym. on Exp. Robot.*, 2021.

Kshitij Goel, **Micah Corah**, Curtis Boirum, and Nathan Michael. **Fast exploration using multirotors: Analysis, planning, and experimentation.** *Field and Service Robotics*, 2019. Videos: [Sim](#), [Real](#).

Micah Corah and Nathan Michael. **Distributed submodular maximization on partition matroids for planning on large sensor networks.** *Conference on Decision and Control*, 2018.

Micah Corah and Nathan Michael. **Efficient online multi-robot exploration via distributed sequential greedy assignment.** *Robotics: Science and Systems*, 2017.

Micah Corah and Nathan Michael. **Active estimation of mass properties for safe cooperative lifting.** *International Conference on Robotics and Automation*, 2017.

Wennie Tabib, **Micah Corah**, Nathan Michael, and Red Whittaker. **Computationally efficient information-theoretic exploration of pits and caves.** *International Conference on Intelligent Robots and Systems*, 2016.

Derek Mitchell, **Micah Corah**, Nilanjan Chakraborty, Katia Sycara, and Nathan Michael. **Multi-robot long-term persistent coverage with fuel constrained robots.** *International Conference on Robotics and Automation*, 2015.

SELECT PREPRINTS AND WORKSHOP PAPERS

Micah Corah and Sebastian Scherer. **On performance impacts of coordination via submodular maximization for multi-robot perception planning and the dynamics of target coverage and cinematography.** *RSS 2022 Workshop on Envisioning an Infrastructure for Multi-Robot and Collaborative Autonomy Testing and Evaluation*, 2022.

Micah Corah. **A simple bound for resilient submodular maximization with curvature.** *arXiv preprint arXiv:2105.04793*, 2021.

OTHER

Benjamin Morrell and **Micah Corah.** **Space exploration underground: A report on tests by NASA's Jet Propulsion Laboratory in Wells Cave, KY.** *The Kentucky Caver*, pages 14–21. Blue Grass Grotto, 2021.