

Siddharth Mayya

PHD CANDIDATE · Robotics · Bio-Physics Inspired Robot Swarms · Resilient Robot Teams

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Research Focus

Minimalistic Robot Swarms	Simple proximity encounters as information sources in robot swarms
Statistical Mechanics In Robotics	Design of predictable emergent behaviors in robot swarms enabled by statistical mechanics
Resilient Multi-Robot Teams	Distributed task allocation and execution in multi-robot systems for long-term operations

Education

Georgia Institute of Technology

PHD IN ELECTRICAL AND COMPUTER ENGINEERING

Atlanta, GA

August. 2016 - Current

- Thesis: *Local Interactions as Information Sources in Robot Swarms*
- Advisor: Magnus Egerstedt
- GPA: 4.0/4.0

Georgia Institute of Technology

MASTERS IN ELECTRICAL AND COMPUTER ENGINEERING

Atlanta, GA

August. 2014 - May 2016

- Thesis: *Safe open-loop strategies for handling intermittent communications in multi-robot systems*
- Thesis Advisor: Magnus Egerstedt
- GPA: 4.0/4.0

Manipal Institute of Technology

B.E. IN ELECTRONICS AND COMMUNICATION ENGINEERING

Manipal, India

August. 2010 - June 2014

- Received a 100% scholarship on college tuition.
- GPA: 8.98/10.00

Professional Appointments

Arizona State University

VISITING SCHOLAR WITH DR. STEPHEN PRATT

Tempe, AZ

May. 2018 - June 2018

- Investigated how *Temnothorax Rugatulus* ants utilize inter-ant encounters to detect quorum.
- Performed experiments on *Temnothorax Rugatulus* ant colonies with the aim of achieving non-uniform densities.
- Investigated the emergence of reverse tandem runs during disrupted emigrations of ant colonies.
- Used Open-CV to track the moving positions of ants within a colony via a camera.

Georgia Institute of Technology

GRADUATE RESEARCH ASSISTANT (PHD)

Atlanta, GA

Aug. 2016 - Current

- Co-Designer of the Brushbot: a vibration-driven robot optimized for large-scale low cost deployment (2019).
- Investigated the connections between active matter physics and swarming robots—to design decentralized algorithms for achieving non-uniform densities in robot swarms (2018-2019).
- Developed an optimization framework for minimum energy task allocation in a team of robots with heterogeneous capabilities (2018).
- Developed algorithms which allow robots to use inter-robot proximity encounters as an information source for achieving density control, decentralized localization and task allocation (2016-2018).
- Served as a firmware developer, circuit-board designer for the Robotarium project: an open-access swarm robotics platform at Georgia Tech (2015-2018).

Georgia Institute of Technology

GRADUATE RESEARCH ASSISTANT (MASTERS)

Atlanta, GA

Aug. 2015 - Current

- Developed reachability-based methods for handling intermittent communications in multi-robot systems.
- Developed an optimization based power-saving hybrid control strategy for multi-robot systems.
- Design and development of the GRITSBot: an open-source robot for use on the Robotarium.

Tesla Motors

AUTOPILOT INTERN

Palo Alto, CA

May. 2015 - Aug. 2015

- Conceptualized schemes to diagnose anomalous driving conditions and realized them in embedded C. These schemes detect potentially dangerous conditions by taking into account factors such as vehicle dynamics, driver reaction times and current road parameters.
- Developed a Software-In-Loop simulator to compute safety performance metrics using test-drive data.
- Implemented MATLAB scripts to automatically facilitate cross-checking of the simulator output with field data and generate statistics to fine tune the design parameters.
- Implemented a spline interpolation method to generate estimates of the road curvature based on intermittent trajectory and GPS data.

Parikshit Student Satellite Team

Manipal, India

TEAM LEAD

March, 2011 - Dec, 2013

- Designed and successfully tested a three-axis PID control system for stabilization of the satellite.
- Managed a team of 7, supervising and aiding the design of attitude estimation algorithms, orbit determination algorithms, hardware design and system integration.
- Incorporated the Attitude Determination and Control System algorithm into the Real Time Operating System (RTOS) of the satellite. This included addressing various scheduling issues and developing firmware code.
- Designed and developed an integrated satellite environment simulator on MATLAB featuring modules for torque analysis, performance testing and orbital positioning. The whole system was later implemented in C.
- GitHub Repository Link: <https://gist.github.com/siddharth119/c90f96c1bd18292a2db1>

Freescal Semiconductors

Noida, India

ANALOG & MIXED SIGNAL INTERN

Jan, 2014 - July, 2014

- Designed and implemented Test Cases to verify specific functionalities of certain I/O Pads within a SoC.
- Deployed scripts to automate execution of test cases involving a large number of files.

Research Summary

With the meteoric rise in computer technologies, large interaction networks play a central role in our lives. With it, comes the need to model, analyze & control such networked dynamical systems given constraints on the inter-agent interaction mechanisms and available information. More specifically, in the field of robotics, there is a need to design multi-agent robotic systems with heterogeneous capabilities specialized for operations in unknown environments for extended periods of time.

Such design entails the need to understand how local interactions among agents in a swarm can provably lead to emergent properties. A part of my research work attempts to approach the crux of this design problem by investigating the information contained in extremely simplistic local interactions among robots in a swarm. In [1, 4], we demonstrated that binary collisions occurring among swarming robots can indeed be used as an information source which can allow the robots to localize themselves in a given region. In [7], we showed that local proximity encounters among robots can be used by the swarm to autonomously allocate itself among tasks that need to be performed. Furthermore, we showed that such a process could be regulated in a closed-loop manner using only proximity encounter measurements. Inspired by observations in ant-colonies, [3] develops an algorithm where the swarm autonomously regulates its population in a given region so as to maximize productivity.

In addition to the above work, I have also developed a minimum energy task allocation framework for heterogeneous robot teams [2], and an algorithm for robustness against communication failures in centralized multi-robot systems [5].

Publications

Refereed Journal Publications

- [1] **Siddharth Mayya**, Pietro Pierpaoli, Girish Nair, and Magnus Egerstedt. Localization in densely packed swarms using interrobot collisions as a sensing modality. *Invited Paper, IEEE Transactions on Robotics*, vol. 35, no. 1, pp. 21–34, Feb 2019.

Peer-Reviewed Conference Publications

- [2] Gennaro Notomista, **Siddharth Mayya**, Seth Hutchinson and Magnus Egerstedt. An optimal task allocation strategy for heterogeneous multi-robot systems. *Accepted. European Control Conference (ECC)*, 2019.
- [3] **Siddharth Mayya**, Pietro Pierpaoli, and Magnus Egerstedt. Voluntary retreat for decentralized interference reduction in robot swarms. *Accepted. International Conference on Robotics and Automation (ICRA)*, 2019.
- [4] **Siddharth Mayya**, Pietro Pierpaoli, Girish Nair, and Magnus Egerstedt. Collisions as Information Sources in Densely Packed Multi-Robot Systems Under Mean-Field Approximations. In *Proceedings of Robotics: Science and Systems*, Cambridge, Massachusetts, July 2017.
- [5] **Mayya, Siddharth** and Magnus Egerstedt. Safe open-loop strategies for handling intermittent communications in multi-robot systems. In *2017 IEEE International Conference on Robotics and Automation (ICRA)*, pages 5818–5823. IEEE, 2017.
- [6] Smit Kamal, Karun Potty, Chandrasekhar Nagarajan, **Mayya, Siddharth**, and Adheesh Boratkar. Descent modeling and attitude control of a tethered nano-satellite. In *Aerospace Conference, 2014 IEEE*, pages 1–14. IEEE, 2014.

Submitted Articles

Journals

- [7] **Siddharth Mayya**, Sean Wilson, and Magnus Egerstedt. Closed-loop task allocation in robot swarms using inter-robot encounters. *Under Review*, 2019.

Conferences

- [8] **Siddharth Mayya**, Gennaro Notomista, Dylan Shell, Seth Hutchinson, and Magnus Egerstedt. Achieving Non-Uniform Densities in Vibration Driven Robot Swarms Using Phase Separation Theory. *arXiv e-prints, arXiv:1902.10662, Feb 2019*.
- [9] Gennaro Notomista, **Siddharth Mayya**, Anirban Mazumdar, Seth Hutchinson, and Magnus Egerstedt. A Study of a Class of Vibration-Driven Robots: Modeling, Analysis, Control and Design of the Brushbot. *arXiv e-prints, arXiv:1902.10830, Feb 2019*.

Thesis

- [10] **Siddharth Mayya**. Safe open-loop strategies for handling intermittent communications in multi-robot systems. *Master's Thesis, Georgia Institute of Technology, 2016*.

Honors & Awards

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| 2018 | Among top 6 papers selected for Extended Publication in IEEE Transaction on Robotics,
Robotics: Science and Systems Conference | <i>Boston, MA</i> |
| 2018 | Executive Vice President of Research Award for Best Poster, Career, Research and Innovation
Development Conference | <i>Atlanta, GA</i> |
| 2010 | Full Tuition Fellowship Award, Manipal Institute of Technology | <i>Manipal, India</i> |

Presentations

Invited Talks

Strength in Numbers: Swarm Robotics and It's Applications

BHABHA ATOMIC RESEARCH CENTER

Future Technologies Talk

Mumbai, India

Jul. 2017

Local Interactions as Information Sources in Robot Swarms

GEORGIA INSTITUTE OF TECHNOLOGY

Robotics Student Seminar Series

Atlanta, GA

Sept. 2018

Conference Talks

2017 International Conference on Robotics and Automation

PAPER PRESENTATION

"Safe open-loop strategies for handling intermittent communications in multi-robot systems"

Singapore

May 2017

2017 Robotics: Science and Systems Conference 2017

PAPER PRESENTATION

"Collisions as Information Sources in Densely Packed Multi-Robot Systems Under Mean-Field Approximations"

Boston, MA

July 2017

2017 Robotics: Science and Systems Conference 2017

WORKSHOP ON ROBUST AUTONOMY IN HETEROGENEOUS ROBOT TEAMS

"Robust Autonomy in Centralized Multi-Robot Systems"

Boston, MA

July 2017

Teaching Experience

Research Mentoring

As a part of the ECE 8803 Special Research Topics course, I provided research guidance and mentoring to 4 students over the course of a semester. This involved weekly meetings to discuss progress in their research and point them towards relevant results in the literature.

Teaching Assistant

1. Georgia Institute of Technology. ECE 6553: Optimal Control

Service

Peer Reviewer

1. IEEE International Conference on Robotics and Automation (ICRA)
2. IEEE International Conference on Intelligent Robots and Systems (IROS)

Media Coverage

1. "This Robot Lab Has No Idea What Its Robots Are Doing", *The Wall Street Journal*, Aug 15, 2017
2. "Ga. Tech Unveils World's First Open Robotics Research Lab", *National Public Radio*, Aug 24 2017
3. "'Robotarium' gives anyone access to robots", *BBC*, Aug 18 2017

References

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