Jaskaran Singh Grover

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I am a PhD. student in the Robotics Institute at Carnegie Mellon. My research lies at the intersection of system identification and control of multiagent systems. I develop algorithms to control robots in a provably-safe, robust and efficient way using ideas from optimization, inverse reinforcement learning and barrier functions. Additionally, I take interest in analyzing mechanical systems exhibiting complex underactuated dynamics using geometric mechanics and nonlinear control.

Education

- **PhD. in Robotics** — **Carnegie Mellon University**
  Advisors: Katia Sycara and Changliu Liu, GPA: 4.00 — *Aug 2018 - Jan 2023*
  Thesis: System Identification and Control of Multiagent Systems through Interactions

- **M.S. in Robotics** — **Carnegie Mellon University**
  Advisors: Howie Choset and Matt Travers GPA: 4.00 — *Aug 2016 - Aug 2018*
  Thesis: Geometric Motion Planning for Underactuated Low-Reynolds Swimmers

- **M.S. in Electrical Engineering** — **UCLA**
  GPA: 4.00 — *Sep 2015 - Aug 2016*

- **B.E. in Electronics and Instrumentation** — **BITS Pilani**
  GPA: 9.00/10.00, Distinction Division — *Aug 2010 - Aug 2014*
  Thesis: Knee Motion Tracking on an Android Phone with a Smart Wearable Band

Industry Experience

- **Microsoft, Autonomous Systems Group** — Seattle, WA
  Research Intern — *June 2021 - Aug 2021*
  Inference in Noncooperative Games: Developed theory and algorithms for inferring players' intentions (costs +constraints) of a Nash equilibrium in a game. Validated on driving scenarios such as lane merging and collision avoidance.

- **Intel Labs, Biosignals and Systems Group** — Bangalore, India
  Systems Engineer — *July 2014 - June 2015*
  IMU-based Foot Position Tracking: Developed a novel extended Kalman filtering method for attitude estimation and measuring foot trajectory with inertial sensors. US patent 10,799,118 application granted.

- **Intel Labs, Biosignals and Systems Group** — Bangalore, India
  Research Intern — *Jan 2014 - June 2014*
  Real-Time Knee Motion Tracking On Mobile Phone
  - Prototyped a smart-fabric based knee band with a wireless sensor network, inertial sensors, and stretch sensors.
  - Programmed a real-time android phone app for tracking knee angle with band's measurements communicated over Bluetooth. Published a paper in BodyNets'15.

Research Experience and Publications

- **Control Through Interactions: Planning for Multirobot Noncooperative Herding**
  Derived algorithms for planning motions for a multirobot team to repel adversarial robots from a protected zone. Integrated online model learning and optimization-based control, and implemented on ten Khepera robots using ROS and Python.

  PUBLICATIONS:

  - **J. Grover**, N. Mohanty, C. Liu, K. Sycara, "Distributed Multirobot Control for Non-Cooperative Herding", *Distributed Autonomous Robotic Systems (DARS) 2022.*
  - **J. Grover**, N. Mohanty, W. Luo, C. Liu, K. Sycara, "Noncooperative Herding With Control Barrier Functions: Theory and Experiments", *IEEE Conference on Decision and Control (CDC) 2022.*

- **Robust Safe Control for Dynamic Systems With Uncertainty**
  Conceptualized a robust safe control framework for multirobot collision avoidance and robot-human safety based on semi-definite programming. Validated on ten Khepera robots with ROS and CVXPY.

  PUBLICATIONS: **J. Grover**, C. Liu, K. Sycara, "Control Barrier Functions-based Semi-Definite Programs (CBF-SDPs): Robust Safe Control For Dynamic Systems with Uniform Parametric Uncertainty", *preprint.*

- **Multirobot Environment Exploration and Task Allocation with Integer Programming**
  Led the development of algorithms for exploration of rooms in a building to search for victims. Integrated task-allocation, path-planning and low-level inter-robot collision avoidance control. Shipped code to Northrup Grumman.

- **System Identification/Inverse Reinforcement Learning for Multiagent System**
  Developed algorithms for reverse-engineering interacting agents' safety margins, goals and aggressiveness from trajectories.
  PUBLICATIONS:
  - **J. Grover**, Y. Lyu, W. Luo, J. Dolan, C. Liu, K. Sycara, "Context-Aware Pedestrian Intent Prediction With Barrier Functions and Mixed-Integer Quadratic Programming", *IFAC Cyberphysical and Human Systems (CPHS) 2022, ICRA Social Robot Navigation Workshop 2022.*
  - **J. Grover**, C. Liu, K. Sycara, "System Identification for Safe Controllers using Inverse Optimization", *Modeling, Estimation and Control Conference (MECC) 2021.*
  - **J. Grover**, C. Liu, K. Sycara, "Parameter Identification for Multirobot Systems Using Optimization-Based Controllers", *Multirobot Systems Symposium (MRS) 2021.*

- **Multirobot Deadlock Analysis and Resolution**
  Investigated conditions behind deadlock resulting from distributed controllers and devised deadlock resolution strategies.
  PUBLICATIONS:
  - **J. Grover**, C. Liu, K. Sycara, "The Before, During and After of Multirobot Deadlock", *International Journal of Robotics Research (IJRR) 2022 (Invited Paper).*
  - **J. Grover**, C. Liu, K. Sycara, "Deadlock Analysis and Resolution in Multirobot Systems", *Workshop on Algorithmic Foundations of Robotics (WAFR) 2020.*

- **Motion Planning for Microscopic Viscous Swimming Robots**
  Collaborated with undergrads to design a 3D swimming robot and ferro-magnetic swimmers. Derived dynamics models, synthesized motion primitives and validated motion plans on robots.
  PUBLICATIONS:
  - **J. Grover**, D. Vedova, N. Jain, H. Choset, M. Travers, "Motion Planning, Design Optimization and Fabrication of Ferromagnetic Swimmers", *Robotics: Science and Systems (RSS) 2019.*
  - **J. Grover**, J. Zimmer, T. Dear, M.Travers, H. Choset, S. Kelly, "Geometric Motion Planning for a Three-Link Swimmer in a Three-Dimensional Low Reynolds-Number Regime", *American Control Conference (ACC) 2018.*

Awards and Fellowships

- (2022) Recipient of Rising Stars in Dynamics and Control Division Award at MECC 2022.
- (2019) Recipient of Uber Presidential Fellowship, Carnegie Mellon University ($42,500).
- (2015) Recipient of UCLA Graduate Division Fellowship ($52,000).
- (2014) All India Rank 8 among ∼20000 candidates in Graduate Aptitude Test in Engineering (GATE).
- (2014) Distinction Division for Undergraduate Studies, BITS Pilani.

Mentoring Experience

- (Spring, Summer, Fall 2022): Nishant Mohanty (CMU robotics masters).
- (Fall 2021, 2022): Indraneel Patil, Rachel Zheng, Charvi Gupta, Jaekyung Song, Narender Sriram (CMU robotics masters).
- (Summer 2019): Mike Cheng (CMU robotics masters, now at Amazon), Kenny Shaw (robotics intern, now at CMU).
- (2018-2021): Daniel Vedova (CMU undergrad, CMU robotics masters, now a submarine warfare officer in training).

Reviewing Experience

- Reviewed papers for (journals) IEEE TAC, JAIR, and (conferences) ACC, MECC and ICRA.
- Substantial writing in grants: DARPA OFFSET (awarded), ONR DURIP (awarded $200k), NSF-Future Manufacturing.
- Critiqued >10 ERC research proposals for PhD advisor.

Teaching Experience

- (Fall 2019, TA+some lecturing) Provably Safe Robotics.
- (Fall 2018, TA+frequent lecturing) Underactuated Robotics.
- (Fall 2017, TA) Robot Kinematics and Dynamics.

Skills Summary

Python, ROS, C++, MATLAB, Simulink, Mathematica, Solidworks, Open-CV, COMSOL Multiphysics, NI LabVIEW.