Jaskaran Grover

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I am a PhD. student in the Robotics Institute at Carnegie Mellon University. I work on analyzing multiagent systems through the lenses of system identification, optimization and control theory. My research aims to endow intelligent behavior to robots by generating provably-safe, robust and efficient controllers that adapt to the behaviors of other interacting agents by leveraging ideas from optimal control, game theory, online learning and control barrier functions. Additionally, I take interest in analyzing mechanical systems that exhibit complex nonlinear dynamics using geometric mechanics and nonlinear control.

Education

- **PhD in Robotics, School of Computer Science** — **August 2018 - Spring 2023**
  Carnegie Mellon University — *Pittsburgh, PA*
  Advisors: Changliu Liu and Katia Sycara
  GPA: 4.00
- **Masters of Science in Robotics** — **August 2018**
  Carnegie Mellon University — *Pittsburgh, PA*
  Advisors: Howie Choset and Matthew Travers
  GPA: 4.00
- **Masters of Science in Electrical Engineering** — **July 2016**
  University of California, Los Angeles — *Los Angeles, CA*
  GPA: 3.97
- **Bachelor of Engineering Electronics & Instrumentation** — **July 2014**
  Birla Institute of Technology and Science, Pilani — *Pilani, India*
  Distinction, GPA: 9.00/10.0

Skills

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

Patents and Publications

- **J. Grover**, V Natarajan, K Ranganathan, "Motion Tracking Using Electronic Devices", US Patent 10,799,118 Application Granted 2020-10-13
- **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", *arxiv*
- **J. Grover**, N. Mohanty, W. Luo, C. Liu, K. Sycara, "A Distributed Approach for Non-Cooperative Herding with Control Barrier Functions", *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*
- **J. Grover**, Y. Lyu, W. Luo, J. Dolan, C. Liu, K. Sycara, "Pedestrian Dynamics Inference Using Control Barrier Functions and Mixed-Integer Quadratic Programming", *ICRA 2022: Social Robot Navigation: Advances and Evaluation Workshop*
- **J. Grover**, Y. Lyu, W. Luo, J. Dolan, C. Liu, K. Sycara, "Semantically-Aware Pedestrian Intent Prediction With Barrier Functions and Mixed-Integer Quadratic Programming", *IFAC Cyberphysical and Human Systems (CPHS) 2022*
- **J. Grover**, C. Liu, K. Sycara, "The Before, During and After of Multirobot Deadlock", *International Journal of Robotics Research (IJRR) 2022.*

- **J. Grover**, C. Liu, K. Sycara, "Simultaneously Learning Safety Margins and Task Parameters in Multirobot Systems", *RSS Workshop on Behavior Inference in Multiagent Systems* 2021
- **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, "FREUD: **F**easible **R**egion-based **E**stimation **U**sing **D**uality", *European Control Conference (ECC)* 2021
- **J. Grover**, C. Liu, K. Sycara, "Parameter Identification for Multirobot Systems Using Optimization-Based Controllers", *Multirobot Systems Symposium (MRS) 2021*
- **J. Grover**, C. Liu, K. Sycara, "Why Does Symmetry Cause Deadlocks?", *IFAC World Congress 2020*
- **J. Grover**, C. Liu, K. Sycara, "Deadlock Analysis and Resolution in Multirobot Systems", *Workshop on Algorithmic Foundations of Robotics (WAFR) 2020*
- K. Shih, C. Ho, **J. Grover**, C. Liu, S. Scherer, "Provably Safe in the Wild: Testing Control Barrier Functions on a Vision Based Quadrotor in Outdoor Environments", *RSS 2020 Workshop on Robust Autonomy*
- **J. Grover**, D. Vedova, N. Jain, H. Choset, M. Travers, "Motion Planning, Design Optimization and Fabrication of Ferromagnetic Swimmers", *RSS 2019*
- S. Kelly, R. Abrajan, **J. Grover**, H. Choset, M. Travers, "Planar Motion Control, Coordination and Dynamic Entrainment in Chaplygin Beanies", *DSCC 2018*
- C.Gong, J. Whitman, **J. Grover**, B. Zhong, H. Choset, "Geometric Mechanics and Gait Design on Cylindrical and Toroidal Shape spaces", *DSCC 2018*
- **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", ACC 2018
- **J. Grover**, V. Natarajan, "Estimation and Tracking of Knee Angle Trajectory using Inertial Sensors and a Smartphone Application", Bodynets 2015
- **J. Grover**, A. Gupta, "Studying Crosstalk Trends for Signal Integrity on Interconnects using Finite Element Modeling", COMSOL Conference 2013

Relevant Coursework

Convex Optimization, Robust Control, Optimal Control, Planning and Decision Making, Robot Kinematics and Dynamics, Linear Systems, Underactuated Robotics, Deep Learning, Machine Learning, Adaptive Filtering, Real Analysis, Math for Robotics, Differential Geometry, Calculus of Variations, Reinforcement Learning.

Work Experience

- **Microsoft** **June 2021-August 2021**
  Research Intern, Autonomous Systems Group *Remote*
  Intention Inference in Dynamic Noncooperative Multiplayer Games
  - Developed centralized and decentralized algorithms for simultaneously inferring user intentions in the form of constraints and costs in Nash equilibria in mulitplayer games.
  - Validated algorithms on autonomous driving scenarios such as lane merging, overtaking and obstacle avoidance.

- **Intel Labs** **July 2014-July 2015**
  Systems Engineer, Biosignals and Systems Research Group *Bangalore, India*
  Pedestrian position tracking and gait analysis using inertial sensors
  - Developed Extended Kalman Filtering algorithms for measuring foot trajectory using inertial sensors.
  - Developed a quaternion-EKF for 3D pose estimation using inertial measurements from IMUs.

- **Intel Labs** **January 2014-June 2014**
  Intern, Biosignals and Systems Research Group *Bangalore, India*

Smart knee motion tracking using wearable bands and mobile phone
- Created a smart fabric based knee band with inertial sensors, a wireless sensor network and stretch sensors.
- Developed a real-time application for tracking the knee angle using the band's inertial measurements on a Bluetooth Low Energy android device.

Research Experience

Intelligent Control Lab and Advanced-Agent Robotics Technology Lab, CMU
- *Development of a Composable Agent Toolbox:* Worked on a team to develop a software package for prediction, estimation, planning and control for model-free and model-based control tasks.

- *Multirobot exploration and path planning with mixed integer linear programming:*
  - Developed algorithms for exploration of rooms in unknown environments to search for friendly/hostile robots.
  - Integrated PRM based planning and barrier certificate controllers for collision avoidance and room clearing.

- *Multirobot System Identification:*
  - Derived parameter estimation algorithms for identifying task parameters of multirobot systems and swarms using position information with theoretical guarantees.
  - Exploring human intent estimation using inverse optimization and system identification.

Biorobotics Lab, CMU
- *Motion planning for a 3D low-Reynolds swimmer with yaw-pitch inputs:*
  - Performed dynamics analysis for a novel three-dimensional swimmer in a viscous regime.
  - Validated gaits and motion plans derived from simulations on a physical prototype.

- *Dynamics modeling, design optimization and planning for elastomagnetic swimmers:*
  - Developed a geometric framework for planning and control of ferromagnetic swimmers.
  - Fabricated elastomagnetic swimmers, designed and programmed a Helmholtz coil setup for locomotion using magnetic fields.

Awards

- (2022) Recipient of Rising Stars in Dynamics and Control Award, MECC 2022
- (2019) Recipient of Uber Presidential Fellowship, Carnegie Mellon University
- (2015) All India Rank 8, Graduate Aptitude Test in Engineering (GATE)
- (2014) Distinction Division for Undergraduate Studies, BITS Pilani

Teaching Experience

- (Fall 2019) Provably Safe Robotics
- (Fall 2018) Underactuated Robotics
- (Fall 2017) Robot Kinematics and Dynamics

Mentoring Activities

- (Spring 2022) Nishant Mohanty (CMU Masters)
- (Fall 2020) Shreya Manjunath (CMU Freshman), Ruohai Ge (CMU Masters), Jeff Hu (CMU Masters)
- (Fall 2019) Michael Cheng (CMU Masters), Kenneth Shaw (Intern), Raghavv Goel (Intern)
- (2018-2019) Daniel Vedova (CMU Undergrad)