Pulkit Rustagi

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Fields of Interest

- Reinforcement Learning
- Multiagent Coordination
- Sequential Decision Making
- Multi-Objective Planning
- Safe Reinforcement Learning
- Autonomous Robotics

Education

Doctor of Philosophy, Robotics **3.61/4.0**
Oregon State University, Oregon, USA *2022 - Present*

Masters of Science, Aerospace Engineering **3.52/4.0**
University of Illinois at Urbana Champaign, Illinois, USA *2018 - 2022*

Bachelor of Technology (Honours), Aerospace Engineering **9.11/10**
Indian Institute of Technology(IIT) Kharagpur, West Bengal, India *2014 - 18*

Research Experience

Mitigation of Negative Side Effects (NSE) in Multiagent Systems | IRAS Research Group
Guide: Dr. Sandhya Saisubramanian, EECS, Oregon State University *Dec'22 - Oct'23*

- Formalized **joint NSE penalty** for multiagents, generalizable to any domain with featured state representation
- Introduced a **novel credit assignment** technique to decompose joint NSE penalties into agent contributions
- Created a **metareasoning** architecture to monitor the performance of the agents and perform credit assignment
- Proposed method displayed **scalability** and was tested for up to 1000 decentralized agents in under 10 mins
- Results showed **significantly improved** NSE mitigation comparison to difference reward methods in 3 domains

Multi-agent Autonomous Systems | Autonomous and Unmanned Vehicle Systems Laboratory
Guide: Prof William Norris, ISE Department, University of Illinois at Urbana Champaign *Jan'21 - Jan'22*

- Lead a team of undergraduate students working towards high accuracy **multi-agent UWB localization** Project
- Programmed a simulator in **ROS** to establish a system of UAVs and UGVs collaborating for accurate positioning
- Wrote an innovative **autonomous** technology based Proposal under **United States Department of Agriculture**
- Crafted a White paper on Dynamic Bi-Directional Trust in Human-Artificial Intelligence Collaborative Systems

$\mathcal{L}_1$ Adaptive Control Motion Planning | Advanced Controls Research Laboratory
Guide: Prof Naira Hovakimyan, Mechanical Engineering, University of Illinois at Urbana Champaign *June'20 - Dec'20*

- Worked with Gazebo and ROS to set up a running model of a quadrotor for $\mathcal{L}_1$ Adaptive implementation
- Used contraction theory to ensure exponential convergence of the quadrotor trajectory to computed trajectory
- Implemented Geometric Control and $\mathcal{L}_1$ Adaptive Control for Quadrotor trajectory tracking in MATLAB
- Modified **Intel Drone** firmware to implement contraction based $\mathcal{L}_1$ adaptive control for flight testing

Multiagent Localization | Stanford University
Guide: Prof Grace Gao, Aerospace Engineering Dept, Stanford University *April'19 - Jul'19*

- Worked on multiagent localization of a swarm of 8 quadrotors using ultra wideband modules(TREK 1000)
- Interfaced all the UWB modules to communication on linux using CooCox CooIDE with C++ environment
- Extended the existing firmware(in **C**) from a 2-agent to 8-agent system providing pair-wise ranging information
- Employed **TDOA** (Time Difference of Arrival) technique to measure all internal distances among the 8 agents
- Investigated integration of **LiDAR** and **IMU** with UWB system to implement **SLAM** on the system of UAVs

***B.Tech Thesis*: Attitude Control of Satellite using Magneto-coulombic Actuator | IIT Kharagpur**
Guide: Prof Manoranjan Sinha, Aerospace Engineering Dept, IIT Kharagpur *Nov'17 - Mar'18*

- Implemented a 2-axis **PD** controller for Attitude Control of Sail Craft using Magneto-coulombic Actuation
- Designed 2-axis **Sliding mode** controller for attitude control for a charge distribution over the solar sails
- Wrote a simulator in **MATLAB** to plot and generate 3D animation to show convergence to final orientation

Collision Recovery Controller | McGill University, Canada
Guide: Prof Inna Sharf, Mechanical Engineering Dept, McGill University *May'17 - Jul'17*

- Worked on a Collision Recovery Controller for **quadcopter** to prevent crash failures on collision with poles
- Involved extensive use of **MATLAB** for simulating collisions with pole for a variety of different orientations
- Conducted experiments to supplement the simulation results, used **PX4** IMU for the detection of collisions
- Made custom modifications to the PX4 autopilot firmware **(C++)** as per the requirements of the controller
- Used **QgroundControl** to calibrate the sensors, monitor and record the parameters during the experiments

Indoor Positioning System | IIT Kanpur
Guide: Prof Abhishek, Aerospace Engineering Dept, IIT Kanpur *May'16 - Jul'16*

- Built an Indoor Positioning System based on **Ultra-Wideband** ranging, used TOA approach for distance
- Coded the triangulation algorithm in **Python** using least square method to obtain the coordinates in space
- The obtained results from the prepared setup showed up to **centimetres of accuracy** in an indoor setting
- Setup the Arduino system on the quadrotors for experimental data collection and low achieved position error
- Obtained convergence results showing improvement over existing satellite attitude control implementations

Swarm persistent surveillance | IIT Kharagpur
Guide: Prof Alok Kanti Deb, Electrical Engineering Dept, IIT Kharagpur *Dec'16 - Jan'17*

- Worked on implementation of an algorithm for **time based surveillance** of sites by a multi UAV system
- Coded a **MATLAB** simulator for an optimal surveillance using cellular decomposition method on the testbed
- Minimized the time gap for which the surveillance sites were left unattended by the UAVs on the testbed field
- **Improved the existing method** by prioritizing specific surveillance point based on distance - velocity factors

Fellowships and Awards

- Recipient of the prestigious **BEATTY FELLOWSHIP** awarded to exceptional student in graduate education
- Received the **INSTITUTE SILVER MEDAL** awarded to student with the **highest GPA** in their Department
- Received the **SUSHUL KUMAR CHOWDHURY MEMORIAL AWARD** at the 64th annual Convocation at IIT Kharagpur, awarded to the best outgoing student in Department of Aerospace Engineering, IIT Kharagpur
- Receiving full **Research Assistantship** with funding from the **National Science Foundation(NSF)** at UIUC
- Part of IIT Kharagpur Contingent for **Inter IIT TechMeet 2018**, highly prestigious Tech competition between the IITs all over India. Awarded **Silver Medal** in Hackathon event to code an orbital mechanics simulator
- Selected for Scholarship for Higher Education under the **Innovation in Science Pursuit** for Inspired Research
- Ranked in **top 1 percentile** in JEE entrance 2014, Extremely selective entrance examination for IITs in India

Positions of Responsibility

- Active Tutor at **24HourAnswers**, for graduate level Engineering and Maths (Tutor Profile) (Oct'20 - Present)
- Worked as online Course Administrator at Aerospace Engineering Department at UIUC (August'19 - April'20)
- Worked as Teaching Assistant for online Aerospace Engineering courses at UIUC (January'19 - August'19)
- Worked as Research Assistant at Coordinate Science Laboratory(CSL) at UIUC (August'18 - October'18)

Publications and Conference Proceedings

- Dicker, Gareth; Sharf, Inna; Rustagi, Pulkit. (2018). Recovery Control for Quadrotor UAV Colliding with a Pole. *6247-6254. 10.1109/IROS.2018.8594512.*

Technical Strengths

- **Programming Languages:** Python, C++, Julia, C
- **Embedded Systems:** AtMega, Arduino, PixHawk, Rπ
- **Softwares:** GitHub, ROS, Rviz, Gazebo, QgroundControl, LaTeX, MATLAB, Simulink, PSpice

Relevant Course Work

- Intelligent Agents and Decision-Making
- Multi-agent Systems
- Machine Learning
- Pattern Recognition
- Algorithms
- Multiple Robot Systems
- Programming and Data Structures
- Sequential Decision Making
- Introduction of Robotics
- Computer Architecture