Atharva Navsalkar

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Education

Indian Institute of Technology Kharagpur — Kharagpur, IN
Dual Degree (B.Tech + M.Tech) in ***Mechanical Engineering; CGPA: 8.82/10*** — *July 2018 – present*
Specialization in ***Mechanical Systems Design***
Micro-Specialization in **Embedded Control, Software, Modeling and Design**

Manuscripts and Publications

- **A, Navsalkar**, A.R. Hota, "Data-Driven Risk-sensitive Model Predictive Control for Safe Navigation in Multi-Robot Systems", **under review** for ICRA 2023. [**ArXiv**]
- R. Chowdhury, **A, Navsalkar**, D. Subramani, "GPU-Accelerated Multi-Objective Optimal Planning in Stochastic Dynamic Environments", Journal of Marine Science and Engineering 2022; 10(4):533 [**Link**]
- **A. Navsalkar**, S. Hota, "Minimum-time Path Convergence for UAVs in Wind Using Vector Field Guidance", 7th Indian Control Conference (ICC) 2021. [**Link**]

Experience

- **Indian Institute of Technology Kharagpur** — Undergraduate Researcher [**Report**] — Kharagpur, IN
  Prof. Ashish Ranjan Hota, Dept. of Electrical Engineering, IIT Kharagpur — *Aug. 2021 - present*
  - Developed **distributed** MPC for multi-robot motion planning in an **uncertain environment** with obstacles.
  - Proposed a novel **data-driven** approach, **robust** to the estimated **probability distribution** for prediction errors.
  - Reformulated distance from **polyhedral** obstacles into **CVaR-based risk constraints** using observations of agents.
  - Validated the **risk-aware behavior** of agents, and **finite sample robustness** on numerical and **Gazebo** simulations.

- **MRASL, Polytechnique Montréal** — Summer Intern [**Report** , **Video** , **Video**] — Montréal, CA
  Prof. David Saussié, Dept. of Electrical Engineering, Polytechnique Montréal — *May 2022 - Aug. 2022*
  - Worked **trajectory planning** and **control** algorithms for a **agile drone flight**, racing through multiple gates.
  - Established a **modular** simulation framework on **Flightmare/Gazebo**, useful for both perception and control tasks.
  - Demonstrated the use of **differential flatness-based** and **model predictive control** on a standard sim-race track.

- **Revolute Robotics LLC** — Controls Team Member — Tucson, US
  Mentored by Dr. Ali-akbar Agha-mohammadi, NASA Jet Propulsion Laboratory — *June 2021 - April 2022*
  - Designed **geometric nonlinear** controller for tracking trajectory for **spherical drone** rolling on uneven surface.
  - Developed **finite state machine** software enabling aerial, terrestrial mode and smooth transitions with a joystick.
  - Extensively tested the performance on the custom-made models using **Gazebo** for realistic, extreme environments.

- **QUEST Lab, Indian Institute of Science, Bangalore** — Summer Intern — Bangalore, IN
  Prof. Deepak Subramani, Dept. of Computational and Data Sciences, IISc. Bangalore — *May 2021 - Aug. 2021*
  - Worked on a data-driven **multi-objective** path planning for an underwater vehicle in **stochastic** ocean flows.
  - Utilised **Markov Decision Process** framework to generate policies for a strongly advected agent, avoiding obstacles.
  - Computed and analysed policies on **pareto-optimal** curves for time-taken and energy-consumed objectives.
  - Implemented **GPU-accelerated** code for a shipping channel crossing mission using sample data of double-gyre flow.

- **Aerial Robotics Kharagpur** — Controls Team Head — Kharagpur, IN
  Prof. Somesh Kumar, Dept. of Mathematics, IIT Kharagpur — *April 2019 - Present*
  - **Vaccine delivery using drone**
    - Assembled a hexacopter with **Pixhawk** flight controller, capable of payloads upto 5kg and maximum range of 10km.
    - Conducted multiple field tests inside IIT campus for autonomous delivery missions using **Ardupilot** Mission Planner.
  - **Tilting-rotor quadrotor**
    - Modelled dynamics and aerodynamics on the **thrust-vectored** quadrotor using **Simulink** for numerical simulation.
    - Designed a **PID controller** for decoupled motion of pitch angle control and forward velocity using servo motor.
  - **Nanodrone Swarm**
    - Set up the **Crazyflie** nano-quadcopter platform with Local Positioning System for formation control.
    - Designed and tested collision avoidance strategies based on **potential field** and **timed-elastic-band** trajectory.

Projects

- **Bachelor's Thesis: Model Predictive Control for Multi-agent Systems** [**Link**] *Sept. 2021 - April 2022*
  Prof. Ashish Ranjan Hota, Dept. of Electrical Engineering, IIT Kharagpur
  - Analysed the **centralised** and **decentralised** MPC algorithms for **safe navigation** in swarm of aerial robots.
  - Constructed obstacle avoidance constraints for **polyhedron-shaped** geometries combined in a **centralized** MPC.
  - Compared the trajectories and computational load to **decentralized reciprocal velocity obstacle** constraints.
  - Setup MPC optimization framework using **CasADi** and **IPOPT** solver for testing in **Gazebo** environment.
- **Minimum-time Path Convergence for UAVs in Wind Conditions** *Sept. 2020 - Jan. 2021*
  Prof. Sikha Hota, Dept. of Aerospace Engineering, IIT Kharagpur
  - Designed a **guidance** algorithm for unmanned aircraft to reach a smooth path in **minimum time** in a constant wind.
  - Proposed a combined **Lyapunov vector-field-based** algorithm considering wind field and input constraints.
  - Computed the vector-field design parameters using a **static optimization** framework over a logarithmic scale.
  - Validated the performance, being very close to the time-optimal but discontinuous bang-bang controller.

Achievements

- Won the **"Most Innovative Project"** (1^{st} prize) award in the UG-category out of **29** funded projects in **Student Innovation Grant Program**. This was the only individual project among all the other winners.
- Selected into the **Mitacs Globalink Research Internship 2022** program for summer internship in **Canada**.
- Awarded a student grant of **300,000 INR** under **Student Innovation Grant Program** by AI & Robotics Technology Park, IISc. Bangalore for the **Bachelor's Thesis Project** for one year. The proposal was amongst **29** selected for funding out of 131 proposals received from across India.
- Qualified for **National Semifinals** (Top 7% teams out of 1600) in the **Flipkart Grid 2.0** for the **Autonomous Stair Climbing Robot** segment. Ideated a load-carrying quadruped robot capable of climbing stairs and traversing uneven terrain.
- Bagged **1st position** as Aerial Robotics Kharagpur team in **International Micro Aerial Vehicles (IMAV) Competition 2019**, in the indoor segment for warehouse management using drones.
- Ranked in National Top **0.5%** (out of 1,200,000 candidates) in JEE(Mains) 2018 and Top **1%** (out of 230,000 candidates) in JEE(Advanced) 2018.

Relevant Courses and Skills

- **Coursework**: Programming and Data Structures | Partial Differential Equations | Transform Calculus | Dynamics | Kinematics of Machines | Basic Electronics | Fundamentals of Embedded Control and Software | Dynamics of Machines | Systems and Control | Model Predictive Control | Soft Computing | Automotive Dynamics and Control | Mechanisms and Robot Kinematics | Robots and Computer Controlled Machines
- **Programming Skills**: C, C++, MATLAB-Simulink, Python, Robot Operating System (ROS)

Extracurricular Activities

- Conducted a 3-day workshop on Aerial Robotics for freshmen as part of induction program.
- Won Gold medal in Music Cup team event, as a pianist, in intra-collegiate championships.
- Won Bronze medal in Badminton team event in intra-collegiate championships.
- Worked as a part of Awaaz, a campus media body and initiated to reach out to administration to resolve student grievances on campus issues.