Naveen Balaji

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Education

- **Georgia Institute of Technology (GT)** — **Atlanta, USA**
  PhD in Robotics, ***CPI: 4.0/4.0*** — *2021 - present*
- **Georgia Institute of Technology (GT)** — **Atlanta, USA**
  MS in CS, ***CPI: 4.0/4.0*** — *2021 - 2023*
- **Indian Institute of Technology Kanpur (IITK)** — **Kanpur, India**
  Bachelors of Technology in Aerospace Engineering, ***CPI: 9.1/10.0*** — *2017 - 2021*

Research Experience

- **Graduate Research Assistant** — **Aug.2021 - Apr.2023**
  Healthcare Robotics Laboratory GT — *Guide: Dr.Charlie Kemp*
  - Incorporated **reinforcement learning** algorithms into assistive tasks for improving **human-robot interaction**.
  - Created assistive environments in **physics simulator**, generating **datasets** for training machine learning policies.
  - Implemented human pose detection in occluded regions using trained **deep-learning models**, enhancing the system's interpretation capabilities.
  - Automated mobile **manipulator** robots to perform autonomous tasks such as object handover and **grasping**, increasing operational efficiency.
- **Undergraduate Student Researcher** — **March 2019 - March 2021**
  Intelligent Guidance & Control Laboratory IITK, — *Guide: Dr.Mangal Kothari*
  - Developed attitude and position estimator using Kalman filter, enhancing **indoor localization** capabilities.
  - Designed novel fail-safe system for **drone pose estimation** in the absence of a GPS module.
  - Implemented optimal **sensor placement** strategies for drones, increasing indoor localization accuracy.
- **Team Head** — **Nov. 2017 - April 2019**
  Aerial Robotics IITK — *IIT Kanpur*
  - Developed a robust vision-based drone landing system on a color box, utilizing precise object tracking techniques, proving critical for a **search and rescue** competition.
  - Enhanced sensor fusion techniques, integrating (AHRS) inertial sensors and optical flow, optimizing sensor performance and data accuracy.
  - Implemented state-of-the-art **Visual Inertial Odometry** methods such as VINS, ROVIO, enhancing navigation and positioning capabilities of the drone.
  - Conducted experiments with linear controllers and an available **Model Predictive controller** on real drones, testing and optimizing flight control strategies.

Experience

- **Robotics Research Engineer** — **May. 2023 - present**
  Joulea LLC — *Atlanta, USA*
  - Implemented a **SLAM system** using Lidar Inertial Odometry, and Point-cloud data, improving autonomous robot navigation via **collision-avoidant** paths in dynamic environments.
  - Optimized **flight control** of DJI drones by leveraging the SDK to design a custom **velocity controller**, enhancing the drone's responsiveness and precision in navigation.
  - Conducted scans and generated **3D models of Atlanta's largest buildings** using drone systems, contributing significantly to the city's building inspection.

Patent

➢: N. Balaji, M. Kothari, and A. Abhishek. System and method for estimation of yaw angle for an aerial vehicle for autonomous navigation, 2019. Indian Provisional Patent

Publications

➢: N. Balaji, M. Kothari, and A. Abhishek. Gps denied localization and magnetometer-free yaw estimation for multi-rotor uavs. In *2020 International Conference on Unmanned Aircraft Systems (ICUAS)*, pages 983–990

➢: N. Balaji and M. Kothari. Range sensor based Localization and control of mobile robots . SURGE 2019 Poster Presentation, IIT Kanpur [Poster]

Technical skills

Robotics: ROS, Gazebo, Arduino, OpenCV, PCL, Moveit

Frameworks: Pytorch, Pybullet, OpenAI Gym

Languages: Python, C++, C, MATLAB

Softwares: GITHUB, HTML, AUTOCAD, LaTeX

Achievements

2021: **Sri Binay Kumar Sinha Award** for the best project at IITK that has industrial applicability and solves a problem affecting the common people

2021: **General Proficiency Medal** for the best academic performance at IITK among the graduate students

2021: **Research Proficiency Medal** for the best undergraduate project work done by graduate students

2019: **Gold medal** in **Inter-IIT Techmeet** Aerial Robotics [Search & Rescue competition] conducted by DRDO

2017: **All India Rank 924** in Engineering entrance [JEE Mains] among 1.2 million students

2016: **Kishore Vaigyanik Protsahan Yojana** (KVPY) Fellowship by Indian Institute of Science

Selected Projects

Language model based trajectory generation

Deep learning: Class project, report *Jan–Apr '23*

- Leveraged large language models like CLIP and BERT to formulate complex, user-defined natural language constraints for robotic trajectory planning.
- Utilized diffusion model-based methodology to learn conditional distributions over feasible trajectory modifications.
- Developed a real-world simulation setup for executing planned trajectories directly on drone platforms, enhancing human-robot interaction.

Reinforcement Learning from Human Feedback for Mobile Manipulation

Human-Robot Interaction: Class project, report *Jan–Apr '23*

- Explored the application of reinforcement learning from human feedback (RLHF) for training robots on household tasks.
- Conducted a comparative study using Stretch RE1 robot in OpenAI Gym for a simulated task, evaluating policies trained with and without human feedback.
- Demonstrated the potential of RLHF in aligning robot behavior with user expectations, emphasizing customization of robotic tasks beyond just task accuracy.

Human Robot Multiagent Reinfocement learning

Robot Intelligent planning: Class project, report *Jan–Apr '22*

- Developed realistic human-robot simulation environment to test multi-agent reinforcement learning algorithms
- Implemented and evaluated various learning algorithms to complete the given task successfully (**PPO, SAC, A2C, behavior cloning, MARWIL**) .

Desktopography

Electronics Club IITK summer project, report *May–Jul '19*

- Developed a Human-**computer interface** by using the low-cost depth-camera and projector.
- Implemented **gesture** recognition of the hand and transformed those actions to control the computer interface.
- Explored **sift, surf, orb** image feature algorithms for finger segmentation and tracking using the **OpenCV** library.

Relevant Coursework

Computer Science:: Computer Vision, Robot Intelligence: Planning, Deep learning,Optimization Methods, Data Structures and Algorithms, Fundamentals of Programming.

Robotics:: Human-Robot Interaction, Autonomous Navigation, Aircraft Design, Helicopter theory , Unmanned Aerial Systems, Optimal Controller theory

Coursera Online:: Probability and Statistics, Neural Networks and Deep Learning, Convolutional Neural Networks, Reinforcement Learning Specialization

Positions of Responsibility

Academic Mentor at Counseling Service *IIT Kanpur*

- Provided tutoring to academically weak students for the introductory **Mechanics** course

Secretary at Electronics Club *IIT Kanpur*

- Coordinated various events, workshops, and competitions for robotics enthusiasts in the university.