

Rahul Rustagi

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Summary

Master's candidate at Georgia Tech, specializing in computer vision, sensor integration, and intelligent system design. Developing scalable algorithms that address real-world automation challenges. I am passionate about creating robust, next-generation robotic systems by analyzing how people perceive and make decisions if faced same scenario.

Education

- MS Georgia Institute of Technology**, Electrical and Computer Engineering Aug 2024 – May 2026
- GPA: 4.0/4.0 | *Concentration: Robotics and Perception*
 - Coursework: Deep Learning, PDEs in Image Processing, Computer Vision, Non Linear Systems, Networked and Distributed Control
 - Responsibilities: Graduate Teaching Assistant
- BS Indian Institute of Technology (IIT) Kanpur**, Aerospace Engineering Aug 2020 – May 2024
- GPA: 9.18/10.0 | *Concentration: Aerial Robotics and Machine Learning*
 - Coursework: Probabilistic Machine Learning, Reinforcement Learning, Optimal Control, Dynamics, Embedded Cyber-Physical Systems, DSA
 - Awards: Academic Excellence (Deans List)
 - Responsibilities: Team Head at Aerial Robotics IIT Kanpur

Research Experience

- Robot Autonomy Interactive Learning Lab – Georgia Tech**, PI: Dr. Sonia Chernova Atlanta, GA
Project Title: 3D Scene Understanding & Object Tracking Jan 2025 – Present
- Collaborated with **Amazon Lab126** to design a human-like perception algorithm enabling robots to interpret dynamic environments using topological **Scene Graphs**
 - Implemented **Khronos** on **Stretch RE2 Robot** to develop a spatio-temporal scene graph combined with **ORB_SLAM2** and **ekf2** for stable odometry
 - Working on creating a **Temporal Object-Location Model** for addressing tasks like Object Search and performing object association using **continuous scene representations**
- Intelligent Vision and Automation Lab – Georgia Tech**, PI: Dr. Patricio A. Vela Atlanta, GA
Project Title: Robot-Agnostic Advanced Navigation Assistance System (ADAS) Aug 2024 – Jan 2025
- Architected a **hierarchical sensor fusion pipeline** (IMU, LiDAR, RGB-Vision) for real-time visual odometry, achieving **<0.1m APE error** in dynamic environments
 - Implemented **GTSAM factor graph** for sensor fusion, improving pose robustness by **40%** under sensor dropout scenarios evaluated **Hessian** matrix to analyze vision pose controllability in X, Y directions
 - Integrated **ORB_SLAM2** for slow high-precision loop closure with **DSOL (Direct Sparse Odometry and Localization)** for rapid local navigation, enabling navigation in unstructured terrains
 - Validated system performance in gazebo simulation on **RotorS** quadrotor and on hardware with **TurtleBot3**, demonstrating robot-agnostic adaptability

Helicopter and VTOL Laboratory – IIT Kanpur, PI: Dr. Abhishek

Project Title: Vision-Based Autonomous Quadrotor Landing on Moving Ship

Kanpur, India
Aug 2023 – May 2024

- Published a **hardware-tested** pipeline to predict landing platform 6DoF motion and achieving touchdown, leveraging deep learning for UAV trajectory planning
- Used **Fractal ArUco markers** for estimating platform 6DoF pose at 60Hz using RGB stream from Intel **Realsense D435i** camera
- Deployed a **LSTM model** on **Jetson Nano TX2**, integrating **TF-TRT & quantization** to predict future pose of platform and iteratively predicted future **2 seconds** of platform 6DoF pose at **20Hz** allowing to plan an optimal landing window time
- Applied **QP Solver** calculating future 2s of optimal time-constrained trajectory waypoints in 0.1s for a real safe touchdown
- Tested the pipeline by landing a custom medium-duty quadrotor with **PX4** autopilot support on a **2PRS-1PRU manipulator** emulating ship-wave motion upto seastate 6

Wireless Sensor Network and IoT Laboratory, PI: Dr. Rajesh Hegde

Project Title: Using RL for traveling towards optimal wireless charging node in IoT network

Kanpur, India
Aug 2022 – May 2023

- Designed a **reinforcement learning (RL) framework** to optimize priority-based charging schedules in **low-power IoT networks**, addressing energy constraints
- Engineered a **custom vectorized Gym environment** using **PyBullet physics** to simulate a decentralized network of **10 IoT nodes**, enabling parallel training and scalable policy evaluation
- Benchmarked **TD3-PG, DDPG, and PPO algorithms**, with **TD3-PG** outperforming others by converging **20% faster** to optimal policies and achieving **35% higher cumulative rewards** in sparse-reward environments
- Published methodology in *IEEE TCAS-II* and *IEEE WF-IoT*, demonstrating applicability to smart city sensor networks and industrial IoT deployments

Publications

Vision-Based Autonomous Ship Deck Landing of Unmanned Aerial Vehicle using Fractal ArUco Marker

2025

C Prachand, **Rahul Rustagi**, R Shankar, J Singh, A Abhishek, K.S. Venkatesh

[10.2514/6.2025-2345](#) | AIAA SciTech Forum: Unmanned Aerial Systems Track

2024

Lifetime Improvement in Rechargeable Mobile IoT Networks Using Deep Reinforcement Learning

Aditya Singh, **Rahul Rustagi**, Rajesh M. Hegde

[10.1109/TCSII.2024.3370686](#) | IEEE Transactions on Circuits and Systems II: Express Briefs

2023

Mobile Energy Transmitter Scheduling in Energy Harvesting IoT Networks using Deep Reinforcement Learning

Aditya Singh, **Rahul Rustagi**, Surender Redhu, Rajesh M. Hegde

[10.1109/WF-IoT54382.2022.10152078](#) | IEEE 8th World Forum on Internet of Things

Robotics Projects

Multi-Scale Image Restoration & Motion Estimation via Nonlinear Diffusion

2025 – Present

- Developed a **Perona-Malik diffusion** model with Laplacian pyramid decomposition to enable noise reduction while preserving critical edge details.
- Leveraged geometric heat equations to reduce edge blurring by 20%.
- Formulated a variational energy functional for **optical flow** (Horn-Schunck) improving accuracy by 12%.

Deep Learning in Computer Vision

- Designed a Vision-Language Model using **CLIP** architecture trained on 20% of CIFAR-10 dataset using contrastive learning and aggressive augmentation.
- Implemented **Sfm** using SIFT features & epipolar geometry for 6DoF pose estimation.
- Reconstructed 3D scene geometry with less than 5% reprojection error using **COLMAP**.

CS6476 / GaTech
Aug 2024 – Dec 2024

Perception-Based Intelligent Robot Localization

- Boosted **JetAuto** robot localization reliability in dynamic environments by deploying **Bayesian sensor fusion** (Kalman filter variant), reducing positional drift by **20%** under sensor noise.
- Refined **Adaptive Monte Carlo Localization (AMCL)** estimates by integrating **g2o** graph optimization with real-time vision feedback

Carleton University
May 2023 – Dec 2023

Vision-Based Robotic Hand Dexterity using Inverse Kinematics (IK)

- Developed an autonomous pipeline for robotic hand object pickup using RGB-D stereo vision and Inverse Kinematics.
- Implemented SE(3) transformations with **tf2_ros** and utilized **Movelt** for end-effector planning.

IIT Kanpur / Robotics
Club
Mar 2023 – Jul 2023

Vision-Guided Payload Pickup-Delivery using Drone

- Developed an autonomous ROS pipeline for UAV payload pickup and drop-off.
- Employed grid-search with **QGroundControl** and **OpenCV** for 6DoF pose estimation using ArUco markers.

IIT Madras / Flipkart
GRID 4.0
Nov 2022 – Jan 2023

Positions of Responsibility

Graduate Teaching Assistant – CS3630 (Introduction to Perception and Robotics)

- Handling a total class of 600 students along with 20 other GTA students. Managing **Piazza** discussion forum and responsible for creating projects and making quizzes for students
- Using **WeBots** simulator to create projects on visual navigation and clearing student doubts regarding concepts on **bayesian modelling**

Jan 2025 – May 2025

Team Head: Software | Aerial Robotics – IIT Kanpur

- **Awarded Bronze Medal** in the Drona Pluto Swarm Challenge and secured a spot in the Final Round of Robotics Flipkart Grid 4.0, among top national teams.
- Led and mentored a **cross-functional team of 5 members** to design, develop, and maintain the **software stack** for a fleet of custom-built autonomous aerial robots.
- Spearheaded **full-cycle software development**, including real-time control systems, path planning algorithms, and swarm coordination logic for competition-ready UAVs.

May 2022 – May 2023

Technical Skills

Robotics Middleware: ROS1/ROS2, Webots, Gazebo, OpenCV, RealSense SDK, PX4, ArduPilot, MAVROS, SITL, HITL

Algorithms & Optimization: VLA Models, YOLO, SfM, ViO, SIFT, ORBSLAM2/3, Segment Anything Model, mIoUs

Programming / Frameworks: Python, C++, TensorFlow, PyTorch, MATLAB, IsaacSim, PyBullet, Eigen, SolidWorks, Movelt