Rahul Rustagi

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Education

Georgia Institute of Technology 2024–2026 *(Exp)*
Master of Science in Electrical and Computer Engineering

- GPA: 4.0/4.0
- Advisors: Sonia Chernova and Glen Chou
- Research: Uncertainty-Aware Active Perception

Indian Institute of Technology, Kanpur 2020–2024
Bachelor of Technology in Aerospace Engineering

- GPA: 9.18/10 (eq. to 3.85/4.0) : 2*nd Best Outgoing Departmental Student*
- Advisor: Dr. Abhishek
- B.Tech Thesis: Autonomous Landing of an Unmanned Aerial Vehicle on an Oscillating Platform
- Certificates / Minors: Machine Learning, Computer Systems, English Literature

Research Statement

My current research focus is at the intersection of robotics, perception, and machine learning, particularly for solving active reduction in uncertainty for perception systems. I am interested in understanding how robots reason about humans and environments when their perception is uncertain and ways that it can be improved.

Research Experience

Trustworthy Robotics Lab, Georgia Tech Aug 2025–Present
Graduate Researcher | *Project: Uncertainty-Aware Active Planning in Learned Latent Space*

- Quantified scene ambiguity using conformal prediction (torch-cods) on continuous scene representation (CSR), providing a rigorous measure of uncertainty to prevent unsafe decisions.
- Enhanced semantic perception by fine-tuning a DINOv3 foundation model on AI2THOR dataset, creating object embeddings that capture spatial and contextual relationships better than pre-trained models.
- Enabled safe navigation by integrating the BLIP Vision-Language Model (VLM) to interpret the scene and generate "safe sets"—context-aware constraints that guide the motion planner to avoid obstacles.

Robot Autonomy and Interactive Learning (RAIL) Lab, Georgia Tech 2025
Graduate Researcher | *Project: Semantic Proactive Assistance for Households*

- Built an end-to-end scene understanding system on Stretch RE2 robot enabling reasoning for assistance.
- Enhanced scene reconstruction by fine-tuning HRNet and EfficientNet segmentation models on the ADE20K dataset, achieving high-fidelity semantic understanding of complex indoor scenes.
- Enabled real-time 4D mapping by integrating ORB-SLAM3 with the *Khronos* system, generating Spatio-Temporal Scene Graphs that track how objects move and change over time.
- Authored a featured article in the Hello Robot Newsletter, releasing the system's architecture.

Intelligent Vision and Automation Laboratory (IVALab), Georgia Tech Fall 2024
Graduate Researcher | *Project: HeirOSLAM (Hierarchical Visual Odometry SLAM)*

- Architected a multi-modal sensor fusion framework, integrating IMU, LiDAR, and RGB streams to ensure robust state estimation in complex, GPS-denied environments.
- Optimized pose controllability by analyzing the Hessian matrix of the GTSAM factor graph, identifying and resolving unobservable directions in the visual-inertial system.
- Engineered a hierarchical state estimator coupling high-frequency DSOL visual odometry with global ORB-SLAM2 loop closures, balancing low-latency control with global consistency.

Helicopter and VTOL Laboratory, IIT Kanpur 2024
Undergraduate Researcher | *Project: Vision-Based Autonomous Quadrotor Landing*

- Authored a deep-learning-based control pipeline for autonomous ship deck landing, predicting 6-DoF platform motion to enable safe trajectory planning under uncertainty.
- Implemented high-speed pose estimation (60Hz) using Fractal ArUco markers, ensuring robust detection and localization from the Realsense D435i RGB stream during rapid descent.
- Trained a lightweight LSTM network to learn the dynamics of ship-sea interactions using SCONE dataset and predict future states of the ship-landing platform at 20Hz with 98% accuracy.

Industry Experience

Symbotic Summer 2025
Machine Learning Intern, Perception Team

- Engineered an automated ETL pipeline to curate warehouse sensor data, synthesizing high-fidelity depth ground truth directly from Amazon Ion telemetry logs to overcome data scarcity.
- Developed a domain-specific monocular depth estimator by fine-tuning KITTI-pretrained Vision Transformers (ViT), integrating DINOv2 embeddings with ResNet backbone for robustness.
- Validated the custom MonoDINO-DETR architecture, achieving 98.9% accuracy and 98.1% recall in predicting collision-triggering events (within 1ft error), significantly enhancing perception reliability.

Publications

Journals

- A. Singh, **R. Rustagi**, and R. M. Hegde, "Lifetime Improvement in Rechargeable Mobile IoT Networks Using Deep Reinforcement Learning," *IEEE Transactions on Circuits and Systems II: Express Briefs*, 2024.

Conferences

- C. Prachand, **R. Rustagi**, R. Shankar, J. Singh, A. Abhishek, and K. S. Venkatesh, "Vision-Based Autonomous Ship Deck Landing of an Unmanned Aerial Vehicle Using Fractal ArUco Markers," *AIAA SciTech*, 2025.
- A. Singh, **R. Rustagi**, S. Redhu, and R. M. Hegde, "Mobile Energy Transmitter Scheduling in Energy Harvesting IoT Networks using Deep Reinforcement Learning," *IEEE 8th World Forum on Internet of Things (WF-IoT)*, 2022.

Highlighted Projects

- Compressing Redundant 3D-Gaussian Splats (Georgia Tech ECE8803) Fall 2025
  - Integrated nerf-acc with spatially-adaptive regularization during 3DGS optimization
  - Achieved x25 compression with 26.2 PSNR, 0.91 SSIM and 0.141 LPIPS compared to 3DGS
- Resolving Stereo Disparity in 2D (Georgia Tech ECE 6560) Spring 2025
  - Formulated variational energy functional for optical flow enhancing motion estimation.
- Pick-n-Place using UAV (IIT Madras Tech Competition) Spring 2023
  - Implemented a hardware solution for search and grasping colored boxes using UAV
- MPC-Guided Landing of UAV (IIT Kanpur CS637) Fall 2022
  - Implemented an integration of MPC with RotorS UAV in Gazebo for position control

Teaching

- Graduate Teaching Assistant, Intro to Perception & Robotics (Georgia Tech CS 3630) Fall 2025
  - Held weekly office hours, prepared projects, graded exams working with Prof. Frank Dellaert
- Graduate Teaching Assistant, Intro to Perception & Robotics (Georgia Tech CS 3630) Spring 2025
  - Held weekly office hours, prepared projects, graded exams working with Prof. Sonia Chernova

Leadership & Mentoring

- Team Head, Aerial Robotics, IIT Kanpur 2023
  - Lead the team to secure Silver and Bronze medals at the national Inter-IIT Robotics Challenges.
  - Mentored 5+ junior members in control theory and embedded systems by organizing projects.
  - Secured funding through academic team advisor Dr. Ketan Rajawat and Dr. Twinkle Tripathy
- Student Counseling Service, IIT Kanpur 2022
  - Mentored 5 junior students during undergraduate for academic and emotional support

Awards & Honors

- **MITACS GRI Research Grant** (2023): Awarded to top 1% of global applicants.
- **Academic Excellence Awards** (2020, 2021, 2022, 2023):
  - Awarded by IIT Kanpur for exceptional performance (Top 10% in the entire cohort)
- **Bronze Medal**, Drona Aviation Challenge at Inter IIT Tech Meet 11.0 (2023).
  - Awarded for implementing a robust industry approved solution for pattern formation using drones
- **Recipient of Shiram Scholarship at CMI**: (2020)
  - Awarded by Chennai Mathematical Institute (CMI) to top 50 students in India CMI Examination

Skills

- **Programming:** Python, C++, MATLAB, LaTeX
- **Robotics Middleware:** ROS1/ROS2, Webots, Gazebo, IsaacSim, Unity3D, PyBullet, MoveIt, PX4
- **Algorithms & Libraries:** PyTorch, OpenCV, GTSAM, ORB-SLAM2/3, VIO, SfM, SAM, DINOv2