

# Kshitij Goel

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## Research Overview

I envision creating teams of robots that can adapt their agency and knowledge with environmental complexity while operating near their sensing, compute, and physical limits. To this end, I design efficient on-device algorithms, spatially-scalable data structures, and tractable probabilistic decision-making systems.

## Education

**Ph.D. in Robotics**, Carnegie Mellon University (CMU) Aug. 2021 – Dec. 2024

Thesis: [Communication-Efficient Active Reconstruction using Self-Organizing Gaussian Mixture Models](#)

Advisor: [Wennie Tabib](#)

Committee: [Wennie Tabib](#), [David Wettergreen](#), [Sebastian Scherer](#), [Nathan Michael](#), [Kostas Alexis](#)

Future Faculty Program Participant, Eberly Center for Teaching Excellence and Educational Innovation

**M.S. in Robotics (Research)**, Carnegie Mellon University (CMU) Aug. 2019 – Jul. 2021

Thesis: [Rapid Subsurface Exploration with Multiple Aerial Robots](#)

Advisor: [Nathan Michael](#)

Committee: [Nathan Michael](#), [Wennie Tabib](#), [David Wettergreen](#), [Paloma Sodhi](#)

**B.Tech. (Honors) in Aerospace Eng.**, Indian Institute of Technology Kharagpur May 2013 – May 2017

Thesis: [Reconfigurable Control for Damaged Fighter Aircraft](#)

Advisor: [Manoranjan Sinha](#)

## Employment

**Postdoctoral Fellow**, CMU (Manager: [Wennie Tabib](#)) Jan. 2025 – Present

**Graduate Research Assistant**, CMU (Managers: [Wennie Tabib](#), [Nathan Michael](#)) Aug. 2019 – Dec. 2024

**Research Assistant**, CMU (Manager: [Nathan Michael](#)) Aug. 2017 – Jul. 2019

**Robotics Institute Summer Scholar (RISS)**, CMU (Manager: [Nathan Michael](#)) Jun. 2017 – Jul. 2017

**Research Intern**, CMU (Manager: [Nathan Michael](#)) May 2016 – Jul. 2016

**Research Intern**, IIT Kanpur (Manager: [Abhishek](#)) May 2015 – Jul. 2015

**Research Assistant**, IIT Kharagpur (Managers: [Bijoy Mukherjee](#), [Manoranjan Sinha](#)) Jan. 2015 – Apr. 2017

## Awards and Honors

**Best Paper Award** 2024

Best paper at IEEE SSRR 2024. Out of 44 accepted papers.

**Alan J. Perlis SCS Graduate Student Teaching Award** 2024

Official citation: *For outstanding work in redesigning and teaching Mobile Robot Algorithms Laboratory, general excellence in teaching and student interaction, and dedication towards improving all courses he TA'd for.*

**Presidential Fellowship** 2023

One year fellowship towards PhD degree at CMU awarded by the CMU President and endowed by Uber Inc.

**King-Sun Fu Memorial Best Paper Award Honorable Mention** 2023

IEEE Transactions on Robotics (T-RO). Out of more than 200 accepted papers.

**Best Paper Award** 2022

Best paper at IEEE SSRR 2022. Out of 56 accepted papers.

**National Science Foundation (NSF) Ph.D. Student Travel Award** 2021

To attend the ISER conference and participate in the Doctoral Consortium.

**FICCI Fellow, Robotics Institute Summer Scholars (RISS) program** 2017

Amongst 5 out of 800 candidates.

Boeing-IIT Kharagpur University Relations Fellow

2015 – 2017

For best all-round performance in Aerospace Engineering, IIT Kharagpur. Amongst 2 out of 50 candidates.

## Publications [Google Scholar; 284+ citations, h-index: 8+]

Award-winning/award-nominated/lead-author publications are highlighted.

### Journal Articles

- J5. **Kshitij Goel** and Wennie Tabib. *Incremental Multimodal Surface Mapping via Self-Organizing Gaussian Mixture Models*. IEEE Robotics and Automation Letters (RAL) 2023. Impact Factor: 5.2
- J4. **Kshitij Goel**, Nathan Michael, and Wennie Tabib. *Probabilistic Point Cloud Modeling via Self-Organizing Gaussian Mixture Models*. IEEE Robotics and Automation Letters (RAL) 2023. [video] Impact Factor: 5.2
- J3. Wennie Tabib, **Kshitij Goel**, John Yao, Curtis Boirum, and Nathan Michael. *Autonomous Cave Surveying With an Aerial Robot*. IEEE Transactions on Robotics (T-RO) 2021. [video] **King-Sun Fu Memorial Best Paper Award Honorable Mention** Impact Factor: 7.8
- J2. Bijoy K Mukherjee, **Kshitij Goel**, and Manoranjan Sinha. *Automatic Control of an Asymmetric Fighter Aircraft Performing Supermanoeuvres*. Advances in Military Technology 2020.
- J1. Micah Corah, Cormac O'Meadhra, **Kshitij Goel**, and Nathan Michael. *Communication-Efficient Planning and Mapping for Multi-Robot Exploration in Large Environments*. IEEE Robotics and Automation Letters (RAL) 2019. [video] Impact Factor: 5.2

### Conference Publications

- C9. **Kshitij Goel** and Wennie Tabib. *Distance and Collision Probability Estimation from Gaussian Surface Models*. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) 2025. (Under Review)
- C8. Jonathan Lee, Abhishek Rathod, **Kshitij Goel**, John Stecklein, and Wennie Tabib. *Rapid Quadrotor Navigation in Diverse Environments using an Onboard Depth Camera*. IEEE International Symposium on Safety, Security, and Rescue Robotics (SSRR) 2024. **Best Paper Award**
- C7. **Kshitij Goel** and Wennie Tabib. *GIRA: Gaussian Mixture Models for Inference and Robot Autonomy*. IEEE International Conference on Robotics and Automation (ICRA) 2024. [code] Acceptance Rate: 44.83%
- C6. **Kshitij Goel**, Yves Georgy Daoud, Nathan Michael, and Wennie Tabib. *Hierarchical Collision Avoidance for Adaptive-Speed Multirotor Teleoperation*. IEEE International Symposium on Safety, Security, and Rescue Robotics (SSRR) 2022. [video] **Best Paper Award**
- C5. Yves Georgy Daoud, **Kshitij Goel**, Nathan Michael, and Wennie Tabib. *Collaborative Human-Robot Exploration via Implicit Coordination*. IEEE International Symposium on Safety, Security, and Rescue Robotics (SSRR) 2022. [video]
- C4. **Kshitij Goel**, Micah Corah, Curtis Boirum, and Nathan Michael. *Fast Exploration Using Multirotors: Analysis, Planning, and Experimentation*. Field and Service Robotics (FSR) 2021. [video]
- C3. **Kshitij Goel**, Wennie Tabib, and Nathan Michael. *Rapid and High-Fidelity Subsurface Exploration with Multiple Aerial Robots*. International Symposium on Experimental Robotics (ISER) 2021. [video]

- C2. [Wennie Tabib](#), **Kshitij Goel**, [John Yao](#), [Mosam Dabhi](#), [Curtis Boirum](#), and [Nathan Michael](#). *Real-Time Information-Theoretic Exploration with Gaussian Mixture Model Maps*. Robotics: Science and Systems (RSS) 2019. [video] Acceptance Rate: 31%
- C1. [Alex Spitzer](#), [Xuning Yang](#), [John Yao](#), [Aditya Dhawale](#), **Kshitij Goel**, [Mosam Dabhi](#), [Matt Collins](#), [Curtis Boirum](#), and [Nathan Michael](#). *Fast and Agile Vision-Based Flight with Teleoperation and Collision Avoidance on a Multirotor*. International Symposium on Experimental Robotics (ISER) 2018. [video]

## Theses

- T3. **Kshitij Goel**. *Communication-Efficient Active Reconstruction using Self-Organizing Gaussian Mixture Models*. PhD Thesis, Carnegie Mellon University 2024. [talk]
- T2. **Kshitij Goel**. *Rapid Subsurface Exploration with Multiple Aerial Robots*. MS Thesis, Carnegie Mellon University 2021. [talk]
- T1. **Kshitij Goel**. *Reconfigurable Control for Damaged Fighter Aircraft*. BTech Thesis, Indian Institute of Technology Kharagpur 2017. **Best Undergraduate Thesis in Aerospace Engineering Nomination**

## Reports

- R1. **Kshitij Goel**, [Micah Corah](#), and [Nathan Michael](#). *Fast Exploration Using Multirotors: Analysis, Planning, and Experimentation*. Technical Report CMU-RI-TR-19-03, Carnegie Mellon University 2019.

## Invited Talks

1. *Introduction to Robotic Exploration (16-761 Mobile Robots, Invited Lecture)*, Carnegie Mellon University (CMU) 2024
2. *Fast Exploration using Multirotors*, Robotics Institute Summer Scholars (RISS) 2020

## Teaching

**Mobile Robot Algorithms Laboratory** (CMU 16-362), Co-Instructor with Prof. Wennie Tabib Fall 2023

Designed learning objectives. Wrote an initial draft of the course syllabus. Created and delivered 11 out of 22 lectures. Created presentation materials and two lab assignments from scratch. Average one to two hours per week in office hours. Coordinated two guest lectures. Applied the pedagogical skills learnt during the Eberly Future Faculty program.

**Computer Vision** (CMU 16-720, Prof. Deva Ramanan), Teaching Assistant Fall 2022

Lead-TA for a homework on Homography. Preparing the handout, releasing the assignment, updating the rubrics, and leading the grading with other TAs. Grading other assignments with 5 other TAs. Office hours once per week.

**Statistical Techniques in Robotics** (CMU 16-831, Prof. Kris Kitani), Teaching Assistant Spring 2022

Leading homework creation for 2 out of 5 homeworks. Co-lead for 1 out of the other three. Proof-read the assignment write-ups, introduced one new problem for the students in each of the assignments I led. Setting up and co-maintaining the GitHub infrastructure for the students to submit scribe notes and get feedback on their technical writing.

Grading for all homeworks (with my co-TA). Two hours per week for office hours in which students can come ask questions. Holding problem review sessions (during some of the office hours) where we walk through some of the difficult problems for the students.

## Mentoring

**Mike Anoruo** Ph.D. in Robotics at RI, CMU

2025 – Present

Terrain-aware stealthy navigation in contested and adversarial 3D environments.

**Nicole Chan** Ph.D. in Robotics at RI, CMU 2025 – Present

Multi-camera visual-inertial odometry for SWaP-constrained aerial systems.

**Jonathan Lee** MS in Robotics (Research) at RI, CMU 2023 – Present

Robust collision avoidance methods via traditional and end-to-end learning methods for aerial vehicles equipped with noisy RGB-D cameras.

**Akshay Chekuri** Integrated BS/MS in ECE, CMU (Now at Shield AI) 2022 – 2024

Visual-inertial odometry system for energy-constrained aerial robots to enable high-altitude flight in visually-degraded environments.

**Rohan Dhesikan** Integrated BS/MS in ECE, CMU (Now at Tesla Autopilot) 2022 – 2023

Safe, adaptive-speed teleoperated flight through narrow tunnels by automatically following the center line of the tunnels.

**Yves Georgy Daoud** MS in Robotics (Research) at RI, CMU (Now at Agility Robotics) 2021 – 2022

Collaborative exploration of unseen workspace by a human-robot team.

## Academic Service

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### Organizing Committee

Gaussian Representations for Robot Autonomy: Challenges and Opportunities (RSS 2025 Workshop) 2025

GIRA: Gaussian Mixture Models for Inference and Robot Autonomy (RSS 2023 Tutorial) 2023

Robotics Institute Summer Scholars (RISS) 2018

### Thesis Committee

David Russell, MS in Robotics (Research) at RI, CMU 2022 – 2023

### Reviewing

Autonomous Robots 2024 – Present

IEEE Robotics and Automation Letters (RAL) 2018 – Present

IEEE International Conference on Robotics and Automation (ICRA) 2018 – Present

IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) 2020 – Present

International Symposium on Robotics Research (ISRR) 2022

IEEE International Symposium on Safety, Security, and Rescue Robotics (SSRR) 2022 – Present

## Community Service

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Pittsburgh Regional Science and Engineering Fair (Category Judge, Engineering and Robotics) 2024

Served as a judge at a large engineering and science fair organized by the Carnegie Science Center. Reviewed and provided feedback to 7th and 8th grade students on their projects.

National Service Scheme (Team Leader, Unit-9) 2013 – 2016

Promoted educational inclusiveness by leading a group of undergraduate students at IIT Kharagpur towards educating underprivileged children in the poor neighborhoods of the university.

## Selected Open-Source Software Contributions

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1. [gira3d/gira3d-reconstruction](#) | ★27 | *SOGMM-based Reconstruction System on CPU and GPU* 2023
2. [gira3d/sogmm\\_py](#) | ★2 | *Self-Organizing Gaussian Mixture Models (Python)* 2023
3. [gira3d/sogmm\\_open3d](#) | ★1 | *Self-Organizing Gaussian Mixture Models (CUDA C)* 2023
4. [gira3d/self\\_organizing\\_gmm](#) | ★2 | *Self-Organizing Gaussian Mixture Models (C++)* 2023