# Akash Patel, PhD

Robotics Autonomy Researcher and Engineer

Postdoctoral robotics researcher with a PhD in autonomous exploration and navigation for aerial, legged, and ground robots in GPS-denied environments. Specializing in onboard exploration planning, traversability-aware navigation, and multi-robot autonomy in C++ on ROS and ROS 2, with fully autonomous field missions in an Icelandic lava tube and an operating underground mine. Background in aerospace engineering.

## Field deployments

**2025**
Raufarhólshellir, Iceland

Custom quadrotor
3D LiDAR
VectorNav IMU
Pixhawk Cube Orange
Intel NUC i5

planner STAGE

### Autonomous Aerial Exploration of a Lava Tube

In collaboration with volcanologists at Durham University.

- Deployed a custom LiDAR quadrotor that explored, mapped, and returned after a single start command, without GPS or pilot input, covering more than 1 km of passage over several flights.
- Ran the STAGE planner onboard under a mission behavior tree (exploration, waypoint navigation, return to home).

**2021 – 2025**
Operating underground mine

Lava tube quadrotor
same software stack

planner STAGE

### Rockfall Inspection in an Operating Underground Mine

- Flew autonomous inspection missions at several sites in one network of drifts after seismic activity or blasting, launching from a safe staging area.
- Returned point clouds and meshes of collapsed roof sections, debris piles, and blockages, planning densely near damaged roof and sparsely over rubble, mesh, and pipes.
- Completed every flight autonomously after a single start command, without safety-pilot intervention.

**ICRA 2025**
Underground missions

Clearpath Husky A200
custom quadrotor

planner STAGE 2.0

### Ground-Aerial Exploration with a Husky and a Quadrotor

- Developed a planner in which a ground robot and a quadrotor share one hierarchy of graphs carrying geometric and semantic traversability.
- Tested in real underground missions: the ground robot marks terrain it cannot cross, and the quadrotor continues past it without a full map transfer.

**ICRA 2024**
Underground tunnel

Boston Dynamics Spot
Velodyne Puck Lite
RealSense D455
VectorNav VN-100
Intel NUC 10

planner STAGE

### Exploration and Replanning on Boston Dynamics Spot

- Deployed the STAGE planner on Spot and compared it against the GBP planner.
- Demonstrated replanning when a door closed behind the robot out of sight: the planner invalidated the blocked route and continued to the remaining frontiers without rebuilding the global map.

**2021 – 2024**
Mine shafts and drifts

NexGen SIMS
Team result

### Shaft Inspection and Post-Blast Gas Measurement

Results of the LTU robotics team (NexGen SIMS, Horizon 2020).

- Contributed to a drone that explored a vertical mine shaft without a pilot and built a 3D model of it.
- Contributed to drone flights that measured gases after blasting, so that crews know when the face is clear.

## Planner lineage

| REF | Rolling graph | ERRT | STAGE | STAGE 2.0 |
|---|---|---|---|---|
| 2023 | 2023 | 2024 | 2024 | 2025 |
| JINT 2023, RAS 2024 | IFAC World Congress 2023 | IEEE T-RO 2024 | ICRA 2024 | ICRA 2025 |
| Quadrotor | Quadrotor | Quadrotor | Quadrotor, Spot | Husky A200 and quadrotor |

## Contact


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## Skills

**Autonomy**
Frontier, sampling-based, and graph-based exploration planning; traversability estimation; 3D scene graphs; multi-robot coordination; behavior trees; NMPC trajectory tracking

**Software**
C++; Python; MATLAB; ROS and ROS 2; Gazebo; PX4 with MAVROS; OctoMap and Voxblox; Docker (multi-architecture, including NVIDIA Jetson AGX Orin); CUDA; Git and GitLab CI; Linux

**Robots**
Boston Dynamics Spot; Unitree G1 EDU humanoids; Unitree Go1 quadrupeds; custom quadrotors; Clearpath Husky

**Sensors and compute**
3D LiDAR (Velodyne, Ouster); VectorNav IMUs; Intel RealSense D455; Pixhawk Cube Orange; Intel NUC; event camera

## Education

**PhD, Robotics and AI**
Luleå University of Technology
2021 – 2025
Thesis: Advanced Exploration and Navigation Autonomy for Robots in Complex GPS-denied Environments
Advisors: Prof. George Nikolakopoulos and Assoc. Prof. Christoforos Kanellakis
Faculty opponent: Prof. Panagiotis Tsiotras, Georgia Institute of Technology
Defended: November 17, 2025

**M.Sc., Space Science and Technology**
Erasmus Mundus SpaceMaster, Luleå University of Technology
2018 – 2020
Thesis: Design, Modelling and Control of a Space UAV for Mars Exploration

**B.Tech., Aerospace Engineering**
University of Petroleum and Energy Studies (UPES), Dehradun, India
2014 – 2018
Final-year project: UAV for the thin atmosphere and low gravity of Mars

## Experience

### Luleå University of Technology
Luleå, Sweden

Robotics and AI Group

**Postdoctoral Researcher** — Dec 2025 – Present

- Lead Work Packages 4 and 5 of the Horizon Europe project PERSEPHONE, covering multi-robot mapping, ore detection, drill path planning, and task scheduling for robotic mining machines.
- Independently drafted and prepared LTU's section of the ROX6G research proposal, funded by Horizon Europe with EUR 600,000 allocated to the robotics group.
- Extend the exploration stack toward 3D scene graphs and vision-language traversability estimation; co-authored GenLaM (ICRA 2026) and TRACE (arXiv, 2026).
- Teach lectures and labs in Robotics and AI (R7010E) and supervise M.Sc. thesis students.

**Doctoral Researcher** — Mar 2021 – Nov 2025

- Developed five onboard exploration planners in C++ on ROS: REF, ERRT (IEEE T-RO 2024, co-developed), a traversability-aware rolling-graph planner, STAGE (ICRA 2024), and STAGE 2.0 for ground-aerial teams (ICRA 2025).
- Integrated the planners with LiDAR-inertial state estimation, NMPC trajectory tracking on aerial platforms, and a mission behavior tree for exploration, waypoint inspection, and return to home.
- Led LTU's work in Work Packages 4 and 6 of IlluMINEation (Horizon 2020) on drone exploration and mapping for inspection and first response; contributed to NexGen SIMS as a team member.
- Began doctoral research within LTU's part of team CoSTAR (NASA JPL, Caltech, MIT, KAIST) in the DARPA Subterranean Challenge.

### KUKA Systems Aerospace
Toulouse, France

**R&D Intern** — Apr – Sep 2017

- Developed end-effector concepts for automated drilling and fastening on aircraft assembly lines, and modular end-effector parts for KUKA industrial robots.

## Open source

**STAGE** C++, ROS
ICRA 2024 planner, used in the lava tube and rockfall missions.

**RGE** C++, ROS
Rolling-graph exploration planner (IFAC World Congress 2023).

**TravBlox** C++, ROS 2, 30 stars
ROS 2 port of Voxblox with traversability as a fourth voxel state.

**px4_comm** C++
Bridge between PX4 flight controllers and the ROS stack.

**ExplorationRRT** C++, ROS, 224 stars
Next-best-trajectory planner (IEEE T-RO 2024), with Björn Lindqvist.

**REF** C++, ROS, Docker
Rapid exploration framework, in Docker with a simulated cave.

**confidence_mapper** C++
2.5D mapping with elevation, slope, and traversability confidence.

**Mars_Coaxial_Quadrotor** MATLAB
Design, model, and MPC of a coaxial quadrotor for Mars.

## Selected publications

**A tree-based next-best-trajectory method for 3-D UAV exploration**
B. Lindqvist, **Akash Patel**, K. Löfgren and G. Nikolakopoulos IEEE Transactions on Robotics, vol. 40, pp. 3496-3513, 2024

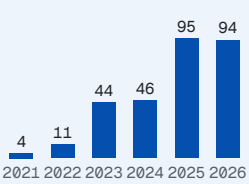
**Towards field deployment of MAVs in adaptive exploration of GPS-denied subterranean environments**
**Akash Patel**, S. Karlsson, B. Lindqvist, J. Haluska, C. Kanellakis, A. Agha-mohammadi and G. Nikolakopoulos Robotics and Autonomous Systems, vol. 176, 104663, 2024

**A hierarchical graph-based terrain-aware autonomous navigation approach for complementary multimodal ground-aerial exploration**
**Akash Patel**, M. A. V. Saucedo, N. Stathoulopoulos, V. N. Sankaranarayanan, I. Tevetzidis, C. Kanellakis and G. Nikolakopoulos IEEE ICRA, pp. 15879-15885, 2025

**SPADE: Towards scalable path planning architecture on actionable multi-domain 3D scene graphs**
V. K. Viswanathan, **Akash Patel**, M. A. V. Saucedo, S. G. Satpute, C. Kanellakis and G. Nikolakopoulos IEEE/RSJ IROS, pp. 17510-17517, 2025

**STAGE: Scalable and traversability-aware graph based exploration planner for dynamically varying environments**
**Akash Patel**, M. A. V. Saucedo, C. Kanellakis and G. Nikolakopoulos IEEE ICRA, pp. 5949-5955, 2024

## Research record




297 citations
10 h-index
10 i10-index

Citations per year, as of November 25, 2026. Source: Google Scholar. The figure for 2026 is the year to date.

## Funding and projects

**ROX6G**
Horizon Europe, 2026

**Extreme Environment Robotized Inspection Beyond Line of Sight**
Industry-university research foundation, 2026, three years

**PERSEPHONE**
Horizon Europe, grant 101138451, 2024 – 2026

**IlluMINEation**
Horizon 2020, grant 869379, 2020 – 2023

**NexGen SIMS**
Horizon 2020, grant 101003591, 2021 – 2024

**SUM Academy, SP14**
Industry-funded

## Reviewing

IJRR, IEEE T-RO, IEEE RA-L, IEEE/ASME Transactions on Mechatronics, Robotics and Autonomous Systems, JINT, ICRA, IROS, and ROBIO.

## Languages

English (full professional)
Hindi and Gujarati (native)
Swedish (basic)

## From aerospace to robotics

2014 B.Tech. in Aerospace Engineering, Dehradun; UAV design for Mars.
2017 R&D internship, KUKA Systems Aerospace, Toulouse.
2018 Erasmus Mundus SpaceMaster, Sweden; coaxial quadrotor for Mars.
2021 PhD in Luleå, beginning within team CoSTAR (DARPA Subterranean Challenge).
2025 Postdoctoral research in Luleå, after the lava tube flights in Iceland.