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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linkedin.com/in/aakapatel
Google Scholar
orcid.org/0000-0002-0020-6020

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

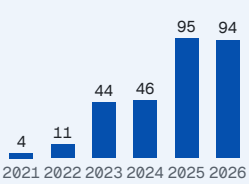
Towards field deployment of MAVs in adaptive exploration of GPS-denied subterranean environments
Akash Patel, S. Karlsson, B. Lindqvist, J. Haluska, C. Kanellakis, A. Agha-mohammadi and G. Nikolakopoulos Robotics and Autonomous Systems, vol. 176, 104663, 2024

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.

Publications

Journal articles

J1 2026
From entities to areas: A semantically driven clustering approach for area delimitation on 3D scene graphs
M. A. V. Saucedo, **Akash Patel**, T.-F. Blounas, C. Kanellakis and G. Nikolakopoulos
Mechatronics, vol. 117, 103505, 2026 doi:10.1016/j.mechatronics.2026.103505

J2 2024
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 doi:10.1109/TRO.2024.3422052

J3 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 doi:10.1016/j.robot.2024.104663

J4 2024
EAT: Environment agnostic traversability for reactive navigation
M. A. V. Saucedo, **Akash Patel**, C. Kanellakis and G. Nikolakopoulos
Expert Systems with Applications, vol. 244, 122919, 2024 doi:10.1016/j.eswa.2023.122919

J5 2023
Towards energy efficient autonomous exploration of Mars lava tube with a Martian coaxial quadrotor
Akash Patel, S. Karlsson, B. Lindqvist, C. Kanellakis, A.-A. Agha-Mohammadi and G. Nikolakopoulos
Advances in Space Research, vol. 71, no. 9, pp. 3837–3854, 2023 doi:10.1016/j.asr.2022.11.014

J6 2023
REF: A rapid exploration framework for deploying autonomous MAVs in unknown environments
Akash Patel, B. Lindqvist, C. Kanellakis, A.-A. Agha-Mohammadi and G. Nikolakopoulos
Journal of Intelligent & Robotic Systems, vol. 108, no. 3, 35, 2023 doi:10.1007/s10846-023-01836-z

J7 2023
The Dvaraka initiative: Mars's first permanent human settlement capable of self-sustenance
A. Mukundan, **Akash Patel**, B. Shastri, H. Bhatt, A. Phen and H.-C. Wang
Aerospace, vol. 10, no. 3, 265, 2023 doi:10.3390/aerospace10030265

Conference papers

C1 2026
GenLaM: Generative layered mesh for multi-modal sensor emulation in robotics
A. S. Bais, **Akash Patel**, C. Kanellakis and G. Nikolakopoulos
IEEE ICRA, pp. 10067–10074, 2026 doi:10.1109/ICRA57385.2026.11696216

C2 2025
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 doi:10.1109/ICRA55743.2025.11128079

C3 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 doi:10.1109/IROS60139.2025.11246795

C4 2024
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 doi:10.1109/ICRA57147.2024.10610939

C5 2024
Belief scene graphs: Expanding partial scenes with objects through computation of expectation
M. A. V. Saucedo, **Akash Patel**, A. Saradagi, C. Kanellakis and G. Nikolakopoulos
IEEE ICRA, pp. 9441–9447, 2024 doi:10.1109/ICRA57147.2024.10611352

C6 2024
Leveraging computation of expectation models for commonsense affordance estimation on 3D scene graphs
M. A. V. Saucedo, N. Stathoulopoulos, **Akash Patel**, C. Kanellakis and G. Nikolakopoulos
IEEE/RSJ IROS, pp. 9797–9802, 2024 doi:10.1109/IROS58592.2024.10802560

C7 2024
DRONECOM: Dynamic relay operations for network efficient communication in mines
Akash Patel, S. Fredriksson, S. Nordström, E. Pagliari, I. Tevetzidis, C. Kanellakis and G. Nikolakopoulos
ICCAS, pp. 1206–1211, 2024 doi:10.23919/ICCAS63016.2024.10773079

C8 2024
TFMarker: A tangible fiducial pattern for enabling camera-assisted guided landing in SubT environments
M. A. V. Saucedo, **Akash Patel**, N. Dahlquist, Y. Bai, B. Lindqvist, C. Kanellakis and G. Nikolakopoulos
ICCAS, pp. 1212–1217, 2024 doi:10.23919/ICCAS63016.2024.10773374

C9 2023
Traversability aware graph-based subterranean exploration with unmanned aerial vehicles
Akash Patel, C. Kanellakis, A.-A. Agha-Mohammadi and G. Nikolakopoulos
IFAC World Congress, IFAC-PapersOnLine vol. 56, no. 2, pp. 9263–9268, 2023 doi:10.1016/j.ifacol.2023.10.072

C10 2023
Event camera and LiDAR based human tracking for adverse lighting conditions in subterranean environments
M. A. V. Saucedo, **Akash Patel**, R. Sawlekar, A. Saradagi, C. Kanellakis, A.-A. Agha-Mohammadi and G. Nikolakopoulos
IFAC World Congress, IFAC-PapersOnLine vol. 56, no. 2, pp. 9257–9262, 2023 doi:10.1016/j.ifacol.2023.10.008

C11 2023
Multi agent coordination strategy for collaborative exploration of GPS-denied environments
Akash Patel, C. Kanellakis and G. Nikolakopoulos
IEEE ROBIO, 2023 doi:10.1109/ROBIO58561.2023.10354634

C12 2023 **Memory enabled segmentation of terrain for traversability based reactive navigation**
M. A. V. Saucedo, **Akash Patel**, C. Kanellakis and G. Nikolakopoulos
IEEE ROBIO, 2023 doi:10.1109/ROBIO58561.2023.10354930

C13 2022 **Design and model predictive control of a Mars coaxial quadrotor**
Akash Patel, A. Banerjee, B. Lindqvist, C. Kanellakis and G. Nikolakopoulos
IEEE Aerospace Conference, 2022 doi:10.1109/AERO53065.2022.9843799

C14 2022 **Fast planner for MAV navigation in unknown environments based on adaptive search of safe look-ahead poses**
Akash Patel, B. Lindqvist, C. Kanellakis and G. Nikolakopoulos
MED, pp. 545–550, 2022 doi:10.1109/MED54222.2022.9837293

C15 2022 **Traversable frontiers based autonomous exploration strategy for deploying MAVs in subterranean environments**
Akash Patel, C. Kanellakis and G. Nikolakopoulos
Indian Control Conference, pp. 260–265, 2022 doi:10.1109/ICC56513.2022.10093322

Book chapters

B1 2023 **Modeling for ARWs**
Akash Patel, A. Papadimitriou and A. Banerjee
Aerial Robotic Workers, Butterworth-Heinemann, ch. 3, pp. 31–47 doi:10.1016/B978-0-12-814909-6.00009-3

B2 2023 **Control of ARWs**
Akash Patel, A. Banerjee, A. Papadimitriou and B. Lindqvist
Aerial Robotic Workers, Butterworth-Heinemann, ch. 4, pp. 49–65 doi:10.1016/B978-0-12-814909-6.00010-X

B3 2023 **Exploration with ARWs**
Akash Patel, S. Karlsson, B. Lindqvist and A. Koval
Aerial Robotic Workers, Butterworth-Heinemann, ch. 7, pp. 109–127 doi:10.1016/B978-0-12-814909-6.00013-5

Space systems design papers

S1 2023 **Novel design of a sweeping 6-degree of freedom lunar penetrating radar**
A. Mukundan, **Akash Patel**, K. D. Saraswat, A. Tomar and H.-C. Wang
AIAA AVIATION Forum, 2023 doi:10.2514/6.2023-4124

S2 2023 **SpiralLift mechanism based drill for deep subsurface lunar exploration**
A. Mukundan, **Akash Patel**, K. D. Saraswat, A. Tomar and H.-C. Wang
AIAA AVIATION Forum, 2023 doi:10.2514/6.2023-4123

S3 2023 **Design of a foldable laser-based energy transmission system for a mini lunar rover**
A. Mukundan, **Akash Patel**, K. D. Saraswat, A. Tomar and H.-C. Wang
ICECCME, 2023 doi:10.1109/ICECCME57830.2023.10252208

S4 2022 **Kalam Rover**
A. Mukundan, **Akash Patel**, K. D. Saraswat, A. Tomar and T. Kuhn
AIAA SciTech Forum, 2022 doi:10.2514/6.2022-1047

Preprints

P1 2026 **TRACE: Traversability-aware reactive navigation via VLM-driven adaptive constraints estimation**
M. A. V. Saucedo, M. E. Kunnath, E. Small, **Akash Patel**, S. Kotpalliwar, C. Kanellakis and G. Nikolakopoulos
arXiv:2610.30994, 2026 arxiv.org/abs/2610.30994

P2 2026 **Towards spatial perception for heterogeneous robot collaboration in subterranean mining environments**
M. A. V. Saucedo, **Akash Patel**, C. Kanellakis and G. Nikolakopoulos
arXiv:2609.37419, 2026 arxiv.org/abs/2609.37419

P3 2023 **Deployment of autonomous UAVs in underground mines: Field evaluations and use-case demonstrations**
B. Lindqvist, N. Stathoulopoulos, S. Karlsson, Y. Bai, J. Haluska, I. Tevetzidis, A. Koval, C. Kanellakis, G. Nikolakopoulos and **Akash Patel**
SSRN 4374895, 2023 doi:10.2139/ssrn.4374895

Theses

T1 2025 **Advanced Exploration and Navigation Autonomy for Robots in Complex GPS-denied Environments**
Akash Patel
doctoral thesis, Luleå University of Technology, 2025. ISBN 978-91-8048-907-2 ltu.diva-portal.org

T2 2023 **Towards Enabling Exploration of Planetary Subterranean Environments using Unmanned Aerial Vehicles**
Akash Patel
licentiate thesis, Luleå University of Technology, 2023

T3 2021 **Design, Modelling and Control of a Space UAV for Mars Exploration**
Akash Patel
M.Sc. thesis, Luleå University of Technology, 2021 ltu.diva-portal.org

Funding and projects

2026 — **ROX6G** Horizon Europe
Independently drafted and prepared LTU's section of the proposal. EUR 600,000 allocated to the LTU robotics group within a larger consortium.

2026, three years — **Extreme Environment Robotized Inspection Beyond Line of Sight** Industry-university research foundation
SEK 13 million. Application builds on doctoral research and on SUM Academy SP14; led by the group's professor as principal investigator, with a minor contribution to the application.

2024 - 2026 — **PERSEPHONE** Horizon Europe, grant 101138451
Lead Work Packages 4 and 5 on multi-robot mapping, ore detection, drill path planning, and task scheduling.

2020 - 2023 — **IlluMINEation** Horizon 2020, grant 869379
Led LTU's work in Work Packages 4 and 6 on drone exploration and mapping for inspection and first response.

2021 - 2024 — **NexGen SIMS** Horizon 2020, grant 101003591
Member of the LTU robotics team.

SUM Academy, SP14 Industry-funded
Managed and developed the tasks on rockfall assessment and on search and rescue with autonomous robots in underground mines.

Teaching, supervision, and reviewing

Teaching — Lectures and labs in Robotics and Artificial Intelligence (R7010E), Luleå University of Technology; lectures in a MOOC on robotic systems.

Supervision — M.Sc. thesis students in the Robotics and AI Group.

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

References

Prof. George Nikolakopoulos, Robotics and AI Group, Luleå University of Technology (PhD advisor).

Assoc. Prof. Christoforos Kanellakis, Robotics and AI Group, Luleå University of Technology (PhD co-advisor).

Prof. Edward W. Llewellin, Professor of Volcanology, Durham University (collaborator, Iceland lava tube campaign).

Contact details are available on request.