

Gabriel Manuel Garcia

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SUMMARY

PhD researcher in Planetary Robotics at the University of Luxembourg, specializing in LiDAR-based terrain traversability, roughness estimation, and autonomous rover perception for challenging environments such as lunar-like terrain, caves, and mines. My research focuses on improving rover autonomy through 3D LiDAR perception, IMU-based validation, point-cloud processing, and ROS2-compatible traversability algorithms.

I hold a Master's degree in Computer Science with a specialization in Artificial Intelligence, a Master's degree in Entrepreneurship, and completed a CPGE, an intensive two-year Mathematics and Physics preparatory program for French engineering schools. My experience combines robotics research, software development, field robotics experiments, teaching, and space robotics outreach.

EXPERIENCE

PhD Candidate in Robotics – Underground Environment Traversability

2022 – Present

University of Luxembourg

Luxembourg, Luxembourg

- Conducting research on LiDAR-based terrain traversability for mobile robots operating in unstructured and underground environments
- Developed and tested algorithms using 3D point clouds and IMU measurements to estimate terrain roughness and support rover navigation
- Designed grid-based terrain representations combining point-cloud features and IMU-derived roughness for traversability assessment
- Tested rover platforms equipped with 3D LiDAR and IMU sensors in mines, caves, and lunar-analogue environments
- Developed a procedural underground environment generation framework, currently extending it toward pyroclastic structures
- Integrated traversability algorithms into ROS2-compatible robotic software architectures
- Explored AI-based approaches for predicting terrain roughness from point-cloud data, with real-time correction using IMU feedback

Teaching Assistant – Introduction to Space Robotics

2022 – Present

University of Luxembourg

Luxembourg, Luxembourg

- Assisted in teaching space robotics concepts, including rover autonomy, perception, mobility, and mission constraints
- Supported students during lectures, practical activities, and technical discussions
- Helped communicate complex robotics and planetary exploration concepts in an accessible and structured way
- Assisted with course preparation and discussions related to robotic platforms, space exploration, and autonomous systems

Science Outreach Facilitator – Lunar Robotics Demonstration

2022 – Present

University of Luxembourg / Public Outreach Events

Luxembourg, Luxembourg

- Facilitated interactive public robotics demonstrations simulating lunar exploration scenarios
- Managed a demonstration environment containing fake lunar regolith and remotely controlled robotic platforms
- Helped participants experience the impact of communication delay between Earth and the Moon through hands-on robot control

EDUCATION

University of Luxembourg

2022 – 2026

PhD in Robotics – Planetary Robotics / Underground Environment Traversability

Luxembourg, Luxembourg

- Research focused on LiDAR-based terrain traversability, roughness estimation, rover perception, and autonomous navigation in underground and lunar-analogue environments

UTBM – Université de Technologie de Belfort-Montbéliard

2021 – 2022

Master's Degree in Entrepreneurship

Belfort, France

- Training in innovation, entrepreneurship, business strategy, and technology-oriented project development

UTBM – Université de Technologie de Belfort-Montbéliard

2019 – 2022

Master's Degree in Computer Science – Artificial Intelligence Specialization

Belfort, France

- Specialization in Artificial Intelligence during the final six months, with a focus on software engineering, machine learning, computer vision, and autonomous systems

CPGE – Classe Préparatoire aux Grandes Écoles

Intensive Two-Year Mathematics and Physics Preparatory Program

2016 – 2019

Paris, France

- Intensive undergraduate-level preparation in mathematics and physics for competitive entrance examinations to French engineering schools

SELECTED PROJECTS

LiDAR-Based Terrain Traversability

Roughness estimation for rover navigation

- Developed methods to estimate terrain roughness from 3D LiDAR point clouds and IMU measurements
- Designed grid-based terrain representations combining point-cloud features and roughness information

Procedural Underground Environment Generation

Simulation framework for planetary robotics

- Developed a framework for generating procedural underground environments for robotic simulation
- Currently extending the framework toward pyroclastic-like structures for planetary exploration scenarios

ROS2 Traversability Wrapper

Robotic software integration

- Integrated traversability algorithms into a ROS2-compatible architecture for mobile robotic platforms

Underground Rover Experiments

Field testing with LiDAR- and IMU-equipped robots

- Conducted rover experiments in mines, caves, and lunar-analogue environments using 3D LiDAR and IMU sensors

TECHNICAL SKILLS

Robotics: Mobile robotics, planetary robotics, rover systems, terrain traversability, roughness estimation, field robotics

Perception & Sensors: 3D LiDAR, point clouds, IMU, cameras, OpenCV, LiDAR-IMU processing

Software: ROS2, Python, C++, Linux, Git, robotic software integration

AI & Data: Machine learning, computer vision, AI-based roughness prediction, grid-based terrain representations

Simulation & Platforms: Procedural underground environments, Leo Rover, NVIDIA Jetson Orin, 3D-printed robotic systems

LANGUAGES

French: Native — **English:** Professional working proficiency

PUBLICATIONS

Loïck Pierre Chovet, Gabriel Manuel Garcia, Abhishek Bera, Antoine Richard, Kazuya Yoshida, and Miguel Angel Olivares-Mendez. "Performance Comparison of ROS2 Middlewares for Multi-robot Mesh Networks in Planetary Exploration." *Journal of Intelligent & Robotic Systems*, vol. 111, no. 1, article 18, 2025.

Dave van der Meer, Loïck Chovet, Gabriel Manuel Garcia, Abhishek Bera, and Miguel Angel Olivares-Mendez. "REALMS2 – Resilient Exploration And Lunar Mapping System 2 – A Comprehensive Approach." *IEEE/RSJ International Conference on Intelligent Robots and Systems*, 2025.

Gabriel Manuel Garcia, Antoine Richard, and Miguel Olivares-Mendez. "PLUME: Procedural Layer Underground Modeling Engine." *arXiv preprint arXiv:2508.20926*, 2025.

Gabriel Manuel Garcia et al. "AMAZEING: A Challenging Maze SLAM Dataset." *Manuscript in preparation*.

Gabriel Manuel Garcia et al. "PLUME-Advanced: Procedural Lava Tube Generation for Planetary Robotics Simulation." *Manuscript in preparation*.

Gabriel Manuel Garcia et al. "Traversability Graphs: A Graph-Based Representation of Terrain Costmaps for Rover Navigation." *Manuscript in preparation*.