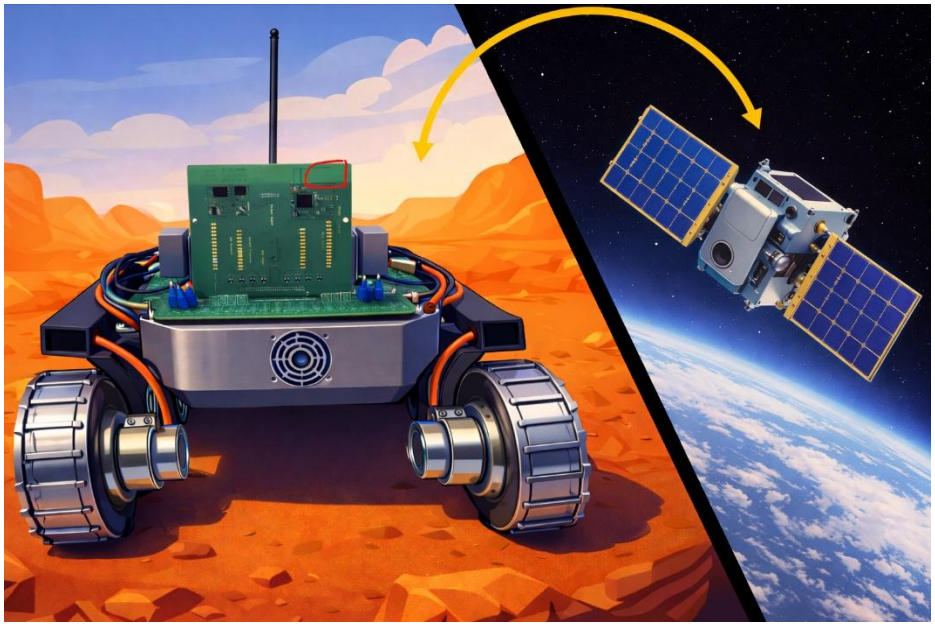
BA/MA thesis: Wireless Communication Architectures for Planetary Rovers Using PCB-Integrated Antennas Inspired by InnoCube



The *InnoCube* satellite mission pioneered a **fully wireless data bus architecture** in a small CubeSat platform, demonstrating short-range radio links between subsystems to replace traditional harness wiring and reduce mass, complexity, and integration risk in spaceborne systems. Building directly on these satellite-scale RF design principles, this thesis explores **embedded PCB-integrated antennas** for enabling wireless communication in **planetary rover systems**.

Future Mars missions aim to increase rover traversal speed while maintaining safe operation in complex and uncertain terrain. Higher driving speeds require improved hazard detection, real-time terrain assessment, and faster decision-making. To achieve this, next-generation rover platforms will integrate a larger number of distributed sensors, including proximity sensors, force sensors in wheels, inertial measurement units, and terrain imaging systems.

As the number of sensors and subsystems increases, conventional wired communication becomes a limitation due to mass, routing complexity, mechanical vulnerability, and reduced modularity. Wireless communication provides a scalable solution for connecting distributed subsystems such as smart wheels, sensor nodes, and detachable modules. In addition, short-range wireless links enable collaborative robotics scenarios in which multiple rovers or robotic units coordinate over limited distances to improve terrain coverage and operational robustness.

In this thesis, the student will prototype and integrate the InnoCube wireless communication antenna into an existing rover platform. The antenna will be embedded

in the rover electronics and connected to the onboard wireless module. Data transmission will be implemented using the already available ROS communication tools of the rover system.

The experimental validation will focus on three aspects:
(1) successful physical integration of the antenna within the rover electronics,
(2) stable wireless data transmission between rover subsystems using ROS, and
(3) evaluation of system performance under realistic rover operation conditions.

The results will demonstrate whether wireless subsystem communication using PCB-integrated antennas can replace selected wired connections and support short-range collaborative robotic operation in planetary rover platforms.

Point of contact: Amenosis Lopez