Autonomous Mars Rover for Real-Time Geological, Chemical, and Atmospheric Exploration

Musariri, Tavonga (School: Milestone College)

This project presents the design, construction, and testing of a miniature autonomous Mars rover The Red Planet Trailblazer engineered to investigate the feasibility of robotic missions for scientific exploration and colonization support. The rover integrates key subsystems including mobility, power management, sensor arrays, and real-time communication, allowing it to traverse diverse terrain while collecting and transmitting scientific data back to mission control. A core innovation of the rover is its camera-based rock identification system, which uses onboard imaging and machine vision techniques to detect and classify geological formations. This is complemented by chemical sensors capable of analyzing elemental composition in situ, offering valuable insights into the planet's geochemistry and potential habitability. The rover also measures atmospheric conditions such as temperature, humidity, and gas concentrations, contributing to environmental characterization. Furthermore, the rover can be remotely operated, can also be autonomously operated while maintaining real-time data transmission, enabling continuous monitoring and rapid scientific analysis from Earth or orbital platforms. Rigorous testing in simulated Martian environments evaluates its navigation performance, scientific data quality, and communication reliability.

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