



A.R.E.S. (AI Rover Exploration Scout)

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Autonomous robotic systems are playing an increasingly vital role in planetary exploration, enabling safe and efficient geological surveys in environments that are hazardous or inaccessible to humans. Integrating artificial intelligence (AI), robotics, and sensor technologies allows these systems to analyze terrain and materials in real time, simulating capabilities needed for future space missions. This project, sponsored by NASA through the California Space Grant Consortium (CaSGC), aimed to design and develop a small-scale, AI-powered rover—named A.R.E.S. (AI Rover Exploration Scout)—that demonstrates the potential for autonomous navigation, environmental mapping, and material classification for planetary exploration. A.R.E.S. is a six-wheeled, all-terrain rover powered by a Raspberry Pi 4 Model B and two Arduino Mega boards. It features a night vision camera, ultrasonic sensors, and a solar-powered system. The rover navigates autonomously using AI-driven

obstacle avoidance and computer vision techniques. A TensorFlow-based machine learning model was trained on thousands of labeled rock images, then optimized using TensorFlow Lite for real-time inference on the onboard Raspberry Pi. The model identifies and classifies rocks such as basalt and granite in live video streams, which are accessible via smartphone over Wi-Fi. The current model demonstrates moderate accuracy in real-time rock classification and autonomous navigation across varied surfaces. The system also transmits identification data for further analysis, highlighting its potential for field deployment. A.R.E.S. provides a scalable framework for integrating AI, robotics, and computer vision into planetary exploration systems, with future work focused on improving classification accuracy, arm precision, and full autonomous pathfinding.

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