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GROUND-BASED AI SIMULATIONS FOR ASTEROID RESOURCE MAPPING AND EXTRACTION: A PREPARATORY FRAMEWORK FOR SPACE MISSIONS

Abstract

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Ground-Based AI Simulations for Asteroid Resource Mapping and Extraction: A Preparatory Framework for Space Missions

Samrat Chakraborty

Abstract

The sustainable exploration of asteroids and near-Earth objects (NEOs) is critical for future space missions and resource utilization. This paper presents a ground-based simulation framework that leverages artificial intelligence (AI) to conduct advanced resource mapping and extraction trials on Earth-based facilities, preparing for future asteroid mining and resource utilization missions. Our approach focuses on developing, testing, and refining AI-driven methodologies in a controlled environment, simulating asteroid surface conditions, material compositions, and gravitational forces.

The proposed framework integrates neural networks trained on multi-spectral imaging, spectral analysis, and simulated surface data to identify key resources such as water, metals, and silicates. Using robotic systems in laboratory analogs, we demonstrate the viability of automated resource extraction techniques, optimized for diverse asteroid compositions and varying surface conditions. This preparatory approach allows for real-time testing and iterative improvements, enhancing mission readiness and mitigating risks associated with on-site failures.

Our model addresses the technological and operational challenges of autonomous space resource extraction, offering insights into the potential effectiveness of AI in guiding robotic exploration systems. By refining these AI-driven techniques on Earth, this ground-based preparatory framework enables mission planners and engineers to develop reliable, data-driven strategies that support resource sustainability and mission success. The results of these simulations offer a scalable approach, bridging the gap between terrestrial testing and deep space deployment, and contributing to the advancement of sustainable space exploration practices.