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ARTIFICIAL INTELLIGENCE IN SPACE EXPLORATION: ADVANCING AUTONOMOUS ROBOTICS FOR NAVIGATION AND LANDING IN EXTREME ENVIRONMENTS

Abstract

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Artificial Intelligence in Space Exploration: Advancing Autonomous Robotics for Navigation and Landing in Extreme Environments

Abstract

Autonomy in space robotics and vehicles is a rapidly advancing field, with artificial intelligence (AI) playing a critical role in enabling these systems to operate independently in harsh and unpredictable extraterrestrial environments. This paper explores how AI technologies, particularly machine learning and deep learning, are enhancing the capabilities of space rovers and autonomous spacecraft to make real-time decisions for navigation, hazard avoidance, and landing on planetary surfaces such as the Moon and Mars. By analyzing sensor data, AI enables these vehicles to traverse complex terrains, optimize energy consumption, and select the safest landing zones. Furthermore, AI-driven autonomy reduces the need for constant human intervention by allowing space vehicles to adapt to unexpected environmental challenges, such as dust storms or rocky landscapes. This paper also examines specific case studies, including NASA's Curiosity rover and the OSIRIS-REx mission, to highlight the practical applications and benefits of AI in space exploration. While significant progress has been made, challenges such as limited computational resources and communication delays between Earth and distant spacecraft remain. This study concludes with an outlook on future advancements in AI-driven autonomy for more ambitious space exploration missions.