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Author: Ms. Sreemedha Ankam
India

Mr. Akshat Mohite
India

AI-DRIVEN AUTONOMY AND ROBOTICS FOR ENHANCING MARS EXPLORATION EFFICIENCY ANDSUSTAINABILITY

Abstract

Exploration of Mars faces many challenges with harsh ambient conditions, communication lapses, and limited energy. The incorporation of artificial intelligence and robotics is thus changing mission efficiency, autonomy, and scientific return. The research aims to advance processes of navigation, autonomous decision-making, and robot collaboration toward optimizing Mars exploration efforts. Machine learning algorithms further enhance real-time hazard detection, terrain classification, and optimal path-planning to allow for reduced control from Earth's end. Swarm Robotics allows a coordinated multi-agent exploration leading to improved surface coverage, enhanced sample collection, and an improved in-situ resource utilization (ISRU). Moreover, reinforcement learning AI improves robotic arms for improvements in infrastructure development and autonomous habitat construction. Doing so in the future will eventually allow for greater resilience, flexibility, and operational efficiency of Mars missions and will allow for long-term exploration and habitation. This study contains a completely new approach that relates to AI and will greatly strengthen mission autonomy and processes to augment interplanetary exploration, thus making it more effectiveandscalable.