Paper ID: 90540
student

IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

Author: Mr. Shreyansh Dubey
University of Petroleum and Energy Studies, India

FRONTIERS OF LUNAR ROBOTICS: UNRAVELING CAPABILITIES, CONQUERING CHALLENGES, AND CHARTING A SUSTAINABLE FUTURE FOR MOON EXPLORATION

Abstract

This research paper delves into the forefront of lunar robotic technologies, providing an in-depth analysis of recent developments that are instrumental in advancing sustainable surface missions on the Moon. The study focuses on the technical intricacies of these robotic systems, elucidating their capabilities, challenges, and implications for future exploration. In terms of capabilities, the paper investigates the integration of state-of-the-art sensors and imaging technologies in lunar robotic platforms. This encompasses the utilization of high-resolution cameras, LiDAR, and spectrometers, enabling robots to navigate autonomously and conduct intricate geological surveys. Furthermore, the exploration of novel propulsion systems, such as ion thrusters and regenerative braking mechanisms, is examined for their potential to enhance mobility and extend the operational lifespan of lunar rovers. Challenges inherent to lunar surface missions form a critical aspect of the research, with a focus on environmental constraints. Extreme temperature differentials on the Moon pose operational challenges for robotic components, necessitating the development of robust thermal control systems and advanced materials. The rugged lunar terrain introduces complexities in mobility and requires adaptive locomotion systems, prompting the investigation of innovative wheel designs and legged locomotion approaches. A significant technical aspect explored in the paper involves the integration of artificial intelligence (AI) and machine learning (ML) algorithms into lunar robotic systems. This encompasses real-time decision-making processes, terrain mapping, and adaptive navigation. The study evaluates the performance of these AI/ML algorithms under lunar conditions, considering factors such as latency in communication with Earth-based mission control. The paper also addresses the intricacies of communication technologies employed by lunar robots. Given the challenges of maintaining a stable and efficient communication link with Earth, the research investigates advancements in communication protocols, data compression techniques, and the use of relay satellites to overcome signal delays. As the culmination of these technical aspects, the research paper underscores the potential of advanced lunar robotic technologies to redefine the scope of sustainable surface missions. The insights gleaned from this analysis contribute not only to the understanding of the evolving lunar exploration landscape but also inform the development of strategies for deploying robotic systems that can withstand the rigors of lunar conditions, ultimately facilitating more effective and enduring scientific exploration on the Moon.

Keywords: Lunar Robotic Technologies, Lunar Exploration, Lunar Rovers