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INNOVATIVE ROVER SYSTEMS FOR PLANETARY EXPLORATION: INTEGRATING ENHANCED MOBILITY, MINIATURIZATION, AND ROBOTIC SAMPLING TECHNIQUES IN THE ASIA PACIFIC CONTEXT

Abstract

Even though planetary exploration is challenging, it has a huge po- tential to reveal new and exciting discoveries. Hence, Rovers play a vital role in this since they are capable of exploring the planetary surfaces and collect data that would be unachievable to obtain from orbit. This pa- per presents a comprehensive study for the improvement of rovers and robotics focused on planetary exploration whilst implementing mobility enhancement, miniaturization, and robotic sampling technologies empha- sizing emerging innovations within the Asia Pacific (AP) region. This work shows the obstacles and solutions related to rovers and robotics created for traversing diverse terrains on extraterrestrial bodies. The pi- oneer mobility solutions that enable these rovers and robotic techniques to overcome extreme habitat conditions and landform challenges will be investigated here. Simultaneously, the critical aspect of rover miniaturiza- tion also will be addressed which implies compact design and fabrication, more efficient prototypes with less energy consumption and payload de- mands yet function sophistically. This study underlines the latest develop- ments in miniaturized prototypes, ensuring how compactness can lead to an economically feasible planetary mission. Additionally, improvements in sampling techniques and robotic manipulation methodologies are ex- plored by examining sophisticated robotic arm prototypes and sampling tools emerged in the AP region foregrounding the efficiency, accuracy, and adaptability to gather and evaluate the extraterrestrial samples. We focus on proposing a rover system design that can address the modern demands in planetary missions like reliable scientific knowledge, more ef- ficiency, and cost-effectiveness by adapting these three key aspects. This grants the technological growth in planetary exploration as well as high- lights the noteworthy innovations of the AP region and its fostering role in the domain. By implying these three critical rover technologies, our study will provide a roadmap for the advancement of next-gen rovers that are guaranteed to overcome the obstacles of extraterrestrial missions in the coming era.