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KOSMOS-STATION: VERSATILE & DYNAMIC SPACE STATION PLATFORM FOR LOW EARTH ORBIT - ADVANCING SPACE EXPLORATION WITH AUTONOMY AND MODULARITY

Abstract

The transition from manual, static space stations to autonomous, modular, and dynamic ones signifies a significant evolution in spacecraft technology. Modular Reconfigurable Space-stations (MRSS) offer superior solutions compared to traditional monolithic space stations, boasting benefits such as efficient design, rapid deployment, adaptable applications, and streamlined management. This paper delves into the development and technology of MRSS, focusing on three key aspects: modularity, reconfigurability, and autonomy. Despite advancements in MRSS research, there remains a lack of standardized protocols and a limited understanding of related concepts. Through a comprehensive review of existing studies, this paper aims to identify technical requirements and propose solutions to bridge these gaps. Looking towards the future of MRSS, a pioneering concept for a modular self-reconfigurable space station, named Kosmos-Station (K-S), is introduced from Indian startup named KosmosOne. The K-S is designed to leverage Modular Reconfigurable Spacecraft (MRS) technology to establish a versatile platform in Low Earth Orbit (LEO). This station is poised to catalyze scientific research through a dedicated Microgravity Experimentation Module (MEM), facilitating experiments in a gravity-free environment across various scientific disciplines. Moreover, the K-S is outfitted with In-Space Manufacturing (ISM) infrastructure, enabling on-site production of materials and components. This capability holds immense potential to transform space exploration and industrialization endeavors. Further analysis delves into the enabling technologies and major challenges associated with MRS, focusing on aspects such as modularization, integrated management, and self-reconfiguration technologies. Finally, future trends in MRS technology are predicted, accompanied by recommendations for continued advancement. The development of the K-S and the broader adoption of MRS concepts signify a pivotal shift towards more efficient, adaptable, and autonomous spacecraft systems.

Keywords: Modular Reconfigurable Spacecraft (MRS), Modular Reconfigurable Space-stations (MRSS), Autonomous Systems, Modularity, Reconfigurability, Microgravity Experimentation, In-Space Manufacturing