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A REVIEW ON DESIGN, FUNCTIONALITY AND SUSTAINABILITY OF CONCEPT AUTONOMOUS ROBOTIC SYSTEMS SUPPORTING HUMAN EXTRAVEHICULAR ACTIVITIES IN MICROGRAVITY ENVIRONMENT

Abstract

Spacewalks are among the most challenging mission concepts in space operations. In these missions conducted in a microgravity environment, personnel face numerous difficulties such as limited mobility, restricted field of view, and the use of complex equipment. Additionally, critical issues such as tool management, detecting damage on the exterior surface of the spacecraft/station, and ensuring a safe return to the vehicle/station in emergencies directly affect the efficiency and safety of spacewalks. As human space missions become more frequent, the number of situations requiring personnel to work in the vacuum of space will increase accordingly. Furthermore, new spacewalk mission profiles conducted for purposes not yet experienced today will begin to emerge. This study examines the possible primary and subsystems of a fully autonomous, free-floating, and minimally sized robot, as well as how it can assist personnel during spacewalks. The proposed robotic system will be developed to assist personnel during extravehicular activities. Its core functions should include transporting tools used during the mission, managing equipment that restricts personnel movement, mapping unexpected work environments, detecting damage, and real-time data analysis. These features are anticipated to be of vital importance in advanced and increasingly complex mission profiles. The robot's design will incorporate a propulsion system to enable free movement in a microgravity environment. In the conceptual design, this system is expected to consist of small but sufficiently maneuverable cold gas thrusters. Additionally, to ensure long-term, uninterrupted, and functional operation, the robot must be equipped with essential hardware, including a Tool Management Module, Refueling Port, Sensing and Imaging System, and Navigation System. This study will investigate the functionality, efficiency, and sustainability of a microgravity robotic assistant possessing all these features and will present objective results.