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21st IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Systems and Infrastructures to Implement Sustainable Space Development and Settlement - Systems (2A)

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A REVIEW AND DESIGN OF THE ON-ORBIT ROBOTIC ARM WITH A CHANGE-OVER END EFFECTOR FOR 3D PRINTING AND SERVICING.

Abstract

Owing to the exorbitant cost of transporting intricate payloads into space, a more economical alternative would be to launch raw materials and utilize on-orbit servicing robots to facilitate zero-gravity printing as well provide an on-orbit servicing such as assembly and inspection supports. Our proposed mission involves the deployment of orbit servicing robots which have an effective change-over apparatus end effector along with 3D printing capability and raw materials in space to construct medium to small size structures of a space station, spare parts, additional spacecraft structures via zero-G printing. This approach eliminates the need for extensive testing procedures, such as vibration and temperature testing, thereby simplifying the launch process. This paper aims to evaluate the economic feasibility by review of such a mission by analyzing the viability of zero-G printing, the complexities of printing in space, the challenges associated with managing service robots and logistical demands of such a mission. It enables on-demand manufacturing, which means that repairs and upgrades can be carried out quickly and efficiently. Then we propose a mission design tackling challenges based on limited space power supply in space, harsh space environment and coordinated working of autonomous robots. The success of this approach could potentially revolutionize space exploration by enabling the creation of mechanical structures in space without relying on Earth-based transportation. Our proposed Fused Deposition Modeling (FDM) 3D printer, capable of printing materials using PEEK (thermoplastic), exhibits superior tensile strength to aluminum and can be recycled for future use. A thorough analysis of this mission and its demonstration in the future can lead to further development in less researched concepts of in-orbit servicing and Zero G printing. As the technology continues to develop, it will enable us to create new and exciting possibilities for space infrastructure and exploration.

Key words: on-demand manufacturing, in-orbit servicing robots, change-over apparatus end effector, on-orbit servicing, assembly and inspection supports.