22nd IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Interactive Presentations - 22nd IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (IP)

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CONCEPT STUDY FOR COST-OPTIMIZED REUSABLE LUNAR ROVER & STANDARDIZED PAYLOAD MODULES

Abstract

Going to the moon and beyond is evidently the direction that the space industry intends to pursue, to broaden our scientific horizons and expand the available resources, enriching the overall life on Earth. However, inferring from past experiences, a sustainable approach must be prioritised when developing the Lunar and Martian missions. The paper presents a conceptual design of a reusable modular payload platform, which can enforce sustainability and bring standardisation to the lunar economy. This rover platform shall be capable of executing multiple missions throughout its lifetime using swappable modules for payloads and sensors on board a 'Modular Laboratory' or ModLab. The interface of the ModLab with the independent modules is designed to ensure compatibility along the varied mission requirements, including external comprehensive power and communication solutions for the different units that may have to be employed. The platform includes a robotic arm that can connect with the multiple end-effector appendages available on the rover for the automated swapping of modules and to conduct various extra-terrestrial tasks. Necessary measures are proposed in the design to ensure the protection of modules while being swapped in harsh lunar environments. To significantly increase the life of the rover platform beyond the current trend, this modularity and swap capability is exercised in some of the core components and subsystems of the platform itself. These are chosen based on their mean time to failure. The proposed architecture has the potential to be extended to use the rover for conducting various physical tasks on the moon required for the development, maintenance, and operation of the bases, reducing the development cost significantly for the lunar industries. The study estimates that using such a concept may not only provide a significant acceleration to the growth of the Lunar economy but also allow for interoperability to encourage national agencies to cooperate on the exploitation of lunar resources. Ultimately, the paper presents a component reliability study for the selection and design of standard repairable modular units, optimising cost per mission and long-term commercial viability.