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SPACE ARCHITECTURE AND COMPUTATIONAL MODELING OF THE LUNAR GATEWAY MODULES AS A TESTBED FOR ECLSS SYSTEMS ANALYSIS

Abstract

We are on the cusp of the era of returning to the Moon with the first planned extraterrestrial space station in lunar orbit - the Lunar Gateway. A number of new missions are planned for the following decade and design and optimization of the Environmental Control and Life Support Systems (ECLSS) that operate in an environment beyond LEO (Low Earth Orbit), still remains a crucial challenge for Space architecture. In the context of these missions, the ECLSS function and close loop management will play a vital role in supporting life for all the space missions to the Moon and subsequently to Mars. In order to investigate and model such intricate systems within the constraints of microgravity, we resort to the use of mathematics, physics, and computational modeling to create a spectrum of possibilities and reliable solutions. As our team focuses to reach the computational modeling of the Lunar Gateway kind space station for additional research and receiving a full understanding and improvement of the ECLSS systems, the below research starts by analyzing and designing HALO and I-HAB Space modules as both will be the main spaces for housing astronauts and of several included systems such as those for life support, waste management, radiation shielding, a window for gazing at the moon and Earth, science racks,and other equipment for conducting experiments in microgravity. In the second part of the same research, computational modeling is used to define a series of comparable parameters and results as testbeds for the scientific and progress study of ECLSS systems and applications in which we are highly interested. This research project is part of the Andromeda research program of the Deep Space Initiative, a non-profit space research organization based in Colorado, USA. This team focuses on the improvements in life support systems design and showcases the importance of computational modeling and how it can help engineers and scientists test and model intricate systems like the ECLSS. It also highlights the need for innovative approaches that integrate different disciplines to solve complex problems in space architecture. Overall, this research presents a novel approach to designing and optimizing the ECLSS operating in an environment beyond LEO.