

30th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Satellite Missions Global Technical Session (9-GTS.5)

Author: Mr. Mohammed Irfan Rashed
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of

STRATEGIC AUTONOMOUS APPROACHES TO EFFICIENTLY UTILIZE CISLUNAR SPACE FOR
MOON TO MARS TRANSIT

Abstract

NewSpace has caused a spunk and competence among space enthusiasts ever since it began in full swing. The technologies to solve major issues in lower Earth orbits to their advancements for deep space missions have only excelled over time. CisLunar space is getting busy with several nations showing their prowess with lunar landings and unique trajectories to place the payloads as determined by mission objectives. Hence, a standard and optimal approach to deploy series of missions in this region is inevitable. Small satellites have been instrumental in defining the NewSpace norms and systems which can propel the effective utilization of the resources, cost and precise objectives. The CAPSTONE and Flashlight missions to Moon have proved how crucial are the Near-rectilinear Halo Orbits (NRHO) within the CisLunar space for guiding the Artemis missions in near future. But the issues with their communications issues have given a reason and scope to research further in aligning these satellites efficiently. A thorough literature review has been carried out to determine the possible solutions in finding and operating necessary solutions for the CisLunar space with this dedicated research. This paper will emphasize the urgent need to optimize and systematically align the CisLunar space with creative approaches to avoid disruption to the operations at Moon for sustenance. This is followed by transfer to the Mars with a well-guided autonomous trajectory. Strategic approaches have been proposed and discussed in detail using advanced technology for gaining sufficient autonomy in this region. Small satellites constellations with well-defined configurations play a vital role in data relay, guidance and logistics tremendously adding value and certainty to Artemis missions moving from Moon to Mars. A detailed analysis is carried out to effectively utilize the CisLunar space to have the Mars transmit cost-effective and asset for the missions aiming for Mars landings in near future. Even the small satellite constellations and their orientation on Moon and Mars have to be optimal with full coverage to the landing sites with minimum satellites managed and operated autonomously. The optimizers nlopt and ipopt have been tested and evaluated for Lunar and Martian operation under their local conditions for an optimal and enhanced data relay and propagation in sync with CisLunar region. The effective control of logistic costs and Delta-v with autonomous maneuvers with a well-aligned configuration along with results are framed. Finally, the essence of this research is bought out through the proposed autonomous operation techniques.