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Human Exploration of the Moon and Cislunar Space (1)

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MISSION ARCHITECTURE FOR HUMAN EXPLORATION OF CIS-LUNAR SPACE VIA TELE-OPERATED ASSETS

Abstract

The work presented here is derived from the 2015 ESA Moon Challenge, an international student competition that took place during October-December 2015. While the ESA Moon Challenge focused on the deployment and assembly of a crewed cis-lunar station, this paper also presents the possible cis-lunar and interplanetary applications of establishing such habitat. The preliminary design of the international space mission HECATE (Human Exploration of Cis-lunar space via Assets Tele-operated from EML2; EML2 = Earth-Moon Lagrange Point 2) is briefly discussed. HECATE aims at exploring the far side of

the Moon via tele-robotic activities during the 2020s and with the objective to establish human presence in cis-lunar space, following the current views of the "Moon Village" as proposed by the European Space Agency. The exploration of the Moon's far side is realized by astronauts from HOPE (Human Orbiting Protected Environment), a space habitat in a halo orbit around the Earth-Moon Lagrange Point 2 (EML2), a critical staging location for robotic and human missions in deep space. HOPE is delivered in three stages via commercial and NASA launch vehicles to EML2. The necessary scientific equipment and exploration rovers are also launched using a commercial launch vehicles. In mid-2024, a crew of three astronauts is launched with the Orion Multi-Purpose Crew Vehicle to rendezvous with HOPE, perform tele-robotic exploration of the Moon for 40 days, retrieve samples of the lunar surface and return to Earth in June 2024. Inside the habitat, astronauts have access to tele-robotic hardware and instruments, used to tele-operate rovers and scientific equipment on the surface of the Moon. A key element of the proposed mission is the partnership of human and robotic components as well as telepresence, the tele-operation of robotic assets on the lunar surface. Tele-presence could significantly enhance the ability of humans and robots to explore together, allowing in the future the exploration of the most challenging locations in the Solar System and preparing sustainable exploration using local resources, i.e. In-Situ Resource Utilization (ISRU). Plans to resupply and maintain HOPE for future missions, using a solar electric tug, are given, making HOPE a reusable and sustainable space station in cis-lunar space. HECATE represents the first step in building a feasible and sustainable mission aimed at furthering the presence of humanity while HOPE represents an energetically favorable intermediate location for missions to the Moon, Mars, Near-Earth Asteroids, and beyond.