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IAF SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 3 (2C)

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EXPLOITING THE LUNAR ENVIRONMENT AS TESTBED FOR FUTURE TITAN EXPLORATIONS

Abstract

In recent years, the international space community has concentrated its efforts on returning humans to the Moon. Following the General Exploration Roadmap of the ISECG, Earth's satellite will also act as a testbed for emerging and qualifying technologies that will be employed at the next step of space exploration; Mars. With regard to the outer Solar System, Saturn's largest satellite, Titan, has triggered the community's interest with its potential for advancements in scientific research and exploitation of in-situ resources. Observations have revealed an active methane-based hydrologic cycle and the presence of a dense atmosphere mainly composed of N_2 with small amounts of CH_4; a unique characteristic for a moon in our Solar System.

In the context of the SpacE Exploration and Development Systems (SEEDS) 2^{nd} level Specializing Master, supported by ESA, ASI and Thales Alenia Space, the similarities and differences of the two natural satellites have been analyzed. The absence of magnetic field, a low surface temperature of about 100K (in shade) for the Moon and 93.7K for Titan and, most importantly, the similar gravitational fields with an acceleration of $1.62m/s^2$ and $1.35m/s^2$ respectively, present an opportunity to exploit the Moon as a test ground for a future mission to Titan. The paper considers a wide range of resources that could be employed for this purpose and studies their performance and working capability given the environmental characteristics. These elements are suitable for testing on the Moon and include transportation and locomotion systems, surface analysis tools, electro-mechanical actuators as well as communication equipment. Their qualification requirements are established and compared in order to demonstrate a common ground for natural and technological resources. For example, the acquired knowledge on rovers and other mobility elements could have an impact on the definition of the primary objectives as well as the preliminary design and mass budget of future Titan exploration missions. In addition, the paper presents an accumulation and investigation of the available resources and facilities, such as the LOP-G as well as an evaluation of the necessary level of human involvement and of systems' autonomy.

The results presented in the paper suggest a selection of technological resources for the lunar environment, which is optimized by identifying the qualification parameters of the technologies chosen for possible future Titan missions. Finally, further work can be carried out by adapting these elements in order to be able to withstand the environment of Saturn's satellite.