Paper ID: 54852
student

IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

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# IN-SITU RESOURCES UTILISATION (ISRU): USING SWARM ROBOTICS TO OPTIMISE THIS KEY TECHNOLOGY FOR FUTURE SUSTAINABLE LUNAR EXPLORATION

**Abstract**

Major spacefaring nations have decided to return to the Moon in a sustainable manner. This renewed interest will now rely on In-situ resource utilisation (ISRU) to guarantee the long-term presence of humans on the lunar surface. The possibility of producing propellant, using water and oxygen in the life support systems, or harvesting metals to build infrastructure is a game-changing factor for future aspirations of the humanity in space exploration. Although this technology is essential, there are several challenges, such as the uncertainty of volatiles on the lunar regolith, the mass of robotic vehicles, adequate power system, appeal to investors, and legal aspects based on the Outer Space Treaty (OST), that must be carefully considered so ISRU can be enabled and benefit states, agencies and businesses. Recent contracts that some commercial companies were awarded to study and demonstrate the ISRU technology show a tendency on the development of mid-size rovers and landers to perform the resource exploitation. However, mass and size of those vehicles can be limiting factors that can extend the duration of prospecting, collecting and processing phases. To solve this issue, swarm robotics technology is proposed in this work. It consists of low-weight and low-cost autonomous rovers that are able to prospect and process the volatiles optimising the duration of the phases. They also are able to cover a wider range of the lunar South Pole and to cooperate with each other by exchanging information. Thus, the result is the availability of more accurate data from the potential areas for exploiting, which minimises uncertainties, the attraction of investors by the reduction of the time to prove the technology, and the enhancement of the system once it is experimented on lunar soil.

Keywords: In-situ resource utilisation, lunar exploration, swarm robotics