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PRO-ACT - Planetary Robots Deployed for Assembly and Construction of Future Lunar ISRU and Supporting Infrastructures

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PRO-ACT (Horizon 2020; https://www.h2020-pro-act.eu/) studies the establishment of a lunar base with the support of a mobile robotic platform formed by three distinct robots, with different features, based on their cooperation and manipulation capabilities. This vision will provide tools in preparation of the commercial exploitation of in-situ resources by assembling an ISRU (In-Situ Resource Utilisation) system, essential for a future human settlement at the Moon. PRO-ACT's vision of ISRU focuses on the extraction of oxygen from lunar regolith to serve as the oxidizer for fuel and artificial atmosphere generation within habitats and 3D printing of relevant structures using regolith for construction purposes – including tiles for roads and elements for shelters. The mineral ilmenite, found in lunar rocks, is the perfect target for the ISRU platform as it contains oxygen, iron and titanium as construction materials.

The main goal of PRO-ACT is to implement and demonstrate the cooperative capabilities of the multi-robot system in a Moon alike environment that will be replicated at two sites, indoors and outdoors, in Europe. For this purpose, the PRO-ACT project (OG11) will also rely on the outcomes of previous space-related projects from the PERASPERA project and its Operational Grants. Therefore, PRO-ACT will: 1) Review, extend and integrate previous OGs outcomes as part of a comprehensive multi-robot system, in a Moon construction scenario, 2) Develop robust cooperation capabilities allowing joint interventions (navigation in close vicinity and joint manipulation actions) in mixed structured/unstructured environment, 3) Make the capabilities available within a CREW module, 4) Customize existing mobile robotic platforms and prepare facilities to perform tests and demonstrations in a selection of relevant scenarios of Moon construction activities (ISRU capabilities establishment; preparing dust mitigation surfaces; assembling and deploying a gantry/3D printer).

PRO-ACT will show what robotic cooperation can achieve and will demonstrate the effectiveness of collaborative mission planning, and manipulation and assembly of a supporting infrastructure. Cooperative scenarios will be based on: 1) fine scale surveying of areas prior to construction work, 2) site clearing by grading stones and debris, 3) unloading equipment/construction elements and transporting them to the assembly sites, 4) assembly of specific modular components of an ISRU plant, 5) assisting partial assembly and mobility of a gantry, 6) 3D printing of modular building elements from pseudo-regolith simulant, and 7) sample assembly of printed elements to construct sections of storage, habitation spaces or dust mitigation surfaces. Following this scenario, the key robotic elements, (the mobile rover IBIS, the six-legged walking robot Mantis and a gantry) are outlined according to the corresponding mission architecture. The ISRU plant size is representative of a future lunar mission, with grasping points to assist robotic manipulation capabilities and considering reduced lunar gravity.

The target of this work is to reach a Technology Readiness Level of TRL 4/5 (depending on scenarios subparts) with this approach, to enable exploration of the Moon environment in the next decade. This will be achieved and proven with the performance of the required tests and demonstrations in Lunar analogues, in order to validate the newly developed capabilities.