Paper ID: 88856
oral

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

Author: Mr. Andre Fonseca Prince
German Aerospace Center (DLR), Germany

Mr. Werner Friedl
German Aerospace Center (DLR), Germany
Mr. Leonard Kluepfel
German Aerospace Center (DLR), Germany
Mrs. Caroline Specht
DLR (German Aerospace Center), Germany
Mr. Ajithkumar Manaparampil
German Aerospace Center (DLR), Germany
Ms. Claudia Philpot
German Aerospace Center (DLR), Germany
Mr. Vincent Vrakking
German Aerospace Center (DLR), Germany
Prof. Daniel Schubert
German Aerospace Center (DLR), Germany
Dr. Daniel Leidner
German Aerospace Center (DLR), Germany

PRELIMINARY STUDY ON HOW AN AUTONOMOUS ROBOTIC SYSTEM CAN IMPACT THE CREW TIME DURING PLANT CULTIVATION ON THE LUNAR SURFACE

Abstract

The sustainable human and robotic exploration on the Moon, which is described in the Global Exploration Roadmap (GER), foresees the in-situ food production for astronauts in long-duration missions. To achieve this objective the deployment of greenhouses on the lunar surface for plant cultivation is necessary. With this long-term vision, the German Aerospace Center (DLR) EDEN LUNA project introduces a Moon-analogue greenhouse facility which can demonstrate nearly closed-loop bio-regenerative life support systems technology and aim to grow plants to feed the crew. To support and optimize this food production the autonomous robotic system EDEN Versatile End-effector (EVE) is incorporated to the EDEN LUNA greenhouse. EVE is designed to automatize the plant cultivation cycle opening new possibilities for the sustained human presence on the Moon. For example, in a scaled-up scenario with several deployed greenhouses or during initial uncrewed missions with the need of remote operations from the Lunar Gateway in preparation for upcoming crewed missions. EVE operates in a shared-autonomy manner, which means that the operator's initial command triggers the robotic system autonomous operation. The user is focused on the high-level task solution while the low-level task execution is performed using the local intelligence of the robotic system. This is an important feature which directly impacts the workload of astronauts inside the greenhouse. In this preliminary study, existing works on crew workload for crop cultivation are considered. These plant-growing ground-based test-beds and space-based experiments are analyzed and compared with the automatized scenario presented in this work. This will provide a significant reference for decisions to be made in future lunar missions. The EVE system is currently in development at the DLR Robotic and Mechatronics Center (RMC) in Oberpfaffenhofen. In 2025, it

will be integrated to the EDEN LUNA Greenhouse at the DLR Institute of Space Systems in Bremen. Finally, by the beginning of 2026, it will start operations in the ESA/DLR LUNA facility at the European Astronaut Centre (EAC) in Cologne.