

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

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EDEN VERSATILE ASSISTANT (EVA): AN AUTONOMOUS ROBOTIC SYSTEM TO SUPPORT  
FOOD PRODUCTION ON THE MOON AND BEYOND**Abstract**

Spacefaring nations have already expressed their plans for a sustainable human and robotic exploration on the Moon. This endeavor highlighted in the Global Exploration Roadmap (GER) foresees the development of infrastructures such as habitats, greenhouses, science labs, power plants, and mining facilities. Following this long-term vision, the German Aerospace Center (DLR) EDEN LUNA Project presents a Moon-analogue greenhouse facility which can demonstrate nearly closed-loop bio-regenerative life support systems technology and aim to produce fresh food for astronauts on the Moon in the near future. To optimize the food production and overcome challenges inherent to space missions, the EDEN Versatile Assistant (EVA) is integrated to the EDEN LUNA Greenhouse. This support system is a valuable payload which will automatize the tasks of the entire plant cultivation process: from germination to harvesting. The automatization is particularly relevant when the food production is intensified either seasonally or in a future scaled-up scenario. The EVA system encompasses a linear rail system installed on the ceiling of the greenhouse, a 7-Degrees of Freedom (DOF) autonomous robotic arm with high precision joint configuration, a sensorized robotic hand which can grasp delicate objects, and a sophisticated computer vision camera with Artificial Intelligence (AI) capabilities for plant identification. When in operation, the EVA system uses shared autonomy features. Thus, while it maintains the human in the loop for some of the decision-making processes, it can also function with some level of autonomy. A set of tasks previously defined by an astronaut in the end of an operational day and carried out autonomously

during the night by the EVA system is one example of this human-robot collaboration. In addition, an optimized motion planning will ensure that the EVA system can perform constrained manipulation tasks in a limited workspace observing energy efficiency and safety requirements. The EVA system is currently in development at the DLR Robotic and Mechatronics Center (RMC) in Oberpfaffenhofen. In 2024, it will be integrated to the EDEN LUNA Greenhouse at the DLR Institute of Space Systems in Bremen. Finally, by the end of 2025, it will start operations in the ESA/DLR LUNA facility at the European Astronaut Centre (EAC) in Cologne.

**Keywords: robotics, shared-autonomy, food production, exploration, Moon**