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MIRA3D – A TERRESTRIAL ROBOTIC PROTOTYPE FOR MOBILE ADDITIVE LAYER MANUFACTURING OF LUNAR REGOLITH

Abstract

Since the successful Apollo missions, mankind dreamed to return to the Moon. One current idea is to create infrastructure to explore and exploit the Moon. To make this dream come true, key technologies need to be developed. One of these is In-Situ Resource Utilization (ISRU) of lunar materials. The most abundant resource on the lunar surface is regolith. Using additive layer manufacturing technologies, regolith can be used to construct infrastructure like streets or houses on the Moon.

To make this vision come real, additive layer manufacturing technology for lunar conditions, like MIRA3D, needs to be developed. MIRA3D is a mobile robot - arm - prototype for 3D printing of lunar regolith developed at TU Braunschweig. It consists of an Innok Heros 444 rover and an Universal Robots UR10 robotic arm.

The rover is a robust outdoor vehicle with four wheel drive developed for automation of agricultural tasks. It has a payload capacity exceeding 100 kg. It can be controlled by a remote control. Using appropriate sensors and algorithms, it is also capable of autonomous navigation.

The UR10 is a collaborative 6 degree of freedom robotic arm able to carry payloads up to 10 kg. The UR10 arm has a repeatability of 0,1 mm and a reach of 1300 mm. Caused by its relatively small mass and the use of a small control box, the UR10 is suitable for mobile applications. It provides protection class IP 54 which can be raised by using a protecting textile. A good protection against dust is very important for testing MIRA3D in Moon-like environments.

The payload of the UR10 is a printing head developed at TU Braunschweig. The printing head uses the so-called powder-feed fused deposition modeling (PF-FDM) process to create three dimensional structures out of lunar regolith without additives.

The hardware of MIRA3D is presented. Additionally, current additive layer manufacturing technologies are explained with emphasis on the PF-FDM process. Thus, a broad overview about the state of the art of additive layer manufacturing of lunar regolith is given with focus on mobilization of the printing process.