

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

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## CONVERTING AN INDUSTRIAL AUTONOMOUS ROBOT SYSTEM INTO A LUNAR ROVER

### Abstract

In this paper, we will present the combined efforts of Milrem Robotics and Tartu Observatory to transfer knowledge from industrial unmanned ground vehicles to Lunar rovers by subjecting the already developed terrestrial architecture to Lunar analogue environments and Lunar environment simulations.

Large scale Moon and planetary surface exploration, and especially automatic in situ resource utilization, require reliable mass produced rovers that can be operated with minimal human intervention and allow for long maximally autonomous traverses and automatic integration of remote sensing with data gathered by the sensors onboard the rover. This task is already being solved for industrial robotics on Earth and in near future the number of terrestrial robots will be significantly higher than Lunar rovers, making it more beneficial to first develop the required technologies for terrestrial use and then to apply them with minimal modification for Lunar use. This approach contrasts to the regular way of developing rovers for space use only.

For both use cases, operators would likely be still required, but for resolving problematic situations and higher level guidance or for precision control. The planned Lunar exploration architectures for Artemis program and the Lunar Gateway station would allow to command rovers from the Lunar orbit, giving operators near realtime teleoperation capabilities. This situation is similar to the unmanned vehicle approach being developed at Milrem Robotics, where the target is to provide semi-autonomous industrial robots that can automate tasks such as forestry, peat mining, agriculture, underground mine inspection and urban cleaning (11 robotic systems already developed, 10 in development, sold to various countries over the world). This would allow for a unified architecture for both cases, allowing to test and develop the required approaches in terrestrial industry and then to transfer the technologies and tools to Lunar rovers.

Milrem Robotics and Tartu Observatory (part of University of Tartu, Estonia) are currently co-developing systems to increase industrial unmanned ground vehicle autonomy by fusing remote sensing data and sensors on the unmanned ground vehicles and both share the interest of transferring this knowledge also for Lunar rovers. We have also already tested the our UGV platform in scenarios comparable to lunar analog sites and are starting a collaboration with European Space Agency's European Space Operations Centre to coordinate our efforts with European Lunar rover development roadmaps to develop

a truly planetary autonomous vehicle architecture do allow both exploration and industrial utilization of both the Moon and Earth.