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

Author: Mr. Benjamin Hülsen
DFKI Robotics Innovation Center Bremen, Germany, Benjamin.Huelsen@dfki.de

Mr. Niklas A. Mulsow
DFKI GmbH, Robotics Innovation Center, Germany, Niklas.Mulsow@dfki.de
Dr. Adam Dabrowski
DFKI Robotics Innovation Center Bremen, Poland, ad.dabrowski@gmail.com
Mrs. Wiebke Brinkmann
DFKI Robotics Innovation Center Bremen, Germany, wiebke.brinkmann@dfki.de
Mr. Joel Gützlaff
FH Aachen University of Applied Sciences, Germany, guetzlaff@fh-aachen.de
Mr. Leon Spies
FH Aachen University of Applied Sciences, Germany, leon.spies@alumni.fh-aachen.de
Prof. Markus Czupalla
University of Applied Sciences Aachen (FH Aachen), Germany, czupalla@fh-aachen.de
Prof. Frank Kirchner
German Research Centre for Artificial Intelligence, Germany, frank.kirchner@dfki.de

TOWARDS AN AUTONOMOUS MICRO ROVER WITH NIGHT SURVIVABILITY FOR LUNAR EXPLORATION

Abstract

In Europe, efforts are underway to develop key technologies that can be used to explore the Moon and to exploit the resources available. This includes technologies for In-Situ Resource Utilization (ISRU), facilitating the possibility of a future Moon Village. The Moon is the next step for humans and robots to exploit the use of available resources for longer term missions, but also for further exploration of the solar system. A challenge for effective exploration missions is to achieve a compact and lightweight robot to reduce launch costs and open up the possibility of secondary payload options. Current micro rover concepts are primarily designed to last for one day of solar illumination and show a low level of autonomy. Extending the lifetime of the system by enabling survival of the lunar night and implementing a high level of autonomy will significantly increase potential mission applications and the operational range. As a reference mission, the deployment of a micro rover in the equatorial region of the Moon is being considered. A detailed overview of mission parameters, including the exploration of lunar skylights and/or rill formations is given in this paper. The mission parameters are based on an in-depth study of current space agency roadmaps, scientific goals, and upcoming flight opportunities. Furthermore, concepts of the ongoing international micro rover developments are analyzed along with technology solutions identified for survival of lunar nights and a high system autonomy. The results provide a basis of a concise requirements set-up to allow dedicated system developments and qualification measures in the future. Based on this, an applicable micro rover concept is designed in its subsystems to serve as a reference model for future developments, system integration studies and TRL increase. A central aspect is the further development and optimization of existing AI-based robot control and navigation software, especially on mission-relevant sensor and processor architectures. Another focus is on the technical design and analysis for surviving the lunar nights. Innovative approaches, such as thermal switches, Infused Thermal Solutions (ITS) as well

as a thermal rover shelter are investigated to find the most flexible and efficient solution for an energy efficient thermal design, to potentially allow night survivability. This paper provides a contribution to the space exploration community, to allow dedicated system developments and TRL increases in robotic subsystems and mission designs for extended autonomous lunar exploration.