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Analogue research from ROBEX Etna campaign and prospects for ARCHES project: Advanced Robotics for next lunar missions

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Abstract

Mobile robotics will play a key role in future space exploration activities. Besides the actual development of the robotic systems, the different ways of commanding those systems, using technologies varying from teleoperation with the human in the loop [1], through shared autonomy [2] towards highly autonomous systems, will be the main challenges of these missions. This paper describes the robotic activities of the DLR institutions within the Helmholtz projects ROBEX and ARCHES, dealing with robots for autonomous space exploration for future lunar missions. Furthermore, it describes the challenges of operating robots from far distances [3] in extreme environments and gives an outlook on future mission possibilities.

1. Robotic Exploration for extreme environments

This paper describes the experience gained during the ROBEX (Robotic Exploration for extreme environments) analogue mission, executed on Mount Etna, Italy in 2017 [4]. The goal of the ROBEX space analogue mission was to demonstrate the highly autonomous robotic deployment and operation of a seismic network in relevant environment. This has included a profile measurement, to distinguish the subsurface constitution. During this analogue campaign, Mount Etna has severed as the simulated lunar environment since the seismic activities in this region are similar to measured and expected lunar quakes.

2. Analogue Campain in H2020

In the context of the Horizon 2020 PERASPERA projects, the potential and the capabilities of future planetary rovers have also been successfully demonstrated in an Mars analogue environment in the Moroccan desert in dec. 2018. The area around Rissani and Erfoud offers a wide variety of excellent test sites starting from vast plains and sand dunes up to rocky terrains and steep cliffs. Based on their sensors, a single rover or team of robotic systems can autonomously roam such an unstructured environment and reliably fulfil challenging tasks. Covering large distances in the range of several kilometers, avoiding critical situations, mapping the environment, detecting scientifically interesting objects and collecting samples are only some examples which have been investigated during this campaign.

3. Multi-Robot-Cooperation

The findings during ROBEX and the Moroccan analogue campaign will benefit the ARCHES project (Autonomous Robotic Networks to Help Modern Societies). During ARCHES key challenges on the cooperative aspects of heterogeneous robotic teams are the focus and under current research. The robots will work together to explore, deploy, and maintain infrastructure and scientific instrumentations on the planetary surfaces. This methods and technologies will be relevant for the robotic support and operation of permanent installations and bases (e.g. the lunar village concept, or large scientific observatories, such as interferometers).

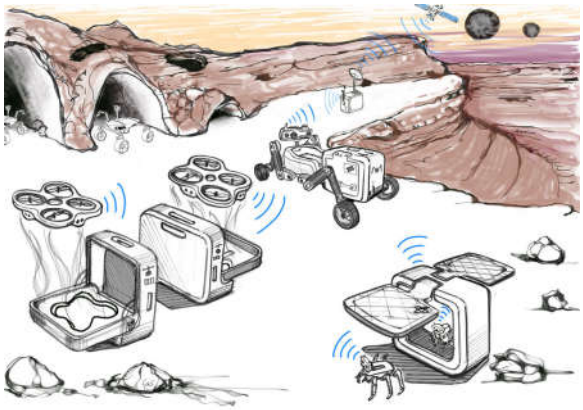

Figure 1: ARCHES Visionary scenario

The goal of ARCHES is to develop methodes that allow robots to acquire, analyze, and interpret measured data autonomously [6]. Consequently, the scope of ARCHES also includes the intelligent automation and cooperation of robotic systems. Both of these aspects are essential to the deployment of standalone robots and robot teams.
Concepts has been and will be investigated for autonomous navigation in unknown areas [7], interaction and manipulation inside the environment, energy management systems and self-organising communication systems, which enables the communication between different robots and mission control.

4. Summary and Conclusions

All mission and operational concepts described in this paper, are in line with the global exploration strategy, toward the goal of human robot cooperation, the installation of permanent bases e.g. lunar village, and the CIS Luna habitat or the Deep Space Gateway. The presented work performed will enable DLR technologies to participate in common mission scenarios. Furthermore a DLR research roadmap will be presented showing its focus on lunar missions.

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References

[1] M. Panzirsch, H. Singh, M. Stelzer, M. J. Schuster, C. Ott and M. Ferre, Extended Predictive Model-Mediated Teleoperation of Mobile Robots through Multilateral Control, in IEEE Intelligent Vehicles Symposium (IV), 2018.

[2] N. Y. Lii, D. Leidner, P. Birkenkampf, B. Pleintinger, B. Bayer, and T. Krueger, Toward Scalable Intuitive Telecommand of Robots for Space Deployment with METERON SUPVIS Justin, 14th Symposium on Advanced Space Technologies for Robotics and Automation (ASTRA), 2017.

[3] M. J. Schuster, S. G. Brunner, K. Bussmann, S. Büttner, A. Dömel, M. Hellerer, H. Lehner, P. Lehner, O. Porges, J. Reill, S. Riedel, M. Vayugundla, B. Vodermayer, T. Bodenmüller, C. Brand, W. Friedl, I. Grixa, H. Hirschmüller, M. Kaßecker, Z.-C. Márton, C. Nissler, F. Ruess, M. Suppa and A. Wedler, Towards Autonomous Planetary Exploration: The Lightweight Rover Unit (LRU), its Success in the SpaceBotCamp Challenge and Beyond, Journal of Intelligent & Robotic Systems (JINT), 2017.

[4] A. Wedler, M. Vayugundla, H. Lehner, P. Lehner, M. Schuster, S. Brunner, W. Stürzl, A. Dömel, H. Gmeiner, B. Vodermayer, B. Rebele, I. Grixa, K. Bussmann, J. Reill, B. Willberg, A. Maier, P. Meusel, F. Steidle, M. Smisek, M. Hellerer, M. Knapmeyer, F. Sohl, A. Heffels, L. Witte, C. Lange, R. Rosta, N. Toth, S. Völk, A. Kimpe, P. Kyr, and M. Wilde, First results of the ROBEX analogue mission campaign: Robotic development of seismic networks for future lunar missions, 68th International Astronautical Congress (IAC), 2017. paper no.: IAC-17-A3.IP.31.

[5] M. Vayugundla, F. Steidle, M. Smisek, M. J. Schuster, K. Bussmann and A. Wedler, Datasets of Long Range Navigation Experiments in a Moon Analogue Environment on Mount Etna, in International Symposium on Robotics (ISR), 2018.

[6] S. Brunner, P. Lehner, M. J. Schuster, S. Riedel, R. Belder, D. Leidner, A. Wedler, M. Beetz and F. Stulp, Design, Execution and Post-Mortem Analysis of Prolonged Autonomous Robot Operations. IEEE Robotics and Automation Letters. PP. 1-1. 10.1109/LRA.2018.2794580, 2018.

[7] M. J. Schuster, K. Schmid, C. Brand and M. Beetz, Distributed Stereo Vision-Based 6D Localization and Mapping for Multi-Robot Teams, Journal of Field Robotics (JFR), 2018.