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ADVANCED ROBOTIC SYSTEMS IN THE CONTEXT OF FUTURE SPACE EXPLORATION

Abstract

Future space exploration is calling for even more sophisticated robotic solutions for various applications. Plans are made by the prime space agencies for challenging and complex missions, ranging from orbital servicing to deep space exploration with a strong focus on robotic and manned missions to Moon and Mars. In order to cope with these upcoming mission goals a need arises for capable robotic solutions, bringing together cutting edge technologies and software algorithms to provide reliable, highly integrated robotic systems with advanced autonomous behavior.

The German Research Center for Artificial Intelligence - Robotics Innovation Center (DFKI RIC) has a traditionally strong background in the field of space robotics. For more than a decade, different robotic systems have been developed and evaluated for a wide application range. This paper aims at presenting an overview of the robotic systems developed at DFKI RIC in the context of advanced space missions.

Based on current mission roadmaps, an overview of upcoming space missions is presented and evaluated, to identify and cluster the mission targets and most demanding needs for robotic systems in future missions. The areas of operation are ranging from on-orbit servicing, system application on the ISS, planetary exploration and infrastructure implementation using heterogeneous robot teams on Moon and Mars, advanced robotic man-machine interfaces for the mission control, and exploring deep space locations like Jupiter's moon Europa. Based on this, the individual characteristics of the developed robotic systems as well as their level of autonomy are described and brought into relation with future mission needs. The type of systems range from advanced (mobile) manipulators to humanoid and multi-legged walking and climbing robots as well as highly mobile rover platforms to autonomous underwater vehicles. The paper presents the main system features, their aspired application scenarios as well as evaluation results gained in analog missions or relevant test scenarios. The robot control ranges from human-in-the-loop control approaches of single systems to fully autonomous exploration missions of heterogeneous robot teams. According to the different use cases, the required level of autonomy is assessed in relation to the mission architectures.

With a view to the aspired future missions, the robotic systems are discussed in context to the upcoming mission needs, and evaluated against their suitability. Furthermore, an outlook for the enhancement of the systems is given as well as a potential view beyond the current mission roadmaps.