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ENABLING IN-SITU RESOURCES UTILISATION BY LEVERAGING COLLABORATIVE ROBOTICS AND ASTRONAUT-ROBOT INTERACTION

Abstract

Space exploration and even more so, the permanent presence of humans on the surfaces of planets, will require a great technological effort with a predominance of collaboration between robots and astronauts. Efficient use of space resources is also crucial when creating extra-terrestrial settlements. In the CISRU (Collaborative ISRU) project, a software suite has been developed to understand the environment, navigate through it, and interact with it and with its agents, both robots and astronauts. The CISRU suite contains five main modules. The first module of the suite includes the multi-agent autonomy components. It communicates between the different agents and the mission control. The second one is the perception module, in which all the functions of perception of the environment have been included, powered by different AI algorithms, the segmentation of the environment, the pose estimation of different objects and agents, the obstacle detection or damage and emergency situations detection. The third module is responsible for providing all the necessary components for safe navigation to the agents, including obstacle avoidance, social navigation with astronauts and cooperation between various robots. The fourth module is the one that includes the manipulation functions. In an ISRU scenario, manipulation becomes especially important, which is why CISRU has incorporated multi-tool manipulation functions,

a new tool-changer design, and different objects, allowing agents to perform autonomously heterogeneous tasks. The fifth module controls the cooperative behaviour of all the modules, including the astronaut's command and Mixed Reality interfaces, as well as the map fusion of the different agents, task supervision and emergency and error control. Finally, to test the suite, an astronaut-rover interaction dataset has been created in a dedicated planetary environment, in addition to different simulators and testing in the analogue environment, GMV SPoT. The test results show that the degree of abstraction that the e4 level of autonomy allows, as well as the capabilities of AI in space systems, can represent a great advantage for a life in space where astronauts and robots must collaborate to build the different structures and carry out the specific tasks of each mission. This paper will address the development of the CISRU suite, as well as the preparation of the field tests and the analysis of the results, showing the potential of this comprehensive suite powered by AI, and the importance of a high degree of autonomy. and collaboration between agents, to pave the way for future planetary exploration missions.