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TECHNICAL CONSIDERATIONS FOR THE DEPLOYMENT OF HIVER-BASED ROBOTIC SWARMS ON CELESTIAL BODIES

Abstract

The vision of establishing a Lunar Village or human outposts on extraterrestrial bodies has caused space mission scenarios to become increasingly complex. These settlements require the use of robotic systems and the cooperation between anthropogenic and automated tasks in order to thrive in these environments. Within this context, the proposal of using an entire swarm consisting of a variety of robotic systems prior to the arrival of a manned mission is coming into focus. This paper describes the technical issues that need to be addressed for the successful deployment of such a framework of collaborative robots. This involves defining the specific roles that robots can take when deployed on the lunar surface. For example, exploration and mining robots are needed. Others, in turn, could repair or replace damaged components of swarm members. It is also necessary to determine which control paradigms can be used and to what extent in addition to how the collaboration of such robots can be realized. The HiveR robot is presented as an example of a highly modular robot, based on the CubeSat standard, specifically designed to work collaboratively with other robots. This system will be used to investigate what payloads are appropriate for each robot and which tools are needed for every robot to complete their various roles. Already on Earth, it provides an important link between the technologies already researched and the ones that need further development for such complex missions in space. For example, while abundant research is being conducted on methods for processing lunar regolith, it usually lacks the concrete application with a real robot. To showcase the capabilities of HiveR, an exemplary demonstration mission is simulated, that realises the collaboration. The simulation shows multiple HiveR rovers with the previously defined roles working on a joint task. The simulation environment used for this purpose and the modules developed for it are described in this paper. It also discusses how the use of a swarm system affects the efficiency of implementing this kind of task. Based on all these concepts,

the HiveR platform is introduced as the basic interface between hardware and software for managing a robot swarm system of this type. In addition to their direct application for space, the roles and processes presented here can also be transferred to similar systems on Earth. For example, such systems can be used in mining or in other places inaccessible to humans.