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PIONEERING STEPS TOWARDS FUTURE HUMAN-ROBOTIC OPERATIONS PERFORMANCE

Abstract

Future human spaceflight exploration missions to the Moon and beyond are hypothesised to benefit from human-robotic integrated operations. The European Space Agency focuses on preparing these operations, following the objective stated in the Global Exploration Roadmap of the International Space Exploration Coordination Group. Currently, human-robotic operations aim at technology development and demonstration, yet essential questions that remain unanswered are: *How do we measure human performance, and which metrics do we use?* This contribution aims at answering this by focusing on human performance assessment for subjects controlling a rover, based on results from a recent study by Hosseini (2016) for ESA. The study identified essential knowledge gaps that must be filled to assess astronaut performance for tele-operations, which is of great importance for future missions since they affect mission planning, task allocation and even tool selection. In this regard, this study proposes follow-on research in which a tele-operations experiment is conducted by driving a rover with time delays representing control from Earth, cis-lunar orbit and lunar surface, in order to evaluate human performance in tele-operations.

In the previous study, two space-to-ground and multiple ground-to-ground tele-operations experiments were analysed in which subjects controlled a rover. Data analysis studied the command time and execution time of the assigned tasks, i.e. the time it takes for the human to give the command to the rover and the time it takes for the rover to execute its tasks, respectively. Results showed that the main challenge for performance assessment is the lack of recorded parameters. The logged data is limited only to time values and success/failure results and it does not specify performance variations. Furthermore, the study concludes that many different sub-tasks were performed in a limited amount of time, resulting in scarce data per sub-task and limiting the statistical significance.

Follow-on research is proposed that aims at solving for the two abovementioned issues. Firstly, the study introduces parameters, which are used to assess the performance of pilots in modern-day aviation. Secondly, an experiment is set up with a set of sub-tasks, i.e. driving from point A to B while avoiding obstacles and retrieving a sample. Multiple operators perform the experiment, each of them repeating the experiment several times to increase statistical significance. We hypothesised that this approach has the potential not only to increase the qualitative assessment of the performance, but also to increase the

quantitative results essential for preparing crew training and future missions.