

IAF SPACE EXPLORATION SYMPOSIUM (A3)
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EVERYTHING IS AWESOME IF YOU ARE PART OF A (ROBOTIC) TEAM: PRELIMINARY
INSIGHTS FROM THE FIRST ISS-TO-SURFACE MULTI-ROBOT COLLABORATION WITH
SCALABLE AUTONOMY TELEOPERATION

Abstract

Through continuing advances, space robotics is playing an increasingly important role in space exploration and crew assistance. The Surface Avatar ISS (International Space Station) Technology Demonstration mission, led by the German Aerospace Center (DLR) in partnership with the European Space Agency (ESA), aims to study and validate the technologies in teleoperation, and robotic team collaboration, as key contributions to these endeavors. This paper presents the first ISS-to-Earth experiments of Surface Avatar conducted with a heterogeneous robotic team. The robotic assets, located on Earth at DLR in Oberpfaffenhofen, Germany, are teleoperated from the ISS by its crew member. Using a multi-modal user interface of the Robot Command Console (RCT), the ISS crew can command the surface robotic team with Scalable Autonomy. As a manager of the robotic team, the crew may choose the level of immersion and task delegation, ranging from direct control, shared control, to supervised autonomy. This gives the teleoperator the flexibility to command the robotic team as best suited to the task and situation.

In our first Prime ISS Session in July 2023, for the first time ever, a team of heterogeneous robotic assets was commanded to work together to carry out different tasks, including a simulated sample tube return mission, and seismometer deployment. The surface robotic team of this session consists of a robotic lander, a bi-manual humanoid robot, and a rover. For this session, the tasks were designed to be collaborations in a sequential fashion. Our further development in the following session with the Axiom-3 mission in January 2024, gave us a first look into robotic collaboration of simultaneous physical handling of a component. Furthermore, an additional robotic asset was introduced in the form of a small quadruped robot to demonstrate the feasibility of surveying and exploring tight, partially enclosed areas.

In addition to detailing the telerobotic collaboration tasks commanded by the ISS crew, this paper also looks into their feedback on the effectiveness of the scalable autonomy driven approach as applied to command a surface robotic team. These feedbacks shall also be applied to the two follow-up Surface Avatar ISS experiments in 2024-2025, along with further advances in methods and Scalable Autonomy collaboration tasks. Finally, the technologies developed in Surface Avatar can be utilized to support future cislunar missions such as Artemis, and deeper into the solar system.