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INTRODUCTION TO SURFACE AVATAR: THE FIRST HETEROGENEOUS ROBOTIC TEAM TO BE COMMANDED WITH SCALABLE AUTONOMY FROM THE ISS

Abstract

As the space community continues its development toward Lunar and Martian exploration and eventual surface habitat construction, Robotics is playing an increasingly vital role to help realize these goals. To help execute these large-scale extra-terrestrial missions, a large team of robots with different capabilities and functions will be required. Furthermore, a powerful, yet intuitive user interface (UI) would be necessary to make the most effect use of the team of robots on the surface. This paper introduces Surface Avatar, the newest series of ISS-to-Ground telerobotic experiments to be conducted in 2022-2023. Spearheaded by DLR, together with ESA, Surface Avatar continues to builds on our knowledge gained from past telerobotic experiments: Kontur-2, Haptics, Interact, SUPVIS Justin, and Analog-1. They laid the ground work on the feasibility of commanding robots with different levels of autonomy, from haptically coupled telepresence with force reflection, to task level command with Supervised Autonomy. Surface Avatar aims to extend the telerobotic capability by putting a team of four heterogenous robots at the command of an orbiting crew member on board the ISS. Included in this team are a dexterous humanoid robot for diverse object/sample handling and construction, a rover for long traverse exploration and sample acquisition, a miniature quad-pedal robot for exploring tight crevices and terrains, and a lander with a robotic arm for component delivery and sample stowage for return to Earth. The ISS crew would be able to command this team with a multi-modal Robot Command Terminal, consisting of an intuitive GUI implemented on a station notebook computer, a 3-DOF open-loop joystick, and a 7-DOF sigma.7 force reflection input device. A selected robot can be commanded as an avatar of the crew through direct command and haptically coupled telepresence. Alternatively, the crew may also delegate to the robots with task level commands, treating the robotic assets more as coworkers. Collaborative tasks will be designed of different exploration and construction scenarios to help examine the robotic team's performance, to be carried out in an analog extraterrestrial surface habitat at DLR with multiple sites of interest. Our experiment includes one preliminary and three sessions of ISS-Ground telerobotic experiments, set six months apart. This paper will present our initial findings from the preliminary run to be conducted in May-June 2022, and discuss the way forward in future experiment sessions.