IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

Author: Dr. Neal Y. Lii
German Aerospace Center (DLR), Germany

Dr. Thomas Krueger
European Space Agency (ESA), The Netherlands
Mr. Peter Schmaus
German Aerospace Center (DLR), Germany
Dr. Daniel Leidner
German Aerospace Center (DLR), Germany
Dr. Simone Paternostro
The Netherlands
Mr. Adrian Simon Bauer
German Aerospace Center (DLR), Germany
Ms. Nesrine Batti
DLR (German Aerospace Center), Germany
Ms. Anne Koepken
German Aerospace Center (DLR), Germany
Mr. Florian Lay
DLR (German Aerospace Center), Germany
Dr. Rute Luz
European Space Agency (ESA), The Netherlands
Mr. Emiel den Exter
ESA - European Space Agency, The Netherlands
Mr. Thibaud Chupin
European Space Agency (ESA-ESTEC), Unknown
Mr. Jacob Beck
Space Applications Services NV/SA, Belgium
Mr. Xiaozhou Luo
German Aerospace Center (DLR), Germany
Mr. Marco Sewtz
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany
Mr. Samuel Bustamante Gomez
DLR (German Aerospace Center), Germany
Mr. Michael Panzirsch
German Aerospace Center (DLR), Germany
Dr. Harsimran Singh
DLR (German Aerospace Center), Germany
Mr. Ribin Balachandran
German Aerospace Center (DLR), Germany
Dr. Thomas Hulin
German Aerospace Center (DLR), Germany
Mr. Maximilian Maier

German Aerospace Center (DLR), Germany
Dr. Maxime Chalon
German Aerospace Center (DLR), Germany
Mr. Werner Friedl
German Aerospace Center (DLR), Germany
Mr. Peter Lehner
German Aerospace Center (DLR), Germany
Mr. Benedikt Pleintinger
German Aerospace Center (DLR), Germany
Mr. Pedro Pavelski
DLR (German Aerospace Center), Germany
Mr. Roman Holderried
German Aerospace Center (DLR), Germany
Mr. Jonathan Arand
German Aerospace Center (DLR), Germany
Mr. Ralph Bayer
German Aerospace Center (DLR), Germany
Dr. Armin Wedler
German Aerospace Center (DLR), Germany
Dr. Martin Goerner
German Aerospace Center (DLR), Germany
Mr. Tilo Wuesthoff
German Aerospace Center (DLR), Germany
Dr. Serena Bertone
ESA, Germany
Ms. Lucia Brunetti
German Aerospace Center (DLR), Germany
Ms. Linda Holl
Deutsches Zentrum fuer Luft- und Raumfahrt (DLR), Germany
Ms. Bevan Mairead
German Aerospace Center (DLR), Germany
Mr. Robert Muehlbauer
German Aerospace Center (DLR), Germany
Mr. Christian Ehrhardt
German Aerospace Center (DLR), Germany
Ms. Catriona Bruce
German Aerospace Center (DLR), Germany
Mr. Thomas Mueller
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany
Mr. Gerd Soellner
German Aerospace Center (DLR), Germany
Dr. Dieter Sabath
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany
Mr. German Zoeschinger
German Aerospace Center (DLR), Germany
Mr. Angelo Giuliano
ESA - European Space Agency, The Netherlands
Mr. Stefan von Dombrowski
German Aerospace Center (DLR), Germany
Dr. Hansjoerg Maurer

German Aerospace Center (DLR), Germany
Dr. Aaron Pereira
DLR (German Aerospace Center), Germany
Dr. Gerhard Grunwald
German Aerospace Center (DLR), Germany
Dr. Jessica Grenouilleau
European Space Agency (ESA-ESTEC), The Netherlands
Mr. Gianfranco Visentin
European Space Agency (ESA), The Netherlands
Dr. Alin Albu-Schäffer
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany

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.