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THE ROBOT AS AN AVATAR OR CO-WORKER? AN INVESTIGATION OF THE DIFFERENT TELEOPERATION MODALITIES THROUGH THE KONTUR-2 AND METERON SUPVIS JUSTIN SPACE TELEROBOTIC MISSIONS

Abstract

The continuing advancement in telerobotics is garnering increasing interest for space applications. Telerobotics enables the operator to interact with distant and harsh environments not reachable by most humans today. Depending on the suitability to the task, robots may be employed as an avatar (e.g. physical extension of the user), or a co-worker to be supervised by the operator. This paper examines these different modalities of robot teleoperation through the lens of two space telerobotic missions: Kontur-2, and METERON SUPVIS Justin.

As a joint mission of DLR and Roscosmos, Kontur-2 aims to study the effectiveness of force-feedback telepresence. A two degrees-of-freedom force reflection joystick was deployed to the International Space Station (ISS) to allow the astronauts to command, among others, DLR's humanoid robot Space Justin, to perform different dexterous tasks including grasping of objects, and haptically interacting with a person on Earth. Commanding the robot through this form of telepresence, the operator in orbit can feel the surrounding as experienced by the robot on Earth. This capability allows future scientists to perform extraterrestrial exploration by seeing and touching through the body of the robot.

METERON SUPVIS Justin, on the other hand, aims to study the use of the robot as a co-worker. Developed by DLR and ESA, the astronauts on-board the ISS are provided with a tablet computer to

command Rollin' Justin, a robot similar to the one utilized in Kontur-2. Using task level command through an intuitive tablet computer user interface together with the robot's reasoning ability, a collaboration is formed between the human supervisor and robotic co-worker to carry out tasks in the robot's surrounding. The supervised autonomy based teleoperation significantly relieves the operator's workload by delegating low-level control to the robot. It extends the astronaut's effective operating time, and gives the possibility for an astronaut to command a fleet of robots to perform larger tasks.

This paper examines the performance of no fewer than nine astronauts and cosmonauts on-board the ISS teleoperating robots on Earth over four years (2015-2018). The aim is to investigate the suitability of different telerobotics modalities for different tasks in the planetary surface environments. Criteria such as teleoperation range, robot capability (e.g. local intelligence, dexterity), task complexity, and interaction with the environment shall be discussed. We also consider the future of telerobotic systems that may fuse these command modalities to give the astronaut a full spectrum of possibilities for intuitive and effective robot command.