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ASTRONAUT-ROBOT INTERACTION FOR COOPERATIVE MANIPULATION ON EXTRATERRESTRIAL SURFACES : OBJECT TRANSFER TO ONE ANOTHER THROUGH VISUAL SERVOING AND GESTURE CONTROL

Abstract

A safe and sustainable human presence on extraterrestrial surfaces require construction of infrastructure (habitat, power, atmosphere control, etc.) on the surface where exploration is planned. Astronaut-robot cooperation could simplify exploration and enable such large-scale constructions. Therefore, future of astronaut-robot cooperation applications is highly dependent on the capability to perform safe and efficient physical interaction using the robot's manipulators. The concept of physical human-robot interaction is motivated by a simple, reliable and robust language between humans and robots, *id est*, the physical world.

Within this research, we look at cooperative manipulation tasks involving a single human, a single robot, and objects that can be considered to be exclusively controlled by the robot, exclusively controlled by the human, or briefly in transition between these two states. A wide variety of manipulation tasks fit this structure.

This work focuses on finding novel solutions to main problems of interactive object transfer between a human worker and an assistive robot: the recognition of the object with partial occlusion by barriers including the hand of the human worker, the evaluation of object grasping affordance, coping with inaccessible grasping points, handover trajectories, predicting object transfer position, and timing.

One major limitation for robotic vision systems is visual occlusion, as it dramatically lowers the chance to recognize the target out of a group of objects and then perform successive manipulations on the target. Besides, in the case of multiple available grasping points, the robot is confronted with the challenge of deciding on a feasible grasping strategy. When passing the object to the human worker, the robot has to deal with the tough case of offering good grasping options as preferred by the human worker.

This study considers an interaction task where the robot and human hand over objects between themselves with the help of real-time hand gesture recognition control. Meanwhile, the visual servoing system enhances the abilities of robotic systems to deal with the unknown changing surroundings and unpredictable human activities.

The proposed experimental setup is composed of a Laptop, one Microsoft Kinect Sensor, Kinova JACO Robot and wearable AOUDA exoskeleton. The Microsoft Kinect Sensor is used to detect and track human movement. AOUDA exoskeleton is a part of the AOUDA.X Spacesuit Simulator developed for planetary surface exploration by the Austrian Space Forum (OeWF). This modifiable exoskeleton is responsible to simulate various pressure regimes from 0.3-1 bar for astronauts for all major human joints, including fingers.