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INT-BALL2 FOR FULLY-TELEOPERATED JEM ONBOARD CAMERA DRONE WITHOUT CREW AID

Abstract

Free-flying robots on the International Space Station (ISS) perform several tasks for supporting astronauts. The JEM Internal Ball Camera (Int-Ball) that is a JAXA's free-flying robot was exploited in ISS for taking images and videos by teleoperation control. The goal of this project is to reduce the astronauts' efforts for taking photos to zero, which could consume nearly 10% in the total crew resources. The first demonstration in ISS has provided us with many technical insights and lessons learned that can improve such free-flying robots in future missions. This paper describes the lessons learned from this project and the renewal design on the updated Int-Ball (Int-Ball2).

The clarified issues to achieve the above goal are autonomous recharge without astronaut support and robust maneuver in microgravity environment where with airflow disturbance. Based on the above analysis results, the new Int-Ball will be updated mainly in the following points; First, an enhanced propelled equipment is integrated for maneuvering stably with respect to strong airflow from diffusers in ISS. The propulsion design is changed from redundant 12 small fans to replaceable 8 large propelled system. Second, the Visual Simultaneous Localization and Mapping (VSLAM) using a stereo camera is applied as a robust navigation system without an intentionally designed marker. Third, an autonomous compact docking system including a capture and release mechanism is provided newly for charging the robot's battery without any astronauts' support. In addition, the Robot Operating System (ROS) that is an open-software used commonly in robotics community is employed in the Int-Ball2, which enables third users to operate this robot as a technical platform for experiments and demonstration in microgravity. This also allows us to verify the flight software directly on an advanced simulator (called Gazebo) including

graphics and dynamics. The total integrated tests with the real hardware are implemented on the granite table surrounded by walls emulating the ISS's module. This paper also presents the details on the ground tests including the hardware and software configuration in JEM mockup field, and discusses the demonstrated results.