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A SIMULATION ENVIRONMENT FOR TELEPRESENT ORBITAL MANEUVERING

Abstract

Future On-Orbit Servicing and space debris removal operations will require high levels of safety, reliability and efficiency in conducting proximity operations and docking. So far, autonomous robotic systems have made use of very complex and computation power consuming sensor processing algorithms which nonetheless mostly depended on visual targets or GPS coordinates provided by the target spacecraft or the a priori knowledge of the targets' geometry and configuration. This will most likely not be available once the current generation of orbiting spacecraft or even space debris is to be approached and captured.

TU Munich's Institute of Astronautics (LRT) therefore investigates technologies and methods that will allow a human operator to intuitively perceive the orbital situation, the relative positions and orientations of the spacecraft involved and their status. The goal is to enhance the operator's situational awareness to a degree that allows him/her to teleoperate the interceptor craft during proximity operations while making maximum use of the human capabilities in perception and spatial modeling and thus reducing computational requirements.

In order to test and verify these approaches, a simulation environment has been developed. It allows an interceptor and a target platform to be moved in 3 degrees-of-freedom in relation to each other. The target platform is mounted on a robotic platform running on omni-wheels, which allows it to translate in the x- and y-directions while simultaneously rotate around the z-axis. This target is maneuvered in relation to the interceptor so that realistic motion within the orbital plane from the interceptor's vantage point is recreated. This includes overlaying all motion controls with the spacecraft dynamics as described by the Clohessy-Wiltshire equations. In order for it to be maneuverable, the target platform only carries lightweight equipment, such as thruster nozzle models as docking targets, geometrical mock-ups of target satellites, optical tracking targets, etc. The stationary interceptor will consist of a satellite body, equipped with a stereo camera, range finders and a robotic camera arm.

The detailed setup of this proximity operations simulator and the experiments conducted with it will be described in this paper, as well as the preliminary results' implication on current and future research at LRT.