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REAL-TIME SIMULATION AND TRAINING ENVIRONMENT FOR ROBOTIC SPACE SYSTEMS.

Abstract

Over the last years, a multitude of robotic missions and activities emerged which require closed loop human interaction or even dexterous real-time teleoperation. While imposing highest challenges to the operator, suitable training and simulation capabilities for such missions are currently still being defined. Most state of the art simulation environments are focused on classical satellite operations. Hence, their applicability for the simulation of dexterous, dynamic, and interactively controlled space robots is very limited.

The here presented 'Robotic Actuation, Control, and On-Orbit Navigation Simulator', RacoonSim, is designed for enhancing the development of new technologies and operational strategies in space robotics. It allows testing of both teleoperated and autonomous robotic scenarios at each development stage. Hence, proof of concept simulations at very low system definition level are possible as well as closed loop verification tests, optimizations of design details and training of operations and procedures.

The challenges of such a simulation and training environment are twofold: Due to the complex nature of dexterous robotic operations in the close proximity of sensitive target systems, human factors, situation awareness and performance of the human control team can have an significant impact on the mission. Hence, the implementation of all technical and environmental features of on-orbit robotics is required without overstretching computational performance and maintaining real- time executability. This includes the representation of all mission segments and of environmental and system intrinsic properties. In addition, a highly adaptable software architecture and model interpretation method is required that is able to represent a high diversity of currently even unknown scenarios and systems.

In this publication, the simulation concept is explained and demonstrated by three exemplary simulations comprising a high diversity of mission types and spacecraft systems: A manually teleoperated robotic capture of a large satellite, a pre-planned fly-around inspection by a light weight freeflyer and autonomous docking with a spinning and nutating target.