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Space Structures III Design, Development and Verification (Orbital infrastructure for in orbit service & manufacturing, Robotic and Mechatronic systems, including their Mechanical/Thermal/ Fluidic Systems) (3)

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EXPERIMENT-BASED PERFORMANCE ANALYSIS OF THE MOTION SUSPENSION SYSTEM FOR SPACE ROBOT TESTING

Abstract

Space robotics plays a critical role in the future of space exploration. The ability to manipulate satellites for repair, refueling, or deorbiting opens up a wide range of applications. However, testing space robots on-ground poses a significant challenge: space robots are designed to operate in zero gravity, but are tested under the influence of Earth's gravity. Space robot arms longer than about 2 meters are typically non-gravity-bearing, thus they require a support system. Conventional space robot test facilities use the air-bearing concept, which limits the robot's workspace to a two-dimensional, horizontal plane. This is problematic for testing complex tasks such as grasping, vision-based approaches, or FDIR trajectories, where the robot's full workspace is required. The Institute of Robotics and Mechatronics at the German Aerospace Center (DLR) and the University of Duisburg-Essen have developed the Motion Suspension System. It is a cable-driven parallel robot that mechanically supports space robots and enables them to operate on ground in a full three-dimensional workspace. In contrast to the passive air bearing concept, the Motion Suspension System uses actively controlled cables to position the connection interface to the space robot. To gain a better understanding of the behavior of the Motion Suspension System, this study presents performance tests of the Motion Suspension System. This includes the influence of the mechanical system as well as the behavior of the closed-loop controller. The main performance criterion is the step position response, which defines the ability of the Motion Suspension System to respond to motion. This ability is necessary for the Motion Suspension System to accurately follow the motion of the space robot. This criterion is tested using a simplified representation of the attached space robot. In addition, the external perturbation response is evaluated, which defines the ability of the Motion Suspension System to respond to external disturbances. This experiment provides a better understanding of how the Motion Suspension System can be influenced by the space robot arm. This performance analysis of the Motion

Suspension System is critical for its use as a qualification facility for autonomous grasping and vision-based servoing of space robot arms. These applications can only be tested on-ground undergo the influence of the support system. Thus, this experimental study provides a better understanding of how the Motion Suspension System is able to interact with the space robot and what is the influence on the space robot arm during testing.