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SPACE SYSTEMS SYMPOSIUM (D1)
Innovative and Visionary Space Systems Concepts (1)

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ROBOTIC AUTONOMY IN SPACE:

CHALLENGES, BENEFITS AND COMPLICATIONS LEARNED FROM DESIGNING AND IMPLEMENTING AN AUTONOMOUS ROBOTIC MANIPULATOR FOR SATELLITE CAPTURE

Abstract

One of the holy grails of space systems is the capacity for robotic autonomy, permitting key benefits to complicated, repetitive, and hazardous tasks while freeing up valuable human mission time. Additionally, autonomy enables previously unforeseeable or unfeasible concepts such as on-orbit servicing of failed or failing space assets. Notwithstanding, autonomy carries risks and complications that have hitherto rendered it an incommodious solution.

Autonomous robots, although varied in their appearance and capabilities, consists of three essential elements: sensors, actuators, and controllers. The selection of these constituents provides abilities and limitations to the system and can typically, although not always easily, be constructed from the set of mission requirements. Balancing the set of requirements and constraints is what births such varied concepts. Sensors provide critical input to the system, being equivalent to the human senses. Vision is a commonly employed artifice in sensing as it easily maps from human understanding to robotic implementation. However, sensors often include laser range finders, GPS, force and tactile sensors, and thermocouples. Actuators grant mobility and typically come in two flavours, rotational and linear. They range from piezoelectric motors and steppers, to shape memory alloys. The controller provides the behaviour in the system and can truly take a nearly infinite number of forms. Simplicity is often the key in selecting the logic, particularly in space applications. The selection process for these constituents for the robotic manipulators will be discussed in detail in the paper and exemplified.

A novel approach will be presented in selecting, designing, constructing, and implementing an autonomous robotic solution to the capture of non-cooperative satellites. The system employs a custom robotic manipulator, vision, force sensors, and an adaptable evaluative target. The goal of the capture operation is to grasp a flexible beam target simulate and minimize stresses while bringing relative motion to a halt. Analysis and testing will be presented, bestowing a better understanding and comprehension for autonomous robotic design and architecture.