Proceedings of the Canadian Society for Mechanical Engineering International Congress 2021
CSME Congress 2021
June 27-30, 2021, Charlottetown, PE, Canada

A Comprehensive Review of Space Manipulator in the Field of Target Sensing and Grasping

Bahador Beigomi[1], Zheng Hong (George) Zhu[2]
[1,2] Department of Mechanical Engineering, York University, Toronto, Canada
[1]baha2r@yorku.ca, [2]gzhu@yorku.ca

ABSTRACT

With the development of space projects, space on-orbit service has gradually become a research focus on the aeronautical area, and space robots are expected to perform more and more important tasks in future space services. When the spacecraft is in orbit, the space robot needs to complete various operations such as assembly, replacement, repair, recovery, the release of the modules, etc. And the primary operation of on-orbit tasks is to capture the floating target.

Task object of the space robots has been diversified due to the growth in their application. In this regard, many studies analyzed robotic manipulation kinematics and dynamics motion in space. However, handling an unfamiliar object is still a challenge for space robots which is a critical problem in this field, knowing that there exists various floating target in the space with unknown characteristics. Focusing on feature sensing and robotic grasping of unfamiliar objects, this work aims to present a literature review of recent works in this field. The objective is particularly concentrating on the robot's understanding of the detailed features of an object to reduce the uncertainties. Moreover, how the robot approach toward object grasping by the learning-based techniques is one topic of interest. Aiming to grasp the target, robots carry out two processes:

The first step is feature sensing; sensing and perceiving the target's features. An optimal/proper combination of sensor sensing data and feature identification models is required in order to receive the necessary information about the target. Various types of sensors, from the simple 2D camera to advanced LiDAR, are used to gather the raw data. By decoding the original sensing data and performing mathematical modeling such as image processing, the target's features could be estimated. The second step in this process is the grasping part. Robotics Grasping is analyzed based on a variety of strategies that could be categorized by different metrics. Some examples are grasper structure, grasping force, grasper form, and success probability.

Based on the unique characteristics of each target, especially in the space robotics area, different approaches toward the feature sensing and robotic grasping have been presented.