Paper ID: 70297
oral

IAF SPACE SYSTEMS SYMPOSIUM (D1)
Cooperative and Robotic Space Systems (6)

Author: Mr. Jose L. Ramon Carretero
University of Alicante, Spain

Mr. Ramón Calvo González
University of Alicante, Spain
Mr. Adrián Trujillo
University of Alicante, Spain
Dr. Leonard Felicetti
Cranfield University, United Kingdom
Prof. Jorge Pomares
University of Alicante, Spain

PATH GENERATION AND CONTROL OF HUMANOID ROBOTS DURING EXTRAVEHICULAR ACTIVITIES

Abstract

Future and under-development missions will require extensive use of on-orbit assembling and manufacturing to build new commercial, research and exploration infrastructures in space. On-orbit assembling involves complex tasks with strict requirements in terms of accuracy, dexterity, reliability, and safety of the operations. The utilization of astronauts performing extravehicular activities might be still considered a viable option, but it is challenged by the numerous technical and technological limitations. The utilization of autonomous robots is indeed a preferable option in the future, especially for tasks where operations are repetitive, structured and standardized. In some cases, robots will be expected to operate with tools and in an environment strongly characterized by human presence: workshop tools, screwdrivers, brackets and pliers are made to be easily used by astronauts as well as modules to be assembled have generally numerous handles and handrails that allow for safe movements around them. For this reason, humanoid robots are a preferable option over other kinds of robotic systems in such kinds of scenarios.

This paper proposes and investigates strategies that can be used to plan the motion and control humanoid robots in some elementary tasks that characterize extravehicular activities. The humanoid robot taken into account is a torso with two arms and two grippers at their extremities. A camera system is located on the head of the robot. The camera is used as the main sensor to detect and track the objects manipulated and touched by the robot's grippers. This study addresses the problem of robot's motion on the complex system of handrails and handles that characterize the ISS. Such a complex task has been divided into two elementary sub-tasks: motion planning and tracking the planned trajectories. First, an optimization procedure is presented to plan and coordinate the robot's arms motions and graspers to achieve the ISS's desired location using handrails. Then, a low-level controller is used to guarantee that the robots' actuators can follow these previously generated trajectories.

The paper outlines the definition of the optimal path planning problem as well as of the tracking controller. It also focuses on the analysis of trajectories, torques and forces to be provided for performing on-orbit operations. Simulations, carried on in ROS/Gazebo environment, show that the overall control architecture (trajectory optimizer + controller) is sufficiently robust and allows for complex and articulated motion of the humanoid robot in an eventual extravehicular activity outside the ISS in free-floating conditions.