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# TRAJECTORY GENERATION FOR AN ON-ORBIT ROBOT MANIPULATOR

**Abstract**

The problem of trajectory generation for on-orbit robot manipulator like-spacecraft is safety-critical for the success of missions to capture any prescribed target and to berth to another space vehicle. The orbital robot must fulfill the requirements to reach a position with zero relative velocity in close proximity of the target from where the manipulator can grasp a target/spacecraft. The position at zero relative velocity must be inside the robot manipulator workspace. The on-board SW must generate a trajectory envelop and command the manipulator arm (s) so as to accomplish the target grasping without collision. The main difference of such on-board control action with respect to ground manipulators is that in orbit the robot floats and is exited by any control command to move the arm(s) toward a point on the target. When a torque/force is commanded we have reactions on the robot that excites two motion modes on the system. The reaction torque that causes attitude motion (rotational motion) and a reaction force that cause a linear back motion of system instantaneous center of mass to keep the orbiting CM in the same position. In this paper we call this configuration as the synchronization of the instantaneous CM with the orbiting CM. A problem arises in such configuration. When the system moves back, it brings together the end effectors. If the trajectory generation does not compensate for this back motion, the robot manipulator fails to reach its target. This paper deals with the problem of trajectory generation which compensate for the robotic system back motion so that the robot arm reaches its target. We do not approach the attitude motion caused by the reaction torque arisen from the joints commanded torque. The reaction torque, if not subject to control actions, causes angular misalignments of the robot manipulator like-spacecraft with respect to the target. Of course this also affects the trajectory generation. In this article we assume that the attitude of both the manipulator like-spacecraft and the target is synchronized. For the case of the linear motion we develop the mathematical model taking into account the instantaneous CM motion to evaluate the amount the robotic system moves back do keep the orbital CM in the same orbital position while the robot arms moves. Such motion is incorporated in the on-board SW trajectory generation module and then the path is tested computationally for precise grasping operations using optimized trajectories.