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Author: Ms. Chise Taniguchi
Tokyo Metropolitan University, Japan

Prof. Hirohisa Kojima
Tokyo Metropolitan University, Japan
Prof. Pavel M. Trivailo
RMIT University, Australia, Australia

ARM/CMG COOPERATIVE CONTROL OF SPACE ROBOT SATELLITE

Abstract

Study on space robotic satellite is indispensable in the future space development. Since a space robotic satellite floats in outer space, the position and attitude of the said satellite itself will fluctuate due to the recoiling effect when the arm is moved. Two ways of controlling the space robotic satellite have been proposed: one is to control the arm while controlling the satellite body so that the body gets fixed on the inertial space, and the second is to forgo any control of the satellite body, and simply rely on the control of the arm's activity itself in a way that minimizes the recoiling effect. If the motion of the satellite body is not controlled, the position and attitude of the satellite body will change due to the recoiling of the arm. To resolve these problems, it is necessary to control the attitude so that the attitude of the satellite body does not fluctuate during the operation of the arm. Because RW output torque is small, there is a possibility that it may not be able to sufficiently cancel out the recoiling effect of the arm. Also, there is a high possibility that RW will not be able to adequately absorb the angular momentum when capturing space debris. On the other hand, the control moment gyro (CMG) has a much larger output torque than RW, thus it can sufficiently cancel out the recoiling effect of the arm. This study aims to derive the control that realizes the desired end effector motion by installing CMG on a satellite body, and having the CMG absorb the recoiling effect of the arm. We expanded the idea of the generalized Jacobian, and controlled the motion of the space robotic satellite by solving the inverse kinematics of the CMG that is loaded onto the space robotic satellite. The problem here is the singularity that exists in the arm and CMG. If both the arm and the CMG enter the singular point, it will be difficult to control the motion and attitude of the arm. Therefore, it is necessary to consider control to avoid singularity of both the arm and CMG. This study shows the validity of the control law that realizes the desired end effector motion while avoiding the singular point, and while controlling the attitude of the satellite body via CMG.