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NONLINEAR H-INF VIA MODIFIED RODRIGUES PARAMETERS FOR ATTITUDE CONTROL IN THE REUSE OF RETIRED SPACECRAFT ANTENNA

Abstract

For the on-orbit running spacecraft, several uncertain factors, such as the fuel exhaustion, the partial device failure or the collision from space debris, will be able to make it become a retired spacecraft as new large space debris and further worsen the space environment. Based on the principle of recycling resources and lower cost, the reuse of the undamaged components with long life time such as large-aperture communication antennas is becoming an urgent problem. To this end, the U.S. DARPA is carrying out an on-orbit operation of technology research project named "Phoenix" program to demonstrate and validate the ability on reusing the retired communication satellite which flights on the GEO orbit, and its significance lies in the development of on-orbit unmanned manipulation in reusing the retired satellite. This project intends to locate multiple cellularized satellite (named Satlet) in the different positions of retired spacecraft antenna to complete the re-use task. In this paper, the Satlet is supposed as a model which can only accomplish the attitude control mission in reusing the retired spacecraft.

Aiming at the attitude control problem for flexible spacecraft has attracted significant attention and research. The problem is readily formulated using modified Rodrigues parameters (MRPs) in conjunction with their shadow parameters for the spacecraft's attitude description. This paper combines the MRPs with their shadow set, displacement theory and assumed mode method to obtain a singularity-free parameterization of the rotation matrix. On this basis, the dynamic modeling for large scale space antenna is shown. The retired spacecraft antenna's nonlinear dynamic equation with multi-Satlet is derived by using the MRPs. When given the appropriate location of the Satlet on the antenna, it will be shown that a linear feedback law consisting of a linear combination of the spacecraft angular velocity and the generic MRPs locally solves the nonlinear H-inf state feedback problem. The control law is globally defined in the presence of MRPs switching. Furthermore, the numerical simulation is shown at last to demonstrate that the retired spacecraft antenna's attitude control project is valid in the re-use mission when the nonlinear control law is used in the antenna's control system.