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Author: Mr. Fengwen Wang
China, 1148068289@qq.com

Dr. Shan Lu
Shanghai Aerospace Control Technology Institute(SACTI), Shanghai Academy of Spaceflight Technology (SAST), China, 9175393@qq.com
Dr. Hou Yueyang
Shanghai Aerospace Control Technology Institute(SACTI), Shanghai Academy of Spaceflight Technology (SAST), China, houyueyang_hit@163.com

DYNAMIC MOTION PLANNING FOR SATELLITE ATTITUDE MANEUVER UNDER ATTITUDE CONSTRAINS USING FUZZY POTENTIAL FIELD

Abstract

In this paper, the fuzzy potential field method for satellite attitude maneuver motion planning with multiple types of attitude-constrained zones is first introduced. During on-orbit missions, satellite needs to adjust its attitude and pointing from one to another. However, there are multiple types of attitude-constrained zones. On one hand, to ensure communication requirements, the angle between satellite antenna pointing vector and the satellite-earth vector need to stay within a certain range. On the other hand, to ensure image quality, the optical detection equipment on satellite requires avoid the sun, moon and other bright objects. Therefore the main motivation of this work is to deal with the attitude-constrained zones in satellite attitude maneuver by using Takagi-Sugeno fuzzy potential field control technique. Through the initialization conditions and attitude determination, the satellite, the target and the attitude-constrained zones will be known by the satellite. The artificial potential field is modeled based on these known values. First, multiple constraints on satellite during attitude maneuver are classified into two categories, attitude-forbidden zone attitude –mandatory zone. By using unit quaternion logarithmic convex potential function, these attitude-constrained zones are uniformly converted into repulsive potential field acting on the satellite. The repulsive torque is defined based on the unit quaternion logarithmic distance between the satellite's current attitude and attitude-constrained zone. By using error quaternion function the error between current attitude and desired attitude is converted into attractive potential field acting on the satellite. The attractive torque is defined based on the relative attitude and velocity of the satellite with respect to the target. Second, Two fuzzy models are used to accomplish the total attractive and repulsive torques. From these steps, the satellite attitude maneuver mission is transformed into a fuzzy system with fuzzy rules. And a law for controlling the attitude of satellite with attitude-constrained zones can be developed from these fuzzy rules. For attractive torque subsystem, according to the defined premise variables and membership functions, a total of 42 rules are required to implement the attractive force model. For repulsive torque subsystem, the satellite cannot enter the attitude-constrained zones because the moment it receives at the attitude-constrained zones is infinite. At the same time, by limiting the scope of every attitude-constrained zone, singularities of attitude maneuver can be avoided. At last, a set of numerical simulations for satellite attitude maneuver with multiple types of attitude-constrained zones demonstrate the effectiveness of the proposed approach.