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DESIGN OF SUBOPTIMAL TURN-TIME ALGORITHM FOR 3-AXIAL ATTITUDE MANEUVERING

Abstract

The objective of this work is to design the PD controller coefficients determination algorithm that provides suboptimal turn-time of 3-axial attitude maneuvers. An analysis of current approaches to determination of control coefficients providing quasi-optimal performance was made. A mathematical model of the spacecraft motion in quaternions is considered taking into account saturation of angular momentum and torque of reaction wheels. Analytical expressions for the 3-axis PD controller coefficients have been obtained for each control case, providing quasi-optimal performance approximate to performance of "Bang-Bang" and "Bang-zero-Bang" optimal control algorithms. The obtained expressions of the control coefficients take into account input parameters listed below:

- spacecraft inertia matrix;
- maximum angular momentum and torque of reaction wheels;
- maximum torque of reaction wheels;
- initial spacecraft attitude;
- initial angular velocity of the spacecraft;
- initial angular momentum of reaction wheels.

Marked that the coefficients should be calculated via the algorithm right before the turn starts and stay valid until spacecraft reaches desired attitude range.

The analysis of the proposed approach is carried out, special cases are highlighted and the boundaries of input parameters are analytically obtained. Behavior of the algorithm was studied via mathematical modeling and ADCS test-bench. Efficiency of the proposed algorithm in comparison with optimal control algorithms has been calculated.

Thus, the results of the work can be used for fast turns starting from various initial conditions for a wide range of spacecraft with various reaction wheels installed.