عنوان مقاله:

Application of Complex Functional of Quality in Optimal Control of Spacecraft Motion

نویسنده:

Mikhail Valer'evich Levskii - *Research Institute of Space Systems, Khrunichev State Space Research-and-production Center, Korolev, Russia*

خلاصه مقاله:

The problem of optimal control of the reorientation of a spacecraft as a solid body from an arbitrary initial position into a prescribed final angular position is considered and solved. The case is studied in detail when the minimized index combines, in a given proportion, the integral of modulus of angular momentum and duration of maneuver. It is proved that the accepted optimality criterion guarantees the motion of a spacecraft with modulus of angular momentum not exceeding the required value. Formalized equations and expressions for the synthesis of the optimal rotation program are obtained using quaternion models. It is shown that the optimal solution corresponds to the strategy "acceleration - rotation with constant modulus of angular momentum-braking", the angular momentum and the controling moment are perpendicular during optimal rotation between acceleration and braking. On the basis of necessary optimality conditions, the main properties, laws, and key characteristics (parameters, constants, integrals of motion) of the optimal solution of the control problem, including the turn time and the maximum angular momentum for the optimal motion, are determined. An estimation of the influence of the bounded controling moment on the character of the optimal motion and on the indicators of quality is made. The construction of an optimal control program of rotation is based on the quaternion variables and Pontryagin's maximum principle. The value of maximal angular momentum magnitude is calculated by condition of transversality. The designed method is universal and invariant relative to the moments of inertia. For dynamically symmetric spacecraft, a complete solution of the reorientation problem in closed form is presented. An example and results of mathematical modeling of the motion of a spacecraft under optimal control are presented, demonstrating the practical feasibility of the method for controlling spacecraft's spatial orientation.

کلمات کلیدی:

spacecraft attitude, Quaternion, optimal control, criterion of quality, maximum principle, Transfersality conditions

لینک ثابت مقاله در پایگاه سیویلیکا:

https://civilica.com/doc/1222035