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RESPONSE-OPTIMAL DECELERATION OF THE ROTATION OF A SYMMETRIC FREE RIGID BODY IN A RESISTIVE MEDIUM

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ABSTRACT

The problem of time-optimal deceleration of rotation of a free rigid body is studied. It is assumed that the body contains a moving mass connected to the body by an elastic coupling with square-law friction. Low deceleration torque of viscous friction forces also acts on the rigid body. It is assumed that the body is dynamically symmetric. The optimal control law for deceleration of rotation of the rigid body in the form of synthesis, the operation time, and the phase trajectories are determined.

INTRODUCTION

Analysis of passive motion of a rigid body with a cavity filled with viscous liquid, motion of a rigid body with a moving mass connected to the body by an elastic coupling with viscous or square-law friction and motion in a resistive medium is fulfilled in [1-8]. The problem of control of rotation of "quasi-rigid" bodies via concentrated torques of forces important for application was insufficiently studied. A class of systems resulting in smooth control actions and allowing one to apply methods of singular perturbations without accumulation of "boundary-layer"-type errors was separated [2, 9-13].

The problem of time-optimal deceleration of rotation of a dynamically symmetric body connected at a point on the axes of symmetry with a mass concerning the small linear sizes by an elastic coupling with square-law friction dissipation is studied. Furthermore, low decelerating torque of a resisting medium acts on the rigid body. Rotation is controlled by the torque of forces with the bounded absolute value. The considered model continues those studied performed earlier in [2, 9-13].

1. STATEMENT OF THE PROBLEM

Based on approach [3, 13] the equations of controlled rotations in projections onto the axes of the coordinate system attached to the fixed rigid body (Euler equations) can be represented in the form [3, 5, 6,11,13]

$$
\begin{aligned}
A\dot{p} + (C - A)qr &= M_p + FG^2qr + Spr^6\omega_\perp - \chi Ap \\
A\dot{q} + (A - C)pr &= M_q - FG^2pr + Sqr^6\omega_\perp - \chi Aq \qquad (1) \\
C\dot{r} &= M_r - AC^{-1}Sr^5\omega_\perp^3 - \chi Cr
\end{aligned}
$$

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