Nonlinear Dyn
https://doi.org/10.1007/s11071-020-06195-0

ORIGINAL PAPER

Evolution of a heavy rigid body rotation under the action of unsteady restoring and perturbation torques

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Received: 28 April 2020 / Accepted: 31 December 2020

Abstract The paper develops an approximate solution to the system of Euler's equations with additional perturbation term for dynamically symmetric rotating rigid body. The perturbed motions of a rigid body, close to Lagrange's case, under the action of restoring and perturbation torques that are slowly varying in time are investigated. We describe an averaging procedure for slow variables of a rigid body perturbed motion, similar to Lagrange top. Conditions for the possibility of averaging the equations of motion with respect to the nutation phase angle are presented. The averaging technique reduces the system order from 6 to 3 and does not contain fast oscillations. An example of motion of the body using linearly dissipative torques is worked out to demonstrate the use of general equations. The numerical integration of the averaged system of equations is conducted of the body motion. The graphical presentations of the solutions are represented and discussed. A new class of rotations of a dynamically symmetric rigid body about a fixed point with account for a nonstationary perturbation torque, as well as for a restoring torque that slowly varies with time, is studied. The main objective of this paper is to extend the previous results for problem of the dynamic motion of a symmetric rigid body subjected to perturbation and restoring torques. The proposed averaging method is implemented to receive the averaging system of equations of motion. The graphical representations of the solutions are presented and discussed. The attained results are a generalization of our former works where μ and M_i are independent of the slow time τ and M_i depend on the slow time only.

Keywords Rigid body · Lagrange's case · Averaging method · Resisting medium

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Published online: 16 January 2021

1 Introduction

Many works have studied the rotational motion of a heavy rigid body about a fixed point and subject to some torques which can be represented as perturbation and restoring torques (see, e.g., [1–4]). The perturbed motions of a rigid body, close to the Lagrange top, and related problems are studied in recent works.