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Stability Analysis of Nonlinear Mechanical Systems with Delay in Positional Forces

A.Yu. Aleksandrov [1*] and E.B. Aleksandrova [2]

[1] *Saint Petersburg State University, 7/9 Universitetskaya Nab., St. Petersburg, 199034, Russia*
[2] *ITMO University, 49 Kronverksky Ave., St. Petersburg, 197101, Russia*

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Abstract: The paper is devoted to the problem of delay-independent stability for a class of nonlinear mechanical systems. Mechanical systems with linear velocity forces and essentially nonlinear positional ones are studied. It is assumed that there is a delay in the positional forces. With the aid of the decomposition method and original constructions of Lyapunov–Krasovskii functionals, conditions are found under which the trivial equilibrium positions of the considered systems are asymptotically stable for any constant nonnegative delay. An example is given to demonstrate the effectiveness of the obtained results.

Keywords: *mechanical system; delay; asymptotic stability, Lyapunov–Krasovskii functional, decomposition.*

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1 Introduction

An efficient approach to investigation of dynamical properties of complex systems is the decomposition method [15, 21]. The approach is successfully applied in various forms to the stability analysis of mechanical systems, see, for example, [15, 17, 20, 22, 24] and the bibliography therein.

An interesting and practically important result on the decomposition of mechanical system was obtained by V.I. Zubov [24]. He studied the stability of gyroscopic systems described by linear time-invariant second order systems and found conditions under which the stability problem for an original system can be reduced to that for two auxiliary independent first order subsystems. However, it should be noted that the Zubov approach

* Corresponding author: mailto:a.u.aleksandrov@spbu.ru