Rotation of the body with movable internal masses around the center of mass on the rough plane

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ABSTRACT

Among the variety of robotic systems, moving along a plane, a class of devices which run without any external moving parts (like wheels, tracks, legs etc.) can be distinguished [1, 2]. Such systems have a number of advantages connecting with their isolation from external adverse factors. Robot motion without external drivers can be achieved by motion of the internal masses and interaction with the environment by the friction forces.

In this paper, we consider a system consisting of a hollow body and movable internal masses which is called slider. The basement of the slider has a parallelepiped form and based on a rough plane. We study two configurations of the internal masses: disk and two points. First one is located in a horizontal plane and its center of mass coincide with the body center of mass. Second one (two point masses) can move inside the cavity along the horizontal rails lying in same plane with the geometric center of the body and parallel to its longitudinal axis of symmetry [3]. We investigate the possibility of the slider rotation because of anti-phase masses movement inside the cavity. As a model of the friction between the plane and the base of the body local Amontons-Coulomb law is used. To determine the normal stress distribution in the contact area between the plane and the body we use dynamically collaborative linear model [4].

Equations of the slider motion were obtained. For both configurations piecewise linear control law was considered. For this control law equations of motion were integrated, the features of the system motion was analyzed.

In the case of the disk area of the control law parameters which correspond to overcome the force of static friction and start the body motion was found. Motion was qualitatively described. In the case of the two point masses is established that the motion of the system is determined by the presence of impact resulting by stepwise changes f the mass relative velocity.

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