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UNIFORM ROTATIONS OF A TWO-BODY TETHERED SYSTEM IN AN ELLIPTIC ORBIT

Abstract

Attitude control of spacecraft by changing its inertia parameters has been studied since 1960th [1]. Recently several efforts have been made to use this control for space system stabilization in elliptic orbits [2, 3].

Here we consider the motion of a dumbbell in a central gravitational field. The dumbbell consists of two material points connected by a massless rigid rod; the length of the rod can be changed according to a given law and is considered as a control function. The attraction center N is fixed; the motion occurs in a given plane that passes through N. If the dumbbell length is much less than the distance between its center of mass C and the attraction center N, the equations of motion for the center of mass separate from the equation of dumbbell attitude motion. Assuming that C moves along a Keplerian elliptic orbit and using true anomaly ν as an independent variable, one can write down the equations of the dumbbell's attitude motion; these equations depend on the dumbbell length L and its derivative.

To obtain the control $L(\nu)$ that implements a given motion of the dumbbell, one should substitute the corresponding particular solution into the above equations and solve the resulting differential equation for $L(\nu)$.

Here we are looking for a control law that results in a uniform, in terms of the true anomaly, in-plane rotation of the dumbbell. For some rotation frequencies (e.g., $\omega = 0$, +-1, +-2, ... or $\omega = 1/2, 3/2, \ldots$) such solutions can be found in closed form.

Analysis of stability for such rotations resulted in identification of intervals of stability both for direct ($\omega>0$) and inverse ($\omega<0$) rotations; some of these intervals correspond to highly eccentric orbits.

References

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