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DEPLOYMENT OF A SPACE TETHER IN A CENTRIFUGAL FORCE FIELD WITH ALIGNMENT TO THE LOCAL VERTICAL

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This study is concerned with a small orbital tether of two bodies to be deployed from a spacecraft so that upon completion of the deployment it turns out to be aligned along the local vertical. The bodies of the tether have equal masses, and the thread connecting the bodies is supposed to be massless. The objective of the study is to build a program law of tether length control taking into account the variation of the angular momentum of the tether under the action of the gravitational torque from the central Newtonian field of forces. The deployment mode of the space tether in a centrifugal force field with its alignment at the conclusion of the deployment along the local vertical is studied. To produce centrifugal forces, the tether is pre-spinned about the orbit binormal. The study consists of two steps. The first step involves the construction of a tether length control law that would provide the planned deployment. At this step, use is made of the tether motion equations written in spherical coordinates for the special case of the tether motion in the orbital plane. A numerical simulation of the tether deployment dynamics is carried out at the second step using the constructed program law of tether length control. Hill-Clohessy-Wiltshire's equations are used as a mathematical model of the tether. They describe the spatial motion of the tether bodies. These equations do not contain the tether length as a variable in explicit form. Therefore, these equations are modified. The tether tension force appearing in these equations is expressed in terms of the program law of tether length change and its two first time derivatives. The novelty of the study consists in the construction of a program control law that allows the tether to be deployed along the local vertical in a single stage. The study used methods of analytical mechanics, numerical methods, and methods developed by the authors. The obtained results make it possible to find the ranges of values of the deployment system parameters allowing a deployment of this type. The errors of the numerical simulation are estimated. The practical significance of the obtained results consists in the possibility of deploying small tethers in orbit with their alignment at the conclusion of the deployment along the local vertical in a single stage with controlling the tether length without the need for further dumping of libratory oscillations.

Keywords: *Control, space tether; deployment, local vertical, one stage*

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