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CONTROLLED DEPLOYMENT OF A PARTIAL SPACE ELEVATOR

Abstract

It is believed that, before the full space elevator is constructed, a smaller partial space elevator might be deployed to test the feasibility of the technology. It has been shown by several researchers, such as Lorenzini, et al., that deployment of a partial space elevator, or a very long tether, starting from a nucleus in the geostationary orbit, is inherently unstable. That is, the center of the orbit gradually comes down from the geostationary altitude when deployment progresses. Hence, there is a need for developing a stabilization procedure. This paper proposes a deployment control strategy. However, before considering controlled deployment, several issues related to uncontrolled deployment are examined first. It is observed that the elasticity of the tether has an important effect on the stability of the deployment process. Furthermore, the manner in which the deployment rate changes with time has also an important impact on stability. The study of uncontrolled deployment is followed by the development of a controller. It is noted that the application of a suitable transverse force, determined by using linear state-feedback and appropriate gains, can make the deployment stable. An optimal LQR controller is developed. Simulations of the dynamics of the system are carried out using this controller for various parametric values of tether elasticity, deployment rates, etc. to show the efficacy of the controller. The weighting matrices in the LQR scheme have an impact on the performance of the controller. Efforts are made to choose the weighting matrices in an optimal manner.