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PARAMETRIC STUDIES OF TRAJECTORY CONTROL SYSTEMS FOR HIGH ALTITUDE BALLOONS TO BE USED FOR EXPLORATION OF PLANETARY SYSTEMS WITH ATMOSPHERES

Abstract

This paper explores the design space for a Trajectory Control System (TCS) concept for a high altitude balloon system capable of generating a force perpendicular to the direction of motion. Such a system would be extremely valuable for exploring planetary bodies with atmospheres, such as Venus, Jupiter, and Titan. NASA has begun initial work in this area, and has been working with the Engineering Mechanics and Space Systems Laboratory (EMSSL) at NC State University to make the concept a reality. In pursuit of this goal, the EMSSL has developed two theoretical models for such a system, and the tether has been modeled using two different techniques. The first utilizes an analytical approach, while the second method is founded in numerical methods. Both models suggest similar behavior for a given set of initial conditions and atmospheric parameters. We have also performed preliminary validation experiments for these models (these results are presented in a separate paper).

In this paper, we use the models described above to perform several case studies showing how a high altitude balloon system with a TCS could be used to explore planetary bodies with atmospheres. Parametric studies on system parameters, such as the mass and location of the TCS, and the length of the tether, are performed to gain insight into the best way to design such systems for planetary exploration, and demonstrate the enormous potential of such systems to further NASA's planetary exploration goals.