BALLOON BORNE ARC-SECOND POINTER FEASIBILITY STUDY

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Abstract

For many years scientists have been utilizing stratospheric balloons as low-cost platforms on which to conduct space science experiments. A major hurdle in extending the range of experiments for which these vehicles are useful has been the imposition of the gondola dynamics on the accuracy with which an instrument can be kept pointed at a celestial target. A significant number of scientists have sought the ability to point their instruments with jitter in the arc-second range. This paper presents the design and analysis of a stratospheric balloon borne pointing system that is able to meet this requirement.

The foundation for a high fidelity controller simulation is presented. The flexibility of the flight train is represented through generalized modal analysis. A multiple controller scheme is introduced for coarse and fine pointing. Coarse azimuth pointing is accomplished by an established pointing system, with extensive flight history, residing above the gondola structure. A pitch-yaw gimbal mount is used for fine pointing, providing orthogonal axes when nominally on target. Fine pointing actuation is from direct drive dc motors, eliminating backlash problems. An analysis of friction nonlinearities and a demonstration of the necessity in eliminating static friction are provided. A unique bearing hub design is introduced that eliminates static friction from the system dynamics. A control scheme involving linear accelerometers for enhanced disturbance rejection is also presented. Results from a linear analysis of the total system and the high fidelity simulation are given.

This paper establishes that the proposed control strategy can be made robustly stable with significant design margins. Also demonstrated is the efficacy of the proposed system in rejecting disturbances larger than those considered realistic. Finally, we see that sub arc-second pointing stability can be achieved for a large instrument pointing at an inertial target.