SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS (D2)
Small Launchers: Concepts and Operations (7)

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ROBUST CONTROL FOR AIR-LAUNCHED SYSTEMS

Abstract

In recent years, the interest towards air-launched systems, as a suitable option for delivering a small payload into the desired orbit is grown, mainly to their ability to perform missions devoted to the responsive coverage of specific areas. Moreover, the use of an air-dropped rocket for launch a small payload has several advantages related to the more favorable start condition achievable with the airplane. First of all, reduced costs are associated with higher efficiency of an aircraft in the lower layers of the atmosphere with respect to traditional ground-launched rockets. Besides that Air-launched systems are able to ensure a flexible, ready-on-demand release of small payloads, because the delivery conditions are independent of ground facilities. Finally the rocket, due to the higher starting conditions, experience lower dynamic pressures, and then lower aerodynamic loads, and can be designed with a more efficient structure in order to enhance the mass ratio. The characteristics of a rocket designed to exploit all the advantages offered by air-launch can lead to some problem in the design of the control system. First of all the rocket will generally be more flexible and the bending modes will have lower frequency, and then, greater influence on the control system. For this reason the elastic motion must be treated with great careful for an air-launched system, however these dynamics are not simple to model correctly and the parameters related to their representation are usually very difficult to estimate with precision and are then know with considerable dispersion. Furthermore the aerodynamic characterization of the rocket can be uncertain both for the dispersion of the aerodynamic coefficient and for an existent dispersion of the release flight conditions. In order to achieve good reliability and performance in spite of these uncertainties it is worth the use of a robust control. This paper shows the design procedures needed to design a good robust controller for an air-launched system with the use of mu-Synthesis which allow for the possibility of obtain both robust stability and robust performance. The design decision shown in this paper allows to achieve a system capable of respect the performance requirements for all the range of dispersion of parameters considered. An example of design of an attitude controller for an air-launched system is presented together with results of numerical simulations of the performance of the system.