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Author: Mr. Luigi Ridolfi
Scuola di Ingegneria Aerospaziale, Italy, Ridolfi.Luigi@gmail.com

Mr. Masashi Miura
Tottori University, Japan, miura@icee.tottori-u.ac.jp

REDUCING UNCERTAINTIES EFFECTS FOR AIR-LAUNCH SYSTEMS

Abstract

In recent years the growing use of small satellites stimulates the development of systems specifically dedicated to orbit injection of small payloads. In this context the use of an air-launched rocket for delivering a small payload into the desired orbit has several advantages. One advantage is the greater flexibility in the payload release due to the independence of ground facilities. However, air-release is less precise than a ground start, and this could reduce the performance, precision and reliability of the system. For this reason specific method to manage and reduce the effect of this uncertainties must be developed. Specifically the uncertainties are related to the rocket flight conditions at the start of the engines. These conditions can have a large dispersion, and then their estimation and inclusion in the on-board guidance strategy can lead to better precision and reliability. Moreover Air-launched rocket attitude dynamic can be difficult to model accurately due to bigger influence of structural dynamics (been launched at higher altitude Air-Launch rocket can be designed more flexible to enhance mass ratio performance) which can be difficult to model, and with related parameter generally associated with high dispersion. Also parameters related to aerodynamic has their dispersion, which is further enhanced by the dispersions of the flight conditions. For this reason the use of a robust controller for air-launched systems can be a worth decision to obtain better performance and reliability. This paper presents possible strategies for both Initial Flight Conditions Estimation and Robust Control. Specifically the use of a particle filter is proposed in order to estimate the motion of the separated rocket and have an estimate of the state at the ignition of the engine. Particle filter is a new powerful technique developed in mathematical statistics and it can provide quick and accurate estimation of high dimensional state vector. In the particle filter method, not only usual state vectors but also system parameters can be efficiently estimated using probabilistic techniques. The results of numerical simulation of this estimation are also shown. For what concern robust control a possible way to develop a controller with the use of Mu-Synthesis will be presented. The aim of this controller is to achieve both robust stability and robust performance in order to respect the performance requirements in all the different conditions.