Paper ID: 13234
oral

63rd International Astronautical Congress 2012

SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Future Space Transportation Systems Verification and In-Flight Experimentation (6)

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# GNC POST FLIGHT ANALYSIS OF THE ITALIAN DROPPED TRANSONIC FLIGHT TESTS

**Abstract**

The Italian Aerospace Research Centre (CIRA), in the framework of the Unmanned Space Vehicles (USV) Program, has developed several advanced Guidance, Navigation and Control technologies for the Terminal Area Energy Management (TAEM) phase of a re-entry flight. These technologies were flight tested during the first two dropped transonic flight tests (DTFT1 and DTFT2) of the program. These missions allowed CIRA to investigate critical technology aspects related to the autonomous execution of a typical TAEM phase of a re-entry flight, from a velocity of about Mach 2 down to the typical Approach/Landing Interface speed of Mach 0.5 and below. This paper presents flight tests results and post flight data analysis of these missions. How technology innovations in the Guidance, Navigation and Control domain can contribute to a more autonomous, more safe and less costly future generation of reusable launch vehicles is well stated in open literature. In the USV program, focus was given to adaptive guidance with on-line trajectory re-planning capabilities and to robust and fault tolerant control, as key enabling technologies for atmospheric re-entry and hypersonic flight. Obviously, the complexity of such missions also required dedicated research on advanced methodologies in the field of robustness analysis, design and verification of GNC systems for highly uncertain and non-linear systems. Methodologies for vehicle model identification from flight data have been also included in this technological road map to maximize the scientific return from the flight tests. Model identification methodologies for processing flight data are frequently used to validate and improve a pre-flight aerodynamic data-base and, specifically, to reduce the associated uncertainties. However in this field conventional techniques need to be improved because the USV flight tests have a non-stationary trajectory and specific identification manoeuvres should be avoided being hazardous for the mission. More specifically, the problem of the identification of the aerodynamic model of the Italian Unmanned Space Vehicle was solved through a multi-step approach, where the aerodynamic coefficients are identified first and, in a following phase, a set of model parameters are updated. The methodology was applied to actual flight data, acquired during the two dropped transonic flight tests.