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ACCESS TO SPACE WITH A REUSABLE AERODYNAMIC VEHICLE

Abstract

Preliminary results from an innovative and low-cost project to develop an aerodynamic, re-usable UAV system for cost-effective sub-orbital and orbital space transport are reported. Although vehicle parameters and flight characteristic have been calculated by numerical simulation, the cost of development has been kept low by a focus on sub-scale flying demonstrators, allowing iterations in design at lower cost than the more intensive numerical simulation and use of subsonic and supersonic wind tunnels more typical of the traditional aerospace design technique.

The overall vehicle concept is that of a triangular lifting body, in which the hull is built of flat panels, greatly lowering the cost of construction, while maintaining acceptable aerodynamic performance. A sub-scale demonstrator (”EARL-D3”) of 70 cm wingspan and 2.4 kg all-up weight, using a small solid-propellant rocket motor and an electronic guidance system, derived from missile guidance programs previously developed by the team, has been test-flown successfully. The flight system was programmed to take control after a ballistic ascent, and pilot the vehicle in a spiral glide path down to a soft landing. Following acceptable performance of the EARL-D3, a scale-up to a vehicle (”EARL-D4”) of 2 m wingspan and 60 kg all-up weight has been constructed. A test flight of this vehicle also demonstrated acceptable flight performance and control. Both on-ground and onboard video data was collected throughout the flight and used to assess the flight characteristics (e.g.: roll rate, longitudinal acceleration).

EARL-D4 uses as a propulsion unit a solid-propellant rocket motor that contains 10 fuel grain segments and delivers 7000 N of thrust over a burn-time of 7 seconds. During the development of the motor, emphasis was placed not on actual Isp performance of the motor but on the reliability and its cost. Interior ballistic simulations are shown and compared with test stand results which were performed within a separate program of validating the propulsion unit. The six-degrees-of-freedom numerical calculations carried out on the vehicle design, aspects of the flight control and navigation system, and extension of the vehicle concept for realizing re-usable orbital access are discussed.

In conclusion, the paper outlines the test flight results of a rocket-powered UAV using a triangular facet-built shape. The test program starting with small models and building up towards the larger one is described. The test flights of the scale down model (EARL-D3) and larger scale model (EARL-D4) are reported.