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SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Future Space Transportation Systems (4)

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PERFORMANCES OF A SMALL HYPERSONIC AIRPLANE (HYPLANE)

Abstract

A number of several supersonic and hypersonic vehicles are being designed, with the attention focused on airplanes-like vehicles for passenger transportation at high altitudes and/or for space tourism perspectives. HYPLANE is a research project dedicated to the study of a six-seat small personal hypersonic airplane. The vehicle is designed for hypersonic point-to-point trip (6000 km range to be flown in less than 2 hours) and for space tourism, by integrating state-of-art aeronautic and space technologies. In particular, HYPLANE is characterized by low wing loading and high aerodynamic efficiency and is designed to provide aerodynamic stability and maneuverability along the considered flight path. The vehicle, powered by Turbine Based Combined Cycle engines plus a throttleable Rocket will perform Horizontal Takeoff and Horizontal Landing (HTHL) on runways. The large wing area provides lift for aircraft take-off at relatively low velocities and allows to reduce, at relatively high altitudes, aerodynamic heating and sonic boom during the supersonic flight, with consequent low environmental impact. In this work a preliminary performance study is presented. Aerodynamic performances for the different flight regimes encountered during the mission, are investigated by means of engineering tools and Computational Fluid Dynamics. Aerodynamic heating effects are also investigated to identify suitable materials and structures design to sustain the hypersonic flight conditions. Steady state hypersonic cruise and sub-orbital parabolic trajectories are analysed in detail. A mathematical six-degree-of-freedom non-linear model to simulate the vehicle's dynamics is implemented. The model encompasses data relating to geometry and inertia properties, aerodynamics (estimated through numerical analysis), propulsion, dynamic characteristics of sensors and actuators. Steady-state trimmed flight, dynamic response to perturbations are investigated. The implementation of a dynamic flight simulator has been considered paramount to address the fundamental problem of maintaining the HYPLANE on a nominal trajectory: typical trajectory analysis, in fact, is often based on a single point-mass model that may assume certain vehicle trim states without specification of the vehicle control surface characteristics to achieve and manoeuver from this trim state. Due to the complex interactions, however, trimming a hypersonic vehicle could be troublesome to the extent that the control system must be redesigned to match the mission requirements. The impact on safety of the hypersonic point-to-point trajectory will be analysed from the perspective of the automated flight control activities that will have to be performed, when flying en route between spaceports, to ensure

safety and separation from other traffic, within the international airspace.