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

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OPTIMAL PRELIMINARY DESIGN OF HYPERSONIC WAVERIDER USING METAHEURISTICS-BASED SOLUTIONS.

Abstract

Means of reducing distances and connecting remote places across the world have been employed since the global occupation by human species, and they have never been so effective as nowadays. Several new technologies for hypersonics are being developed by numerous countries in the search for a disruptive option for providing fast suborbital transportation and cost reduction for space access. Such an achievement could rearrange the conjuncture of transport modals and expand our horizons significantly. One of the well-studied lifting-bodies for hypervelocity is the waverider, which carries its name by taking advantage of hypersonic shock waveforms. However, the waverider geometry depends on the shock wave considered. A comparison of possible assumptions that might turn into feasible solutions under legacy constraints is of utmost importance to drive the development of a hypersonic vehicle project. This paper presents a methodology for obtaining optimal preliminary designs of wedge-derived, cone-derived, and generalized wedge-derived waverider configurations relating coefficients based on geometric constraints and external aerodynamic surfaces. Computational optimization may be used for addressing this task. The optimization process makes use of different metaheuristics, such as Vortex Search, Particle Swarm Optimization, and Evolutionary Algorithms, to explore diverse search algorithms aiming to avoid local minima and provide good solutions. Multiple variables of interest are analyzed via Pareto fronts built by searching the minima of a multiobjective cost function written to find better-constrained geometrical parameters. Additionally, the methodology generates designs that are automatically best-fitted into a given payload fairing, providing better use of the available volume. Achieved results, regarding the lift/drag ratio and the internal volume subject to restrictions such as the geometry and payload volume of the launching vehicle, led to several optimal designs that may be chosen according to the goals of the hypersonic vehicle project. The presented methodology may lead to a better aerothermodynamic integration between both the current Brazilian scramjet engine 14-XS (under pre-flight preparation) and the future lifting-body surfaces discussed herein.