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Author: Prof. Élcio Jeronimo de Oliveira
Luleå University of Technology, Sweden, elcio.jeronimo.de.oliveira@ltu.se

Mr. Breno Silva
Instituto de Estudos Avancados, Brazil, brenobos@fab.mil.br
Mr. Ângelo de Carvalho Paulino
Instituto de Estudos Avancados, Brazil, angeloacp@fab.mil.br
Dr. Angelo Passaro
Instituto de Estudos Avancados, Brazil, angeloap@fab.mil.br
Dr. Israel da Silveira Rêgo
Instituto de Estudos Avancados, Brazil, israel.rego@ieav.cta.br

OPTIMAL PRELIMINARY DESIGN OF HYPERSONIC WAVERIDER USING MULTIPLE METAHEURISTICS.

Abstract

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The possibility of developing hypersonic commercial transportation vehicles (endo and exo-atmospheric) for the next two decades is very promising. One of the well-studied lifting-bodies for hypersonic endo-atmospheric flight is the waverider, due to the high lift-to-drag ratio they present at the same lift coefficient in comparison with conventional lifting-bodies and their ideal pre-compression surface for scramjet engine integration. A comparison of possible assumptions that might turn into feasible solutions under legacy constraints is of utmost importance to drive the development of any hypersonic vehicle design. This paper presents a methodology for obtaining optimal preliminary designs of a generalized wedge-derived waverider configuration relating coefficients based on geometric constraints and aerodynamic efficiency. Computational optimization is used for addressing this task. The optimization process makes use of different metaheuristics, such as Evolutionary, Black Hole and Vortex Search algorithms, to explore diverse search mechanisms aiming at avoiding local minima and providing 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-to-drag ratio and the internal volume of the waverider subject to restrictions of the fairing configurations (geometry and inner payload volume) of its launching vehicle, led to several optimal designs that may be chosen according to requirements and constraints of the intended application. Finally, the presented methodology is helping to identify the most promising candidates for the scramjet-powered waverider under the Brazilian 14-X hypersonic research program.

Keywords: Design optimization, Waverider, Hypersonics.