AERO-STRUCTURAL OPTIMIZATION OF JOINED-WING AIRCRAFT

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Abstract: The subject of proposed paper is a multidisciplinary optimization of joined-wing aircraft. In a result of the research an optimization algorithm of whole configuration of joined-wing with electric propulsion is proposed. The optimization process is a global search optimization suitable for preliminary design of joined-wing. Modular algorithm based on automatic geometry generator, FEM solver and aerodynamic panel method is developed. Whole process is optimized to decrease huge computation cost to the minimum.

The general optimization objective is to maximize the range of aircraft for assumed mission, as it is the major disadvantage of electric aircrafts. The payload and battery capacity are fixed. Global, local geometry and structural parameters are selected as a design variables.

Optimization is performed in serial manner – structure optimization is conducted inside aerodynamic optimization step. During structure optimization, strength is checked for few sizing load cases obtained from loads envelope. Only structural parameters are variable at this stage. In the aerodynamic loop objective function is optimized by changing only geometrical parameters. Constraints on maximum value of stall speed and margin of static stability are used. These are introduced using linear or quadratic penalty function.

For optimization purpose a meta-model of response surface is created and then used in next steps. Final optimization is conducted in two stage process. The first stage is the global one and it uses genetic algorithms. The second stage which is gradient based optimization is the local stage that improves first estimation of optimum.

Based on proposed algorithm a program was coded and some tests were done. Next, two optimization test cases for UAV and VLA inverted joined-wing aircrafts were performed. Based on results of prepared optimizations it was proven that proposed algorithm can be successfully used to improve the range of inverted joined wing aircraft.

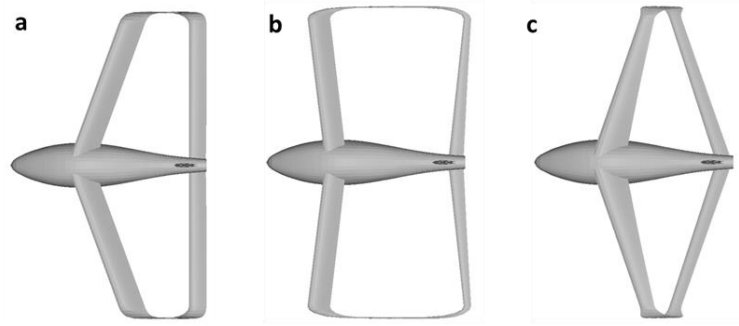

Fig. 1. Comparison of optimization results, a – baseline model, b – optimization with linear penalty function, c - optimization with quadratic penalty function.

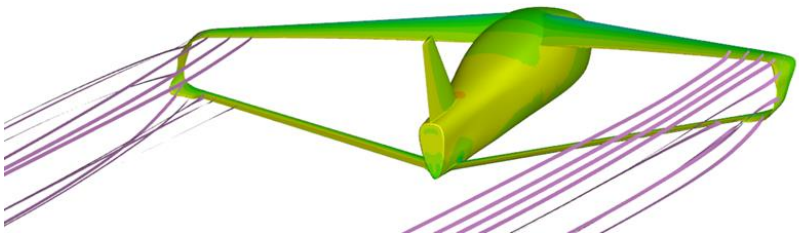

Fig. 2. Stream lines on the tip of one of the optimal configuration (in cruise conditions).

Keywords joined-wing; optimization.