The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

HYBRID OPTIMIZATION METHODS APPLIED TO PRELIMINARY DESIGN OF A WING

Martí Coma[1,2], Jordi Pons-Prats[1,2] and Gabriel Bugeda[1,2]

[1] International Center for Numerical Methods in Engineering (CIMNE), Campus Nord UPC, Edificio C1, Gran Capità s/n, 08034 Barcelona, Spain, {mcoma,jpons,bugeda}@cimne.upc.edu, http://www.cimne.com

[2] Universitat Politècnica de Catalunya BarcelonaTech (UPC), Universitat Politècnica de Catalunya,Campus Nord UPC, 08034 Barcelona, Spain, http://www.upc.edu

Keywords: *Hybrid Methods, Genetic Algorithms, Particle Swarm Optimization, Gradient-Based Methods, Optimization Methods, Multi-Objective Optimization*

Optimization is a field which continues to get attention from all engineering fields, and is especially important in aerospace. In this article a new Hybrid Method is presented and tested with a two objectives optimization problem. The presented Hybrid Method is compared against a Genetic Algorithm (GA) and a Particle Swarm Optimization (PSO). The new Hybrid Method combines three minimization algorithms running concurrently and sharing information: An evolutionary algorithm, working with both objective functions, and two gradient based methods (Conjugate Gradient) each one working with one objective function. For the evolutionary algorithm we can select between two different alternatives: a GA and a PSO.

The test case used to compare the performance of the different optimization algorithms is aimed to assist in the preliminary design of a remote controlled aircraft to compete in the Air Cargo Challenge [1]. The objective functions are the maximum speed at cruise conditions and the maximum takeoff weight (MTOW) for a given runway length, which are the main factors in the competition punctuation. The design variables are the chord at a different wingspan locations. The airfoil, wingspan and propulsion system are fixed. The fuselage, the horizontal tail plane and the vertical tail plane are not taken into account.

The optimization runs have been performed several times to take into account the random component of the evolutionary algorithms and to ensure the robustness of the solution. The results show an improvement in both the distance and diversity metrics [2], which measure the convergence and spread of the solution. The improvement is appreciated in both the mean and standard deviation of the metrics, meaning that the Hybrid Methods are more accurate and robust.

REFERENCES

[1] AkaModell München, *https://akamodell-muenchen.de/acc-2022/*, December 2021.

[2] Deb, Kalyanmoy and Pratap, Amrit and Agarwal, Sameer and Meyarivan, TAMT, A fast and elitist multiobjective genetic algorithm: NSGA-II. *IEEE transactions on evolutionary computation*, Vol. **6**, pp. 182–197, 2002.