

Multidisciplinary and Multilevel Aircraft Design Methodology using Enhanced Collaborative Optimization

Pedro F. Albuquerque*, Pedro V. Gamboa[†] and Miguel A. Silvestre[†]

Universidade da Beira Interior, 6200-358 Covilhã, Portugal

Since aircraft design is an inherently multidisciplinary undertaking, the quest for increasingly optimized solutions can only be comprehensively successful by implementing multilevel or system design optimization architectures to step up disciplinary optimizations. In this study, a methodology which uses the Enhanced Collaborative Optimization (ECO) multilevel architecture with the purpose of developing a multidisciplinary design optimization methodology within the context of the preliminary design stage of unmanned aerial vehicles is presented. The concepts of weighting coefficient and dynamic compatibility parameter are presented and assessed for the ECO architecture. A routine that calculates the aircraft performance for the mission profile and vehicle's performance metrics under consideration has been implemented using low fidelity models for the aerodynamics, stability, propulsion, weight, balance and flight performance. A benchmarking case study of two different mission profiles for evaluating the advantage of using a variable span wing within the optimization methodology developed is also featured.

Nomenclature

b	= wingspan, m
c	= wing mean chord, m
C_l	= airfoil lift coefficient
d_{prop}	= propeller diameter, inch
e	= Oswald efficiency number
E_{to}	= take-off energy, J
E_{cb}	= climb energy, J
E_{cz}	= cruise energy, J
E_{dt}	= descent energy, J
ECO	= enhanced collaborative optimization
FW	= fixed wing
h_{min}	= minimum altitude for each mission stage, m
h_{max}	= maximum altitude for each mission stage, m
h_{to}	= take-off altitude for each mission stage, m
MDO	= multidisciplinary design optimization
Opt.	= optimization
p_{prop}	= propeller pitch, inch
R	= range, m
RoC	= rate-of-climb, m/s
VSW	= variable span wing
V	= velocity, m/s
V_{wind}	= wind velocity, m/s

*PhD Student, Aerospace Sciences Department, AIAA Student Member.

[†]Assistant Professor, Aerospace Sciences Department, AIAA Senior Member.