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Automated Design Process of a Fixed Wing UAV Maximizing Endurance

The design of Unmanned Aerial Vehicles (UAVs) requires significant efforts in terms of prototyping, testing, and design iterations. To reduce design time and improve wing performance, an automated design and optimization framework named (MOOGA-OpenVSP-API) is proposed using open-source software (OpenVSP, XFOIL and python). This work presents a preliminary design approach for an UAV wing with a focus on weight estimation, drag, stall prediction, and optimization for maximum endurance.

First, the Roskam methodology is used for determining the weight of UAVs during the conceptual design phase. The weight estimation of the UAV is conducted using a matching plot technique in order to get the reference surface and the power required.

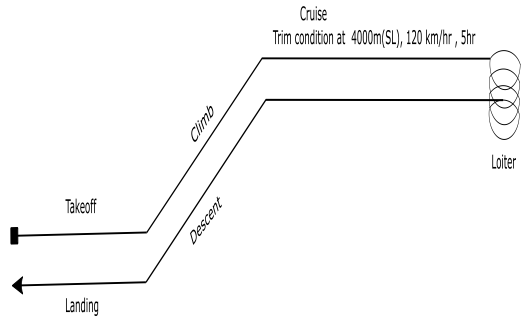

Figure 1: UAV flight mission

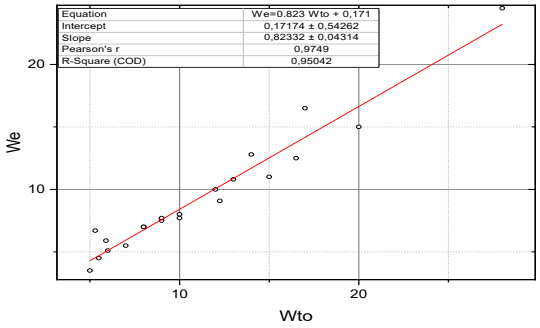

Figure 2: We vs Wto data from similar existing UAVs

Second, a solver with low-fidelity models is used to predict the drag coefficient and maximum lift coefficient of the designed wing. This solver combines between the vortex lattice method (VLM) and some analytical expressions. A comparison of aerodynamic models is also presented to determine the most accurate and efficient method for quick evaluations.

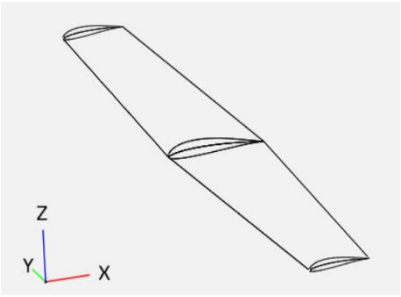

Figure 3: Wing used during the validation

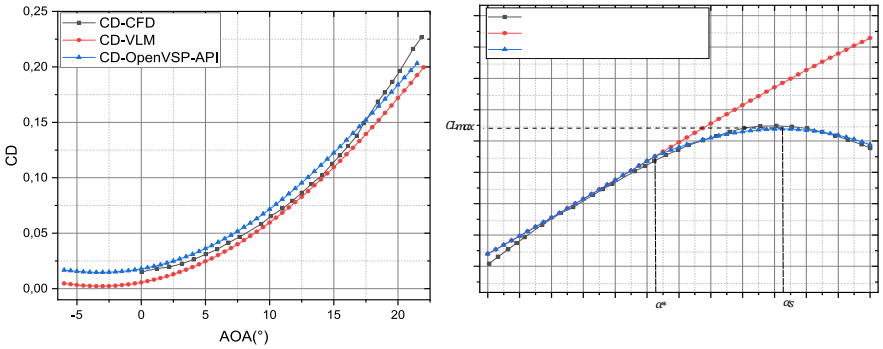

Figure 4: Aerodynamic coefficients vs. angle of attack

Finally, an optimization process using genetic algorithm is applied to the wing design to maximize endurance. The optimization objective is to maximize the endurance while satisfying: rate of climb, maximum speed and stall speed.

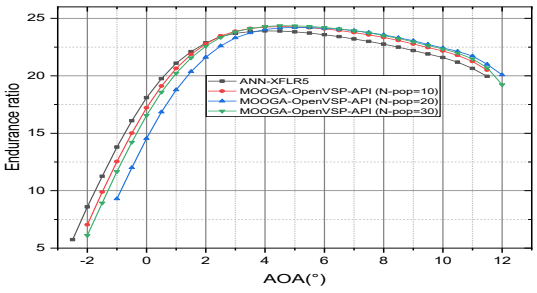

Figure 5: Comparison between the evolution of endurance ratio vs. AOA using ANN-XFLR5 optimization and MOOGA- OpenVSP-API

The proposed methodology provides a systematic and efficient approach to design, analyze, and optimize UAV wings for endurance. The approach can be extended to other design problems and applications, where endurance is a critical factor in achieving mission objectives. In Addition, the proposed framework's main advantage is the use of open-source software, which provides a cost-effective and accessible solution for small and medium-sized startups to design and optimize UAVs. The proposed framework also reduces the time of calculation significantly, enabling quick design iterations and reducing the time to market.

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