MULTI-OBJECTIVE OPTIMIZATION OF THE STALL CHARACTERISTICS OF AN UNMANNED AERIAL VEHICLE

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Abstract. The widespread use of unmanned aerial vehicles (UAV) has become clear over recent years. These aircraft are often characterized by a blended wing body (BWB), noted by their tailless design and swept wings: the former to increase its efficiency and the latter to ensure longitudinal static stability, i.e. the natural desire of the airplane to remain in its equilibrium position. The consequence of the swept wing is an increased likelihood of flow separation initiating at the tip, resulting in a nose-up pitching moment which pulls the plane further into stall, commonly referred to as tip-stall.

The presence of tip-stall has led to a renewed interest in the use of devices to counter it, such as wing fences. These aerodynamic devices can be seen as planes placed on top of the wing aligned with the flow and developed from the idea of stopping the transverse component of the boundary layer flow. The straightforward design and application has led to an extensive usage from the '50s to '80s and still persists up to this day.

The influence of the design parameters of wing fences on the flight behavior of the UAVs is yet to be laid bare. Therefore, these are optimized in order to obtain the design that would fence off the appearance of a pitch-up moment at high angles of attack, without a significant loss of lift and controllability. This brings forth a constrained multi-objective optimization problem. The influence of the design parameters on the aerodynamic coefficients is assessed through CFD simulations. The γ-Re_θ model is used to correctly model the low Reynolds effects that characterize the flow over a UAV.

The high computational cost that is attributed to this model encourages the use of effi- [illegible] round surrogate modeling, namely kriging. Furthermore, a Generalized Asynchronous Multi-objective Optimization (GAMO) infill criteria is realized that allows multiple points to be selected to be evaluated in an asynchronous manner while the balance between design space exploration and objective exploitation is adapted during the optimization process.

The result is a wing fence design that extends the flight envelope of the aircraft, obtained with a feasible budget. Both the framework and the infill methodology lend themselves to be used within a wider range of aeronautical design problems and further pave the way to extending the capabilities of aircraft.