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Design of a morphing flap in a two component airfoil with a droop nose

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Abstract. The performances of lifting surfaces are particularly critical in specific flight conditions like takeoff and landing. Different systems can be used to increase the lift and drag coefficients in such conditions like slat, flap or ailerons. Nevertheless they increase the losses and make difficult the mechanical design of wing structures. Morphing surfaces are a compromise between a right increase in lift and a reduction of parts movements involved in the actuation. Furthermore these systems are suitable for more than one flight condition with low inertia problems. So, flap and slats can be easily substituted by the corresponding morphing shapes. This paper deals with a genetic optimization of an airfoil with morphing flap with an already optimized nose. Indeed, two different codes are used to solve the equations, a finite volume code suitable for structured grids named ZEN and the EulerBoundary Layer Drela's code MSES. First a number of different preliminary design tests were done considering a specific set of design variables in order to restrict the design region. Then a RANS optimization with a single design point related to the take-off flight condition has been carried out in order to refine the previous design. Results are shown using the characteristic curves of the best and of the baseline reported to outline the computed performances enhancements. They reveal how the contemporary use of a morphing acting on the nose of the main component and the trailing edge of the flap drive towards a total not negligible increment in lift.

Keywords: deflection; genetic algorithm; gap; Euler; morphing; overlap; RANS

1. Introduction

The idea of acting geometry variations to meet the best requirements at several flight regimes, has been pursued since the beginning of flight history, movable parts like ailerons, flaps, equilibrators represent just some of the most common solutions aimed at extending aircraft flight envelope, Anderson (2011). Anyway, despite of related advantages, both weight increase caused by actuators, and discontinuities induced onto aerodynamic surfaces, penalize these solutions. Thus, several alternative design approaches have being taken into account; among the others, one recalls the morphing oriented design, that envisages actuation strategies able to produce smooth and, at the same time, significant geometry variations. The morphing mechanism is useful to realize strong variations of curvature without to adopt slat and flaps with their related variations of gap overlap and deflections. Morphing aircraft structures can in this manner significantly enhance aircraft

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