MULTI-OBJECTIVE OPTIMIZATION OF A MORPHING AEROFOIL'S ACTIVE INTERNAL STRUCTURE

Florian Dexl[1]*, Andreas Hauffe[2] and Klaus Wolf[3]

[1] florian.dexl@tu-dresden.de
[2] andreas.hauffe@tu-dresden.de
[3] klaus.wolf@tu-dresden.de
[1 2 3] Institute of Aerospace Engineering, Technische Universität Dresden, 01062 Dresden, Germany, https://tu-dresden.de/ing/mw/ilr/lft

Key Words: *Morphing aerofoil, drag reduction, topology, evolutionary optimization.*

Being a promising technology to increase the flexibility and efficiency of aircraft, morphing wings are of current research interest. Smart structures have the potential to combine actuators and load-carrying structures to allow highly integrated designs of future morphing wings. A challenging task is to find structural layouts, which enable aerodynamically optimal shape changes without defining the target shape a priori. The current work addresses this task and presents a methodology that combines the optimization of an aerofoil's active structure and an aerodynamic evaluation, predefining neither the structural layout nor the target shape.

The layout of the active structure is optimized with the aim to deform the aerofoil in a way that the deformed contour is a shape which minimizes the drag coefficient for a given lift coefficient and is aerodynamically robust. Therefore, a multi-objective optimization is done using the in-house optimization tool GEOpS² based on evolutionary algorithms. Objectives are the structural mass, the drag coefficient, its deviation for varying angles of attack and the shape parameter of the boundary layer theory. A two-dimensional finite element simulation models the structural behaviour. For aerodynamic analysis, the viscous-inviscid panel program XFOIL is applied.

The internal structure is parameterized by Lindenmayer cellular systems [1] and modelled with beam elements. On this basic structure, active structural elements, which act as linear actuators, are defined using a moving morphable components approach [2]. By this approach, the topology of the internal structure, the placement of linear actuators and the setting of their actuation degree can be optimized concurrently.

It is shown that the present approach allows to find an optimized internal layout consisting of passive and active structural elements for a morphing aerofoil. The actuation of the internal structure allows the deformation of the aerofoil to an aerodynamically optimized shape. This research was performed within the Luftfahrtforschungsprogramm (LuFo) V-2 project HyMoWi funded by the German Federal Ministry for Economic Affairs and Energy. The financial support is gratefully acknowledged.

REFERENCES

[1] H.-T.C. Pedro and M.H. Kobayashi, On a cellular division method for topology optimization. *Int. J. Numer. Meth. Engng.*, Vol. **88**, pp. 1175–1197, 2011.

[2] X. Guo and W. Zhang and W. Zhong, Doing topology optimization explicitly and geometrically—A new moving morphable components based framework. *J. Appl. Mech.*, Vol. **81**, pp. 081009–081009-12, 2014.