3D Design of a Large-Displacement Droop-Nose Wing Device

Srinivas Vasista* and Hans Peter Monner
Institute of Composite Structures and Adaptive Systems
German Aerospace Center (DLR)
Lilienthalplatz 7, Braunschweig, 38108, Germany
e-mail: srinivas.vasista@dlr.de, web page: http://www.dlr.de/fa/en

ABSTRACT

The 3D numerical design and optimization of an extremely-deformable morphing droop nose device for the leading edge of a wing is presented in this paper. This research forms part of the project on novel future aircraft high-lift designs by the Collaborative Research Center 880 (Sonderforschungsbereich SFB880 in German) in Braunschweig, Germany [1]. The motivation for such a project stems from the need to improve aircraft flying efficiency, reduce door-to-door travel times, enable quiet operations from smaller airports close to neighbourhoods with shorter runways, and allow for flexibility to changes in the design over the lifetime of the aircraft, which may be achieved through a new high-lift system. The envisaged high-lift system features a blown trailing edge Coanda flap with regulated blowing through an active lip, and a smoothly-deformable leading edge to ensure an appropriate pressure-gradient and reduce the power requirements of the compressor system for the blown flaps. The leading edge component features a hybrid combination of fiberglass and EPDM elastomer to enable large deflections whilst possessing sufficient stiffness. [2]

The 3D design of the leading edge system is performed with the aid of optimization tools. The consideration of different skin, substructure, and actuation types is handled through different optimization tools with varying results in the structural performance. This paper presents a comparison of two different approaches: 1) a flexible skin with conventional substructure, and 2) a fully flexible skin and substructure system. The optimization tools include the use of a Simplex routine to determine, for example, optimum skin thickness distributions and stringer positions, as well as the Load Path Representation method [3] to determine structural layouts, thicknesses, etc. The optimization tools output a design which best meets shape accuracy and strain requirements over a number of load cases, including landing, manoeuvre, approach, and cruise loads. A final design will be achieved by June 2017 and this paper will aim to describe the final design in detail.

Intermediary results are shown in Figure 1 and show reasonable matching of the target profile. Further improvements to the tools are necessary to ensure appropriate strain levels and will be discussed.

REFERENCES

