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TOWARDS THE INDUSTRIAL APPLICATION OF MORPHING AIRCRAFT WINGS - DEVELOPMENT OF THE ACTUATION KINEMATICS OF A DROOP NOSE

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Summary: The idea of morphing wings goes back to the Wright brothers who used wing warping to control their flying machines at the end of the 19th century. Since then many experimental and numerical studies showed the aerodynamic benefit of morphing wings in various application scenarios but until now morphing is still not a state-of-the-art technology in civil transport aircraft.

Some necessary steps towards the industrialization of morphing have been taken in the EU (FP7) project SARISTU (Smart Intelligent Aircraft Structures). The application case is a seamless and gapless leading edge droop nose for a single aisle transport aircraft. As enabler for laminar wings the droop nose contributes to a 6% drag reduction and thus to positive implications on the fuel burn. The selected droop nose concept consists of a flexible skin being actuated by a composition of kinematics and actuators.

The actuation of the leading edge poses a huge challenge for the internal kinematics as it has to synergize with other functionalities like bird strike protection, de-icing, surface and lightning protection. The design of the kinematics is therefore a key element for the development of a droop nose. In this context this paper focuses on computational modeling as a design tool.

A separation of actuation and skin is mandatory to meet the joint aviation requirements. The large deflection versus little space allocation ratio removes the possibility for directly reaching the support points by the actuator with the consequence that a kinematic chain is utilized. Special note has to be taken within the design process of a least complex actuation system capable of smoothly modifying the extensive flexible skin between the shape for high-lift and cruise flight.

The developed tool aims for minimal deviation from optimal kinematical path and a simultaneous and uniform deployment of all differently sized kinematic stations. The methodology is split into a geometrical construction tool whose results go in a subsequent second numerical optimization tool. Design variables are hinge points and angles of the kinematics.

In this study we are paving the way towards the industrial application of morphing wings in future aircraft.