Actuators for smart rotorblades

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Introduction

Smart structures have the ability to change accordingly to external constrains. Within the aerodynamic field, adapting the response of a blade to match the airflow perturbations is of great interest for cleaner and more efficient aircrafts and rotorcrafts. This constitutes a milestone in CleanSky european project. Early investigations have proven the interest of Gurney flap (figure 1) among the smart rotorblade concepts which enhance the aerodynamic performances [1]. The objective is to review actuator systems that are suitable for these kinds of concepts.

Method

Computation Fluid Dynamics methods are used to investigate the pressure field around the rotorblade to obtain the energy required to actuate the Gurney flap (figure 1).

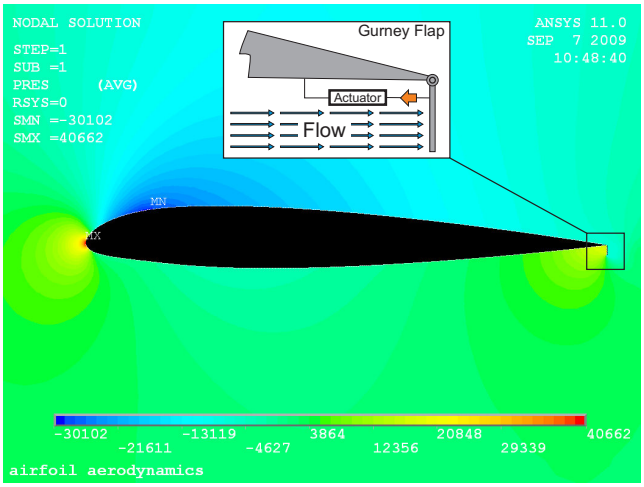

Figure 1 : Pressure distribution around Naca 23012 airfoil with a 2% chord length Gurney flap at the trailing edge.

The actuators are then selected according to the following parameters:

- Specific work	- Dimensions
- Weight	- Shock resistance
- Power consumption	- Fatigue

Piezoelectric linear actuators

Piezoelectric stepped linear actuators use small piezoelectric stacks to perform small displacements and transmit motion to a linear rod through friction forces (figure 2). Although they cannot convey the force of standard piezoelectric stack actuators, the displacement ranges are much more consequent. They achieve superior specific work per weight and sustain an holding force when no power is applied which ease the design of an actuation mechanism. Unfortunately, the deployment time cannot be reached within one blade revolution.

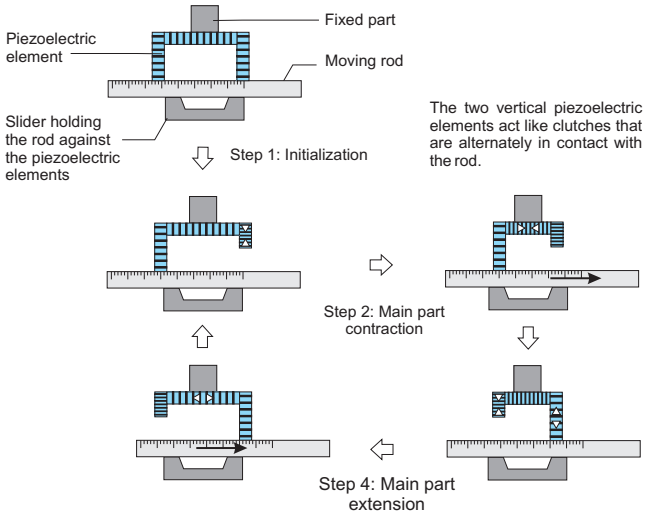

Figure 2 : Working principle of a stepped actuator.

Conclusion & Further Research

Linear piezoelectric stepped actuators seem to be relevant for smart systems integrating Gurney flaps. However, in order to make those actuators suitable for active control the speed of the actuation mechanism need to be increased. Further research will focus on actuators for flow control devices that are less complex to integrate in a structure.

References

1. Wang, J.; Li,Y. and Choi,K.-S. Gurney flap - Lift enhancement, mechanisms and application *Progress in Aerospace Sciences, 2008, 44, 22 - 47.*

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