Aerodynamic performance increase of a morphing wing using piezoelectric actuators and shape memory alloys - a study towards adaptive feedback control

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Abstract. The present study relates the feedback control of the flow over a morphing wing. This work is a part of the european project Smart Morphing and Sensing (SMS), a multi-disciplinary upstream project for the improvement of aerodynamic performance ($\nearrow$ lift, $\searrow$ drag) by modifications of an electro-mechanical airwing shape and advanced flow control techniques. A reduced scale of an Airbus A320 wing, of chord $c = 0.7$ m and span 0.3 m, is used here. The wing is actuated by two means: (i) high frequency vibrating trailing edge (HFVTE) actuators to interact with the vortex structure past the trailing edge, and (ii) shape memory alloys (SMA) to achieve high deformation of the shape. Time-resolved PIV is performed to characterize the effect of morphing on the downstream flow structures. Pressure taps are also located upstream to the trailing edge on the upper surface. Three dynamic pressure transducers are put to measure the characteristic state of the flow under control in real-time. Adaptive methods for feedback control are performed by a dSPACE MicroLabBox from the pressure sensors to stabilize dynamic phenomena – the Von Kármán vortex shedding and the mixing layer instability – and reduce fluctuating pressure. First tested on a large-band spectrum Van der Pol oscillator, the adaptive control is then performed experimentally in real-time.