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FLUID-STRUCTURE INTERACTION TOOL FOR MORPHING BLADES

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The design of aeronautical components commonly involves two highly coupled disciplines: aerodynamics and structural mechanics. The interaction between them becomes even more relevant when morphing aeronautical structures are studied.

Considering the importance of morphing technology for the future of the aerospace industry, several tools have already been developed to couple these two disciplines together, but all of them deal with pure two-dimensional or three-dimensional aero-structural problems. In some circumstances, the study of aeronautical components requires to couple a 2D computational fluid-dynamic (CFD) analysis with a 3D finite element analysis (FEA). This usually happens in the preliminary design phase of engine blades (i.e. compressor blades) where the aerodynamic study of the original 3D geometry is replaced by the analysis of a 2D blade cascade in order to reduce the overall computational cost. However, such an approach requires a specific method to couple the 2D CFD geometry/mesh with the 3D FEA geometry/mesh in order to transfer the aerodynamic loads from the CFD analysis to the structural one. As mentioned before, a 2D-3D coupling cannot be implemented by the already available tools; therefore, a novel 2D-3D aero-structural coupling approach must be developed.

This presentation wants to show step-by-step the developed 2D-3D aero-structural coupling strategy, and how it can be applied to study the performance of a morphing blade cascade. In particular, the leading-edge of the blade is adapted to the inflow conditions by using shape memory alloy (SMA) actuators placed on the upper and lower sides of the blade. The activation of one of the two actuators leads to a bending of the blade leading-edge in order to decrease the inflow metal angle, and therefore enhancing the overall cascade performance.