Industrial Applications of a Multibody-CFD Co-Simulation

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Specific aircraft components present a complex aeroelastic behavior due to the interaction of structure and aerodynamic. Structural deformations due to aerodynamic load may change the aerodynamic load distribution, compared to the initial rigid configuration, which may result in significant changes to the aeroelastic behavior of the component. In this context, there is a clear need to include fluid-structure interactions. The chosen structural modeling approach is the multibody approach [2] and the models are built up with the commercial software Adams. The structural models are successively coupled with high-fidelity aerodynamic models. The goal of this work is to provide a simulation platform that can possibly predict loads and vibrations during the design phase in order to avoid costly flight test campaigns. A quasi-steady and an unsteady Adams - Computational Fluid Dynamics (CFD) co-simulations of the high-lift system of a commercial aircraft are performed. This approach represents a novelty and an improvement in studying high-lift systems where at each iteration step the aerodynamic surfaces are updated taking structural deformations into account. Furthermore, the developed methodology is independent of the considered component, allowing the possibility of analyzing other aircraft components. The co-simulations are performed in a multi-disciplinary environment on a parallel cluster architecture [1].

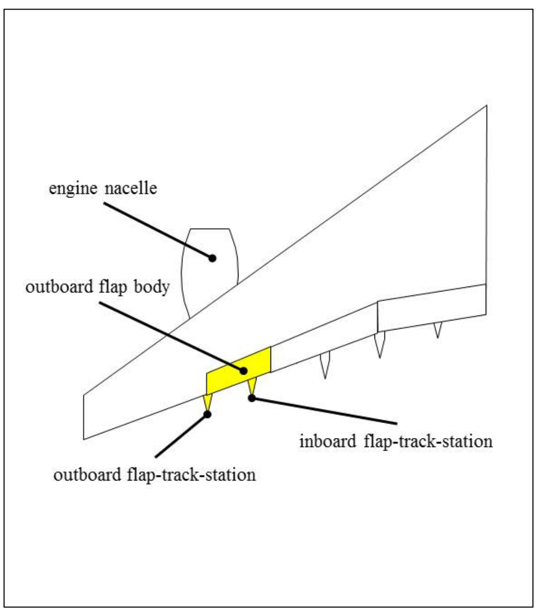

Fig. 1: High-lift system of a commercial aircraft.

The purpose of a high-lift system is to increase the surface and the camber of the wing through the deployment of additional aerodynamic surfaces, the flap bodies. The deployment mechanisms are mounted in streamlined bodies called fairings bodies, Fig. 1. The whole system is located at the wing trailing edge where, in addition to the aerodynamic load due to a particular flight condition, it may be subjected as well to the load generated by the engine jet efflux.

Static deflections of the structure under stationary aerodynamic forces, including the engine influence, are investigated, Fig. 2. An unsteady simulation is successively performed and the time history of the pressure coefficient on the surface of the outboard fairing body only at time $t = 0.042$s is presented, Fig. 3. The pressure coefficient is

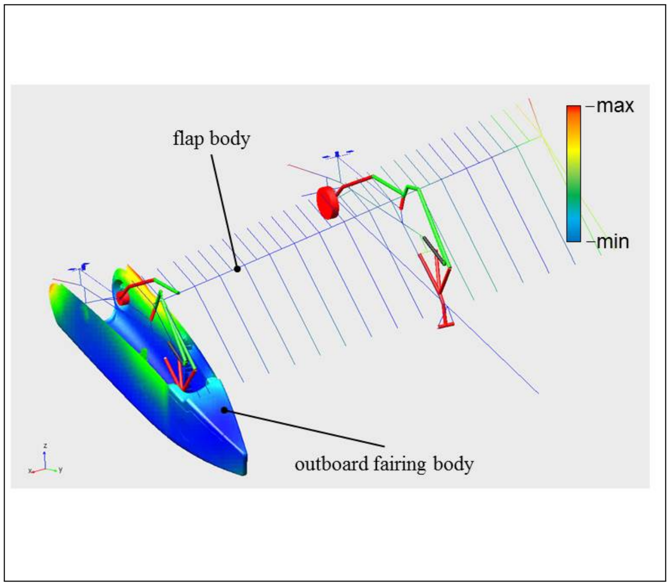

Fig. 2: Deformations of the outboard fairing body from Adams simulations: outboard view. Deformations are normalized respect to the highest deformation value. Ascending level of deformation intensity from blue (min) to red (max).

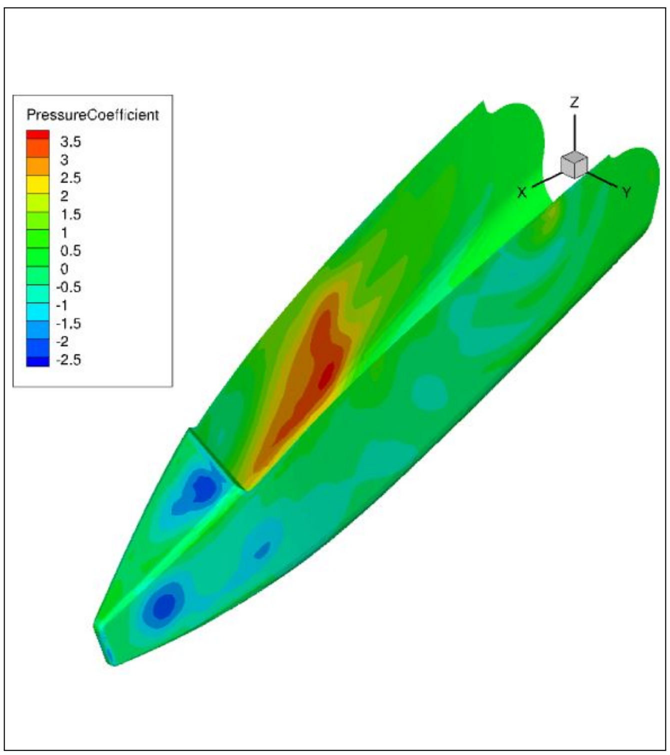

Fig. 3: Pressure coefficient on the outboard fairing surface only at time $t = 0.042$s.

defined as $C_p = \frac{p - p_0}{\frac{1}{2}\rho_0 V_0^2}$, where p is the static pressure at a point on the surface, p_0 and $\frac{1}{2}\rho_0 V_0^2$ are respectively the static pressure and the dynamic pressure of the undisturbed flow, [3].

References

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