MASTER RECHERCHE

Dynamique des Fluides, Energétique et Transferts, Mécanique des fluides pour l'environnement

Proposition de sujet de stage 2016 – 2017

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TITRE : Numerical simulation of a ZNMF-type, synthetic jet piezoelectric actuator for the active control of the flow past a UHBR powerplant installation

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Context and Objectives :

The aerodynamic interaction promoted by the nacelle/pylon/wing junction is a major issue which affects the aerodynamic performance of HBR (High Bypass Ratio, and, by extension, UHBR, U standing for Ultra) powerplant-equipped aircrafts, in particular for take-off, initial climbing and landing phases. In this context the development of innovative active flow control strategies in the region of the nacelle/pylon/wing junction of large passenger aircrafts appears as a promising alternative to the currently implemented passive flow control systems, namely the strakes. The X-Pulse project, part of the European Commission-funded CleanSky 2 program and led in partnership with Airbus, Fraunhofer and Hit09 S.R.L., directly addresses the challenges inherent to the development and integration of UHBR powerplant on large passenger aircraft specifically, but more generally on any aircraft equipped with close-coupled powerplant installation (*e.g.* military transport aircrafts like the Boeing C17). More precisely, the X- Pulse project aims at developing innovative active flow control strategies, based on synthetic pulsed jets, also referred to as ZNMF for Zero Net Mass Flux, to mitigate the flow separation induced by UHBR powerplant installation on the suction side of the wing when the aircraft is operated at high angle of attack and low speed -during take-off, initial climbing and landing-.

The definition of an efficient ZNMF actuator in controlling a separated flow is still nowadays highly challenging as it is influenced by several parameters, ranging from the design of the actuator geometry, its operating conditions, its positioning, etc.

The objectives of this project is to assess the capability of RANS turbulence models to accurately represent the ZNMF pulsed-jets induced effects. In fact, accurate prediction of the control effect based on ZNMF actuators largely relies on the ability to capture the interaction with the turbulent crossflow, and in particular to reproduce the correct flow dynamics. Moreover, the flow mechanisms associated to ZNMF are not fully understood and it has been shown that URANS has difficulty to capture the interaction of ZNMF pulsed jets with detached flow.
Reference data will be produced in the context of this project, using LES and they will be compared with URANS computations achieved on the StarCCM+ solver. A simplified canonical configuration will be considered to this purpose, composed of a flat plate with/without adverse pressure gradient (ZPG/APG), and a limited number of actuators (typically up to 3), able to take into account the jet/jet interactions. LES will be performed at ISAE-SUPAERO using grids of moderate size (typically 10^7 points), and the in-house flow solver CharLESX and leveraging previous studies on the topic.