M2 DET – Dynamique des fluides, Énergétique et Transferts

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PROPOSITION DE STAGE 2018-2019

Titre : Numerical Analysis of Propeller Aerodynamic Efforts at High Incidence

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Background

Convertible Micro Aerial Vehicle (MAV) attracts growing interest thanks to its ease of launch and recovery, which will further expand current drone applications in ground survey or on-site inspection. One of the challenges in convertible drone development is to achieve good handling characteristics during transition between hover to horizontal flight, which requires accurate modelling of aerodynamic forces and moments acting on the aircraft. An important part of the aerodynamic modelling is propeller efforts. When the rotor is tilted from 0° to 90° incidence angle during transition maneuverings, the forward flight velocity creates asymmetric flow condition on propeller disk, generating additional normal force and yaw moment. Furthermore, low Reynolds number effects and post-stall behaviors make accurate prediction of propeller loading difficult.

Objectives

The proposed project aims at providing a numerical database for propeller forces and moments as functions of freestream velocity and incidence angle. The student will perform high-fidelity computational fluid dynamic (CFD) simulations on propellers at different freestream conditions. Simulation results will be validated with experimental database obtained in ISAE-Supaéro low-Reynolds number wind tunnel (SaBRe). Thereafter, flow analysis will be conducted to identify flow patterns that generate the asymmetric propeller forces and moments. The effect of different blade geometries (pitch angle) may also be analyzed.

Methods and Tools

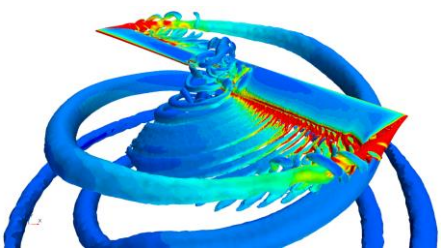
The research project will be numerical analysis on simplified small-scale propeller at various high incidence configurations. The propeller geometry will be generated from CAD software, and then imported to StarCCM+ software for computational domain discretization and numerical simulation. The instantaneous flow field will be calculated using high fidelity numerical methods such as URANS.

A reduced-order blade element model and SaBRe test data are available for comparison.

Duration and Requirements

The present project is part of collaboration between ISAE-Supaéro and Delair company. The project will last from 5 to 6 months, starting from early 2019. Master students with good knowledge of numerical methods and fluid mechanics are encouraged to apply. Basic skills in CAD software is preferred.

Convertible Drone – Cyclone (ENAC)



CFD simulation of the flow past a two-bladed rotor