Master or Bachelor Thesis Topic
Develop a Trim Method for Cycloidal Rotor CFD Simulations

Cycloidal rotors have the advantages of providing $360^\circ$ thrust forces and having constant flow velocities on their blades. However, the deformation of their blades reduces efficiency and is not well understood. Also, while air enters and exits the rotor, it encounters the blade twice and this favors dynamic stall and blade-vortex interaction. The given advantages over conventional helicopter rotors and consequent challenges make cyclorotors ideal for research. The aerodynamic phenomena they produce are investigated by means of numerical fluid simulation.

The current state of the art models work with pre-imposed pitching functions. This does not allow to study the behavior of a cyclogyro aircraft under a chosen flight condition.

The theme of the proposed thesis is thus to develop a method which will allow to tune the controller of the rotors during the CFD simulation. The objective is to allow cycloidal rotor CFD simulations to be automatically trimmed for a given flight condition.

Tentative milestones:
- familiarize with the OpenFOAM CFD toolbox and the pimpleFoam tutorials
- implement the pitching motion of an oscillating airfoil in non-viscous fluid
- insert a feedback loop to consecutively adjust the angle of attack for a target lift force
- extend the case to a full-rotor simulation
- use the developed single-airfoil methodology to control the pitch function to reach given rotor lift and thrust
- verify and improve the stability and rapidity of the developed method in achieving different flight regimes through controller tuning, likely a PID
- refine the method to allow considering the influence of every component of the airframe

Prerequisites:
- interest for fluid mechanics and rotors
- willingness to work with scripts and the Linux console
- patience and attention to detail; ability to understand C++ code may be necessary
- experience with PID controllers and system dynamics is a plus but is not essential

Language:
The supervision can be conducted in German, English, French, or Italian according to the preference of the student.

The thesis should be in German or English.

Interested?
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