Evaluate the Performance of a Camber Controlled Cycloidal Rotor

Cycloidal rotors have the advantages of providing 360° 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.

In their actual form, these rotors rely on the pitching of the airfoil to generate thrust. It is suspected that an implementation with no pitching could be simple yet efficient. In such a configuration, the creation of aerodynamic forces would be achieved by dynamically morphing the blades to considerably camber them.

The theme of the proposed thesis is thus to improve the current cycloidal rotor CFD models to allow modeling morphing blades. The objective is to demonstrate possible improvements in the aerodynamic forces and power introduced by such a modification.

Tentative milestones:
- familiarize with the OpenFOAM CFD toolbox and the pimpleFoam tutorials
- model an oscillating airfoil using an interpolation interface for rotation
- force changing of the pitch through the addition of a mesh deformation
- extend the case to a full-rotor simulation using data from the literature
- verify model with different literature cases
- compare the flow and rotor properties for both pitching and cambering airfoils

Prerequisites:
- interest for fluid mechanics and rotors
- willingness to work with scripts and the Linux console
- patience and attention to detail
- experience with airfoils, meshing, or CFD is desired

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?
Advisor: Louis Gagnon, room 0.011, Tel. 0711/685-64278, gagnon@iag.uni-stuttgart.de
Examiner: Manuel Keßler, room 0.37, Tel. 0711/685-63419, kessler@iag.uni-stuttgart.de