The interest in unmanned aerial vehicles (UAVs) and micro air vehicles (MAVs) is growing continuously. Not only economically, but technologically as well [1]. Drones can carry out different tasks, that would not be possible with any other kind of vehicle or without the risk of endangering the pilot. Nowadays these vehicles exist mainly with conventional propellers. These propellers tend to be sluggish when maneuvering and are susceptible to winds and gusts. An alternative means of propulsion is a cyclorotor. Cyclorotor technology is being revived lately [2], [3]. A cycocopter uses cylindrically arranged rotating wings which can change their pitch. This results in lift, good maneuverability and vertical take-off and landing capability.

Cyclorotors need to be well researched before they can enter the market safely. Therefore it is important to understand the aerodynamics behind this technology. Aerodynamic research of these rotors is widely conducted via computational fluid dynamics (CFD) simulations. This presentation discusses the usage of OpenFOAM Overset and Foam-extend Overset to investigate the aerodynamics of a cyclorotor. Overset, which is also known as Chimera, uses multiple overlaid meshes. These overlaid meshes allow complex motions without altering any mesh. The Arbitrary Mesh Interface (AMI) on the other hand, consists of multiple meshes with interpolated values at their mesh fringes. Simulations on cyclorotors have been conducted already with AMI [5], [6], [7], [8] and the Overset mesh motion method [9], [10]. Compared to Overset, AMI runs quicker whereas Overset delivers conservative results at the cost of more simulation time. The scope of the presentation is to explain the usage of OpenFOAMs and Foam-extends Overset and to verify its results compared to an AMI simulation. The process of setting up of an Overset case begins with generating a mesh, creating the motion for each mesh and setting up the entire file structure needed to run a simulation. The results of these simulations are introduced and further investigations on parallel processing efficiency as well as a comprehensive comparison between AMI, OpenFOAM and Foam-Extend is conducted. Overset is a strong tool given its ability to handle complex motion. This makes it universal and useful to analyze the aerodynamics of a cyclorotor.
Figure 2: Exemplary comparison of flow velocity results. Overset (left image) and AMI (right image) deliver nearly identical results [11].

Acknowledgments

The work of Louis Gagnon is supported by the Alexander von Humboldt foundation for the “A Novel and Simple Aircraft Requiring Minimal Power to Hover” project through their Research Fellowships for Postdoctoral Researchers.

References


