Validation of dynamic stall models of pitching airfoils in comparison with experimental data

Wind turbine is often operating at harsh conditions under constantly changing wind velocity and directions, causing strong unsteady effects to appear. This can result in the periodic change of effective the angle of attack on the blade section which lead to the dynamic stall phenomenon. The onset of dynamic stall is characterized by the formation of an intense vortical structure near the leading edge of the sectional airfoil causing the lift coefficient ($C_L$) to increase beyond the static stall angle widely known as stall delay. This vortical structure is convected on the suction side of the airfoil indicated by the lift gradient increase. The vortex detaches from the airfoil body at a larger angle and starts to breaking down followed by the formation of the trailing edge vortex. This behavior is marked by a significant drop in $C_L$. These effects are illustrated in Figure 1. The dynamic stall issue challenges the accurate prediction of the aerodynamic forces using low order simulation tools. Therefore, appropriate models shall be developed for particular purposes.

The main tasks of the present work are to implement and to investigate suitable dynamic stall models for airfoils characterized by leading edge or trailing edge separation. The candidate is expected to have general knowledge of fluid dynamics and a strong proficiency in programming of at least one of the following languages: Fortran, Python, C or C++. It shall be noted that all discussions and communication will be in English, and the thesis must be written in English. The thesis will be supervised by Dr. Bangga and Dr. Lutz and shall be started as soon as possible. For more information please contact:

Dr.-Ing. Galih Bangga
bangga@iag.uni-stuttgart.de
Institute of Aerodynamics and Gas Dynamics
University of Stuttgart