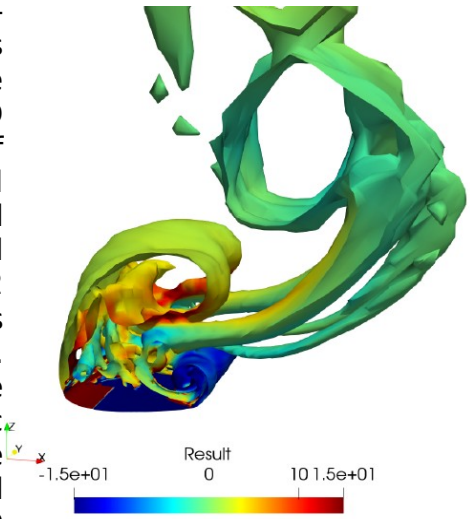
Investigation of far-field noise generated by an airfoil in deep-stall: a coupled CFD/CAA study

MSc Project Proposal
November 2023

Introduction

The assignment focuses on aeroacoustics of airfoils using high fidelity CFD simulations and Ffwocs-Williams Hawkins acoustic analogy. Wind turbine noise is a major reason for the low acceptance of turbines onshore and in this project, we will study the different noise mechanisms numerically by focusing on individual airfoil sections under various flow conditions.

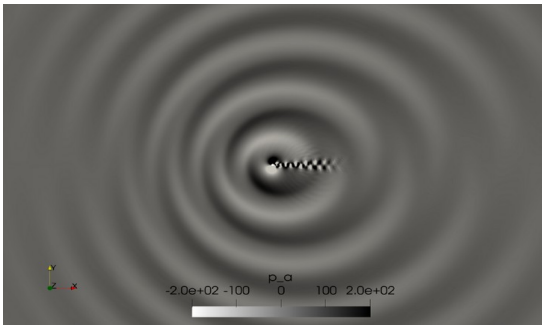
Problem Description



The aim of the project is to determine the far-field noise generated by an airfoil under various flow conditions. The numerical solution will be obtained in two steps: a high fidelity CFD simulations (DDES) to determine the details of the flow field and the acoustic sources and simulation of the acoustic noise in the far-field by an acoustic analogy method. Simulations will be carried out with an open source CFD suit SU2 and an implementation of Ffowcs-Williams Hawkings (FWH) acoustic analogy method. Primary motivation of the study is to validate the acoustic results against an in-house acoustic analysis code based on engineering models. The mentioned acoustic analysis code that is based on engineering models do not require CFD simulations but based on simplified assumptions of certain flow conditions. High fidelity aeroacoustics analysis under non-standard conditions will be performed and used to improve these existing engineering models.

Furthermore, during the project the existing in-house FWH method that is implemented for the solid acoustic volume formulation can be extended for the permeable volume formulation. The method is implemented in Python.

Your Profile



- Basic knowledge of fluid dynamic
- Knowledge of CFD and/or aeroaouctics is a pre.
- Knowledge of numerical analysis and algorithm development
- Knowledge of a programming language like Python, C, C++ or Fortran

Project Details

- Work will be carried in cooperation with the Wind Energy Unit of TNO and University of Bristol.
- Project duration will be 6 to 12 months (in mutual agreement with the student).
- A possible internship position at TNO (Petten and/or Delft office).

References

- SU2, https://su2code.github.io
- Nataraj P.P., Investigation of acoustic noise mechanisms with a CFD/CAA method, MSc thesis, University of Twente, 2022 http://essay.utwente.nl/90643/1/PindiNataraj_MA_ET.pdf
- Nataraj P.P., Ravishankara. A.K., Ozdemir H., Venner C.H., Computational Aeroacoustic Analsyis of Airfoil Sections in Deep Stall, AIAA 2023-0610, 2023 DOI: 10.2514/6.2023-0610

Contact information

For more details and general info please contact to:

Dr. Huseyin Ozdemir

h.ozdemir@utwente.nl
Horstring – N252