ParCFD'2021
32^{nd} International Conference on Parallel Computational Fluid Dynamics
May-17-19, 2021, Nice FRANCE

IMPLEMENTATION OF GENETIC ALGORITHM FOR SHAPE OPTIMIZATION OF AIRFOILS INTO OPENFOAM

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Key words: CFD, Airfoil Design, Genetic Algorithm, Shape Optimization, OpenFOAM, Parallel CFD applications.

Abstract. The objective of this work is develop a Genetic Algorithm suitable for shape optimization of airfoils and implement the algorithm into open-source code OpenFOAM.

1 INTRODUCTION

Coupling of Optimization and Computational Fluid Dynamics (CFD) has been used during the recent years in the design of aerospace structures, especially, airfoil design. This coupling has various advantages like diminishing the number of prototypes required to examine the airfoil and allowing the use of several cost functions at the same time. In this study, one of the branches of heuristics method family, genetic algorithm (GA) is used, combined with CFD in design process of the airfoil and implemented into multidisciplinary open source program OpenFOAM. Genetic algorithm is inspired by nature and basically based on the process of natural selection mechanism of the evolutionary theory. It is a powerful optimization tool handling the demand of high design requirements. In mechanical and aerospace engineering applications, usage of heuristics method is gaining popularity, although it is in great demand in other engineering applications, especially industrial [1] and software engineering [2], and has been proven to conduct efficient outcomes. By means of this research, GA method can be introduced and popularized among CFD engineers in the field of optimization design of airfoil. There are various studies for implementation of genetic algorithms for airfoil design with open-source codes. They contain generally optimization code/s in addition to CFD code/s. Some of these studies are combining OpenFOAM with other optimization codes externally. CFD calculations are made in OpenFOAM and then the results are exported to an outsource optimization code. GA calculations are done externally in this code and then exported again into CFD code in OpenFOAM. This cycle continues until optimization criteria are satisfied. For instance Oh and Chien [3] use OpenFOAM as CFD code to solve continuity and momentum equations and then deliver these results to DAKOTA optimization code. In our approach we will handle both GA and CFD calculations in OpenFOAM.

2 GENETIC ALGORITHM

The Genetic Algorithm is designed to seek the global optimum solution in a probabilistic way, while the non probabilistic methods search for the local optimum solution in a deterministic way. Also, the GA pays attention on a set of points, not on a single point. The computer time and memory requirements are significantly less when using GA. Additionally,the GA is also very suitable for parallelization.

The objective of this work is to develop a modular code that allow users to implement their applications easily into OpenFOAM.

3 TO BE PRESENTED

In this paper, the implementation of the genetic algorithm in OpenFOAM will be demonstrated,the parallelization strategy and its performance will be discussed and the advantages of the method will be illustrated with the test cases to be presented.

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