LARGE-EDDY SIMULATION OF AIRFOIL FLOW USING OPENFOAM

by

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ABSTRACT

The goal of this thesis was simulating turbulent flow around airfoil RAF-6E. As first steps, two dimensional simulations were performed by both OpenFOAM and FLUENT. Then their results were compared to each other.

Then several numerical schemes were selected in OpenFOAM and they were compared to FLUENT and measurement. The goal of this part of the project was finding the proper numeric settings for the LES. As the necessary computation time is long for 3D LES simulation, these simplier, faster 2D cases were suitable for testing several possible numeric settings.

After performing mesh-dependence examination in 2D, the former mesh turned out to be coarse. A new, refined mesh generation was necessary, which meant new challenges and extra working time on preparing the LES case for simulation. From the refined 2D mesh a 3D one was generated in OpenFOAM with extrusion.

Finally, a Large-Eddy Simulation (LES) of the airfoil in OpenFOAM was performed in 3D.

KIVONAT

A dolgozat célja a RAF-6E típusú szárny körüli turbulens áramlás vizsgálata. Első lépésként két dimenziós szimulációt futtattunk OpenFOAM-ban és FLUENT-ben, majd az eredményeket összehasonlítottuk egymással.

Később számos különböző numerikus sémát választottunk ki OpenFOAM-ban, melyek eredményeit összevetettük a FLUENT-es szimuláció, illetve tanszéki mérések eredményeivel. A cél ebben az részben az volt, hogy a megfelelő numerikus sémákat ki lehessen választani a LES számára. Mivel a 3D LES szimuláció számítási igénye jelentős, ezek az egyszerűbb, gyorsabb, 2D-s esetek alkalmasak voltak több lehetséges numerikus séma tesztelésére.

Hálófüggetlenségi vizsgálat elvégzése utána (2D) kiderült, hogy a korábban használt háló nem volt elég finom felbontású. Egy új, jobb felbontású háló készítésére volt szükség, ami új kihívásokat és többlet munkaigényt jelentett a LES-eset beállításában. A finomított 2D hálót OpenFOAM-ban kihúzva hoztuk létre a 3D hálót.

Végül nagy örvény szimulációt (LES) végeztünk OpenFOAM-mal 3D-ben.

CONTENTS

NOMENCLATURE

Mark	Name	Unit
c	chord length	m
C_D	drag coefficient	1
C_L	lift coefficient	1
FTN	flow through number	1
N_x	cells in streamwise dicetion	1
N_y	cells in wall-normal direction	1
N_z	cells in spanwise dicetion	1
p	static pressure	Pa
p_{mean}	mean of static pressure	Pa
p_{RMS}	root mean square of static pressure	Pa
u_{mean}	mean velocity in tangential direction	m/s
u_{RMS}	root mean square of velocity in tangential direction	m/s
U_{ref}	reference velocity	m/s
v	instantaneous velocity in wall-normal direction	m/s
v_{mean}	mean velocity in wall-normal direction	m/s
v_{RMS}	root mean square of velocity in wall-normal direction	m/s
w	instantaneous velocity spanwise direction	m/s

GREEK INDEX

Mark	Name	Unit
α	angle ot attack	°
Δ_t	time step	s
Δ_x	step size of the grid in x direction	m
Δ_y	step size of the grid in y direction	m
Δ_z	step size of the grid in z direction	m
$\tau_{w,x}$	x component of wall shear stress	Pa
$\tau_{w,x,mean}$	mean of x component of wall shear stress	Pa