Faculty Engineering Technology
Program Mechanical Engineering

UNIVERSITY OF TWENTE.

COLLOQUIUM

Group: **Engineering Fluid Dynamics**

As part of his MSc thesis assignment

Khoi Vu

will give a presentation, entitled:

Study on combining overset grids with high order finite difference schemes.

Date: **Friday April 01, 2016**

Time: **14:00**

Room: **Horst Building Room N.109**

Summary:

The Navier-Stokes equations govern most flows. Solving these equations exactly for realistic flows is often difficult and exact solutions exist only for simple flows. To solve the more complex flow problems often numerical solutions are sought which is the field of Computational Fluid Dynamics.

Numerical solutions require computational grids which discretize the domain. There are two types of grids: structured and unstructured grids. Structured grids give the user good grid control and generally give the best results, however they are difficult to generate. On the other hand, unstructured grids are easier to construct but reduce the quality of the solution. To increase the flexibility of structured grids, the concept of overset grids was introduced. The basic concept is to construct seperate structured grids for individual bodies, which are easier to make, and let the grids overlap. Grid connectivity is done with inter-grid interpolation.

In the industry nowadays most of the production CFD codes are second order in accuracy. For modelling turbulence or acoustics, where the high frequency waves are important, second order schemes are not good enough to capture the relevant flow features. That is the reason for doing reseach into high order schemes. In this thesis the explicit Summation-By-Parts (SBP) schemes in combination with a weak enforcement of the boundary conditions through the Simultaneous-Approximation-Terms (SAT) are used. The SBP-SAT method allows for the derivation of an energy bound and allows the proof of stability. The used schemes have globally an accuracy of third, fourth and fifth order.

The objective of this thesis was to investigate if the accuracy of the high order schemes can be maintained while using the overset grids. This means that the inter-grid interpolation also has to have high order accuracy. Another aspect of the investigation is to investigate how to amount of overlap influences the accuracy.

In this thesis three interpolation methods are implemented: the '10 point stencil' interpolation, Lagrange interpolation and wavenumber optimized interpolation. The interpolation methods have been used with different grid configurations and are applied to two testcases: the inviscid convection of a vortex and the subsonic inviscid flow over a NACA0012 airfoil. The results of the inviscid convection of a vortex test case showed that design accuracy could be maintained but not for all schemes. The results of the NACA0012 test case showed that design accuracy was not achieved. The reason is the introduction of entropy errors due the inter-grid interpolation. Furthermore the amount of overlap influences the accuracy. If the overlap is chosen poorly it leads to a decrease in accuracy due to the need of a boundary stencil and due to the reduction of quality of the interpolation.

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