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Vakgroep: **Technische Stromingsleer**

In het kader van zijn doctoraalopdracht zal

Tijmen Antonie Ton

een voordracht houden getiteld:

Vorticity Confinement in Compressible Flow – Implementation and Validation

Datum: **15-2-2008**

Tijd: **14.00**

Zaal: **HR C101**

Summary:

The Euler equations describe the motion of non-heat-conducting, inviscid flow. An important aspect of the numerical schemes used for solving these equations, is that some form of numerical dissipation is required to maintain numerical stability. This dissipation is either implicitly present (inherent to the discretisation) or added explicitly. Without dissipation, numerical instabilities that disrupt the solution, such as the well-known checkerboard instability, can arise. Numerical dissipation effectively damps these instabilities, so that the solution remains smooth.

A consequence of numerical dissipation is that high gradients in the flow variables tend to smear out, while physically the high gradients should be preserved. An example of this problem is encountered when dealing with highly vortical flows, since high gradients in velocity are associated with vortical structures such as thin shear layers and compact vortex cores. The Euler equations do not contain a dissipative mechanism and vorticity, once generated, should therefore persist indefinitely. However, numerical simulations show that numerical dissipation has such a strong impact that vortices lose their strength rapidly.

In order to achieve an accurate capturing of vortical structures, conventional techniques have aimed at lowering numerical dissipation. Examples of these techniques are (adaptive) grid refinement, which reduces numerical dissipation since it typically scales with the mesh width squared, and the use of high-order discretisation schemes, which possess higher-order numerical dissipation. Both methods however involve a substantial increase in computational effort. For vortical flows grid refinement is costly , because the regions with grid refinement may comprise a large portion of the computational domain, therefore rapidly increasing the number of grid points. High-order methods are very costly as well, because the discretisation schemes involve a far greater number of cells.

A relatively new technique called Vorticity Confinement might provide a cost-effective solution to the problem. A body force term that operates in vortical flow regions only is added to the Euler equations in order to counter the vorticity diffusing effect of numerical dissipation, acting as a kind of anti-diffusion term, mitigating the unwanted effect of numerical dissipation.

In this research the properties of the confinement term are studied analytically and numerically. To validate the method it is applied to several two-dimensional flows. Finally the method is applied to the flow around a complex three-dimensional finite wing geometry.

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d.d. 20-1-2008