



Computational Fluid Dynamics LABORATORY

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Adaptive Grid Refinement for Compressible Flow Computations

The aim of every numerical flow calculation is to reach a given accuracy with the smallest amount of computational work. The difficulty to accomplish this lies in the unknown behavior of the flow in the calculation domain. By using the Finite Element Method (FEM) the grid must be well-adapted to the problem, i.e., regions with high gradients in the flow variables need smaller elements. Mesh generation is usually restricted to users with enough experiences in fluid dynamics to generate reasonable grids.

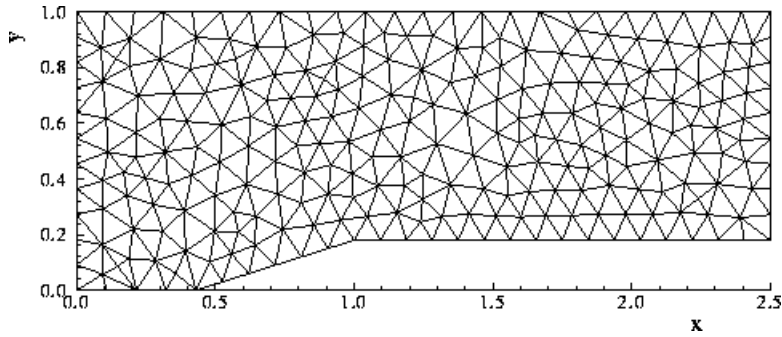
Adaptive mesh generation based on error estimators offer a change in this mesh generation procedure. Error estimators identify automatically regions on a coarse grid which need finer elements. Then, the utilized mesh refinement method does the refinement. This study investigated error estimators for hyperbolic problems based on the discretization error for 2-dimensional unstructured meshes. Mesh enrichment is chosen for the refinement method. The enrichment is done by reducing the element size h , which is called h -refinement.

The result of the study was an error estimator based on stronger stability concepts, which consists of the first and second derivative of a characteristic flow variable. The derivatives are taken anisotropic. The usage of only one flow variable is not enough to consider all features of inviscid and viscous flow. Therefore, the error estimator is applied to pressure p and Mach number Ma values of the flow.

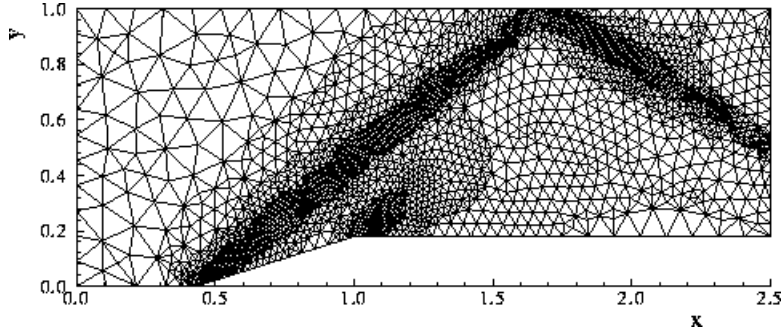
Channel Flow

Flow characteristics: $Ma = 2.6$, inviscid and steady

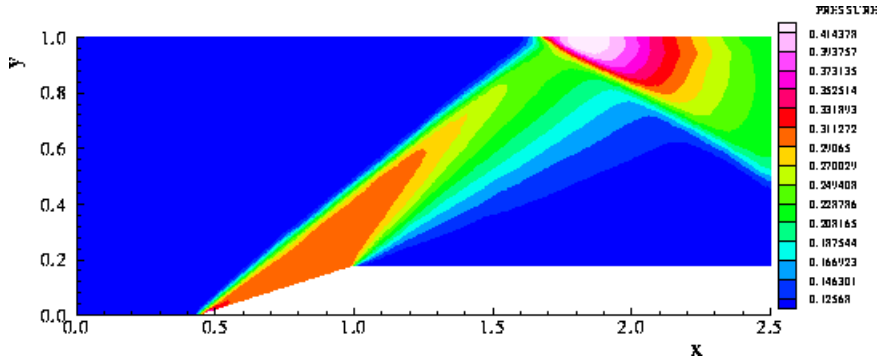
Initial Grid



Final Grid



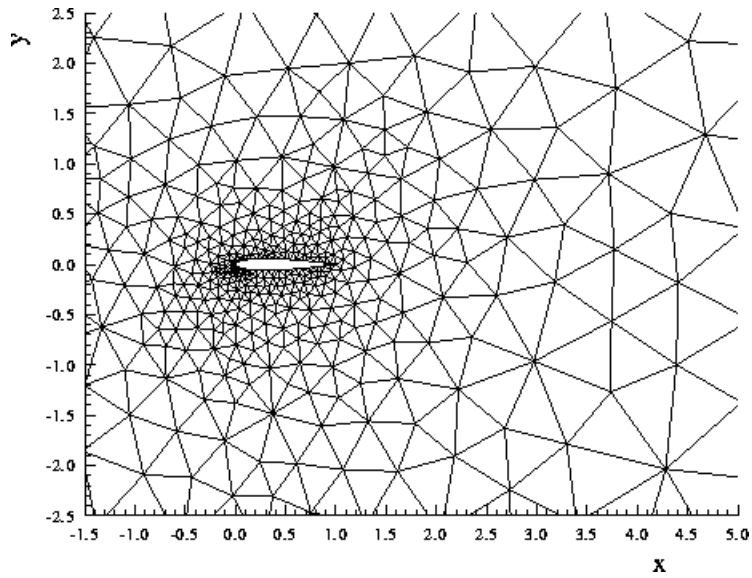
Pressure Contours on Final Grid



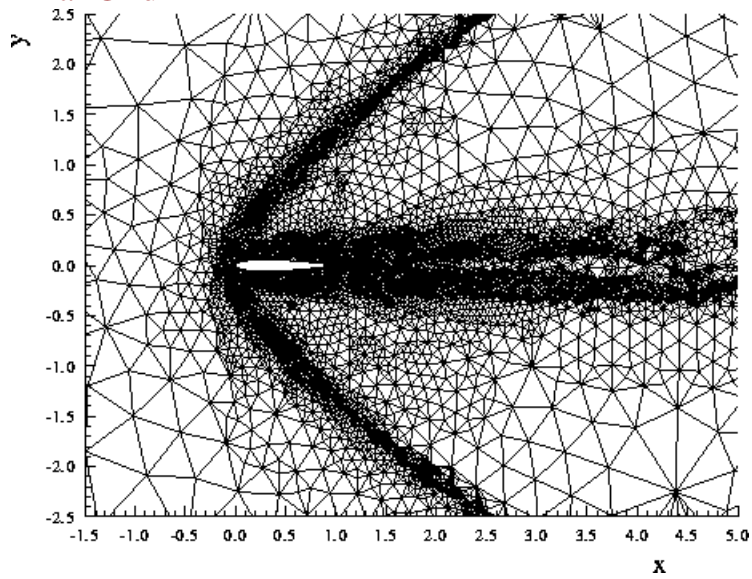
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Flow characteristics: $Ma = 2.0$, viscous and steady

Initial Grid



Final Grid



Mach Number Contours

