Vehicle Aerodynamics based on Virtual Boundary Method

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ABSTRACT

This work develops a numerical method for the solution of incompressible bidimensional flow for vehicle geometries based on the Finite Difference method. The computational code solves the Navier-Stokes equations for an adequate distribution of the discrete points in the mesh. The integration is based on the three-stages Runge-Kutta explicit sheme for momentum equations and sucessive under-relaxation for pressure.

The virtual boundary technique based on Gaussian approximation is employed to indicate the solid body in the flow field, with the surface not coinciding with the computational grid. This technique allows the transference of information between the points of the immersed contour and its neigbouring points.

We opt to use cartesian coordinates, instead boundary fitted, because the application of finite differences turn simple. However, this option imply in difficulties to apply the boundary conditions.

Figure 1 indicates the vector field for a simplified vehicle geometry, and figure 2 shows the surface pressure distribution on the model, for Euler, potencial and Bernoulli equations. Preliminary results indicate difficulties when comparing analytical/potencial (Laplace) with numerical results. Such occurs because of an increase of the velocity in the geometry corner and because of a vortex formation behind the corner, which influences the pressure coefficient on the horizontal surface.

We intend to obtain an efficient code to easily improve vehicle geometry of competition automobiles. Therefore, we stress the fact that there are still few information about vehicle aerodynamics in the available literature; the contribution of our work goes in this direction.

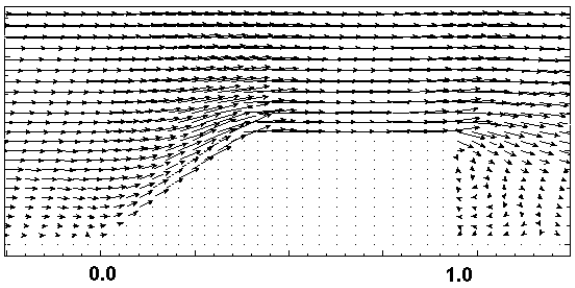

Figure 1: Vector field for a simplified vehicle geometry (model)

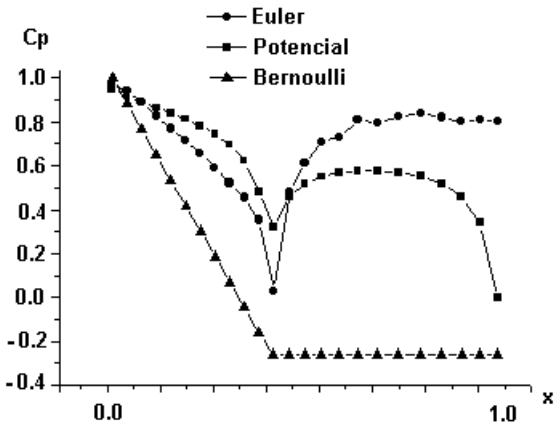

Figure 2: Pressure coefficient comparison for vehicle model

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