DEVELOPMENT OF INVERSE DESIGN METHOD FOR INCOMPRESSIBLE FLOW

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A numerical technique to solve the two dimensional incompressible inviscid inverse flow in turbomachinery is presented in the project. The time marching approach, which is well established for compressible flows, is extended to the incompressible case with the help of artificial compressibility. The modified system of equations is solved with a cell centered finite volume method with constant space-wise approximation over a control volume, based on two-dimensional second order central discretization. The solution of the inverse problem is obtained for the same solver but with modified boundary condition, which are the prescribed pressure distribution. The method is extended to solve the inverse problem i.e. define to the blade shape corresponding to a prescribed pressure distribution. In this method the initial geometry may be modified during the flow calculation, adapting it step by step to achieve the imposed pressure or velocity distribution using a physical algorithm.

The geometry modification algorithm is based on the pseudo incompressible Euler equations, which are hyperbolic. Allowing the walls to move with the flow provides new blade geometry, while modifying the boundary conditions along the blade walls to make them permeable allows a non-zero normal velocity, which can be used to define a new blade shape by means of transpiration. Figure1. and Figure 3. show the initial geometry and the redesigned geometry corresponding pressure distribution shown if Figure 2.

The main aspects of the permeable wall approach and some test case results are presented for the inverse solution.

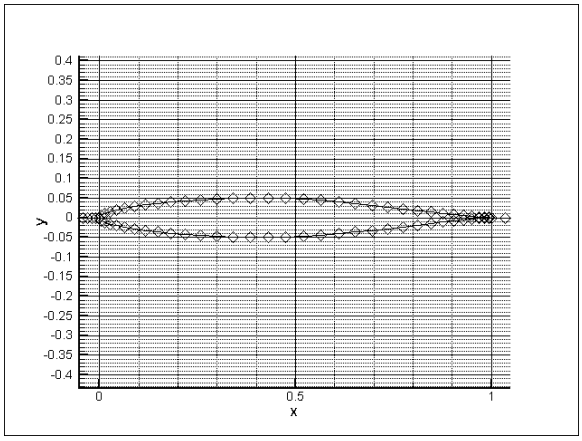

Figure 1: Initial geometry

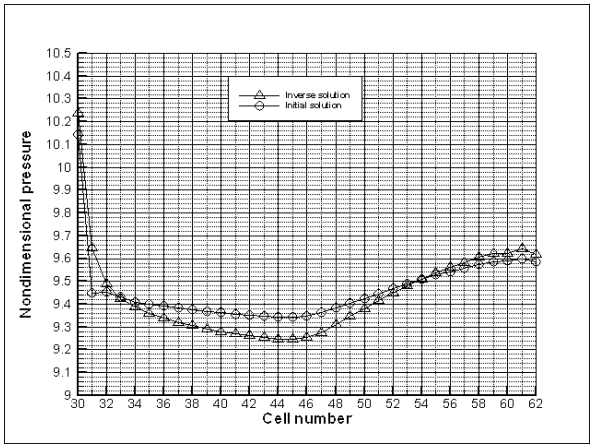

Figure 2.: Initial and prescribed pressure distribution

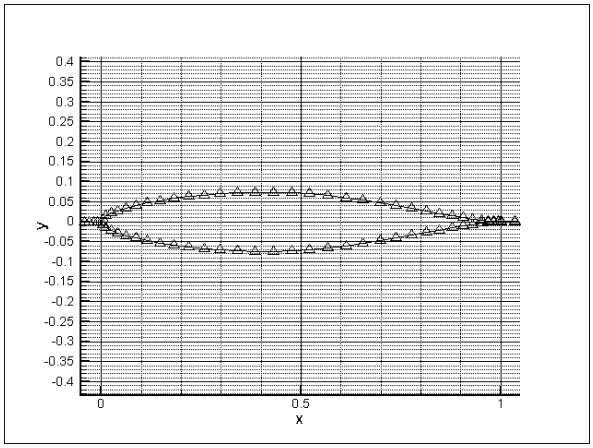

Figure 3.: Modified geometry