Inverse Aerodynamic Shape Design of Gas Turbine Blades

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Abstract: A three-dimensional viscous/inviscid method for aerodynamic shape design of gas turbine blades is proposed. Prescribed data are the blade thickness and pressure loading distribution as well as the leading edge position. The corresponding blade shape and steady flow field are sought.

The method is based on a finite volume discretization on a structured H-mesh. The resulting ordinary differential equations for the flow state and the (algebraic) pressure loading constraints form a DAE system. A half-explicit Runge-Kutta method is employed to solve this system: The flow state is advanced in time by a Jameson type explicit Runge-Kutta scheme for advancing the solution to steady state.

At each stage the algebraic constraints are satisfied by updating the unknown circumferential positions of the blade surface nodes. The corresponding system of equations is small and sparse, as only the cells along the blade surfaces are involved.

In comparison to the direct problem with known geometry the overhead per iteration is below 10 %. In terms of number of iterations the method proves robust. This work has been done by the second author in his Ph.D. Thesis.

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