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ADJOINT OPTIMIZATION OF 2D-AIRFOILS IN INCOMPRESSIBLE FLOWS

M. Schramm[1*], B. Stoevesandt[1] and J. Peinke[2]

[1] Fraunhofer IWES, Ammerländer Heerstr. 136, 26129 Oldenburg,
matthias.schramm@iwes.fraunhofer.de, bernhard.stoevesandt@iwes.fraunhofer.de,
www.iwes.fraunhofer.de
[2] ForWind, Ammerländer Heerstr. 136, 26129 Oldenburg, joachim.peinke@forwind.de,
www.forwind.de

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In wind energy, the numerical design of airfoils is often done using panel codes, which are fast to compute and thus are also used in design optimization. To achieve a higher accuracy of the pressure distribution on the airfoil, we propose to use CFD calculations instead. Due to the higher expense of those calculations, most optimization processes are limited regarding the number of design parameters. The adjoint method overcomes this disadvantage [1] and thus is used to calculate the gradient of a cost function independent of the number of design variables.

In this work as an example, the adjoint method is used to optimize the lift over drag ratio of a DU 91-W2-250 for different angles of attack. The cross-section area of the airfoil is chosen as geometric constraint. The design parameters are the grid faces of the airfoil, which can be moved in two directions. This leads to several hundred variables and gives a maximum of flexibility. This may lead to shapes, which otherwise might be excluded by the use of splines or Bézier-curves.

The optimization is done via a steepest-descent method and the one-shot approach is used, which means that primal and adjoint fields are solved in the same iteration step. The turbulence in the adjoint equations is "frozen" and due to the relatively low tip speed of wind turbines, the flow can be considered as incompressible. As CFD tool the open source code OpenFOAM is used, which is based on C++ and can be modified by each user. The implementation of this work is based on an already existing adjoint solver for internal flows and now runs in parallel.

The shapes are compared with solutions gained by incomplete sensitivities [2] and the effect of geometric constraints will be discussed.

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