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The Actuator Surface Model: A New Navier-Stokes Based Model for Rotor Computations

This paper presents a new numerical technique for simulating two-dimensional wind turbine flow. The method, denoted as the 2D actuator surface technique, consists of a two-dimensional Navier-Stokes solver in which the pressure distribution is represented by body forces that are distributed along the chord of the airfoils. The distribution of body force is determined from a set of predefined functions that depend on angle of attack and airfoil shape. The predefined functions are curve fitted using pressure distributions obtained either from viscous-inviscid interactive codes or from full Navier-Stokes simulations. The actuator surface technique is evaluated by computing the two-dimensional flow past a NACA 0015 airfoil at a Reynolds number of 10(6) and an angle of attack of 10 deg and by comparing the computed streamlines with the results from a traditional Reynolds-averaged Navier-Stokes computation. In the last part, the actuator surface technique is applied to compute the flow past a two-bladed vertical axis wind turbine equipped with NACA 0012 airfoils. Comparisons with experimental data show an encouraging performance of the method.

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