Karlsruhe Institute of Technology

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Master Thesis - numerical

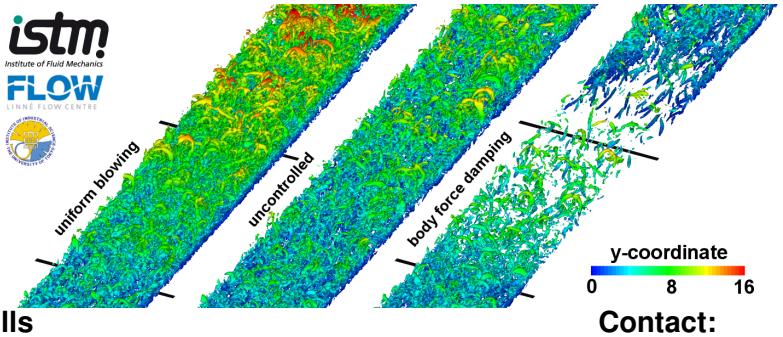
Inhomogeneous blowing in spatially developing turbulent boundary layers

Background

Turbulence control techniques leading to skin friction drag reduction are of great economical and ecological interest. One of the most simple and effective control techniques is uniform blowing applied at the wall surface. Application of a weak blowing (0.5% of the mean flow) in a turbulent boundary layer can reduce the skin friction drag up to 70%. However, any practical realization like an airfoil with such a control scheme requires a physical body which prohibits a true uniform flow through its surface. Instead some kind of hole or slot pattern has to be applied for the control fluid to cross the surface. Therefore, blowing will not be uniform in space. Within the present master thesis, the effect of a spatially inhomogeneous blowing in a turbulent boundary layer is investigated in terms of its impact on the flow control performance.

Content of the Thesis

The investigation of heterogeneously distributed blowing in a spatially developing turbulent boundary layer is to be carried out utilizing direct numerical simulation. The main focus is set on determining the payoff of different surface patterns in the control scheme and its effect on the boundary layer and drag reduction compared to the true uniform case. In addition, the question of the optimal blowing distribution for drag reduction shall be derived. Based on a literature study and scale estimations for relevant blowing slot dimensions in aerodynamic applications, a DNS based parameter study is to be designed. The main part of the thesis consists of generating a database with an available DNS code and evaluating the data with the goal to identify the physical flow mechanisms that influence skin friction drag.



Required Skills

good knowledge of fluid mechanics

Beneficial skills

CFD, Linux, Fortran, Matlab

You will learn

methods of scientific research, flow control, high performance computing

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