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FLOW CONTROL SENSITIVITIES FOR VEHICLE AERODYNAMICS

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Within the research activities to further improve vehicle aerodynamics, the application of vortex generator jets (VGJs)[1] for flow control is considered as a promising option. VGJs generate longitudinal vortices that increase the mixing in the boundary layer and thus accelerate the flow and delay separation. They have been successfully demonstrated on aircraft wings to increase lift and delay aerodynamic stall[2]. In contrast, to date only little is known about how to successfully apply them to improve car aerodynamics.

In this paper, an approach to compute sensitivities for the positioning of VGJs will be described. On the basis of time-averaged unsteady simulations for the flow field, the adjoint method[3] is employed in order to indicate VGJ configurations with beneficial effect on the aerodynamic drag of the vehicle. The calculation of the sensitivities on a simplified geometry of a production vehicle is demonstrated, with further numerical experiments being conducted so as to verify the accuracy of the computed sensitivities in complex 3D flow conditions. For the flow field simulations one of the standard OpenFOAM® solvers is used, while the adjoint field is computed with an in-house OpenFOAM®-based solver including the continuous adjoint of the Spalart-Allmaras turbulence model[4], developed at the National Technical University of Athens (NTUA) and Volkswagen AG.

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