Master's Thesis

Application of hybrid URANS-LES turbulence model for CFD prediction in Automotive industry

The main objective of this master thesis is to assess the predictive capability of hybrid turbulence model available in OpenFOAM for CFD simulation of road-cars geometries. Through mandatory geometry, boundary conditions and computational grids the aim is to provide practical modelling guidelines to the automotive community e.g best-practice turbulence modelling, meshing, numerical schemes. The test case for this master thesis is a notchback version of the DrivAer obtained from the 3rd Automotive CFD prediciton workshop in Barcelona, Spain Sep 2022. A detailed description of DrivAer test cases (Test-case 2a) is available in [1]. For DrivAer test case the focus is on a closed cooling configuration with static wheels and static floor. A comprehensive set of experimental data from the Pininfarina Wind Tunnel (Courtesy of Ford) including aerodynamic forces, surface pressure, velocity profiles and 2D flowfield measurements is available for DrivAer Test-case 2a [2]. **Please see Ref. [1] for the available meshes which were created using ANSA by BETA-CAE Systems. Two mesh were provided with $y^+ \approx 1$ (244Mio) and $y^+ \approx 30$ (128Mio). Both meshes are identical except for boundary layer region.**

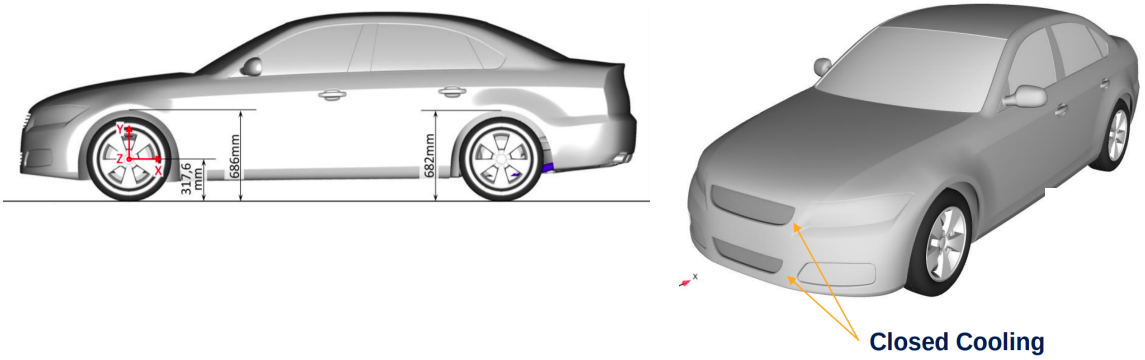
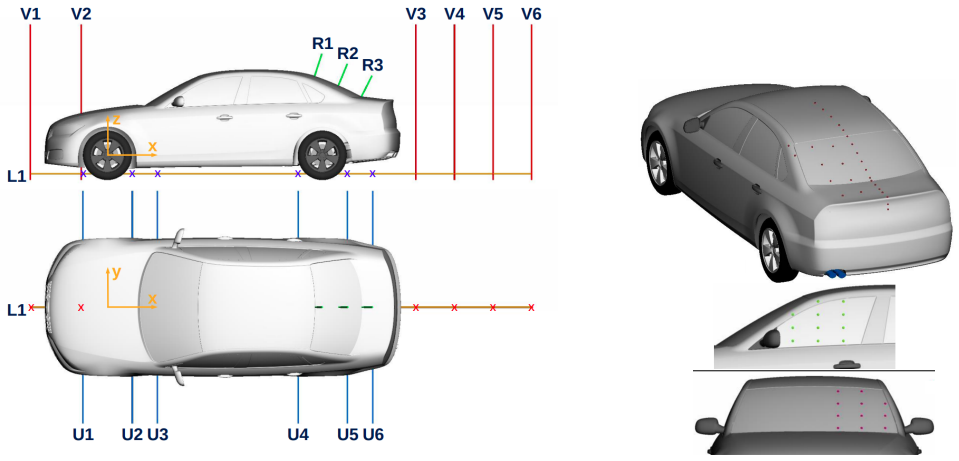


Figure 1: Test-case 2a, DrivAer Geometry.

The following CFD investigation must be covered in this master thesis:

1. Calculation of the Aerodynamic forces (Drag, Lift (front & rear)).
2. Calculation of surface pressure (pressure value at 209 probes location are available form measurement).
3. Calcualtion of velocity profile (11 profiles, see the profiles location in [1] & [2])).
4. Visualizing the Flow field at 4 planes (see [1] & [2]).
5. Validation of CFD simulation through comparing the post-processing no 1-4 with the experimental data.



(a) Locations of the velocity profiles.

(b) Location of pressure probes.

Figure 2: Location of the measurement of the velocity profile and pressure in the Wind Tunnel.

The report must include the capability of LeMoS hybrid turbulence model (LH and SLH) and comparison with DES-based turbulence model available in OpenFOAM. A scientific report with discussion of the result must be submitted. In case of satisfactory result the work can be submitted to the next AutoCFD workshop.

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References

[1] https://autocfd.eng.ox.ac.uk/

[2] Hupertz, B., Chalupa, K., Lewington, N., Howard, K. et al., "On the Aerodynamics of the Notchback Open Cooling DrivAer: A Detailed Investigation of Wind Tunnel Data for Improved Correlation and Reference," SAE Technical Paper 2021-01-0958, 2021.