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DEMONSTRATION OF AUTOMATED CFD PROCESS USING MESHLESS TECHNOLOGY

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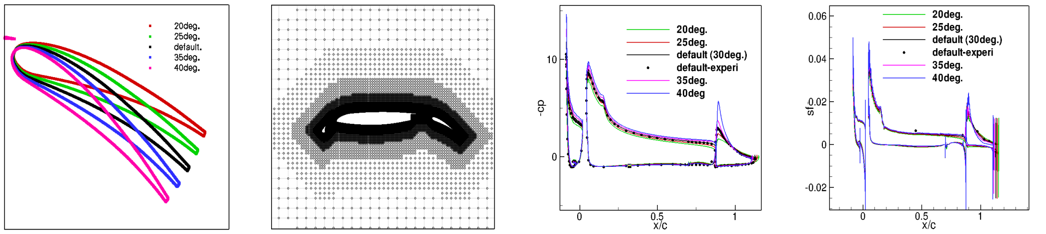
Meshless solvers show lot of promise in industrial computations involving complex geometries. One of the important reasons behind this hope is, generating a set of points, needed for the meshless solvers, is expected to be easier as compared to discretizing the domain into non-overlapping volumes, as needed by the finite volume methodology. But till date, in the course of development of meshless methodologies, most of the significant works have assumed a point distribution from an established grid generator [1-4], with the exception of our earlier work [5], where the meshless solver LSFD-U (Upwind - Least Squares Finite Difference method) is projected as a Cartesian grid method. Here the point distribution needed for the generalized finite difference solver LSFD-U is obtained from a hybrid Cartesian grid. This way, limitations of the Cartesian grids as applied to a classical finite volume solver, like the appearance of small cut cells, are obviated, while the advantage in terms of automation is retained. Therefore, the work presented here can be considered as the logical next step in evolution of the LSFD-U solver, where its potential in an automated CFD process is demonstrated.

Two problems, one each in 2D and 3D, with representative geometric complexity, have been chosen for this demonstration. The 2D demonstration is towards optimizing the flap position of the MDA 3 element airfoil, for maximizing the cl_{max}. A CFD process for accomplishing this task, should be in a position to generate the grid (points distribution, in the present case) in an automated way, for every new position of the flap and the cl_{max} and α_{max} for this position are obtained by the repeated use of the flow solver for the entire range of α. Towards this objective, for a sequence of five flap positions the solutions for a given flow condition are obtained in an automated way using the LSFD-U based RANS solver on a hybrid Cartesian point distribution.

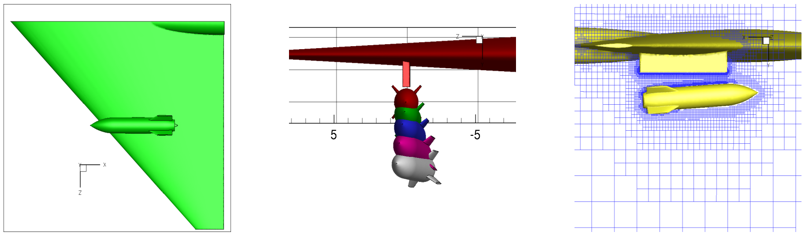
For the 3D demonstration, the inviscid LSFD-U solver is used for solving a store separation problem [6]. For a sequence of five pre-defined store positions, including the carriage position, the Cartesian point distributions are generated in an automated way and the store loads are computed using the LSFD-U solver. In the final paper, the store trajectory will be predicted by coupling the LSFD-U solver with a 6-DOF simulator and compared with the experimental result.

The results presented below have been generated using the Roe flux formula and higher order accuracy is achieved using a linear reconstruction procedure in conjunction with the Venkatakrishnan limiter. The Spalart-Allmaras turbulence model is used for simulating the effect of turbulence. Details of the generalized finite difference discretization used in the LSFD-U solver will be discussed in the final paper.



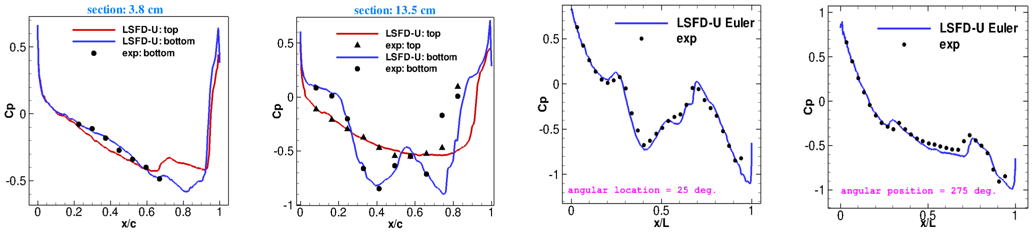
a. Flap positions b. Hyb. Cartesian grid c. Pressure coefficients d. skin friction coefficient

Figure 1: MDA-3 element flap deployment simulation ($M_\infty = 0.20$, $\alpha = 16.21 deg.$, $Re_\infty = 9.0 \text{ x } 10^6$)



a. Geometry b. Store positions d. Cartesian grid

Figure 2: Store separation simulation ($M_\infty = 0.95$, $\alpha = 0 deg.$)



a. Wing sectional Cp b. Store angular Cp

Figure 3: Sectional pressure coefficients ($M_\infty = 0.95$, $\alpha = 0 deg.$)

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