Framework for fluid-structure interaction simulations with UZEN and preCICE: Simulations Procedure and Validation

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ABSTRACT

The report illustrates a new framework developed to face with Fluid Structure Interaction phenomena in a partitioned approach, by upgrading the CIRA multi-block structured flow solver[1], UZEN, for unsteady RANS equations, tightly coupled with an open-source FEM code that solves structural problems, CalculiX[2]. Within certain tolerance, even if partitioned, the solvers are glued in space and time, thanks to the framework developed to deliver exchanging data among solvers through an open source library, preCICE[3]. preCICE manages the communications, loads mapping and time coupling.

Motivation of the work is the simulation of unsteady aerodynamic problems strongly dependent upon structural behaviour, like flexible aircraft, rotor-craft, counter-rotating rotors, etc.

This work shows the framework flowchart, describes the UZEN adapter and the procedure to set up FSI simulations. Furthermore, as validation tests, the results of panel flutter response at supersonic velocity are illustrated. The solution independence from grid density and time-step will be shown in detail.

The time-coupling and load mapping technique available in preCICE library have been investigated, in order to find an optimal setting, able to give reasonable CPU-time and accuracy.

Validation of results is made by comparing the Limit Cycle Oscillation amplitude of panel flutter with data available in literature.

REFERENCES

[1] Marongiu C, Catalano P, A. M. e. a., "U-ZEN: a computational tool solving U-RANS equations for industrial unsteady applications," *34th AIAA fluid dynamics conference, Portland OR*, No. AIAA Paper 2004-2345, 2004.

[2] Dhondt, G., *CalculiX CrunchiX USER'S MANUAL version 2.13*, 08 2017.

[3] Bungartz, H.-J., Lindner, F., Gatzhammer, B., Mehl, M., Scheufele, K., Shukaev, A., and Uekermann, B., "preCICE – A Fully Parallel Library for Multi-Physics Surface Coupling," *Computers and Fluids*, Vol. 141, 2016, pp. 250—-258.