Computational Simulation of Coupled Multiphysics Problems

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ABSTRACT

Fluid flows frequently couple to other physical processes, for example heat transfer, stress and vibration of solid objects in the flow, and electromagnetism. Typically, this is to enable simulation capability beyond the scope of a single solver. Such problems often involve solving different equation sets using different numerical and computational methods, on different domains of the problem, or different spatial or temporal scales. A lot of these problems arise in free surface flow problems, such as wave-structure interaction problems, where waves in an air-water flow interact with solid objects such as support structures.

Two basic approaches can be followed to implement multi-physics simulations in software; a software-monolithic approach, in which the different physical problems are solved using a single code (in a numerically monolithic or partitioned way), or a code coupling approach, in which separate computational codes are joined together using a coupling tool. Examples of such coupling tools include the Multiscale Universal Interface (MUI) [3] and the preCICE library[4].

This Minisymposium arises from the UK Collaborative Computational Project on Wave-Structrure Interaction, which has run a series of events on code coupling, including a recent Hackathon in this area. Submissions are invited from researchers working on any form of multiphysics coupling and with any implementation approach.

REFERENCES

[1] S. Perotto, A. Ern, and A. Veneziani. Hierarchical local model reduction for elliptic problems: a domain decomposition approach. *Multiscale Model. Simul.*, Vol. **8(4)**, pp. 1102–1127, 2010.

[2] O.C. Zienkiewicz and R.C. Taylor, *The finite element method*, 6th Edition, Elsevier, 2005.

[3] Tang Y.-H., Kudo, S., Bian, X., Li, Z., & Karniadakis, G. E. Multiscale Universal Interface: A Concurrent Framework for Coupling Heterogeneous Solvers, *Journal of Computational Physics*, 2015, 297.15, 13-31.

[4] Chourdakis G, Davis K, Rodenberg B et al. preCICE v2: A sustainable and user-friendly coupling library [version 1; peer review: 2 approved]. Open Res Europe 2022, 2:51 (https://doi.org/10.12688/openreseurope.14445.1)