Temporal Multiscale Simulations for Multiphysics Problems

Martyna Soszyńska*

Multiphysics problems model multiple physical phenomena interacting with each other simultaneously. One of the classes of such problems is fluid-structure interactions (FSI), which includes coupling of two different physical models – fluid flow and elastic material. Each of the subproblems operates in distinct temporal scales. Fluid flow is usually modeled by a parabolic set of equations, whereas the hyperbolic framework is applied to modeling elastic material. Thus, in most cases, the elastic model requires much smaller time-step sizes than the fluid flow model.

Simulation of multiphysics problems can be performed using two approaches. The first one is the so-called monolithic approach, where all of the interacting subproblems are formulated and simulated together as one big problem. In many cases such models are robust, however, they lack the flexibility needed to reflect individual characteristics of each of the subproblems. From the perspective of temporal multiscale problems, that means that the time-step of the simulation has to be adjusted to the temporal scale of the subproblem with faster dynamics. The other approach is the partitioned approach, where each of the subproblems is simulated separately. This approach requires introducing additional decoupling strategies.

In this talk, we present two decoupling methods – relaxation and shooting methods. We briefly discuss their effectivity and present further possible ways to proceed.

*Institute for Analysis and Numerics, Otto von Guericke University Magdeburg, Germany, martyna.soszynska@ovgu.de