Multirate Adaptive Time-stepping Schemes for Coupled Systems of PDEs

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We study time discretization schemes for coupled systems of partial differential equations. We assume that the subproblems are defined over spatially distinct domains with a common interface, where the coupling is enforced. Each of the physical problems can be governed by a different type of equations (either parabolic or hyperbolic) and therefore can exhibit different dynamics. Fluid-structure interactions are one type of important application problems that fall into this framework. Here however, we will consider linear problems only.

Our aim is to develop time discretization schemes allowing for different time-step sizes in each of the domains without violating the coupling conditions. We are able to achieve it by formulating the problems within the space-time framework. Although the formulation is monolithic, we solve the systems sequentially relying on a partitioned approach. We further develop an a posteriori error estimator based on the dual weighted residual method. This estimator is then used as an adaptivity criterion. To justify this method, we show stability estimates.

References:

[1] https://link.springer.com/article/10.1007/s10543-021-00854-3?fbclid=IwAR27-yZZ2ZQotNXmNr4MjASwSWIwhs3gpbCT2YJpMQXQPomiFbXmIH66Dts

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