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Adaptive and flexible macro-micro coupling software

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For many challenging applications in simulation technology, micro-scale phenomena often dominates macro-scale behavior. We present a novel software and algorithm framework to couple existing micro-scale and macro-scale simulation programs in a black-box fashion. To achieve this, we present a managing component for all micro simulations, which is coupled to the macro-scale simulation through the coupling library preCICE [1].

The aim is to develop macro-micro coupling methods and softwares that are independent not only of the concrete multi-scale application but also of the used macro-scale and micro-scale codes. While reusing key coupling implementations of preCICE (e.g., parallel communication and fixed-point acceleration schemes), we present a new software component called *Micro Manager* which orchestrates all micro-scale simulations. The Micro Manager calls all micro-scale simulations as libraries and it is itself coupled to the macro-scale simulation using preCICE.

In this talk we present the design of the Micro Manager. Using results of parallel simulations we show that adaptive initialization of micro simulations is critical. Introducing adaptivity also brings forth the challenge of load balancing. Load balancing strategies in the context of adaptive macro-micro coupled simulations are also shown. The working of the Micro Manager is demonstrated using a two-scale porous media application. In this case, each micro simulation consists of a grain structure. The grain size evolves depending on the temperature at the corresponding macro location. The effective thermal conductivity and amount of grain material at each macro point is computed by resolving a micro simulation. Application of the Micro Manager in two-scale simulations in the field of human body modeling are also discussed.

REFERENCES

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