Parallel coupling for TherMoS with preCICE

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ABSTRACT

The Thermal Moon Simulator (TherMoS) is a software to compute transient thermal models of the surface of the Moon as well as moving objects operating on the surface[1]. Thermal modeling rests on computing the three different kinds of heat fluxes: Convective fluxes, conductive fluxes and radiative fluxes. Convective fluxes are negligible in space due to the lack of an atmosphere. While conductive fluxes are straightforward to model and compute, radiative fluxes are more involved: Computing them requires to determine the visibility of elements of the model with respect to each other. In addition, solar radiation has to be considered. For this purpose, TherMoS utilizes a ray tracer component based on NVIDIA's OptiX library.

The ray tracer component runs in parallel on multiple GPUs and is interfaced with a MATLAB solver component which runs on a CPU. Currently, the communication between the two components is implemented via memory mapping[2]. In our work, we replace this interface with the parallel multi-physics coupling library preCICE. In a first step, we implement the required adapters and configure preCICE to set up the coupling. In the second step, we experiment with the capabilities of preCICE to maximize the performance of TherMoS. Most importantly, our aim is to use a parallel coupling scheme to achieve overlap between the two components. As of now, the components are executed sequentially.

The primary goal of our work is to boost the performance of TherMoS. Beyond that, however, it is also interesting for preCICE from the developer perspective. So far, the library has mainly been used in the fields of fluid-structure interaction and conjugate heat transfer. The coupling of a thermal solver and a ray tracer is hitherto untested to the best of our knowledge.

Furthermore, TherMoS is also a cross-platform application due to the ray tracer running on GPUs. This requires preCICE to deal with the coupling of components running on hybrid hardware.

REFERENCES

[1] Hager, Philipp. *Dynamic thermal modeling for moving objects on the Moon.* PhD thesis, Technical University of Munich (2018)

[2] Alhasni, Mohammad. *Multi-GPU parallelization of dynamic heat transfer model on the Moon.* Master's thesis, Technical University of Munich (2018)