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STABLE MESH TRANSFER FOR PARALLEL MULTI-PHYSICS SIMULATIONS

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The exchange of information between non-matching meshes of possibly different sizes is an important ingredient for coupled multi-physics simulations or for problems involving interfaces as, e.g., contact problems. In order to transfer quantities as displacements, stresses, pressure, ore velocities between possibly different and non-related meshes, stable and efficient discrete transfer operators have to be derived. In particular when meshes with highly differing resolution are employed, straight forward techniques as simple interpolation can fail and might lead to unwanted "aliasing" effects. This is particularly the case for "downsampling", i.e. information transfer from a finer mesh to a coarser mesh.

In this talk, we present and discuss different approaches for constructing transfer operators which are based on local averaging, i.e. discrete (pseudo) L^2-projections. We note that these approaches can be used for information transfer along neighbouring surfaces as well as within non-nested volumes.

As we will see, these approaches provide an efficient and stable way for information transfer between non-matching meshes and therefore allow for employing different meshes for the respective physical quantities in coupled simulations. In the first part of our talk, we provide a quantitative analysis of the quality of different projection operators. Thi analysis will include simple operators as point-wise interpolation as well as (pseudo)-L^2-projections.

In the second part of our talk, we discuss in more detail the realization of these projection operators. As most of the transfer-operators are based on local averaging, for the assembling of the corresponding scaled mass-matrices, quadrature on the intersections of non-matching meshes has to be performed. Within a masively parallel environment, the computation of these intersections and thus the assembling of the discrete transfer operators is far from trivial, as the different meshes for the different sub-problems might be distributed more or less arbitrarily among different processors.

Here, we present and discuss a novel approach for setting up these transfer operators in a parallel environment. More precisely, we show how the above transfer operators can be assembled efficiently and in parallel, even if the considered meshes are arbitrarily distributed among different processors. We illustrate the performance of this approach along different test examples and comment in detail on its scalability.

REFERENCES

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