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Evaluation of Radial Basis Function Mapping for Fluid-Structure Interaction Simulations

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Partitioned fluid-structure interaction (FSI) simulations exchange data across a common coupling interface. The solver meshes at the coupling interface are often non-matching. Data mapping is used to interpolate the values from one surface of a solver to another on the coupling interface. Methods such as nearest-neighbor, nearest-projection and radial basis function [1] (RBF) mapping are all common methods used in partitioned FSI simulations, and are also implemented in preCICE [2].

We evaluate the three mapping variants mentioned above. Several input parameters are required for RBF mapping in preCICE, such as which basis function to use, what shape parameter value or the solver tolerance value to use, as the RBF mapping utilises PETSc as a parallel linear solver [3]. We evaluate the impact that these input parameters has on the data mapping accuracy [4]. We see that the required input parameters can have a large influence on the mapping stability, computational cost and accuracy.

Finally, an initial assessment of partitioned RBF mapping methods in PyRBF [5] is provided. PyRBF is a python based RBF mapping code. A comparison is made between PyRBF and preCICE. A partition of unity (POU) approach is used in PyRBF to decompose the coupling interface into overlapping domains, and solving the RBF equations on each domain independently. The POU mapping method is compared to the standard RBF method in PyRBF and its advantages and disadvantages are discussed.

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