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INTERPOLATION OF REDUCED BASES BY INVERSE GRASSMANN DISTANCE WEIGHTING AND GRASSMANNIAN KRIGING WITH APPLICATION TO INCOMPRESSIBLE FLOWS

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The computation of reduced bases (RBs) for the solutions to CFD problems coupled with projection of the associated PDE is now a standard approach to the construction of reduced order models (ROM), which are widely used in the analysis and the control of engineering processes. However, a given RB and the subsequent ROM are valid in the vicinity of a given parameter only so that the (usually costly) computation of the RB has to be carried out for every new parameter. Interpolation between a set of known RBs seems a promising approach to build an interpolated reduced basis (IRB) for any new parameter with a low number of numerical operations. It is known from the work of Amsallem and Farhat [1] that the appropriate objects to interpolate are the spaces generated by the RBs, that is, points on the Grassmann manifold. A first method to interpolate RBs over the Grassmann manifold is available in [1]. In this contribution, we propose two other Grassmann interpolation methods to produce IRBs. The first method is based on an Inverse Grassmann Distance Weighted (IGDW) combination of the known RBs. An interesting feature of this method is that the resulting IRB does not depend on the choice of a reference point. Additionally, this method can be made robust to bifurcations in the solutions since it naturally gives low weights to distant points. The second method is a Grassmannian kriging interpolator (GKI). This method captures the geometrical auto-correlation of the known RBs and guarantees a minimal variance of the estimation error. Moreover, this method has a very low computational cost compared to other methods. The capabilities of both methods are shown on the interpolation of POD bases built from finite-element simulations of the standard two-dimensional vortex shedding flow.

REFERENCES

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