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Towards real-time cardiac mechanics modelling with patient-specific heart anatomies

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Abstract

A reduced order method (ROM) called the Proper Orthogonal Decomposition with Interpolation (PODI) is used to solve cardiac mechanics problems in an efficient manner such that the computation time and resources needed are drastically reduced. Here, PODI makes use of a precomputed set of simulations stored in a database which allows for the interpolation of the solution of the problem at hand in a low-dimensional space.

For the case of a database being built from patient-specific heart models, the corresponding datasets are not compatible with each other and the Proper Orthogonal Modes extracted from selected ensemble of datasets are inadequate. To solve this problem, it is proposed to standardise the datasets utilizing a template grid. Two types of templates are investigated, namely, a cube and a heart-shape grid. For the latter, the accurate standardisation requires that the datasets linked to a patient-specific heart anatomies are registered on the heart template heart geometry using the Coherent Point Drift (CPD) method coupled with a moving least square-based interpolation scheme. This facilitates the transfer of the given solution fields to the template where the PODI computation can be adequately performed.

The suitability of the approach is demonstrated for the diastolic filling phase of a bi-ventricular heart model. It is shown that fast computation speeds and accurate results can be achieved.

Keywords: Reduced Order Method, Proper Orthogonal Decomposition with

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