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Uncertainty Quantification in Multi-Scale Coronary Simulations Using Multi-resolution Expansion JUSTIN TRAN, DANIELE SCHIAVAZZI, ABHAY RAMACHANDRA, Stanford University, ANDREW KAHN, University of California, San Diego, ALISON MARSDEN, Stanford University — Computational simulations of coronary flow can provide non-invasive information on hemodynamics that can aid in surgical planning and research on disease propagation. In this study, patient-specific geometries of the aorta and coronary arteries are constructed from CT imaging data and finite element flow simulations are carried out using the open source software SimVascular. Lumped parameter networks (LPN), consisting of circuit representations of vascular hemodynamics and coronary physiology, are used as coupled boundary conditions for the solver. The outputs of these simulations depend on a set of clinically-derived input parameters that define the geometry and boundary conditions, however their values are subjected to uncertainty. We quantify the effects of uncertainty from two sources: uncertainty in the material properties of the vessel wall and uncertainty in the lumped parameter models whose values are estimated by assimilating patient-specific clinical and literature data. We use a generalized multi-resolution chaos approach to propagate the uncertainty. The advantages of this approach lies in its ability to support inputs sampled from arbitrary distributions and its built-in adaptivity that efficiently approximates stochastic responses characterized by steep gradients.

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