 Proceedings of ICCES'08, pp.1175-1175

Localized Collocation Meshless Method (LCMM) Shape Optimization of Vascular Grafts Part II: Multiobjective femoral bypass graft shape optimization

Z. El Zahab[1], E. Divo[2], A. J. Kassab[1]

Summary

We implement the LCMM method in shape optimization of vascular grafts with the goal of mitigating deleterious hemodynamics features that lead to restenosis. The architecture of a shape optimization system is comprised of an optimization algorithm, a simulation code, and an automated pre-processor. Those three computational objects communicate collectively via an information passage loop. The optimization algorithm chosen for the present shape optimization is the Non-dominated sorting genetic algorithm, which is an evolutionary algorithm designated for multi-objective optimizations. The current optimization process should operate in an autonomous manner and a key task for the automation is the "blind" pre-processing of the re-shaped geometries. If a mesh-dependent pre-processing is implemented without the user inspection, skewed cells would potentially occur in the mesh leading to incorrect numerical results. Thus, a geometry-independent pre-processing would be more favorable for such an automated shape optimization process. Due to the LCMM pre-processing independence from the geometry shape, an automatic point re-distribution becomes a straightforward task that is readily invoked in a shape optimization process. The goal of the present shape optimization is to improve the blood flow conditions at the junction between a vascular graft and a host artery upon which a peripheral bypass surgery is performed. This goal is met by minimizing the spatial and temporal gradients of the wall shear stress, which are fluid mechanics parameters correlated with cardiovascular diseases causing the graft post-surgical failure. The results consist of the Pareto-optimality fronts for each optimized graft model as well as the reduction percentage of the wall shear stress gradients achieved by the optimized shapes.

[1]Department of Mechanical, Materials, and Aerospace Engineering, University of Central Florida, Orlando, FL, 32816, USA

[2]Department of Engineering Technology, University of Central Florida, Orlando, FL, 32816, USA