Ecole Centrale de Lyon
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Séminaire commun
LaMCoS-Ecole Doctorale MEGA
Mécanique, Energétique, Génie Civil, Acoustique

Virtual surgical planning: computing blood flow within real patient geometries.

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Lundi 20 Novembre 2006 à 13 heures

INSA Lyon - Amphithéâtre M. Godet
Bâtiment J. d'Alembert, 18-20 rue des Sciences, Villeurbanne

The current paradigm for interventional and surgery planning for the treatment of congenital and acquired cardiovascular disease relies exclusively on diagnostic imaging data to define the present state of the patient, empirical data to evaluate the efficacy of prior treatments for similar patients, and the judgment of the surgeon to decide on a preferred treatment. The individual variability and inherent complexity of human biological systems is such that diagnostic imaging and empirical data alone are insufficient to predict the outcome of a given treatment for an individual patient. We are developing a new paradigm of predictive medicine in which the physician utilizes computational tools to construct and evaluate a combined anatomic/physiologic model to predict differential changes in blood flow for alternative treatment plans for an individual patient. A software framework is being developed to provide an integrated set of image segmentation, geometric solid modeling, automatic finite element mesh generation, computational mechanics and scientific visualization tools accessible through an intuitive human-computer interface.

A brief overview of the current status of the framework will be given before focusing on the flow solver which has recently added: 1) a simple, fully-coupled, membrane model to capture wave-like wall motions at a modest increase in cost, 2) physiologically realistic outflow boundary conditions that capture the effect of the downstream vascular bed, and 3) a new anisotropic mesh modification scheme to automatically adapt the mesh to the complex features present in cardiovascular flow. A balance of theory, implementation and application to patient specific cases will be provided to illustrate the advancements made thus far and the future work remaining to be done.

This study is part of an ongoing cooperative project between RPI with the Institute for Computational Engineering and Sciences at the University of Texas-Austin, and the Departments of Bioengineering and Surgery at Stanford University.

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