SPECIAL SEMINAR

Mechanical Engineering & Materials Science

"Advanced Computational Modeling Tools for Cardiovascular Applications"

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Friday, September 14
2:00-3:00PM
Green Hall, Rodin Auditorium

Abstract

Advances in numerical methods and three-dimensional imaging techniques have enabled the quantification of cardiovascular mechanics in subject-specific anatomic and physiologic models. Research efforts have been focused mainly on three areas: i) pathogenesis of vascular disease, ii) development of medical devices, and iii) virtual surgical planning.

However, despite great initial promise, the actual use of patient-specific computer modelling in the clinic has been very limited. Clinical diagnosis still relies on traditional methods based on imaging and invasive measurements. The same invasive trial-and-error paradigm is often seen in vascular disease research, where animal models are used profusely to quantify simple metrics that could perhaps be evaluated via non-invasive computer modelling techniques. Lastly, medical device manufacturers rely mostly on in-vitro models to investigate the anatomic variations, arterial deformations, and biomechanical forces needed for the design of medical devices.

Our laboratory has been developing an integrated image-based computer modelling framework for subject-specific cardiovascular simulation (CRIMSON) that can successfully bridge the gap between the research world and the clinic. The main features of the CRIMSON simulation environment are:

i) A parallel blood flow solver based on the academic code SimVascular.
ii) A modern GUI for medical image data segmentation based on the Medical Imaging Interaction Toolkit (MITK).
iii) Libraries for automatic estimation of parameters required for boundary and material parameter specification. These parameter estimation routines are based on Kalman-filtering theory.
iv) Routines to enable the automatic simulation of transitional cardiovascular stages. These routines mimic the action of key cardiovascular functions such as the baroreflex, and local auto-regulations such as those in the coronary and cerebral circulations.

In this talk, we will provide an overview of the most novel features for the software, specifically the functions for parameter estimation and simulation of transitional stages, and highlight a series of future developments for the project.

Biography

Dr. Figueroa received his PhD in Mechanical Engineering at Stanford University, where he developed computational methods to simulate fluid structure interactions in hemodynamic flows.

His first academic appointment was a King's College London in the UK, where he was Senior Lecturer in the Division of Biomedical Engineering and Imaging Sciences.

Dr. Figueroa is currently the Edward B. Diethrich M.D. Professor in Biomedical Engineering and Vascular Surgery at the University of Michigan. His laboratory is focused on three main areas: 1) developing tools for advanced modeling of blood flow. His group develops the modeling software CRIMSON (www.crimson.software); 2) studying the link between abnormal biomechanical stimuli and cardiovascular diseases such as hypertension and thrombosis; 3) simulation-based surgical planning to aid with the optimal planning of cardiovascular surgeries.

Faculty, students, and the general public are invited.