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CARDIAC FLUID DYNAMICS: FROM COMPUTATIONAL MODELS AND FLOW PHYSICS TO DIAGNOSIS AND SURGICAL INTERVENTION

Rajat MITTAL*
The Johns Hopkins University, 3400 N. Charles St, Baltimore, USA
*Corresponding author, E-mail address: mittal@jhu.edu

ABSTRACT

Continued advancements in computer hardware and algorithms are allowing us to model heart function to a degree that has not been possible before. We are developing fast algorithms for large-scale multi-processors and GPU based computers to conduct high-fidelity flow simulations (LES and DNS) of ventricular flows. While flow patterns in the ventricles oftentimes indicate the presence of heart disease, fluid dynamics may, in many cases, also be implicated in the progression of heart disease. The simulations are being used to understand the correlation between ventricular fluid dynamics and heart conditions such as diastolic dysfunction, myocardial infarction and hypertrophic cardiomyopathy. We go beyond just an exploration of the flow dynamics in normal and diseased hearts to develop models for flow-induced heart sounds as well as ultrasound based echocardiography. The talk will focus on the computational aspects of these multi-physics models and describe some of the new insight s that are derived from these modelling studies. Finally, computational modelling has an important role to play in the planning and optimization of heart surgery as well as the design of prosthetic devices, and the talk will touch briefly on these aspects as well.