Colloquium

An Image-Based, Parallel Dynamic Meshing Framework for Patient-Specific Medical Interventions

Suzanne M. Shontz
Department of Computer Science and Engineering, Pennsylvania State University

Abstract: Patient-specific mesh generation is an important issue in computational simulations of the potential effectiveness of a medical device or the progression of a disease in a specific patient. Many radiology applications involve movement by the patient and medical device and require dynamic meshes for use in the associated imaged-based computational simulations. Two important examples include blood clot entrapment by inferior vena cava filters in pulmonary embolism (PE) patients and the evolution of the brain ventricles and cerebrospinal fluid (CSF) in hydrocephalus patients.

There are several limitations of existing dynamic meshing algorithms that make them unsuitable for use in radiology applications. For example, the mesh warping algorithms upon which they are based often do not yield the desired volume meshes when applied to a noisy target surface mesh created from medical images of the patient. In addition, the mesh warping algorithms are often not designed to handle the large deformations that the patient's body and the medical device undergo. In particular, existing mesh warping algorithms sometimes yield tangled meshes with inverted elements which are invalid for use by the associated partial differential equation solver in the computational simulation.

In this talk, I will describe the image-based, parallel dynamic meshing framework for patient-specific medical interventions, which we are designing. In particular, I will discuss two image-based meshing techninques we have developed for radiology applications. The first algorithm I will describe is a mesh warping technique for virtual implantation of an inferior vena cava (IVC) filter in the venous anatomy of a PE patient. The corresponding embedded geometric models are then used in generation of non-manifold topology meshes of the embedded device and venous anatomy for use in computational fluid dynamics simulations of the blood flow, and ultimately, for improved prevention of the disease. The second algorithm I will discuss is a combined level set/mesh warping technique for use in tracking, and, eventually, for predicting, the evolution of the deforming brain ventricles and CSF in hydrocephalus patients before and after shunt treatment. I will conclude by describing our plans for future research in these areas.

Thursday, February 9, 2012, 4:00 pm
Mathematics and Science Center: W201

Mathematics and Computer Science
Emory University