High-Order Tetrahedral Mesh Generation for Cardiac Simulations VII International Conference on Computational Methods for Coupled Problems in Science and Engineering – Coupled Problems 2017

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ABSTRACT

The heart comprises four chambers (two ventricles and two atria) enclosed by the myocardium – the cardiac muscle wall that extends from the inner (endocardial) surface to the outer (epicardial) surface. Large vessels connect the heart to the circulatory system of the rest of the body, while valves regulate blood flow into and out of these vessels and between the chambers. Thus, the heart is a complicated organ whose function involves bioelectricity, calcium dynamics, biomechanics, and hemodynamics aspects. Operation of the heart is therefore a coupled, multi-physics problem.

There are numerous challenges in generating high-quality meshes of cardiac anatomies due to the complex geometry of the heart, its high curvature, and its motion. It is also difficult to generate meshes that can be employed for all such cardiac multi-physics simulations. For example, finite element meshes are used in biomechanical simulations of the beating heart; however, finite volume meshes are used in computational fluid dynamics simulations.

Here we present our method for generation of high-order curvilinear tetrahedral meshes. Such elements are desired for geometries with high curvature, such as the heart. The method is based on a log barrier approach and is referred to as LBWARP2Gen. The method deforms low-order tetrahedral elements into high-order mesh elements. This research extends the previous work of Stees and Shontz on high-order triangular mesh generation [1], as well as the work of Linte *et al*. on the left ventricle segmentation [2] and biomechanical modeling [3]. We apply our method to the generation of high-order meshes for the 3D myocardium geometry. We will present statistics on the mesh quality as well as information on the efficiency of our high-order mesh generation method. We will also summarize additional challenges in cardiac mesh generation.

REFERENCES

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