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A SHAPE-BASED COMPUTATIONAL METHOD FOR ESTIMATION OF IN VIVO MECHANICAL MATERIAL PROPERTIES OF THE MYOCARDIAL WALL

Jing Xu[1], Timothy C. Wong[2], Marc A. Simon[2] and John C. Brigham*[3,1]

[1] Department of Civil and Environmental Engineering, University of Pittsburgh, Pittsburgh, PA, USA, jix57@pitt.edu

[2] Heart and Vascular Institute, School of Medicine, University of Pittsburgh, Pittsburgh, PA, USA, wongtc@upmc.edu, simonma@upmc.edu

[3] Department of Engineering, Durham University, Durham, UK, john.brigham@durham.ac.uk

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The objective of the present study is to develop a technique to estimate the *in vivo* mechanical material properties of the heart wall from untagged medical imaging data combined with measured haemodynamic information (e.g., intraventricular pressure). The key to the proposed approach lies in the use of shape analysis techniques to quantitatively compare the ventricular shape estimated by a simulation to that derived from medical images. By applying this approach within a standard optimization-based inverse solution estimation procedure, it is possible to avoid the need for image tagging or otherwise estimating the deformation or strain within the heart wall from the imaging data prior to inverse solution estimation. Therefore, the proposed approach can be more direct than similar existing techniques to estimate the material properties, potentially resulting in both improved computational efficiency and inverse solution estimation accuracy.

The current implementation of the characterization approach utilizes patient-specific 3D finite element analysis to estimate the diastolic function of a bi-ventricle model of the human heart. The model is constructed by first generating a finite element mesh from segmented clinical cardiac imaging data at approximately the start of diastole. Then, the measured *in vivo* intraventricular pressure is applied to simulate diastolic function as a quasi-static process, and the shape of the ventricle(s) is extracted at the estimation of end diastole. The difference between the estimated end diastolic shape and the end diastolic shape extracted from the medical imaging data is quantified using a variation of the Hausdorff distance. Lastly, a standard gradient-based optimization technique is applied to estimate the material parameters within the finite element analysis that minimize the shape difference metric. The details of the framework will be presented, and the capability of the process to accurately estimate heart wall material properties will be shown through simulated inverse problems (i.e., simulated target end diastolic shapes). Finally, to display the real life applicability, the concept will be extended and applied to actual *in vivo* target end diastolic shapes, and the additional challenges and constraints will be detailed.