**Neural Network Models of Myocardium Hyperelastic Material Models**

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*Abstract:* The full characterization of three-dimensional (3D) mechanical behavior soft tissues is essential in understanding their function in health and disease. The hierarchical structure of soft tissues results in their highly anisotropic mechanical behaviors, with the spatial variations in fiber structure giving rise to heterogeneity. We have developed a novel numerical-experimental approach to determine the optimal parameters for 3D constitutive models of soft tissues [1, 2] using optimal design of full 3D kinematically controlled (triaxial) experiments coupled to an inverse model of the experiment and local fibrous structure. Due to the natural variations in soft tissue structures, the mechanical behaviors of soft tissues can vary dramatically within the same organ. Thus, to obtain the responses of soft tissues with different realizations of structures, the resulting hyperelastic problem needs to be solved with spatially varying parameters and in certain cases different boundary conditions. To alleviate the associated computational costs at the time of simulation, we have developed the following neural network-based method. The present method does not require generating a large labelled training dataset via a number of simulations, which is computationally intractable. Due to their learnability characteristics, the neural network should be able to predict solutions with given individual specimen fiber structures and loading path boundary conditions. The neural network model will be trained with satisfactory convergence, it can be used to give fast predictions of complex 3D deformations in full kinematic space with population-based fiber structures by forward passes in the neural network. When developed, the NN model will be implemented into our current cardiac model to evaluate it usability. This will provide efficient and robust computational models for clinical evaluation to improve patient outcomes.