Computations of elastic modulus of biological tissues by using the smoothed finite element methods and the particle swarm optimization

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Abstract

Pathological change of the biologic tissue may cause the change of the physical behavior. Therefore, the quantification of physical parameters of biological tissues is helpful to analyze its pathological change. Although CT and MRI provide clinical diagnosis more efficiently, these methods based on the medical image cannot give the analytical results for the pathological change. This paper propose a hybrid algorithm by combing the smoothed finite element (SFEM), finite element method (FEM), and the particle swarm optimization (PSO) to predict the Pathological change by computing the elastic modulus of the biological tissue. The Poisson's ratio in the biologic issue generally approaches to 0.5. We first propose a method by combining FEM/NS-FEM to void the volumetric locking in computing elastic modulus. Next, the computing of the elastic modulus is described as an inverse problem. By using the particle swam optimization, a mathematical model is constructed and the elastic modulus is computed inversely based on the displacement information of the biological tissue. Based on Newton's method, particle swarm optimization and orthogonal particle swarm optimization (OLPSO), different optimization algorithms are developed. The convergence and stability of the algorithm are studied. The numerical simulations show that the OLPSO combined the FEM/NS-FEM give a better prediction of the elastic modulus of the biological issue.

Keywords: Elasticity modulus, Smoothed Finite element method, volumetric locking, particle swarm optimization

Reference

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