11th World Congress on Structural and Multidisciplinary Optimisation
07th -12th, June 2015, Sydney Australia

Fluid-structure interaction and Optimization-based Approach for Homogenization of Soft Tissue Viscoelasticity

Behnam Esfandiar Jahromi[1], Javier Palacio-Torralba[1], Frank Yntema[1], Robert L. Reuben[1] and Yuhang Chen[1]

[1] Heriot-Watt University, UK

Abstract

Biological soft tissue often presents highly nonlinear mechanical behavior, with certain anisotropy and heterogeneity, and undergoes large deformation when fulfilling its functionality. Therefore, standard linear homogenization method which has been used in evaluating the effective properties of heterogeneous materials may become unsuitable.

In this study, we present an optimization based approach for homogenization method that integrates fluid-structure interaction (FSI) to evaluate the viscoelastic nonlinear behavior of soft tissue. The microstructures of soft tissue are treated as bi-phase materials, solid material representing the cells and fluid phase for the extracellular fluid. Homogenization method is used here, together with an embedded optimization process taking into account different boundary conditions that mimic the in vivo tissue environment under various physiological and pathological conditions. Variations in strain rate, viscosity of extracellular fluid and different tissue microstructures are assessed under the proposed homogenization framework, where the viscoelastic behavior of the soft tissue is quantitatively linked to the abovementioned factors. Such proposed method would be beneficial for quantitative assessment of mechanical properties of soft tissue, as well as understanding the role of multiscale architectural features of soft tissues in its biological functionality.