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IDENTIFICATION OF ANISOTROPIC DIRECTIONS IN SOFT TISSUE AND THEIR SIMULATION WITH P-VERSION FINITE ELEMENTS

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Anisotropy of soft tissue is governed by the preferred distribution of collagen fibers. The orientations of collagen fibers differ throughout the whole human body. For example, in human skin the orientations are represented macroscopically in the form of Langer's lines [1]. Identification of the anisotropy directions plays an important role on surgery operation. Taking tissue expansion as an example, which is a common procedure in reconstructive surgery, skin gain is found to be substantially larger when the expenders placed along the Langer's lines [2]. Numerical identification of the anisotropy directions is important for placement of expenders and is a vital step in FE-simulation of soft tissue. In this contribution, we proposed two numerical methods to automatically generate these preferred directions. The first one is based on an analogy with the heat conduction problem. It uses a FE-simulation of the thermal flux under certain temperature boundary condition as anisotropy directions. The other one is a sketch-based method, which calculates anisotropy directions by the Laplacian smoothing [3]. Numerical results of both methods agree well with the Langer's lines in human skin. Moreover, the p-version finite element method is exploited to simulate large deformations of soft tissues by considering the result obtained for anisotropy directions. The FE-solution is free of volumetric locking in the case of near incompressibility of soft tissues.

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