SOME REMARKS ON CONTACT MODELS OF FINGERPAD - PART I: STATE OF THE ART

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Abstract: Distal phalanx biomechanics is important in human manipulation of objects and therefore the model of fingerpad is essential. In order to model finger grasping for a wide range of applications, from medical to robotics, information on a large variety of parameters is necessary. A succinct review of modelling the fingerpad, from analytical, based on Hertzian contact theory (with alternatives from classical elastic to nonlinear viscoelastic models), to structural, made by finite element method, was made. Computer applications are needed, requiring either numerical calculus or specialized FEM programs. More convenient are the analytical models, which give rapid results and involve less edge technology. An extreme wide range of parameters occurs during touching or grasping and should be considered, as for modelling any of biological tissues. Experimental studies and data upon measurable physical parameters are needed, such as forces, deformations, contact pressures, mechanical impedances, elastic characteristics etc., but also neuronal responses of mechanoreceptors and their time dependence. An ideal model should correlate both mechanical and neural information. Three main classes of models are used in tissue modelling of the distal phalanx: continuous medium, phenomenological and structural models. The classical Hertzian elastic contact model is the basis of models such as: linear elastic contact, [2], modified elastic contact, quasi-viscoelastic model, [3], and linear viscoelastic model. A simplified model, Fig.1, was proposed by Srinivasan, [4]. As structural models, the 2D and 3D finite element method models for fingertip, [1], estimate the stress state in the real position of mechanoreceptors for different punch geometries and displacements applied to skin surface, Fig. 2.

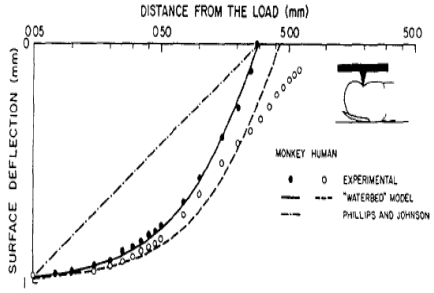

Fig. 1. Waterbed model: experimental and estimated deformed profiles, [4]

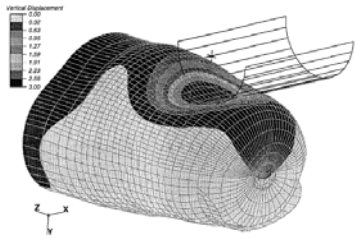

Fig. 2. Human fingertip model, loaded with a cylinder, [1]

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