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Identification of Material Parameters in Biological Soft Tissues

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Biomechanics is interested in uncovering the link between the structure (nanoscale to milli-scale) of a biological tissue (morphology and histology) to external forces. From a mechanical stand point, properties of these tissues must be determined where an interest is given to load-bearing tissues, bones and connective soft tissues. Collagen fiber-reinforced soft tissues are known to exhibit a complex mechanical behavior that can be separated into a passive response (elastic and inelastic) and an active response (chemical factors, growth and remodeling). In this context, we discuss a behavior law (Holzapfel et al. 2002) that models the mechanical passive behavior of the arterial wall and the related parameter identification problem.

It is widely accepted that the instantaneous response (elastic) of collagen fiber-reinforced soft tissues is fairly modelled by employing the hyperelastic theory. As for Long term inelastic response of the tissue, the theory of viscoelasticity gives good results. However, viscoelasticity raises the challenge as the mathematical formulation of a behavior law will lead to a highly non-linear system with many material parameters to be identified. Fung (2002) proposed the quasi-linear viscoelasticity (QLV) theory after observing that certain connective tissues exhibit a strain-rate insensitive response. QLV resides uses a multitude of classical viscoelastic elements (spring and dampers) to cover the insensitivity spectrum of the tissue. This formulation reduces the complexity of the system but leaves us with many material parameters to be identified. Hence, we propose a new parameter identification approach where the formulation of the problem accounts for the strain-rate insensitivity of soft issues. It is then solved using genetic algorithms. Consistent parameter identification results are obtained despite the non-linearity of these mechanical models.

Biography:

Dr. Nizar Harb is an assistant professor of mechanical engineering at the American University in Dubai since fall 2015. He received his Ph.D. in Mechanics in 2013 from the University of Technology of Belfort-Montbeliard, and also M.Sc in mechanical engineering and design in 2008. His thesis works led to developing novel numerical tools in the context of inverse identification of biomechanical parameters. In 2014, he was assistant professor of mechanical engineering at Higher Engineering School of Mechanics and Aerotechnics (ENSMA), Poitiers, France and was part of research institute Pprime (CNRS).

His main field of research is non-linear solid mechanics, biomechanics, metaheuristic optimization and numerical modeling.