INVERSE PROBLEMS IN SOFT TISSUE BIOMECHANICS AND MECHANOBIOLOGY

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MINI-SYMPOSIUM PROPOSAL

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1 BACKGROUND

Although the topic of soft tissue mechanics is not recent, inverse problems arising in hybrid experimental - computational methods for soft tissues become more and more popular. Recently a series of symposia were organized on this topic including a successful Euromech colloquium at Saint-Etienne (France) in 2012 and a whole day of special sessions in the World Congress of Biomechanics at Boston in 2014. Several special issues in important journals (Journal of the Mechanical Behaviour of Biomedical Materials, Computer Methods in Biomechanics and Biomedical Engineering journal) also recently focused on this topic [1, 3]. All these series of events, including also a CISM advanced school [4] in 2015 at Udine (Italy), highlight the increasing number of researchers interested in inverse problems posed by soft tissues biomechanics and mechanobiology.

2 MOTIVATION

It has become a common practice to combine image based full-field displacement measurements experienced by tissue samples in vitro, with custom inverse methods to infer (using nonlinear regression) the best-fit material parameters and the rupture stresses and strains [5]. Similar approaches also exists for characterizing the material parameters of soft tissues in vivo, where advanced medical imaging can provide precise measurements of tissue deformation under different modes of action, and inverse methodologies are used to derive material properties from those data [3]. Nowadays, these approaches offer important possibilities for fundamental mechanobiology which aims at gaining better insight in the growth, remodeling and ageing effects in biological tissues [2]. It is well-known that biological soft tissues appear to develop, grow, remodel, and adapt so as to maintain particular mechanical metrics (e.g., stress) near target values. To accomplish this, tissues often develop regionally varying stiffness, strength and anisotropy. Important challenges in soft tissue mechanics are now to develop and implement hybrid experimental - computational method to quantify regional variations in properties in situ.

The main motivation of the symposium is to review the latest progress and permit scientific discussions on these methods by bringing together researchers interested by characterizing material properties of soft tissues.

3   FOCUS OF THE MINI-SYMPOSYUM

Topics to be considered are related to the different challenges posed by inverse problems in soft tissue biomechanics and mechanobiology, such as:
- optimization approaches and model order reduction
- model fitting against uncertain experimental results
- uniqueness of identified parameters
- reliability of computational models for biological tissues.
- uncertainty assessment in inverse problems
- optical full-field strain measurements
- digital image/volume correlation
- in vivo identification using medical imaging
- virtual fields method
- regularization approaches
- hyperelastic image registration.

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