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INVERSE IDENTIFICATION OF BI-MATERIAL SOFT TISSUE PARAMETERS

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Keloid scars are considered to be benign tumors of the skin that can grow beyond the initial limits of a wound. The preferential appearance of keloids in certain anatomical sites and their pattern of growth attests to the influence of the mechanical stress as one of the driving factors [1]. Thus, a mechanical characterization of a keloid scar is to be done in order to better understand the keloid and, ultimately, to prevent its growth. A uniaxial tensile experiment was performed *in vivo* on a young caucasian female with a keloid scar located on the upper part of her left arm. The reaction force measurements were acquired by a force sensor in the loading cell and the surface displacement field was captured using the Digital Image Correlation technique [2]. The scared skin was modelled as a bi-material 2D-structure. The non-linear forward solver used artificially generated measurements with an additive white Gaussian noise [3]. By using the simulated data, the material parameters of the both the keloid and the healthy skin media were identified through an FEMU-based open-source framework [4, 5]. The results show that it is possible to identify accurately at least 4 material parameters from a uniaxial test. Different uncertainty analyses including noise levels and the number of snapshots have been performed to explore the computational limits of model parameters.

REFERENCES

- [1] R. Ogawa, "Keloid and hypertrophic scarring may result from a mechanoreceptor or mechanosensitive nociceptor disorder," *Med. Hypotheses*, vol. 71, pp. 493–500, 2008.
- [2] J. Chambert, T. Lihoreau, S. Joly, B. Chatelain, P. Sandoz, P. Humbert, E. Jacquet, and G. Rolin, "Multimodal investigation of a keloid scar by combining mechanical tests in vivo with diverse imaging techniques," *J. Mech. Behav. Biomed. Mater.*, vol. 99, pp. 206–215, 2019.
- [3] H. Rappel, L. A. A. Beex, and S. P. A. Bordas, "Bayesian inference to identify parameters in viscoelasticity," *Mech. Time-Depend. Mater.*, vol. 22, pp. 221–258, May 2018.
- [4] H.-P. Chen and Y. Ni, "Finite element model updating," in *Structural Health Monitoring of Large Civil Engineering Structures*, ch. 6, pp. 123–154, John Wiley & Sons, Ltd, 2018.
- [5] P. Hauseux, J. S. Hale, S. Cotin, and S. P. Bordas, "Quantifying the uncertainty in a hyperelastic soft tissue model with stochastic parameters," *Appl. Math. Model.*, vol. 62, pp. 86–102, 2018.