A STOCHASTIC MODEL FOR TISSUE CONSISTENCE EVOLUTION BASED ON THE INVERSE PROBLEM

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1. Introduction

An inverse-stochastic framework is proposed to reproduce the pattern evolution and predict the mechanical properties of a tissue-engineered culture from ultrasonic measurements in an in-vitro culture. A Markovian type of evolution is expected in tissue cultures for mechanical properties such us bulk modulus (K) or attenuation coefficient (AC), under the hypothesis that the future of the process depends only upon its present state, and not upon past states. Additionally a spread in the evolution histories for different repetitions of the same process is expected, consequently stochastic models such us Markov chains [Gallager, 1996] seems to be more suitable. The method proposed is predictive in nature and can be applicable to any measurable biomechanical process, under the assumption that the process shows Markovian evolution.

2. Methods

A monitoring Petri dish with a 20 [MHz] ultrasonic transmitter and receiver is specifically designed and data for bulk modulus (K) and attenuation coefficient (AC) of a culture process is sequentially taken. Specific aspects about the problem of ultrasonic propagation and parameter identification in soft tissue-engineered cultures used in this work are found in [Rus, 2011]. Then a nonstationary Markov chain model is inferred form data based on the inverse problem [Ramm, 2005]. The nonstationarity is accounted by a novel unitary time-transformation concept by means of parameterized monotonic splines. The entire process is then governed by a reduced set of model parameters controlling a unique Markov transition kernel. An inverse procedure is proposed to find the optimal set of parameters by genetic algorithms [Goldberg, 1989] which iteratively minimize the distance between the experimental and model sampled measurements. The validity of this methodology has been previously tested for an agar-agar gelification process [Chiachio, 2011]. Results are shown in Figure 1.

3. Discussion

The proposed methodology shows viability to reconstruct the stochastic evolution of mechanical properties in a tissue-engineered culture process with a reduced set of model

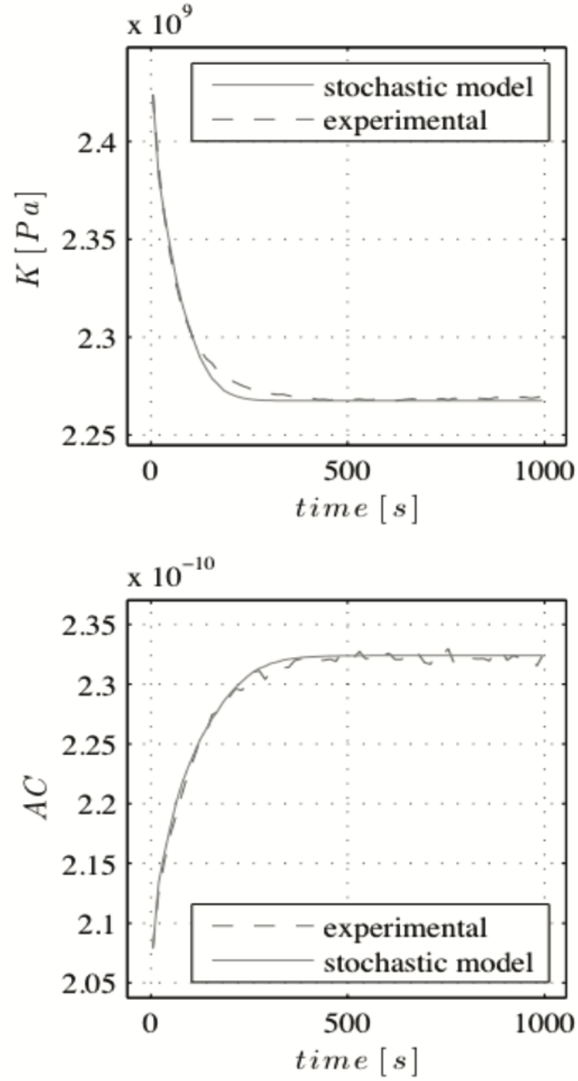

FIGURE 1. Preliminary results for gelation process

parameters. More experiments for in vitro tissue-engineered cultures will be done and the stochastic-inverse problem proposed herein will be validate on them.

4. Acknowledgements

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5. References

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