A MODELING APPROACH TO ULTRASOUND EVALUATION OF MATERIAL PROPERTIES

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ABSTRACT

A method for estimating the mechanical properties of a viscoelastic sample from ultrasound measurements was developed. The sample was represented as a mechanical network according to the Kelvin-Voigt model and linear state-space equations were derived to describe the system dynamics. Four parameters can be extracted by comparing the model with measured transmission waves. These parameters can be related to viscoelastic properties of the sample. Broadband pseudo-random binary sequences were designed and used to perturb the sample. The Levenberg-Marquardt method was employed to adjust the model parameters and the least-squares algorithm was used to obtain optimal model parameter estimates. Model verification showed that the algorithm developed could converge to known model parameters. Estimated model parameters showed consistency and reflected known facts about the materials tested. The model could capture the major dynamics of transmitted ultrasonic waves and allow repeatable estimation of model parameters. The model parameters could not only differentiate the materials tested but also follow expected trends of variation. The model parameters were useful for sensory crispness prediction and crispness was more correlated to the elastic modulus than to viscosity, which is consistent with existing research.