Mechanical Engineering

UC UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

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Quantifying Tissue Attenuation and Damping Structure with Magnetic Resonance Elastography

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Abstract:

Magnetic Resonance Elastography (MRE) has gained recognition as an effective method for quantifying soft tissue elasticity through images of elastic properties deduced from displacement measurements within the tissue obtained by Magnetic Resonance Imaging (MRI) techniques. For time-harmonic motions, the displacement data can be used to reconstruct not only the distribution of elastic modulus within the tissue, but also information about elastic energy attenuation. This information may offer some diagnostic value for certain diseases, and currently methods are being developed to implement a multi-structural damping model into MRE reconstruction so that the nature of the energy absorbing mechanisms within the tissue can be investigated as well as the overall level of attenuation. This model, known as *Rayleigh* or *Proportional Damping*, involves two components; one related to structural stiffness and the other related to structural inertia. In the case of time-harmonic motions, these two components are equivalent to complex valued shear modulus and complex valued density, respectively. The overall *damping ratio* can be calculated from the combined effect of these two components, while a *damping composition* can be calculated by measuring the relative proportion of damping generated by one component in particular. Results to date have shown that while the two damping components can be shown to differ mathematically, they can be distinguished uniquely in the time-harmonic case only at material boundaries. Total variation minimization is being investigated as a tool for reducing the effects of this non-uniqueness on the interior of material regions. Imaging experiments conducted on a variety of damping phantoms, constructed from both viscoelastic and inviscid gelatine as well as fluid saturated tofu, indicate that both overall damping levels and damping structure can be distinguished based on MR detected motion data. Further experiments on *in vivo* data indicate that measurements of damping levels and damping structure show statistically significant variation across different tissue types, including cancerous tissue.

All are welcome!