White Paper

Elastography

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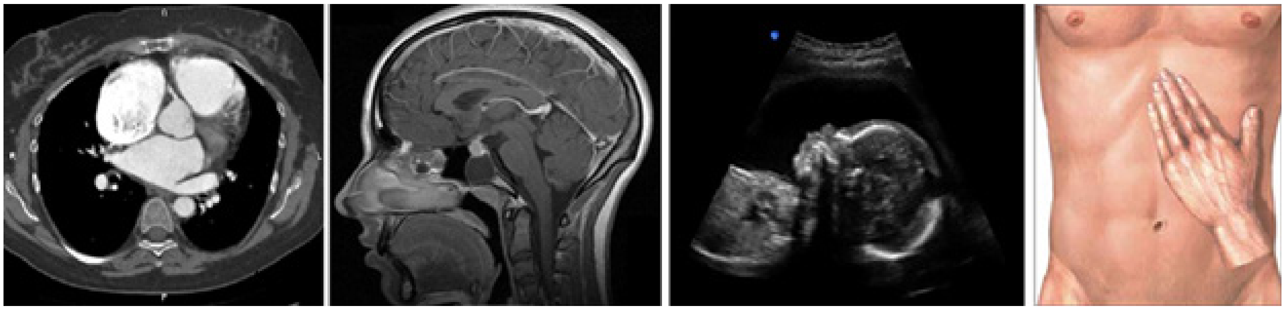
Introduction

Many diseases cause changes in tissue mechanical properties. Palpation is commonly used by healthcare professional to detect tissue abnormality. Unfortunately, palpation has several limitations. Firstly, it is subjective. Secondly, it is limited to superficial information.

Current medical imaging devices such as computed tomography (CT), ultrasound (US) and magnetic resonance imaging (MRI) are also not directly capable of measuring the mechanical properties of soft tissue.



Different imaging modalities compared to palpation

Elastography as a strain imaging technique has been well established in the literature as an alternative imaging method. The strain distributions in tissues in response to an external (or internal) deformation are shown to closely relate to tissue stiffness or elasticity. These strain images can give a clear illustration of the underlying tissue stiffness distributions which has been shown to provide useful clinical information.

Static Elastography

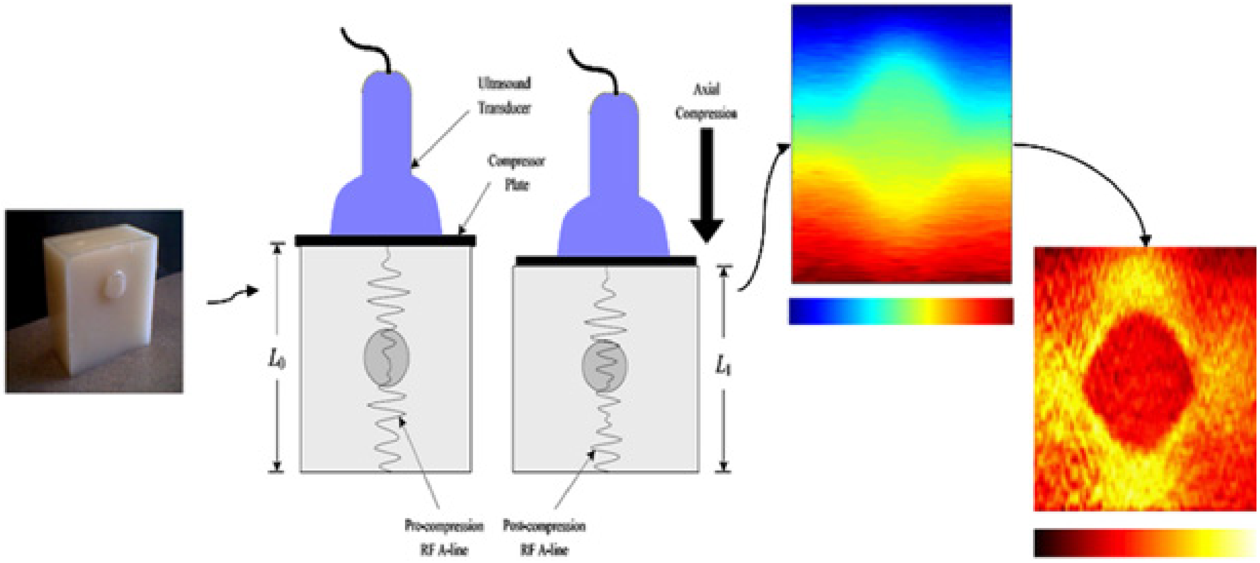
In earlier days, static elastography was introduced. This is performed by:

1. obtaining a set of raw ultrasound signals from a target (i.e. pre-compression data),

2. subjecting the target to a small uniform deformation, and

3. obtaining a second set of echo signals (i.e. post-compression data).

Motions along the direction of the applied load are estimated by performing piecewise motion estimation on corresponding data sets. Once displacements are calculated, strain estimation algorithms are applied to generate the strain images generally referred to as elastograms. These strain images can then be used to visualize the relative stiffness of the underlaying tissue by showing low amount of strain on hard tissue and high amount of strain on soft tissues.



Real-Time Elastography

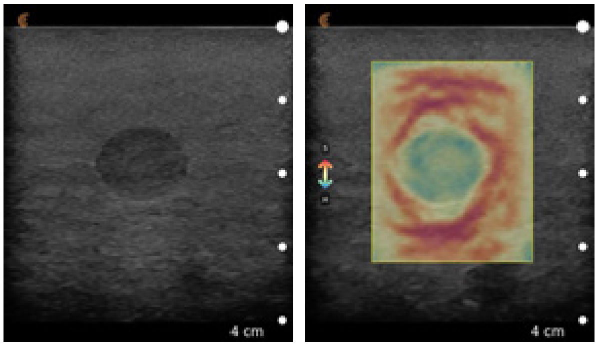
Real-time elastography takes the concept of static elastography one step further. In this technique, raw ultrasound data are acquired continuously and elastograms are generated by estimating strain between sequential frames in real-time. During real-time elastography the user may apply some external deformation or may hold the transducer stationary and solely relay on internal tissue motions due to breathing or heartbeats.

It is important to note that strain imaging only provides relative information about stiffness of the tissue and is mainly used for detection of tissue abnormality. Advantages of real time elastography has been shown in several clinical applications.

Implementation on Clarius

Strain imaging is computationally intensive and requires additional hardware resources such as dedicated CPUs or GPUs in order to run in real-time. As a result, up until now, it has only offered on high-end ultrasound scanners and is not available on any ultraportable solution.

By leveraging Clarius scalable architecture and reprogrammable hardware, a fast version of strain imaging is now implemented on the scanner and is now offered, for the first time, in an ultraportable form factor.



Clarius strain imaging mode on L7 scanner

Real-time strain imaging is now offered on Clarius L7, C3, and EC7 scanners as a new imaging mode and can be activated by pressing “E” on the list of available imaging modes. For more information visit www.clarius.com.

References

[1] Reza Zahiri, Tim Salcudean “Motion Estimation in Ultrasound Images Using Time Domain Cross Correlation with Prior Estimates” IEEE Transactions on Biomedical Engineering, vol 53, pages 1990-2000, 2006.

[2] J. Ophir, “Elastography, a quantitative method for imaging the elasticity of biological tissue,” Ultrasonic Imaging, volume 13, pages 111–134, 1991.

[3] J. Ophir, “Elastography: Imaging the elastic properties of soft tissues with ultrasound,” Medical Ultrasound, vol. 29, pages 155–171, 2002.