Virtual Instrumentation for Evaluation of Arterial Compliance

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Arterial Compliance

The stiffness of the walls of arteries is used as an important measure of the cardiac health of a person. Clinically accepted measures of arterial stiffness such as compliance, distensibility, stiffness index etc are all calculated based on the change in the arterial diameter over a cardiac cycle normalized with respect to the blood pressure. Numerous epidemiological studies over the years have shown that the stiffness of the human carotid artery is very strongly correlated to coronary heart disease (CHD). This makes the carotid artery an ideal measurement site for evaluation of arterial stiffness. Measures of carotid artery compliance could also find use in improving the existing paradigms for estimation of CHD risk and in predicting future cardiac events.

State of the Art

Most of the clinically evaluated methods for measuring arterial stiffness use an ultrasound scanner to capture a sequence of B-mode images of the carotid artery. These images are then fed to a vessel wall tracking system that identifies and keeps track of the movement of the arterial walls. Some methods use the image as a marker to identify the location of the vessel walls and then use the ultrasound radio frequency echo signals to measure the dimensional changes of the artery. The complexity involved in the operation of these systems, and also the cost limit their use in a clinical environment.

Virtual Instrumentation and Arterial Compliance

We have developed a single element ultrasound transducer based system for non-invasive estimation of arterial compliance. The use of a single transducer reduces cost, complexity, and size of the measurement system. The basic idea of measurement is illustrated in Fig. 1. An ultrasound transducer is used to interrogate the carotid artery. The echoes coming from the walls of the artery are picked up and tracked to calculate the change in arterial diameter over each cardiac cycle.

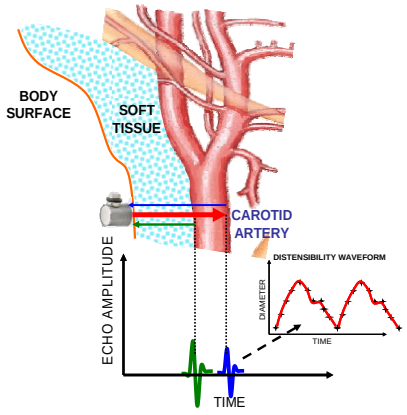

Figure 1: Measurement of arterial compliance

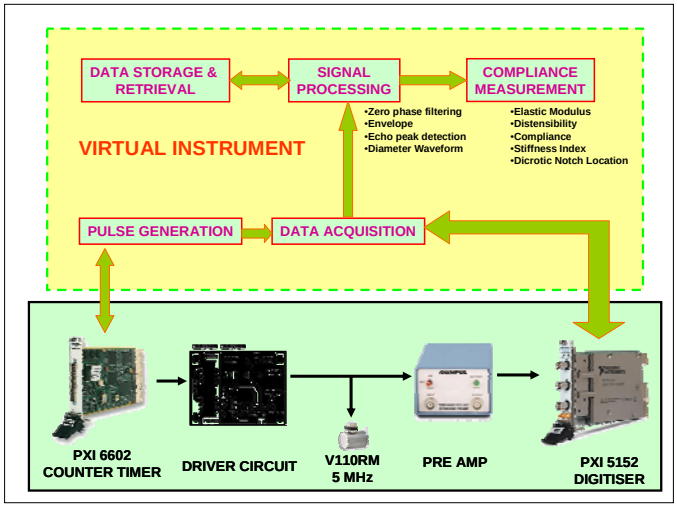

Figure 2 : Measurement system architecture

The system is built around a PXI chassis that houses a counter timer card and a digitizer card. The transducer excitation, data acquisition and signal processing are all controlled from a LabVIEW virtual instrument. The performance of the system has been characterized using simulated data sets and experiments on phantom models of the carotid artery. Measurements on volunteers have demonstrated the capability of the instrument to accurately capture the dynamics of arterial wall motion.

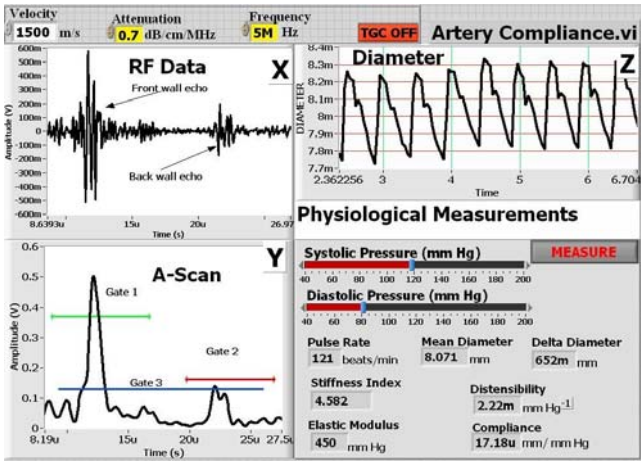

Figure 3 : Front panel of the virtual instrument

Ongoing Research

- Algorithms for automatic extraction of distensibility waveform from the ultrasound echo signal array.
- Automated characterization of the dynamics of wall motion.
- Development of phantoms for arterial distensibility studies
- Calculation of "vascular age" from arterial compliance.

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