Determination of the spatial autocorrelation function of ultrasonic scatterers using the frequency dependence of backscattering

Michael Charles Macdonald

Current clinical ultrasound images are qualitative and are, therefore, subject to interpretation by the viewer. Much work in the past few years has been directed toward attempting to measure quantifiable characteristics of tissues with the goal of being able to characterize various disease states based on these parameters. One particular area of research deals with searching for the isotropic spatial autocorrelation function of the ultrasonic scatterers.

Most present techniques for finding the spatial autocorrelation function of scatterers require the function to have one of a few "expected" functional forms such as an exponential or Gaussian, even though the actual spatial autocorrelation function may have a very different form. This dissertation proposes a unique method of computing the spatial autocorrelation function of scatterers such that the function may be a completely general form and independent of the instrumentation used for measurement.

A rigorous derivation of the theory used for the development of this technique is presented. The derivation of a second, less general, model for finding the spatial autocorrelation function is also presented. This second approach follows from the theory used in the first model, however some simplifying assumptions regarding the nature of the scattering medium are made.

Since the application of both models requires numerical evaluation, an in depth study of the development, testing and implementation of the computer algorithms used for this study is included.

Two ultrasound phantoms with known spatial autocorrelation functions for the scatterers were used to test the viability of both models. The initial results from the rigorous model indicate that, while the theory and the computational techniques seem to be correct, additional work needs to be done to find a numerical technique which will yield favorable results. The second model found spatial autocorrelation functions for both phantoms which were very close to the predicted functions.