Lesion Size-Dependent Signal-to-Noise Ratio Analysis as a Clinically Relevant Metric of Ultrasound Scanner Performance

James Kofler
Under the supervision of Professor Ernest L. Madsen
At the University of Wisconsin - Madison

The research described in this dissertation is aimed at quantifying ultrasound scanner performance in a clinical environment via automated analysis of phantom images. Several tissue-mimicking phantom types were used, each type containing a unique combination of spherical simulated lesion size and object contrast. The spherical lesions are coplanar and are positioned in a regular array throughout the imaging depth. Software was developed that automatically determines the location of each sphere within the phantom image. A lesion size-dependent signal-to-noise ratio (LSNR) is calculated at known lesion locations, and the average LSNR is determined over 1-cm depth intervals, each interval separated by 1 mm. The depth range over which the average LSNR value is above an LSNR threshold value is defined as a ?resolution zone,? indicating that all lesions (of a given size and object contrast) within that range are detectable by human observers. Resolution zones are determined for a series of spherical lesion phantoms using a single scan configuration (a scan configuration is the combination of transducer, frequency, scanner, and scan parameters). Phantom raw scores at each depth equals the number of detectable lesion types at that depth, and these scores are scaled for comparison with the clinical ratings.

A two-alternative forced choice study, consisting of 5,700 paired images acquired using six different scan configurations, associated LSNR values to the probability of correct detection by human observers. The results also showed that for a given LSNR value, the probability of correctly detecting a lesion is independent of transducer frequency and lesion size.