Public Abstract

First Name:Raina
Middle Name:Janel
Last Name:Cepel
Adviser's First Name:Dominic
Adviser's Last Name:Ho
Co-Adviser's First Name:Steven
Co-Adviser's Last Name:Neal
Graduation Term:FS 2007
Department:Electrical Engineering
Degree:MS

Title:THE SPATIAL CROSS-CORRELATION COEFFICIENT AS AN ULTRASONIC DETECTION STATISTIC

In ultrasonics, image formation and detection are most commonly based on signal amplitude. Matched filtering is an amplitude independent approach, but requires accurate template estimation. In this work, we introduce the use of the spatial cross-correlation coefficient as an additional detection statistic.

The correlation coefficients are calculated between A-scans digitized at adjacent measurement positions and can be formed into images that are similar to C-scan images. In these images, defects are revealed as regions of high or low correlation relative to the background correlations associated with noise. Correlation coefficient and C-scan images are shown to demonstrate flat-bottom-hole detection in a stainless steel annular ring and crack detection in an aluminum aircraft structure.

To enable a quantitative comparison of the three detection techniques, it is necessary to simulate accurate A-scans, which are a sum of flaw signals and acoustic noise. To compare the spatial correlation coefficient to the other techniques, the simulated acoustic noise must match measured acoustic noise. In this work, we describe an approach for generating simulated acoustic noise with a spatial correlation coefficient distribution and maximum extreme value (MEV) distribution which matches those distributions for measured acoustic noise. The basic approach forces the correlation of neighboring signals to the desired correlation by creating each signal as the sum of appropriately scaled neighboring signals plus a new random signal. Results are shown which demonstrate the effectiveness of the approach.

Using the simulated acoustic noise, grain noise and noise-corrupted flaw signals are simulated under varying conditions. Receiver operating characteristic curves are calculated for each detection statistic and the area under the curve is used to compare performance. The spatial cross correlation approach is found to outperform gated peak detection at low signal to noise ratios. When the a priori flaw signal prediction is inadequate, the correlation approach also outperforms matched filtering. Techniques to maximize the efficacy of the spatial cross correlation approach are suggested.