LAMB WAVE DIFFRACTION TOMOGRAPHY

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Abstract

As the worldwide aviation fleet continues to age, methods for accurately predicting the presence of structural flaws, such as hidden corrosion and disbonds, that compromise airworthiness become increasingly necessary. Ultrasonic guided waves, Lamb waves, allow large sections of aircraft structures to be rapidly inspected. However, extracting quantitative information from Lamb wave data has always involved highly trained personnel with a detailed knowledge of mechanical wave guide physics. In addition, human inspection process tends to be highly subjective, slow and prone to errors. The only practical alternative to traditional inspection routine is a software expert system capable of interpreting data with minimum error an maximum speed and reliability. Such a system would use the laws of guided wave propagation and material parameters to help signal processing algorithms automatically extract information from digitized waveforms. This work discusses several practical approaches to building such an expert system. The next step in the inspection process is data interpretation, and imaging is the most natural way to represent two-dimensional structures. Unlike conventional ultrasonic C-scan imaging that requires access to the whole inspected area, tomographic algorithms work with data collected over the perimeter of the sample. Combined with the ability of Lamb waves to travel over large distances, tomography becomes the method of choice for solving NDE problems. This work explores different tomographic reconstruction techniques to graphically represent the Lamb wave data in quantitative maps that can be easily interpreted by technicians. Because the velocity of Lamb waves depends on the thickness the travel times of the fundamental modes can be converted into a thickness map of the inspected region. Lamb waves cannot penetrate through holes and other strongly scattering defects and the assumption of straight wave paths, essential for many tomographic algorithms, fails. Diffraction tomography is a way to incorporate scattering effects into tomographic algorithms in order to improve image quality and resolution. This work describes the iterative reconstruction procedure developed for the Lamb Wave tomography and allowing for ray bending correction for imaging of moderately scattering objects.