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Study of Ultrasonic Phased-Array Methods for the Inspection of Composite Structures with Different Geometric and Mechanical Properties

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Ultrasonic phased-arrays have shown a growing interest in the industrial nondestructive testing and evaluation of materials. The application of such a technology in different areas (aerospace, nuclear industry, line control industry, etc.) demonstrated its efficiency especially during the realization of specific controls where the geometry of component parts has to be taken into account to perform reliable imaging with a consequent gain in productivity.

The aim of this work is to compare different phased-array methods applied to components made of different composite materials. In particular, it puts forward the influence of materials and geometries on the performance of the imaging methods in terms of signal-to-noise ratio, number of processed signals, and data processing and accuracy in the defect characterization.

The application of several imaging methods on the same samples provided different results, where some of them are not in accordance with real defects. It was then possible to establish several criteria, according to the defect sought and operating conditions, in order to use the most reliable method on the basis of the identified performances and limitations of each one of them.

The final objective of this work is to optimize the adaptive phase-array methods by considering the effects of anisotropy in the elastic properties of the characterized composite structures and their heterogeneities as well. Therefore, the different measurements are focused on three adaptive imaging methods: SAUL (Surface Adaptive Ultrasounds), adaptive TFM (Total Focusing Method) and adaptive PWI (Plane Wave Imaging).