Application of Machine Learning techniques for defect detection, localization, and sizing in Ultrasonic Testing of Carbon Fibre Reinforced Polymers

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The growing interest in applying Machine Learning (ML) techniques in Non-Destructive Testing (NDT) to assist expert detection and analysis is facing many unique challenges, one of the most significant being a lack of experimental training data. This research aims to develop an object detection network that can automatically generate bounding boxes around various defects in Carbon Fibre Reinforced Polymers (CFRPs), allowing for the inference of quantitative defect size and other relevant information. The anisotropic nature of CFRPs results in complex interactions between emitted acoustic waves and the material structure during Ultrasonic Testing (UT), making the detection of defects such as porosities, delamination and inclusions particularly challenging. To address these challenges, a combination of advanced ML methods including object detection (You Only Look Once algorithms), synthetically generated datasets, Generative Adversarial Networks (GANs) and advanced statistical methods for data augmentation, and UNet segmentation networks were used. The combined outputs of these methods were evaluated on representative CFRP experimental data collected in-house using Phased Array Ultrasonic Transducer (PAUT) and a KUKA KR90 robotic arm. This presentation will provide insight into the state-of-the-art techniques and methods used in the field of NDT for CFRPs and their potential applications in the industry.