Enhancing Near Surface Defect Detection in Ultrasonic Testing Using Self-supervised Learning

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Ultrasonic examination, when enhanced by artificial intelligence (AI), has demonstrated remarkable potential for defect detection, especially within the realm of industrial applications. Nevertheless, the efficacy of AI models for ultrasound examination is contingent on the availability of closely aligned label data, a requirement that frequently proves impractical. This paper introduces an innovative self-guided learning-based ultrasonic testing method designed to identify defects within inspected objects. What distinguishes our approach is its capacity to generate defect characteristics, circumventing the necessity for separate, hard-to-acquire label data. We accomplish this by strategically augmenting the floor reflection signal, permitting the extraction of defect characteristics, even in the absence of precise label data. Our method leverages a residual model rooted in a denoising autoencoder to discern defect characteristics exclusively within the inspected object, facilitated by the generated defect signal. To authenticate the efficacy of our proposed technique, we conducted Ultrasonic Testing (UT)-based B-scan inspections on aluminum blocks featuring uneven surfaces and defects near the surface. Our empirical results unequivocally establish the superiority of our method in defect detection when contrasted with conventional gate-based inspections and advanced methodologies such as BeatGAN and DRAEM. Importantly, our approach excels in scenarios where securing perfectly aligned label data is virtually unfeasible, offering a promising avenue for AI-augmented ultrasonic examination.