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Characterization of Structural Noise Patterns and Echo Separation in the Time-Frequency Plane for Austenitic Stainless Steels.

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Abstract : The aim of this study is to characterize the structural noise for a better flaw detection in heterogeneous materials (steels, weld, composites...) using ultrasonic waves. For this purpose, the continuous wavelet transform is applied to ultrasonic A-scan signals acquired using an ultrasonic non destructive testing (NDT) device. The time-scale representation provided, which highlights the temporal evolution of the spectral content of the A-scan signals, is relevant but can lead to misinterpretation. The problem is to identify if each pattern from the wavelet representation is due to the structural noise or the flaw. To solve this problem, a detection technique based on statistical significance testing in the time-scale plane is used. Information about the structural noise signals is injected into the decision process using an autoregressive model, which seems relevant according to the spectral content of the signal. The approach is tested on experimental signals, obtained by ultrasonic NDT of metallic materials (austenitic stainless steel) then on a weld in this steel and indeed enables to distinguish the components of the signal as flaw echoes, which differ from the structural noise.

Keywords : Austenitic stainless steels, Structural noise, Flaw detection, Wavelet transform, Autoregressive model, Significance testing