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WAVELET NOISE FUNCTION AND REGRESSION ANALYSIS FOR ULTRASONIC NDT MATERIAL CHARACTERIZATION

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ABSTRACT

Internal defects detection by ultrasound non destructive testing is widely used in industry. Ultrasonic time signal data are difficult to interpret since they require continuous signal analysis for each point of the piece. Inverse problem in materials analysis puts some challenges because the composition variables are both discrete and continuous and because the engineering properties are highly nonlinear functions. In this paper we address the non linear features of back scatted ultrasonic waves from steel plate, for understanding its micro structural behaviour. The experiments show a challenging interface between material properties, calculations and ultrasonic wave propagation modelling.

Keywords: material microstructure, ultrasonic ndt , regression analysis, wavelet, de-noising.

INTRODUCTION

The performance of ultrasonic examination techniques in stainless steel austenitic structures, clad components, and welds are often strongly affected by the materials anisotropy and heterogeneity. The major problems encountered are beam skewing and distortion, high and variable attenuation and high background noise. Following the exact defect localization, sensitivity to inner flaw detection and identification benefit, ultrasonic testing is widely used in the inspection of many industrial components as austenitic steel or composite samples. Ultrasonic data are difficult to interpret since they require analysis of a continuous signal for each point of the material under consideration. Due to the inherent inhomogeneous and anisotropy nature of these materials, ultrasonic waves undergo high acoustic attenuation and scattering effect, making data interpretation highly complex. Echoes backscattered from the front and back surface of specimen, combined with other backscattered flaws or microstructures echoes, are often overlapped, making the identification of flaws difficult.

In this paper we present a method based on the multi-resolution theory as ultrasonic signal multi-scale modeling for the exploration of the structural noise features and its analyzing function. In the proposed de-noising procedure the noise features were extracted by an energy smoothing algorithm by which the random nature of the noise in the spatial domain is bypassed. This energy characterization of the structure noise and the defect to be detected has given an improved filtering process. The de-noising algorithm performs an accurate signal reconstruction with an enhanced detection of very little defects. However if anisotropic noise is related to local variations in texture or shapes of macro etches, the relationship of this ultrasonic property to microstructure is not well understood, and no careful theory has been presented to quantitatively describe these relationships. The following experiments obtained from a structural noise of a steel plate, will give significant insights into the relationship of backscattered noise and microstructure which will ensue to understand the microstructure dimension scales.

RESULTS AND CONCLUSIONS

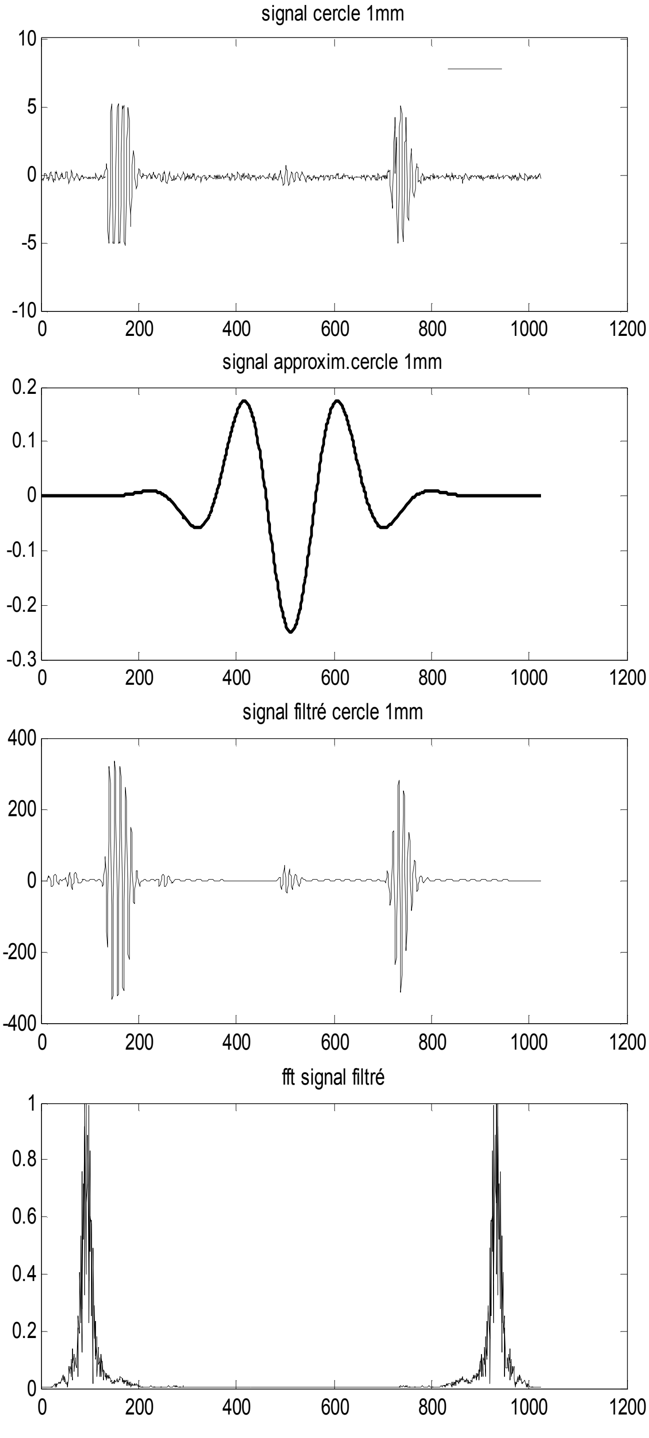

Fig. 1 - Input signal 'circle of 1mm size', and the de-noised signal 'circle of 1mm' after processing

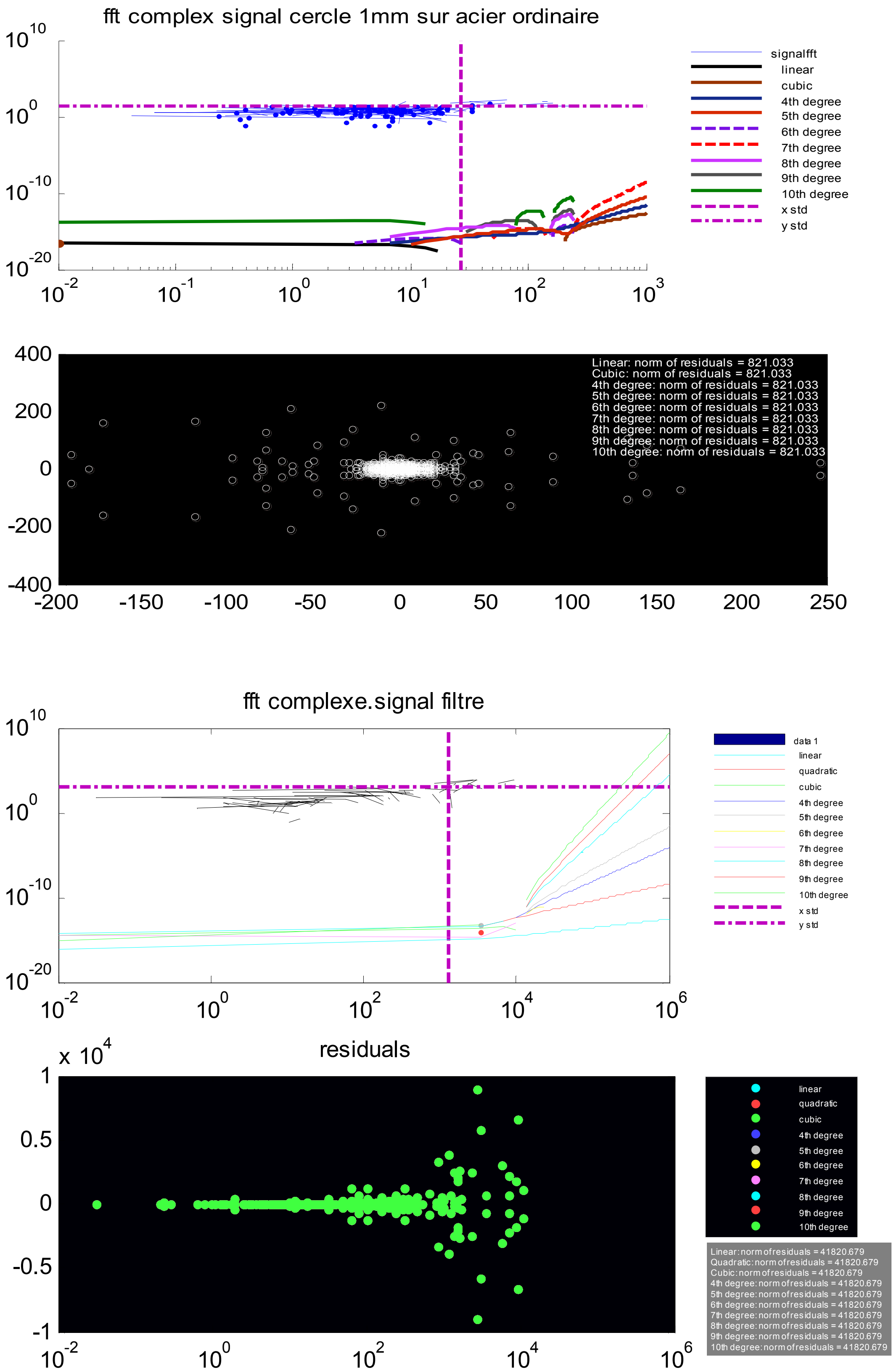

Fig. 2 - Regression analysis of the input signal ‘complex fft and residuals’, and the filtered one

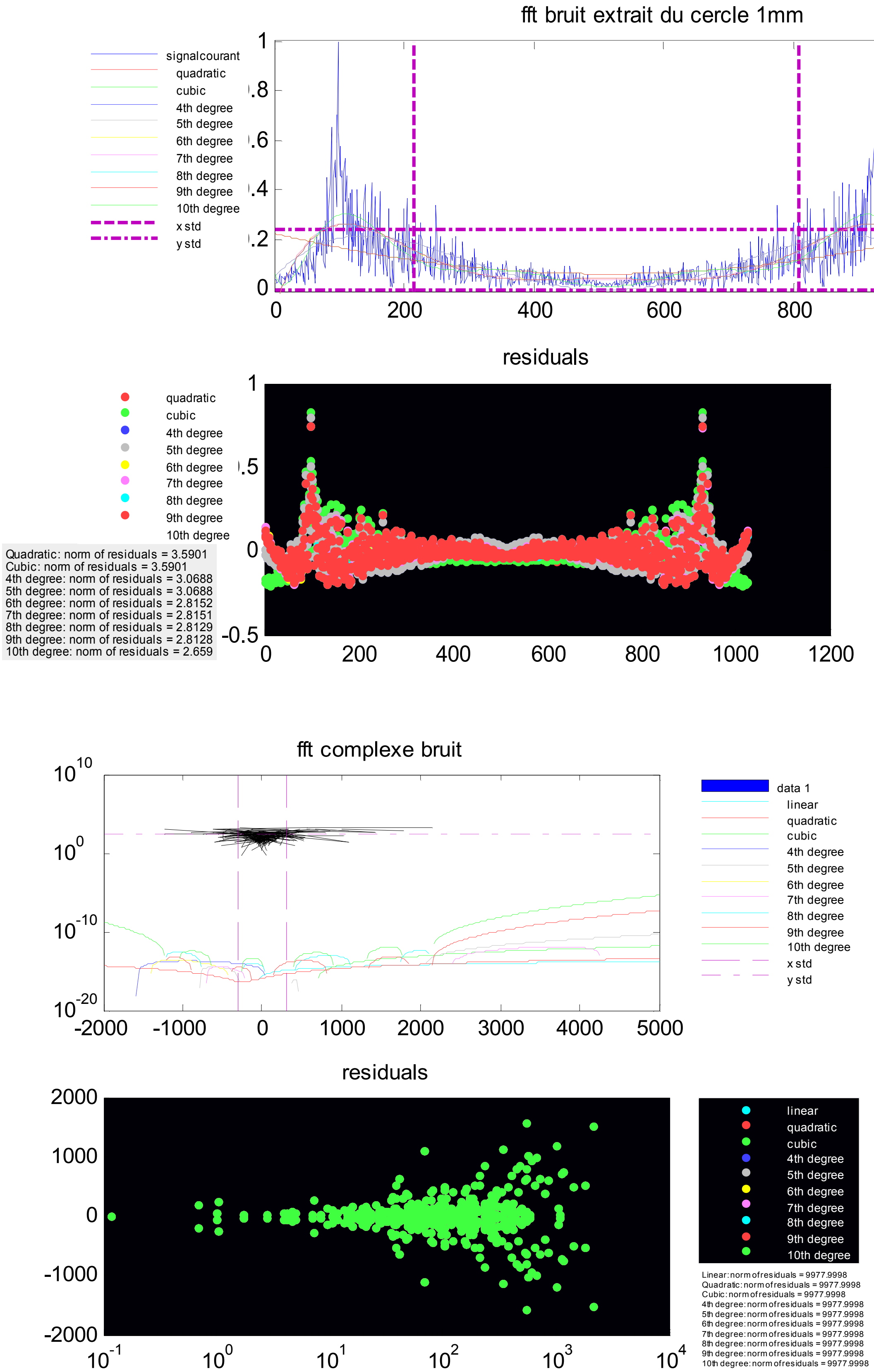

Fig3. Extracted noise, complex fft and residuals

This study shows that many data are recovered by the noise function. The de-noising process is very suitable for even little sized defects. The regression analysis shows occurrence of data of microstructure level. A powerful and deep analysis could give correlation with material properties.

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