EVALUATION OF FLAW SEVERITY IN CYLINDRICAL PRODUCTS BY AN ELECTROMAGNETIC METHOD

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Non-destructive material evaluations (NDEs) have undergone a continuous transformation in the last decade, from the detection of discontinuities and the characterization of the condition of materials to their automatic classification using robotics for inspection and maintenance. This requirement goes once with the apparition of new materials, which require certification and improvement of future maintenance systems forecasting methods [1]. The use of eddy current (EC) technology to detect damage in complex structures with hard-to-reach areas is a key part of NDE that requires connecting technology to industrial / sectoral requirements. These structures require an accurate and precise assessment of any detected discontinuities to properly guide repairs and support the tasks of maintenance programs. The efficient use of information technology to improve human knowledge, although it seemed a futuristic theory, is proving necessary to increase the quality of life. NDE automated operating systems are designed to improve human reaction in decision making. These systems used in NDE, automated systems, can be applied for a variety of purposes from image processing to database development in decision making [2]. An effective NDE flowchart requires a robust schema for diagnosing damage and causes, including establishing the nature of the damage, the location, and the volume of the defect. The problem of damage diagnosis is one of model recognition, each state of damage has a collection of measurement data from sensors. Knowing that none non-destructive testing method can be qualified as maximum detection capability and maximum sensitivity, more reliable information and a correct characterization of defects is obtained by data fusion. Figure 1 shows the block diagram of the processing algorithms.

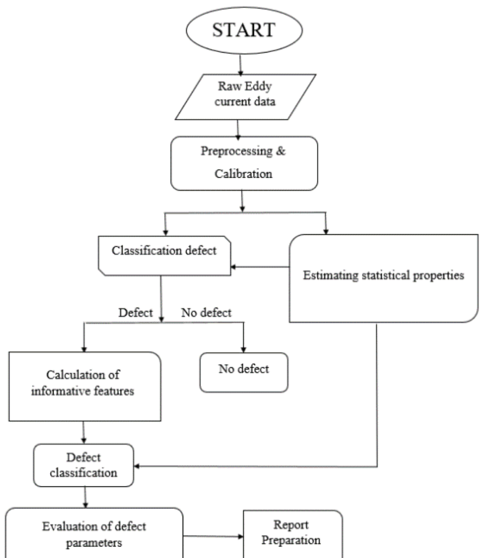

Figure 1.

The detection and classification of the information obtained from the EC technique offers the premise of several approaches for extracting information on the integrity of the examined structures [3]. Discontinuity image reconstruction technology overcomes the shortcomings of traditional EC testing that cannot provide detailed information on discontinuities. In recent years, in the field of image processing, the neural network has been widely applied, offering a new idea for the recognition and classification of EC images of existing discontinuities in complex structures.

To increase the probability of detection (POD), an automatic system that pre-filters the signal can be used, a Neyman Pearson detector with the probability of false alarm imposed allows to determine those areas from the fault signal provided by the EC equipment.

Figure 2 presents the filtered signal and the effect of Neyman-Pearson on this signal. The emphasized points appertain with POD 95%.

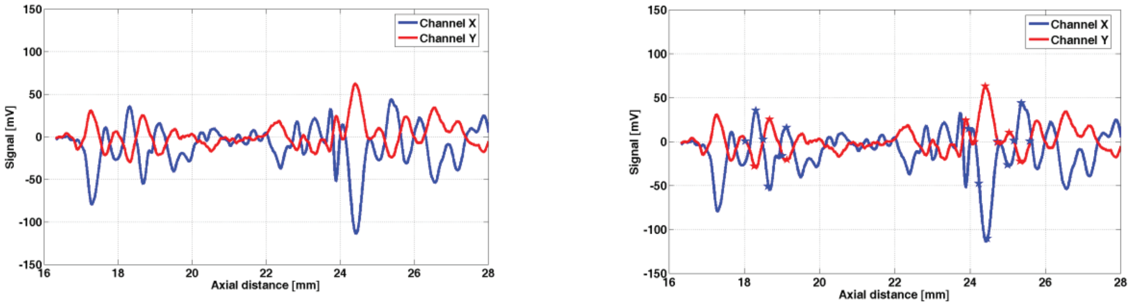

Figure 2.

The EC method as a fast and reliable method is gaining terrain in inspections of cylindrical products, for emphasizing surface and subsurface discontinuities, being able to digitally test complex shapes and storing a large volume of information without operator dependence. In order to reach a decision, the information must be processed by going through a product history (manufacturing data, previously performed tests, conditions of use, etc.), the whole system requires learning, images recognition, planning, problem solving, knowledge. Step by step, as these machine learning (ML) become able to make decisions on tests, their tasks are no longer in the domain of artificial intelligence (AI). The EC technique can use both a single coil transducer and a transducer based on a sensors array, able of covering a large inspection area. Each sensor from array generates a signal that can be detected in amplitude and phase and provides information about the inspected area. Thus, low sensitivity to lift off allows a less difficult inspection of complex geometries that can then be automated. It is also useful to characterize the location and shape of the defects provided that adequate maps of the impedance variations induced by the defects are available. This can be done with Mahalanobis distance, membership being ensured by minimizing distance. This variation data can be collected by the transducer operating at a single frequency / multifrequency and displacing at a constant velocity close to the inner / outer surface of the cylindrical product, sweeping the surface.

The real flaws have various causes and shapes, the method of analysis can allow a classification in quality classes of the severity of possible discontinuities. Thus, there is the possibility of managing the results much faster by establishing the quality and classification of the product. This paper proposes to present a short overview of automated data analysis algorithms for processing and automated evaluation of data, being based on Bayesian and fuzzy logic methods. These methods help both at the evaluation of flaws nature using feature extraction and clustering as well as well their severity using a data mining procedure. The data referring to noises and data of emphasized flaws are considered “apriori” knowledge [4].

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