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A SURVEY ON FINDING FAULTS OF INTERLAYER GAPS AND LIFT-OFF IN AIRCRAFTS USING AUTOMATED CLASSIFICATION METHOD IN PEC

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Abstract: Today it is very important to provide more security to the aircraft in the multi-layer structure of PEC. They were requires extreme skilled workers and the outcomes are usually partial one from the workers. Lift-off effects and air gaps between interlayer are the main difficult in eddy current fault of multilayer structure. Therefore automated fault classification in multi layer structure is one of the required and also tough one. Nowadays researchers have interested on automated fault finding of PEC in aircraft method. This paper includes an overview of PEC and introduces the reader to some fundamental concepts of aircraft methodology of PEC. Also, we emphasizes classification algorithm to implement automated fault classification such as SVM, PCA, Neural Classifiers, etc.

Keywords: PEC Aircrafts, Air gaps, SVM, PCA, Neural classifiers.

1. INTRODUCTION

Pulsed eddy current (PEC) testing is one of the new technologies of eddy current testing technology. PEC testing possesses over many advantages against the predictable eddy current testing, including wider detection depth, rich knowledge about faults and high toughness of anti-interference. Most of the eddy current applications use single frequency excitation for each particular application. In this case, the information is generally given from the analysis the faults in terms of lift-off and air gaps. But these two parameters can be insufficient to characterize or discriminate some discontinuities of conductivity in the materials. The pulsed eddy current (PEC) nondestructive testing is an effective technology that has been established to be accomplished of measuring fault in the aircraft structure. PEC emerging techniques that have been particularly devised for multi layer structure for subsurface flaw measurement. PEC techniques motivate the fault finding in aircrafts. At present, this method obtains the widespread applications in the airplane structure, the air gaps problem while lift-off equipment's fault of testing methods.

Pulsed Eddy Current (PEC)

The transient or pulsed-eddy current (PEC) technique presents an important advance over other Eddy Current (EC) methods because it rapidly acquires data over a wide range of frequencies, thereby providing more information in the frequency domain. PEC has been widely used in fault characterization and corrosion detection and it has been proved as an effective tool for quantitative characterization of idden corrosion and crack in multilayer aircraft structures.

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PEC defect classification theory and feature extraction techniques have been developed and studied. Due to time-domain transient analysis, different features can be extracted in PEC to classify the faults. (In the frequency domain, the PEC response signals contain more information than regular EC testing.) Time–frequency analysis of PEC signals provides specific visual patterns that can be related to interlayer gap, liftoff method, and material loss.

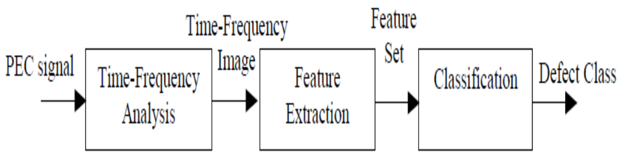

Figure 1: Architecture of Pulsed Eddy Current

Meanwhile, air gaps can be easily generated and controlled and the other advantage of PEC method over multilayer structure eddy current method is less expensive instrumentation [2]. Because of some advantages over conventional eddy-current testing, includes more comprehensive recognition depth, easier generation and control, PEC testing has been particularly developed and devised for sub-surface fault measurements and fault finding. Finding fault can be classified into three, fault detection, fault classification and fault quantification.

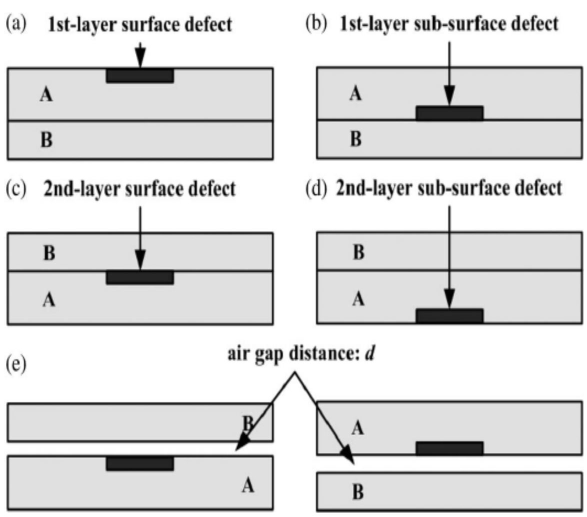

Figure 2: Multi-layer structure of air gaps.

Fault detection

Fault detection is the first stage where a feature threshold is usually set to detect whether the sample being tested has a defect or not. If a fault is detected then the second stage will start.

Fault classification

In this section, the faults should be classified to surface or sub-surface defects. The rising of air gaps and lift-off is selected as the aspect. It is concluded that the rising of air gaps surface defect is smaller than that of non-defect, while the rising of air gaps sub- surface defect is more than that of non-defect in peak area of defect results.

Fault quantification

In this section, the fault quantification is achieved to gain knowledge about the detected fault. The length can be quantified by peak area and low area in classification technique. The time to maximum value in peak area and time to minimum value in low area are equivalent to the instant of sensor entering and leaving the edge of fault.

PEC testing has been demonstrated to be capable of tackling different assessment tasks such as measurement of air gaps. This survey shows that what and all algorithms were used for finding the faults of air gaps

2. ANALYSIS OF ALGORITHM

A situation may occur where many algorithms are available for solving a particular problem. In aircrafts the lift-off and the air gaps is one of the main difficult. The lift-off is commonly known to be one of the main obstacles for effective eddy-current Non Destructive Testing (NDT). In this survey there are various latest techniques used are described for finding the fault. The analysis of algorithm is focus on classification of the air gaps in an Aircrafts problem.

3. CLASSIFICATION METHOD

Classification is used to determine the predetermined output. It predicts the target class for each data item. It assigns the data into target classes. For example it is used to identify the credit risk as low, high, medium. It is the task generalization one. Common algorithms include decision tree learning, nearest neighbor, Naive Bayesian classification, neural networks and support vector machines. The role of the classification method in this survey is what and all algorithm were used to solve the air gaps problem is

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described. To classify or describe the fault finding and the solutions for the air gaps problem by describing in algorithm wise, what and all existing technique were used. The classification method is usually based on the availability of a set of faults in the lift-off and air gaps. That has already been described. This set of faults is termed the training set and the resulting learning strategy is characterized as supervised.

4. NEURAL CLASSIFIER

Neural networks, is used to distinguish aircraft targets extraction and providing real-time performance in radar target recognition is a critical one to be satisfied, usually neural networks with massive parallel structure and capacity of learning are used in the classifier.

The recognition process must be invariant with respect to the target position of finding the faults. They were three technique were proposed they are invariance by training, pattern representation of different faults for different patterns during training phase of fault analysis. The main drawback of such an approach is that it is inapplicable in many operating situations. Second one is invariance by structure, uses neural networks whose outputs are always invariant to certain transformations. The disadvantage of such an approach is that high-order neural networks are required and didn't find the fault exactly. It is too complicated and their application is limited. Finally, the third technique uses feature vectors as inputs for the neural networks. Recognition system usually uses the magnitude of the Fourier transform, which is invariant to linear shifts of its input vector of the air gaps in the aircraft. The requirements on the classifier are relaxed, and the invariance for all input objects is ensured. On the other hand, the main drawback of using invariant feature spaces is the processing time (it can be very long) needed to extract the features before the classifier of faults can be employed.

In this technique it focuses on a neural classifier that uses Fourier descriptors as inputs for the neural networks. As said before, a deterministic way to define the number of hidden layers and the number of neurons does not exist (i.e.) no. of faults are not exists by using the classifier method.

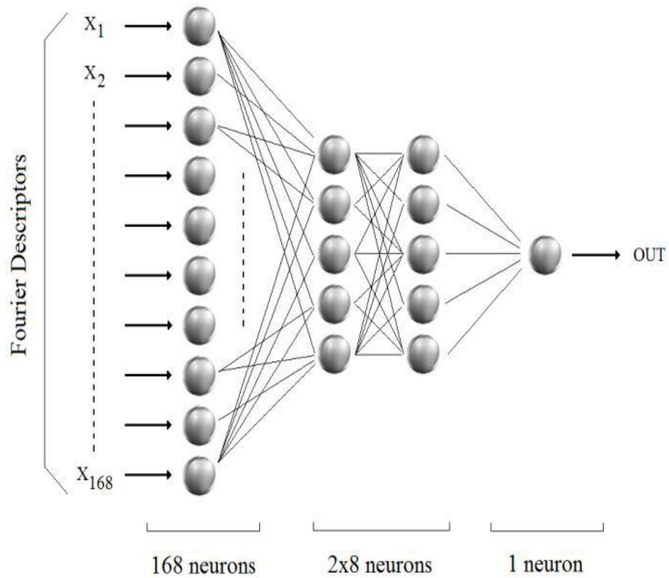

Figure 3: Neural Network

5. FAULT CHARACTERIZATION WITH EDDY CURRENT

In eddy current (EC) testing, the response signal of pick-up unit is affected not only by fault, but also by the change in other properties of material under examination, such as thickness, magnetic permeability, and electrical conductivity. Usually, the edge or end of specimen will affect the response signal, which is called as edge effect or end effect. The specimen five providing defects 7–9is used in the experiment. The excitation pulse used in this paper is 10 VIN amplitude, 100Hz in frequency, and 5ms in pulse duration. The upper blue area in C-scan image is resulted in by edge effect, which disturbs the C-scan images.

For surface defects and sub-surface defects, the experimental tests are carried out on the same experimental conditions. The horizontal axis represents the frequency; the vertical axis represents the FFT amplitude. Obviously, the surface defects and sub-surface defects can be discriminated preliminarily in the frequency range of 4–15 kHz. In this frequency range, the FFT amplitude of surface defects is larger than that of sub-surface defects. That is because the surface defects can affect the high-frequency components, while sub-surface defects do not affect the high- frequency components. Appropriate features are needed to be used to distinguish the different

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defects. It is useful in detection and evaluation of hidden defects under the edge effect of specimen.

6. PCA-BASED CLASSIFICATION METHOD

PCA is a multivariate analysis technique, which converts the unique measured data into the new uncorrelated variables called principal components (PCs). The original measured data are treated as independent variables. Each PC is a linear combination of the original variables. The PCs form the basis of the respective vector space, and they are arranged in order of decreasing fault. Thus, the first PC carries the most of information regarding the original data and so on.

Multilayer structures are widely used in aircraft fuselage. Because of the interlayer air gap caused by deformation, conventional single-frequency eddy current cannot discriminate between second-layer defect signals and gap signals. In this approach, several faults at varied locations (i.e., first-layer surface, first-layer subsurface, second-layer surface, and second-layer subsurface) were finding in alloy specimen with various air gaps. Pulsed eddy current (PEC) is investigated in combination with principal component analysis (PCA) to classify and locate fault in the specimen.

The principal components are used for locating defects. The experimental results show that first-layer surface defects, first-layer subsurface defects, second-layer surface defects, and second-layer subsurface defects can be classified in air gap. PEC testing with the help of PCA can eliminate the interlayer air gap and liftoff effect, which has potential for defect characterization in multilayer aircraft structures.

7. SUPERVISED AND UNSUPERVISED

Learning can also be unsupervised, in the sense that the system is not given an a priori labeling of faults, instead it establishes the classes itself based on the statistical regularities of the faults in aircrafts. The classification scheme usually uses one of the following approaches: template, statistical (or decision theoretic), syntactic (or structural), or neural. In template matching, a template or a prototype of the pattern to be recognized is available. Statistical pattern recognition is based on statistical characterizations of patterns, assuming that the patterns are generated by a

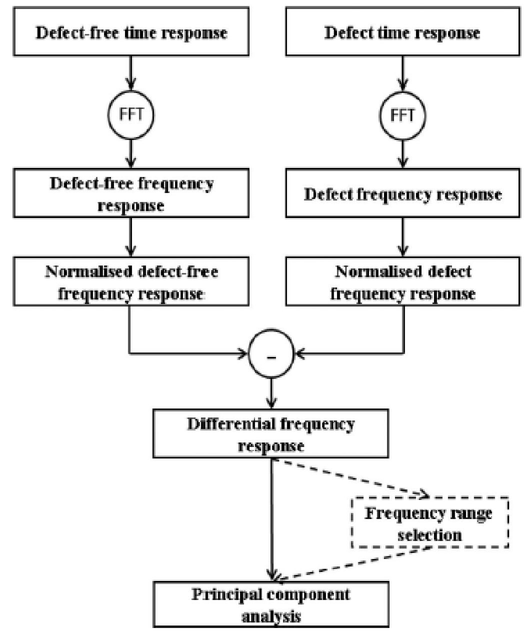

FIGURE 4: PCA-based classification method

probabilistic system. Structural pattern recognition is based on the structural interrelationships of features. Neural pattern recognition employs the neural computing paradigm that has emerged with neural networks. In our case, a supervised linear classifier based on normal densities for all classes is implemented to take care of the last processing step that consists of the decision making regarding the fault class in the multilayer structure of the aircrafts. This classifier is chosen for its simplicity, and because it appears to provide a reasonable classification performance in most applications. It estimates the mean and covariance matrices from the learning set, supposes the different classes have identical covariance matrices, and it is designed based on the optimal Bayes decision rule (called Bayes-normal-linear).

8. SUPPORT VECTOR MACHINE

It is a machine learning algorithm which is used for both classification and regression. Which are powerful tools for fault classification, classifies two-category points by assigning them to one of two disjoint of faults in either the original layer of the problem for linear classifiers, or in a higher dimensional feature of nonlinear classifiers Support vector machine (SVM) performs classification by constructing aircrafts in a multilayer structure that

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separates faults. SVM tries to achieve maximum separation between the faults in the air gaps.
Linear Support vector machine was composed by the set of given support vectors of ‘z’ and set of given weights ‘w’.

The output with N support vectors z1, z2… Zn and weights w1, w2… w_N is given by:

$$F(x) = \sum_{i=1}^{N} w_{i\,(z_i,x)+b}$$

In the SVM study, a predictor variable is called an *attribute*, and a converted attribute that is used to describe the faults of air gaps in aircrafts. That is why the goal of SVM modeling is to find the faults and also monitor the faults by using this technique. Support vector machines (SVM) maximize the margin between the classes by selecting a minimum number of support vectors.
Non-linear SVM classifiers operate in two stages: they perform a non-linear mapping of the feature vector onto air gaps that is hidden in the multilayer structure, and they construct optimal separating faults in the air gaps and give the better solution.

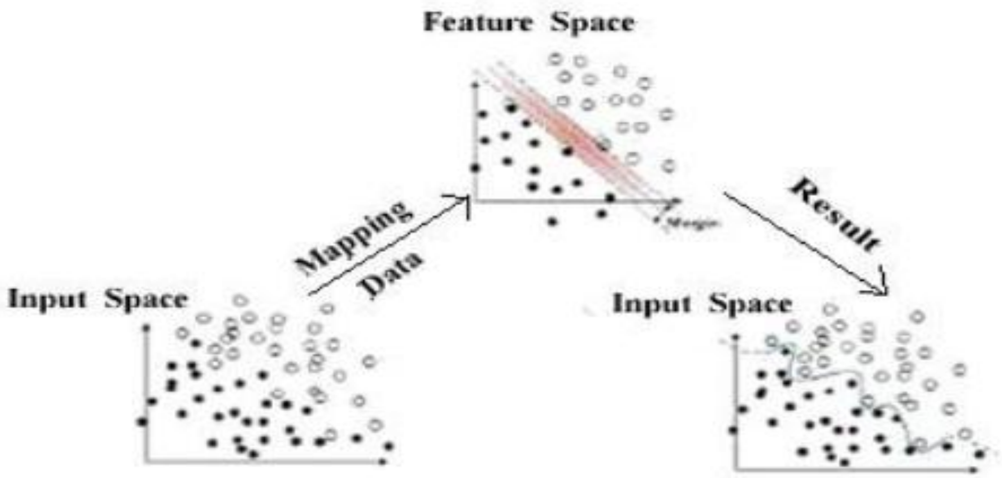

Figure 5: A SVM Algorithm

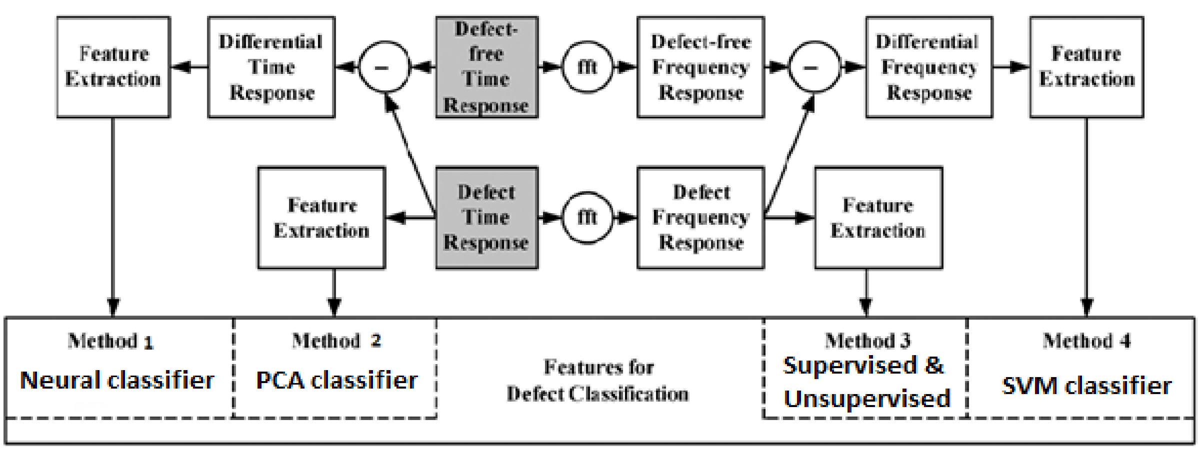

Figure 6: Comparison of Algorithms

9. CONCLUSION

Air gaps in one of the issues in multilayer of PEC. Because of the faults of the interlayer they were air gaps formed. So to solve this problem here we described many classification algorithm like Neural network, PCA, supervised and Unsupervised and finally SVM are used for solving the air gaps problem in the aircrafts using different technique of eddy current and pulsed eddy current. It draws the conclusions on the basis of implementation accomplished using various classification algorithm. Combining more than one SVM algorithms may used to eliminate the faults in aircrafts.

REFERENCES

[1] Yunze He n, FeiluLuo, MengchunPan, XiangchaoHu, BoLiu, JunzheGao, "Defect edge identification with rectangular pulsed eddy current sensor based on transient response signals"- 2010.
[2] Deqiang ZHOU, Binqiang ZHANG, Guiyun TIAN, Haitao WANG, " Research on Surface Defect Detection Using Pulsed Eddy Current Testing Technology" – 2008
[3] Yunze He, MengchunPan, FeiluLuo, GuiyunTian, "Pulsed eddy current imaging and frequency spectrum analysis for hidden defect nondestructive testing and evaluation", -2011.
[4] M.S. Safizadeh, Z. Liu, D.S. Forsyth, and A. Fahr, "Automatic Classification and Characterization of Hidden Corrosion Using Pulsed Eddy Current Data".
[5] Mengchun Pan, Yunze He, "PEC Frequency Band Selection for Locating Defects in Two-Layer Aircraft Structures With Air Gap Variations"-2013.
[6] Yunze He, Mengchun Pan, Feilu Luo, and Guiyun Tian, "Reduction of Lift-Off Effects in Pulsed Eddy Current for Defect Classification".
[7] T.Clauzon, F.Thollon, A. Nicolas Flaws "Characterization with Pulsed Eddy Currents N.D.T".
[8] Monika Xess1, S. Akila Agnes2 "Survey On Clustering Based Color Image Segmentation And Novel Approaches To Fcm Algorithm".
[9] F Lotte, M Congedo, A L_ecuyer, F Lamarche and B Arnaldi, "A Review of Classification Algorithms for EEG-based Brain-Computer Interfaces".
[10] Bruce Vanstone and Clarence Tan, "A Survey of the Application of Soft Computing to Investment and Financial Trading".
[11] Mohammad Jahirul Islam, "Finite-Element Analysis Of Eddy Currents In The Form-Wound Multi-Conductor Windings Of Electrical Machines".