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Spatial-Time-State Fusion Algorithm for Defect Detection through Eddy Current Pulsed Thermography

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Abstract: Eddy Current Pulsed Thermography (ECPT) has received extensive attention due to its high sensitive of detectability on surface and subsurface cracks. However, it remains as a difficult challenge in unsupervised detection as to identify defects without knowing any prior knowledge. This paper presents a spatial-time-state features fusion algorithm to obtain fully profile of the defects by directional scanning. The proposed method is intended to conduct features extraction by using independent component analysis (ICA) and automatic features selection embedding genetic algorithm. Finally, the optimal feature of each step is fused to obtain defects reconstruction by applying common orthogonal basis extraction (COBE) method. Experiments have been conducted to validate the study and verify the efficacy of the proposed method on blind defect detection.

Key words: Eddy current pulsed thermography, independent component analysis, common orthogonal basis extraction, genetic algorithm

I. INTRODUCTION

Non-destructive testing (NDT) refers to a wide group of analysis techniques used in industry to evaluate the properties of a material, component or system without causing damage [1, 2]. Conventional NDT methods include X-ray detection, ultrasonic testing, magnetic particle testing and eddy current testing [3]. Stress concentration and superficial cracks inevitable exist in mechanical parts during the manufacturing and in service process. This leads to considerable hazards in industrial activities. Therefore, the detection of cracks is important [4].

Magnetic Particle Testing (MT) [5] is effective for the detection of surface and near-surface discontinuities while it has a complicated detecting procedure. The surface of the sample requires pretreatment and the detection time is relatively long. Moreover, MT produces pollution. Penetrant Testing (PT) [6] is sensitive to open surface cracks. Unfortunately, the surface coating significantly affects the detection rate that leads to ineffective inspection for fatigue cracks. Alternatively, the electromagnetic method has been widely used for the inspection of surface/subsurface flaws. Alternating Current Field Measurement (ACFM) has been proven to be effective in detecting surface breaking geometrical defects in any direction under simulation [7].

In recent years, with the rapid development of thermal imaging equipment, infrared thermography (IT) based NDT has been used for composite defect detection and cracks identification among others. It has several promising advantages [8, 9] such as rapid inspection over a large region, non-contact and high sensitivity.