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Sparse Ensemble Matrix Factorization for Debond Detection in CFRP Composites Using Optical Thermography

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Highlights

1. Sparse ensemble matrix factorization approach to remove the noise and enhance the resolution for the defects detection.
2. Gaussian low pass filtering and non-linear enhancement is conducted for further enhancement.
3. Common defect detection methods have been conducted for comparison.

Abstract: With the increasing use of CFRP in aircraft and automotive industry, it has become necessary to monitor the health of the composite structure during the manufacture and service process from flaws such as debond or delamination by using optical pulsed thermography non-destructive testing (OPTNDT) techniques. However, current OPTNDT methods cannot efficiently tackle the influence from the strong noise, and the resolution enhancement of the defects detection remains as a critical challenge. To alleviate this problem, this paper proposes the sparse ensemble matrix factorization approach to remove the noise and enhance the resolution for the defects detection. Specifically, the algorithm is based on the sparse representation and noise is modeled as a mixture of Gaussian (MoG) distribution. It provides a projection from the raw data onto the sparse and low dimensional sub-space while the defects information is significantly enhanced with the layer decomposed approach in the low dimensional space. Not withstand above, a Gaussian low pass filtering and non-linear enhancement is conducted for further enhancement. The proposed method is coupled with several comparison studies to verify the efficacy.

Keywords: Optical pulsed thermography, debond defects, CFRP, sparse MoG low-rank matrix factorization, Non-destructive testing.

I. Introduction

The use of CFRP as the composite material is increasing sharply in the aerospace industry [1]. This is due to its unique advantage over other materials such as high strength, high fatigue resistance, low thermal expansion and good resistance to corrosive damages [2]. Thus, it becomes necessary for the industry manufacturers to inspect and check the health and quality

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