Mechanical Systems and Signal Processing 25 (2011) 2462–2474

Contents lists available at ScienceDirect

Mechanical Systems and Signal Processing

journal homepage: www.elsevier.com/locate/jnlabr/ymssp

Spatial scanning for anomaly detection in acoustic emission testing of an aerospace structure

James Hensman [a,*], Keith Worden [a], Mark Eaton [b], Rhys Pullin [b], Karen Holford [b], Sam Evans [b]

[a] Department of Mechanical Engineering, The University of Sheffield, Mappin Street, Sheffield S1 3JD, UK
[b] School of Engineering, Cardiff University, Queen's Buildings, The Parade, Newport Road, Cardiff CF24 3AA, UK

ARTICLE INFO

Article history:
Received 15 September 2010
Received in revised form
12 January 2011
Accepted 10 February 2011
Available online 3 March 2011

Keywords:
Spatial scanning statistics
Acoustic emission
Fracture detection
Damage identification
Damage localisation

ABSTRACT

Acoustic emission (AE) monitoring of engineering structures potentially provides a convenient, cost-effective means of performing structural health monitoring. Networks of AE sensors can be easily and unobtrusively installed upon structures, giving the ability to detect and locate damage-related strain releases ('events') in the structure. Use of the technique is not widespread due to the lack of a simple and effective method for detecting abnormal activity levels: the sensitivity of AE sensor networks is such that events unrelated to damage are prevalent in most applications. In this publication, we propose to monitor AE activity in a structure using a spatial scanning statistic, developed and used effectively in the field of epidemiology. The technique is demonstrated on an aerospace structure – an Airbus A320 main landing gear fitting – undergoing fatigue loading, and the method is compared to existing techniques. Despite its simplicity, the scanning statistic proves to be an extremely effective tool in detecting the onset of damage in the structure: it requires little to no user intervention or expertise, is inexpensive to compute and has an easily interpretable output. Furthermore, the generic nature of the method allows the technique to be used in a variety of monitoring scenarios, to detect damage in a wide range of structures.

1. Introduction

Acoustic emission (AE) testing or analysis is the name given to the technique of detecting small releases of energy (so called acoustic emissions) within a structure, usually pertaining to microscopic structural changes. The occurrence of energy release is generally caused by some outside loading of the structure: in the laboratory this may consist of some applied fatigue or tensile load to a specimen; where AE is used to monitor a structure *in situ*, the loading consists of the structure's normal service load. The point from which energy is released is known as the *source*, and the energy may arise from a variety of mechanisms including those related to fatigue fractures, tribological phenomena, corrosion, fibre breakage or pullout in composite materials, or a variety of other mechanisms. Strain energy released at the source propagates through the structure as elastic waves: these waves can be detected by transducers mounted on the surface of the structure. The response of the transducer can then be stored digitally for analysis.

In the field of condition monitoring, AE techniques have seen some successes [1–3]. In this case, where AE is used to monitor rotating machinery, the source of AE is continuous. Energy is released steadily as the machinery rotates, and the resulting signal recorded at a surface mounted transducer is stationary. Changes in the signal can be used to detect the

* Corresponding author.
E-mail address: james.hensman@sheffield.ac.uk (J. Hensman).

0888-3270/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.ymssp.2011.02.016