Detection of Fatigue Crack under Temperature Changes Using Stress Waves and Statistical Analysis

Jianfei TANG, Gang YAN, Chenning CAI
College of Aerospace Engineering, Nanjing University of Aeronautics & Astronautics, China
E-mail: tangjf@nuaa.edu.cn; yangang@nuaa.edu.cn; caichenming@nuaa.edu.cn

SUMMARY
This paper presents a study on monitoring and detecting of fatigue crack in metallic structure under temperature changes using stress waves and statistical analysis. The specimen is installed on a testing machine for generating fatigue crack under cyclic loads and an environmental chamber is employed to simulate temperature changes. The stress wave signals are processed by continuous wavelet transform (CWT) to extract signal features, and a statistical outlier analysis is adopted to detect the existence of fatigue crack from a statistical prospective.

INTRODUCTION
In aerospace engineering, one critical problem threatening the structural integrity is fatigue crack. A lot of stress wave-based methods have been proposed for crack detection. Most of them can be categorized as deterministic ones without consideration of uncertainties. Nevertheless, for the operation of real structures, due to various environmental conditions, such as temperature changes, even the structure is in pristine state, the stress wave signals obtained under different environmental conditions may be substantially different from the baseline signals obtained under a specific condition, leading to spurious results and false alarm. This paper presents a study on monitoring and detecting of fatigue crack in a metallic specimen under temperature changes using stress waves and statistical analysis.

EXPERIMENTAL SET-UP

EFFECT OF TEMPERATURE ON STRESS WAVES

SIGNAL PROCESSING & FEATURE EXTRACTION

OUTLIER ANALYSIS

• Outlier analysis can be considered as a special class of pattern recognition, which classifies the abnormal data or state from the normal ones. In structural health monitoring, outlier analysis has emerged as a robust unsupervised learning pattern recognition tool for damage detection.

CONCLUSION
The effects of temperature on stress waves in metallic specimen is studied by using experimental set-up consisting of an environmental chamber, a MTS testing machine and a monitoring system. The stress wave signals under different temperatures are processed by CWT to extract signal features, and a statistical outlier analysis is adopted to detect the existence of fatigue crack from a statistical prospective. Experimental results demonstrate that the proposed statistical method can successfully detect the existence of fatigue crack under the effects of temperature changes.