IMPACT DAMAGE DETECTION USING A VIBRATION BASED HEALTH MONITORING SYSTEM

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The high complexity and costs of modern aircraft and aerospace structural systems, combined with their high operational reliability and safety needs, have brought to an increasing interest in new approaches for structural health monitoring and damage analysis. Laminated composite materials often contain a variety of hidden internal flaws. They occur during manufacturing and processing of the materials or while the structure is subjected to service loads. A major concern in these structures is the growth of undetected hidden damage, caused by fatigue and foreign object's impact, that can reach a critical size during service. A continuous health monitoring system, sensitive to quite small changes of the structural integrity should be able to foresee the remaining operative life and recommend maintenance strategies.

It is well known that the presence of damage (cracks, delaminations, connecting elements faults, corrosion, etc.) modifies locally and globally the dynamic behaviour of a structure, due to a variation of structural damping, mass and stiffness distributions. A careful model-based analysis of this behaviour can, in principle, be used to determine the location and nature of the damage. Studies have been conducted to relate changes in the modal parameters to detect and characterize damage in idealized structures. However, the effects of a small flaw on the global vibrational properties (e.g., modal frequencies and mode shapes) of a structure, are usually not easily appreciable and the associated inversion problem is highly nonlinear and nonunique. Thus the inversion of the normal mode data, to detect the presence of localized damage in a structure, has proven to be extremely difficult.

The approach followed in this paper is based on the frequency response functions' (FRFs) measurements carried out on different damage conditions [1,2]. The comparison between the FRFs amplitudes allows to develop damage indices in order to locate and quantify impact damage in composite structures. Both the data acquisition and analysis phases have been implemented into dedicated PC codes developed in LABVIEW and MATLAB programming environment in order to reduce as much as possible the human factor and the time consuming. The technique stipulates the use of a sparsely distributed network of low frequency sensors to measure the structure's global response. The relative effectiveness of the method is examined for various sensor locations relative to the defects. Ultrasonic non-destructive scanning are also carried out to have an exact localization and characterization of the impact damage. The experimental tests have been carried out on woven composite test articles.

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References

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