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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
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A NEW STRUCTURAL HEALTH MONITORING (SHM) SYSTEM USING INTEGRATED POLYVINYLIDENE DIFLUORIDE (PVDF) TRANSDUCER NETWORKS

Abstract

The problem of material monitoring on composite structures can be solved with a set of methods developed during the recent years, especially in the aerospace field. The current project aims to develop a robust, effective and low-cost system combining an integrated network of transducers. Several elements compose the whole system, namely an optimized integrated transducer network, an identification algorithm, a numerical finite element (FE) model, a frequency model and a modal model of the structure. The core physical principle the system is based on takes advantage of the quadratic relation between structural stiffness and natural frequencies. The evolution of stiffness can be recorded as a structural ageing pattern or a local damage, which is one of the main structural health monitoring (SHM) objectives. In this particular case, a prototype system has been developed using a polyvinylidene difluoride (PVDF) patch transducers network, with a data acquisition and handling system managed by a computer or a similar device. The software includes a MATLAB code performing the signal acquisition and the modal extraction, necessary to obtain the natural frequencies, through Operational Modal Analysis (OMA). Complementary tools as the transducer placement optimizer and a material characterizing program are also included as a part of the system. Basically, using only random unknown excitation sources (e.g. like wind) widely present in nature, this SHM system is able to extract information about the state of the structure. The power of the tool is evident when even in any natural excitation source is absent or insufficient, the transducer network itself can actuate in order to simulate the excitation and so study the structure. One of the main industrial applications of such a system is the technical support that can be delivered by an integrated light transducer network in large full-scale composite structures, such as the new-generation commercial airliners B787 and A350, of which most of the dry weight is composed by certified carbon fibre reinforced plastics (CFRP). This system can be expanded to other aerospace industrial applications, or even purely scientific applications, in the frame of aero-space testing and certification of novel materials submitted to highly demanding environments, such as the high atmosphere or the outer space.