Survey of Non Destructive Evaluation Techniques for Structural Health Monitoring of Aging Aircraft

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Abstract

Civil and military aircraft are being used significantly longer than their original design life because of cost benefits. Since these aircrafts are being used beyond designed life, there is significant aging of these aircraft structures due to prolonged use. This aging aircraft issue caught international attention when an in-flight structural failure occurred in Aloha Airlines Boeing-737. This structural failure forced regulatory agencies to impose more stringent airworthiness requirement for aging aircrafts. To meet airworthiness requirement, aging aircraft fleet has to follow various maintenance procedures and undergo mandatory inspections to control structural failures like fatigue, corrosion, multiple site damage (MSD), etc. The mandatory inspections are typically done offline and use conservative inspection frequencies to ensure safety. These inspections tend to be expensive and incur downtime because of the need of teardown inspections. Therefore, reliable and cost effective techniques for the non-destructive evaluation (NDE) of aircraft materials and mechanical structures have become very important to ensure minimal maintenance cost and maintaining high safety standards. Recent advances in NDE technology, smart sensors, signal processing and presentation techniques offer the possibility of significant cost saving as well as improved safety and reliability. Aircraft designers have started integrating sensors, actuators and intelligent signal processors in structure design for reliable damage monitoring. Smart structures and materials have opened new opportunities for damage monitoring. The purpose of this survey paper is to review the primary aging mechanisms in aircraft structures and identify current and upcoming NDE technologies for integrated structural health monitoring.