Flight testing of an ultrasonic based SHM system

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We have been developing an Ultrasonic based structural health monitoring (SHM) system which can provide essential information on structural integrity of airframes. The SHM system can be used in whole aircraft lifecycle from design phase to disposal / recycle phase. In order to achieve implementation of the SHM system, we have conducted various types of tests, in which we assessed damage detection capability, accuracy and probability of damage detection, environmental durability, and applicability to aircraft system, and so on, based on the building block approach. In the SHM system, ultrasonic waves are generated and measured with micro actuators and optical fiber sensors which are installed in aircraft structures directly. When damages initiate and grow in the structures, ultrasonic waves which propagate thorough the structures are influenced and changed by the damages. The changes of the ultrasonic waves are analyzed in the SHM system; consequently, the damages can be detected. Overview of the SHM system is shown in figure 1.

In order to evaluate compatibility to an actual aircraft and detection capability in actual aircraft operating conditions, which influence to measurement of ultrasonic waves, flight testing for the SHM system was conducted. Micro actuators and optical fiber sensors were installed to airframes directly and to a test specimen which was installed to an airframe as well. An interrogation unit and control PC were also installed in the cabin with a rack. The flight testing was conducted with a flying test bed (FTB), which was modified by Japan aerospace exploration agency (JAXA) from a biz-jet class aircraft, Sitation Sovereign, manufactured by Cessna. Some flight maneuvers were carried out in a series of the flight testing and ultrasonic waves were measured not only on ground but also in-flight conditions. From the result of the flight testing, it was confirmed that ultrasonic waves could be measured in-flight conditions just like those measured on ground and damages introduced to the test specimen could be detected by analyzing the changes in waveforms of the ultrasonic waves even in the actual operating aircraft.

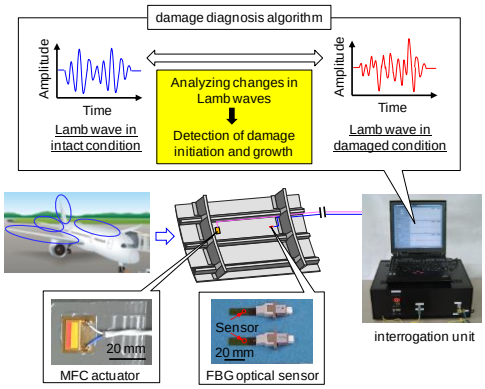

Figure 1. Overview of the ultrasonic based SHM system.

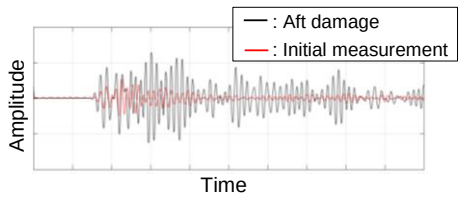

Figure 2. ultrasonic waves before and after damage measured in the test specmen.

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