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STRUCTURAL HEALTH MONITORING DURING SUBORBITAL SPACE FLIGHT

Abstract

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Abstract

Structural Health Monitoring (SHM) has potential to revolutionize assessment and qualification of space vehicles. This technology is seen as important element in improving safety of space travel and reducing spacecraft operation costs. It is envisioned that structural health monitoring will provide near real-time information on structural integrity and report potentially abnormal behavior to astronauts or support personnel. In this capacity, SHM system is viewed as an integral part of spaceflight information system and flight recorder.

A concept of spacecraft SHM system was implemented in a payload designed by New Mexico Institute of Mining and Technology and flown in November 2013 on NASA FOP commercial suborbital spaceflight. The aim of the test was to investigate performance of state-of-the-art SHM technologies in launch, accent, space, and decent environments as well as survivability at landing. Two SHM approaches were considered: wireless strain and temperature sensing and active/passive embedded ultrasonic, which included elastic wave propagation studies, electro-mechanical impedance diagnostics, and acoustic emission monitoring.

Wireless strain and temperature measurements, which university conducted in collaboration with Microstrain Corporation, allowed for collecting data at various locations inside payload and for investigating prospects of wireless sensing during commercial spaceflight. Interference with other payloads and vehicle's command/control/communication were considered and the test has demonstrated utility of on-board wireless sensing.

The university cooperated with Metis Design Corporation on active and passive embedded ultrasonic experiments. Active ultrasonic testing provided data on variation of structural sound speed during the flight and confirmed noticeable difference for in-space and on-the ground conditions. Additional active ultrasonic experiments have demonstrated potential for in-flight detection of structural cracks and loose bolted joints. Acoustic emission activity was measured in the passive embedded ultrasonic experiment, which indicated possibility for sensing structural events. Electro-mechanical impedance data was collected using measurements boards provided by Los Alamos National Laboratory's Engineering Institute.

Collected structural health data indicates feasibility of SHM during suborbital flight and highlights importance of acquiring environmental parameters that could influence diagnostic decisions.