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Author: Prof. Andrei Zagrai
New Mexico Tech, United States, azagrai@nmt.edu

SUBORBITAL AND ORBITAL STRUCTURAL HEALTH MONITORING USING THE GUIDED WAVES AND THE ELECTRO-MECHANICAL IMPEDANCE METHOD

Abstract

The use of space systems is essential for modern life, and technological innovations are crucial for making space vehicles reusable, safe, and affordable. Smart space systems have been developed to improve vehicle's self-awareness, adapt to operation conditions, and reduce operation costs. Structural health monitoring (SHM) is seen as one of key technologies to support future smart spacecrafts. SHM aims to sense, assess, and predict structural behavior providing crucial input into mission control and retirement decisions. In-flight data is of a paramount importance to implementation of SHM to space vehicle's management. This contribution discusses results of the use of SHM systems in suborbital and orbital flights. SHM results from several suborbital flights show a notable dependence on the flight trajectory. The development and preliminary tests of the SHM payload for LEO experiments on ISS are presented, which include investigating guided wave propagation and structural vibration for a payload placed outside the ISS. Authors present practical considerations for SHM payload designs and electronic component selection for guided wave and electro-mechanical impedance experiments. A particular attention is given to the development of a miniaturized electro-mechanical impedance hardware and its application in suborbital and orbital flights. A program of utilizing the electro-mechanical impedance measurements for structural dynamic measurements on ISS is outlined. Recommendations for the integration of SHM in future space vehicles and research directions are provided.