Paper ID: 88342
oral
student

IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures III Design, Development and Verification (Orbital infrastructure for in orbit service & manufacturing, Robotic and Mechatronic systems, including their Mechanical/Thermal/ Fluidic Systems) (3)

Author: Mr. Lukas Peterson
New Mexico Tech, United States

Prof. Andrei Zagrai
New Mexico Tech, United States

PIEZOELECTRIC SENSOR SYSTEM FOR STRUCTURAL HEALTH MONITORING OF SPACECRAFT DOCKING

Abstract

Since the advent of the space industry average satellite lifetimes have been gradually increasing. With the increase in satellite lifespan on orbit it is becoming increasingly economically advantageous to refuel and conduct in-orbit servicing rather than launching new satellites. This presents a challenging problem as current docking state indicators are suboptimal for the docking of small automated spacecraft. A structural health monitoring system with an aim to assist in on-orbit serving is proposed. The active elements of the system are small unobtrusive piezoelectric sensors capable of passively listening to mechanical events and enabling ultrasonic assessment in the active mode. A laboratory specimen representative of a docking interface was instrumented with piezoelectric sensors and was subjected to typical docking loads. The acoustic emission signals generated by docking were collected and analyzed for features indicative of a reliable connection. An algorithm was developed to de-noise the signal and to classify the state of the current docking sequence. The classification algorithm was deployed on a small microcontroller unit to enable future experiments in a space environment. Docking impact loads were used to excite structural vibrations in the docking tube enabling its structural dynamic characterization. The obtained structural dynamic responses were utilized in structural health monitoring of the docking system and verification of the successful docking. It is proposed that integration of the SHM into the servicing spacecraft could improve reliability and efficiency of on-orbit service.