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Author: Mr. Joel Quintana
University of Texas at El Paso, United States

Dr. Jack Chessa
University of Texas at El Paso, United States
Dr. Virgilio Gonzalez
University of Texas at El Paso, United States

LOCATION OF A MAXIMUM DEFLECTION POINT WITH FIBER BRAGG GRATINGS IN POLARIZATION-MAINTAINING OPTICAL FIBER

Abstract

With the recent prevalence of composite laminated or fully composite, reusable rocket structures, it is of critical need to evaluate the structural health of each rocket before, after and possibility during each launch. FBG sensors have proven to be excellent devices for structural health monitoring (SHM) and are quickly becoming economically advantageous over electronic, conventional strain gauges. FBG strain sensors offer many well-known advantages and are exceptionally accurate when measuring strains that are orientated in the longitudinal direction with respect to the sensor. FBG sensors written in PM fiber offer additional dimensions of strain measurement per sensing element, reducing the number of sensing units per area.

We build a strain profile of a flat composite plate with concentrated load acting at the center. The FBG PM sensors are placed at random on the surface of the plate. We then calculate spectral shifts caused by the applied axial and traversal strains on the sensors and compare to a predetermined optical baseline. From the optical signal, the shift deltas in wavelength are parsed to correspond to axial and transversal strains. This exercise validates a method of optical detection and shift calculation for multi-axis sensors as an automated, integrated system.

Of particular interest is defining the minimum number of sensors required to detect a critical flaw. In this spirit, this paper defines the theoretical minimum number of the PM FBG sensing elements needed to detect a point of maximum deflection on the panel. The point of maximum deflection has been located on a Cartesian plane by formulating orthogonal vectors from the strain tensor of each sensing element at the its location. A group of vector intersects with the minimum Euclidian distance from each other correspond to said point.

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