Fiber Bragg grating sensors probed by artificial intelligence to detect and localize impacts on structures

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***Abstract*— This work proposes a system composed of four optical sensors based on fiber Bragg gratings to monitor a planar structure regarding to external localized impacts. Data processing occurs into two stages in which cascaded multilayer perceptron artificial neural network models supervise the FBGs: one determines the relative distance between the impact and each FBG and the other establishes the Cartesian coordinate. Results show that FBG strain sensors can identify impact location on structures, despite the complexity of the events and without the need for a fast response optical interrogation unit. The sensing system provided the impact location with a mean squared error of 1.11 cm in the test step.**

***Index Terms* —** optical fiber sensor; fiber Bragg grating; smart sensor; structural integrity; artificial neural network.

I. INTRODUCTION

Dynamical monitoring of structures is an important engineering field, since the obtained data allows detecting, localizing and quantifying the occurrence of events on the body structure. Furthermore, the whole condition of the structure monitored along the time provides information about its structural health that may be impaired by a series of events. Among a number of applications, important examples of dynamical structural monitoring include non-destructive test of materials, sensing of bridges, buildings, aircrafts and ships [1]-[3]. In a sense, an efficient system for impact detection, able to supply data in real time to identify accurately the event location and its intensity can be used to indicate whether a structure must be subject to maintenance or not. A sensing system for impact location allows the development of projects for optimizing performance, minimizing damages and increasing the structure reliability.

In the past few years, optical fiber sensors based on fiber Bragg gratings (FBG) have been applied on the monitoring of structures [4]-[6]. In 2006, Cowie et al. proposed the usage of a small number of FBG in distributive tactile sensing. A set of nine FBG sensors was able to distinguish the location and

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