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Use of Smart Technologies in Bridge Construction

George Akhras
Department of Civil Engineering,
Royal Military College of Canada,
P.O. Box 17000, Stn Forces
Kingston, Ontario, Canada, K7K 7B4

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To perform a qualitative as well as a quantitative assessment of a bridge, appropriate diagnostic information on its health is required. As in many industries such as the aerospace or the automotive ones, three distinct techniques are used to examine the integrity of civil engineering structures, e.g., a bridge. There are: the visual inspection technique, the destructive methods and the non-destructive evaluation (NDE) methods. Among the prevalent conventional NDE methods are the following procedures: acoustic, ultrasonic, X-ray imaging, pulse echo and sonic. Alike the first two methods, many of these NDE techniques are passive, occasionally expensive, sometimes inconclusive, and mostly external to the structure.

Adding smart sensing and actuating functions in a bridge has two basic advantages. The first is to reduce the need for inspection to assess the integrity of the structure or at least increase the reliability of the diagnostic process and the second is to take some action to preserve the integrity of the bridge. These sensors and actuators are typically made of materials such as piezoelectric, shape memory alloy, magneto restrictive, electrorheological, fiber optics, and are usually attached or embedded into the host structure to either measure or excite its behaviour.

The recent advances in smart structures and materials technologies offer a unique opportunity for the owners of large civil engineering structures like bridges to monitor continuously their health condition and assess efficiently their behaviour and structural integrity. So, based on the definition of smart structures presented previously by Spillman *et al* [1], the author [2-3] and others [4-6], this paper starts by introducing a system of classification of structures in order to rate the status of a structure and its degree of "smartness". This consists of the description of the four types of structures: passive, active, adaptive and smart. However for a better characterisation, the previous classification and definition of a smart structure are adapted to reflect the specifications and conditions directly related to bridges. Hence, the five components of a smart bridge are:

1. Data acquisition
1. Data transmission
3. Control Centers
4. Data instructions
5. Action devices

The paper proposes a table listing various products, devices and technologies related to each of the previous five components of a smart bridge. This table serves as a base reference to describe each bridge and the following figure presents a schematic view of a smart bridge with few of the previous components. A second table presents a selection of bridges with

different degrees of "smartness". The paper concludes with remarks on the state of this new technology. This is a part of an ongoing work on the use of smart materials and structures for applications in Civil Engineering.

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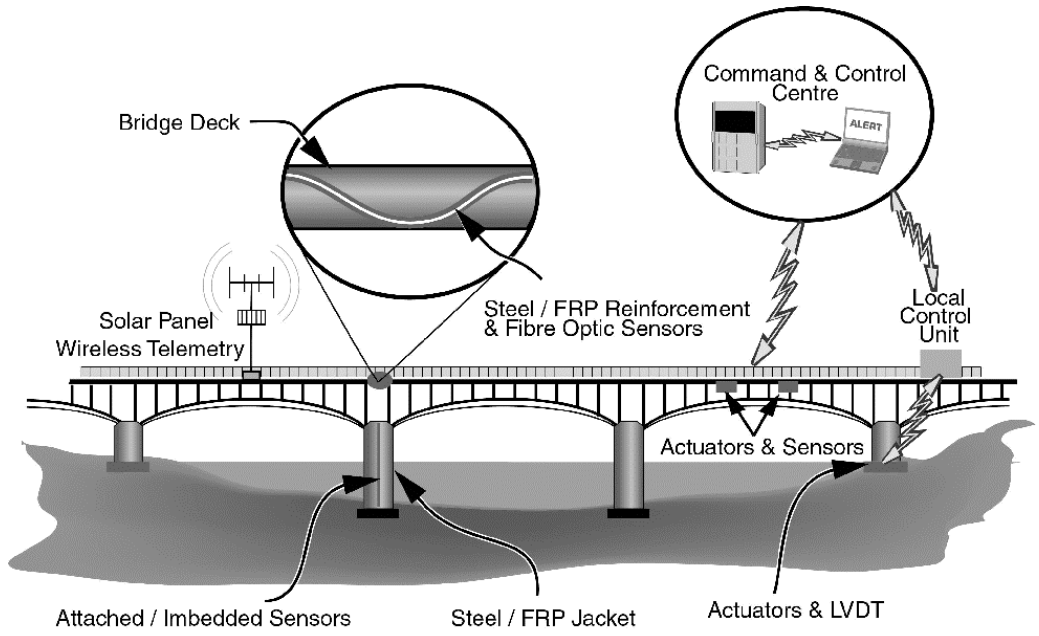

A schematic view of a smart bridge.