Big data and structural health monitoring

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Abstract

Structural health monitoring (SHM) has experienced decades of progress in developing sensors and data processing systems, collecting and storing massive amounts of information. Today, for structures' owners or stakeholders, this data constitutes a promising material of knowledge. This information is a form of "big data", so-called not only for its sheer volume, but also for its complexity, diversity and timeliness. Learning from these large volume of data is expected to bring significant advances in science and engineering. From banking to retail, many sectors have already embraced big data; grocery stores examine customer loyalty to identify sales trends, optimize their product mix, and develop special offers. Healthcare industry is currently following the same way. While big data come with "big blessings", there are formidable challenges in dealing with large-scale data sets. Big data challenges offer ample opportunities for "Data Processing" research. Through different examples of bridges' monitoring, the paper will contribute to the ongoing cross-disciplinary efforts in data science by putting forth encompassing models capturing a wide range of data analytics tasks for structural health monitoring.

Keywords: Big data, structural health monitoring, forward techniques, data learning.

1 Introduction

Structures (bridges, buildings…) are continuously submitted to aggressive environmental conditions, the aging of their components or constitutive materials, changes or exceptional loading effects. In order to improve the assessment of structural performance, or at least to appreciate the condition of structures in an objective and accurate way, it is important to characterize the real behaviour of the structure. This process of determination, monitoring and assessment of the level of service of structures is the core of structural health monitoring (SHM). Structural health monitoring is basically an activity where actual data related to structures is observed, measured, recorded and processed. This service has been performed through all times by designers, contractors and owners with almost identical objectives – to check that the structures behave as intended.

Structural health monitoring has drastically changed thanks to the development within information technology in the last two decades. High performance sensors, precision signal conditioning units, optical or wireless networks, global positioning systems… have contributed to the development of more accurate and cost efficient data acquisition systems. In turn, data sets are growing rapidly. This explains an international enthusiasm for implementing monitoring systems on structures. Figure 1 gives, as an example, the exponential evolution of the number of sensors installed on some major new bridges during the past 10 years. This figure only indicates the number of sensors. As one sensor has at least one measurement channel, it is easy to show that the values given in Fig.1 may largely under-estimate the data workflow (as example, the Rion-Antirion bridge carries 400 channels). Structural health monitoring (SHM) has thus emerged as a high-tech technical discipline,

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