Chapter 8
Feature Engineering for Structural Health Monitoring (SHM):
A Damage Characterization Review

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ABSTRACT

Feature engineering is a key component contributing to the performance of the computer vision pipeline. It is fundamental to several computer vision tasks such as object recognition, image retrieval, and image segmentation. On the other hand, the emerging technology of structural health monitoring (SHM) paved the way for spotting continuous tracking of structural damage. Damage detection and severity recognition in the structural buildings and constructions are issues of great importance as the various types of damages represent an essential indicator of building and construction durability. In this chapter, the authors connect the feature engineering with SHM processes through illustrating the concept of SHM from a computational perspective, with a focus on various types of data and feature engineering methods as well as applications and open venues for further research. Challenges to be addressed and future directions of research are presented and an extensive survey of state-of-the-art studies is also included.

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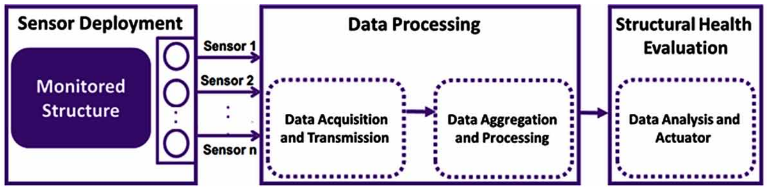
Figure 1. General architecture of standard SHM system



INTRODUCTION

In recent years, Structural Health Monitoring (SHM) is an emerging field that received remarkable attention from many researchers, and its techniques have been noteworthy improved by integrating advancements in communication and sensing technology. The focus of SHM is on the condition assessment, especially structures durability, of different structure types; including civil structures, mechanical, and aerospace, using a dense deployment of various sensors. Thus, SHM is a substantial method of estimating the integrity of structures through detection, localization of damages, and estimation of structures durability, based on the appropriate analysis of the measured data in situ. The goal of SHM is not solely monitoring the integrity of structures, but also is providing an estimation for the damage at earlier stages, which results in determining the ideal repair strategies before the structural damage results in failure, increasing safety, and decreasing maintenance cost (Dorvash, Pakzad & Cheng, 2013; Fang, Liu & Teng, 2018; Bolandi et al., 2019; Abdulkarem et al., 2020).

A standard SHM system comprises three major components (Dorvash, Pakzad & Cheng, 2013; Zhou & Yi, 2013; Fang, Liu & Teng, 2018; Bolandi et al., 2019; Abdulkarem et al., 2020), as depicted in Figure 1.

1. Sensor Deployment: This component aims to use the different sensors to measure the required data parameters of a structure, such as acceleration, images, stress, and displacement. Moreover, the influential environmental parameters (e.g., humidity, temperature, and wind speed) are measured. These parameters provide necessary data for structural health assessment.
2. Data Processing: This component comprises data acquisition and transmission, data aggregation and processing, and storage modules. Data acquisition and transmission module is responsible for data collection from various SHM sensors and achieved by sensor nodes. Data aggregation and processing module is necessary for extracting features of SHM algorithms and can be allocated in different units such as sensor nodes and base stations. It also can take place before or after data transmission, according to the network topology and data processing strategy.
3. Structural Health Evaluation: The main task of this component is to estimate the overall stability and safety of the structure.

Accordingly, having an SHM system helps at the following domains (Yan, Chen & Mukhopadhyay, 2017):

1. **Enhancement of Structural Integrity:** The weak structure can be enhanced based on the conditional information of SHM.