



Structural health monitoring with wireless sensors to enhance sustainability in structural engineering

Markus KRUEGER

Senior Researcher
MPA Universität Stuttgart
Stuttgart, Germany
markus.krueger@mpa.uni-stuttgart.de

Christian U. GROSSE

Head of Department NDT
MPA Universität Stuttgart
Stuttgart, Germany
christian.grosse@mpa.uni-stuttgart.de

Hans-Wolf REINHARDT

Professor
IWB, Universität Stuttgart
Stuttgart, Germany
reinhardt@iwb.uni-stuttgart.de

Summary

Acoustic emission techniques (AET) are an alternative monitoring method to investigate the status of a bridge or some of its components. It has the potential to detect defects in terms of cracks occurring during the routine use of bridges. A monitoring system for large structures is developed based on a new kind of MEMS sensors as well as conventional sensors requiring just very low power. Besides the sensors the recording and analysis technique needs powerful algorithms to handle and to reduce the immense amount of data. Systems developed for structural health monitoring use embedded network techniques along with wireless communication and MEMS. Algorithms to reduce the amount of data and to enable the localization of damage areas by array techniques have to be developed. The paper is giving an overview about data processing and analysis techniques needed for wireless sensor networks with respect to structural health monitoring. The focus is especially in the field of acoustic emission techniques where often a large amount of data must be processed.

Keywords: Structural health monitoring; wireless sensor networks; acoustic emission; MEMS; acoustic beamforming.

1. Introduction

In Europe, the demand for non-destructive testing methods and monitoring techniques is rapidly increasing. For maintenance purposes it is more and more recommended not only to inspect building structures like bridges or structural elements at certain time intervals. This problem becomes very important at railway bridges that are confronted with higher axle loads and higher train speeds. In this context a European Research Project was approved in the Sixth Framework Programme where, among others, the Institute of Construction Materials of the University of Stuttgart is involved [1]. One objective of the project is to provide monitoring techniques that could help the bridge owners to specify the real structural behaviour of their bridge stock.

In several cases of uncertainty wired monitoring systems were already installed on bridges to analyze the structural behaviour and the deterioration processes. For such monitoring systems often standard sensor technologies or high-tech sensor technologies were used that are relatively expensive in respect to the value of the structure and often time consuming to install. Consequently the installation of conventional monitoring systems is considered on a few bridges only.

A wireless monitoring system equipped with competitive sensors could reduce these costs dramatically. One objective of monitoring civil engineering structures is to detect failure of the structure or moreover of structural parts of a structure that reduce the load bearing capacity or the remaining lifetime. The detection and localization of steel tendon failure or concrete cracking in bridge constructions are some examples of a monitoring task. Among other monitoring techniques the acoustic emission technique is commonly used for the detection and localization of such failures.