BRIDGE MONITORING WITH WIRELESS ACOUSTIC EMISSION SENSORS

N. F. Ince[1], Chu-Shu Kao[2], M. Kaveh[1], A. Tewfik[1], J. Labuz[2] and T. He[3]

[1]Department of Electrical and Computer Engineering, [2]Civil and Environmental Engineering and [3]Computer Science and Engineering,
University of Minnesota
Minneapolis MN

The recent collapse of the I-35W bridge has highlighted the need for continual health monitoring of bridges. Currently, bridges are mainly inspected visually. The recent advances in wireless sensor networks, micromechanical sensors and acoustic emission (AE) processing techniques have opened new possibilities for monitoring of the health of bridges and the provision of alarms related to the potential for serious degradation of structural integrity in an automated manner. In this paper, we describe the design issues, recent progress in signal processing methods and challenges in the detection and propagation of cracks in critical components of structures such as bridges using AE data. We summarize two suites of techniques developed for denoising and clustering the observed AE recordings. In particular, the first suite of procedures relies on a combination of covariance analysis, principal component analysis (PCA), differential time delay estimates and self-organizing map (SOM) neural network classification for separating signals of interest from noise and interference and for localizing the source of such AE signals. The second suite of algorithms implements hierarchical clustering procedures by using the cross correlation across different events. We also present some preliminary laboratory results in detecting the location of the crack in a rock by examining the AE events recorded from 8 piezoelectric sensors. Increases in the rate of production of acoustic emissions, changes in their spatial distribution and cross correlation across events are indicative of a potential catastrophic failure.

References

[1] J. P. Lynch and K. J. Loh, (2006). *A Summary Review of Wireless Sensors and Sensor Networks for Structural Health Monitoring.* The Shock and Vibration Digest; 38; 91.

[2] C. Grosse, S.D. Glaser, Krüger M. *Wireless acoustic emission sensor networks for structural health monitoring in civil engineering,* 2006. Proc. European Conf. on Non-Destructive Testing (ECNDT), DGZfP BB-103-CD, Berlin, Tu.1.7.3, pp 1-8.

[3] V. Emamian, M. Kaveh, A.H. Tewfik, Z. Shi, L. J. Jacobs, J. Jarzynski. *Robust Clustering of Acoustic Emission Signals Using Neural Networks and Signal Subspace Projections*, 2003. EURASIP Journal on Applied Signal Processing, vol. 2003, no. 3, pp. 276-286.

[4] N. Iverson, Kao C-S. and Labuz J.F. *Clustering Analysis of AE in rock.* 6th International Conference on Acoustic Emission, 2007. ICAE-6, Lake Tahoe NV USA.