

Development of a real time hardware-software system for Structural Health Monitoring using ultrasonic guided waves

1 – Subject

The ‘Laboratoire d’Acoustique de l’Université du Maine (LAUM CNRS 6613)’, Le Mans, France and the ‘Groupe Signal Image and Instrumentation’ ESEO graduate school of engineering, Angers (GSII-ESEO) are partners in academic research since many years. More in detail, the GSII-ESEO main field of expertise is the development of real time signal processing techniques and data analysis for acoustic and vibration problems, with a particular attention to Non Destructive Testing (NDT) and Structural Health Monitoring (SHM) [1, 2, 3]. In this framework, the GSII-ESEO, together with the LAUM, proposes a PhD thesis focused on real time communication systems to monitor *in situ* the integrity of structures using ultrasonic guided waves.

The PhD thesis main goal is to develop a stand-alone real time system for Structural Health Monitoring composed by a network of several ultrasonic transducers (PZT transducers) integrated in metallic or composite components (i.e. airplane components and/or building materials). Thanks to a dedicated real time signal analysis and processing, the proposed system will be able to detect and locate in continuous mode typical fatigue or stress flaws (cracks, delamination) as well as humidity conditions.

This work will count on recent achievements in signal processing able to identify *in situ* mechanical properties of several materials as well as temperature changes [4]. These techniques have been already successfully used to improve the quality and the reliability of flaws detection using imaging techniques, in Aluminum plates [5]. This work will include as well an estimation of the precision *a priori* tied to the flaw localization in a plate. This will lead to an optimal choice of the transducers position [6]. A particular attention will be paid to potential industrial applications. For this reason, the realization of a prototype fully operational for aeronautics components testing will be considered.

2 – Keywords

Structural Health Monitoring, embedded signal processing, real time electronics, data analysis, array transducers, composite materials.

3 - References

- [1] S.-E. Hamdi, Contribution au traitement du signal pour le contrôle de santé in situ de structures composites : Application au suivi de température et à l’analyse des signaux d’émission acoustique, Université du Maine, Thèse de doctorat, 2012.
- [2] M. Darwiche. Apprentissage statistique pour l’évaluation et la contrôle non destructif : application à l’estimation de la durée de vie restante des matériaux par émission acoustique sous fluage. Université du Maine, Thèse de doctorat, 2013.
- [3] S.E. Hamdi, A. Le Duff, L. Simon, G. Plantier, A. Sourice, and M. Feuilloy, Acoustic emission pattern recognition approach based on Hilbert-Huang transform for in situ structural health monitoring in polymer-composite materials, *Applied Acoustics*, Volume 74, Issue 5, May 2013, Pages 746–757
- [4] A. Le Duff, S.E. Hamdi, P.C. Ostiguy, G. Plantier, and L. Simon. Comparison of scale factor estimators for ultrasonic temperature monitoring: Application to structural health monitoring. *Applied Acoustics*, 76(0):346 – 358, 2014
- [5] P.C. Ostiguy, A. Le Duff, N. Quaegebeur, L.P. Brault and P. Masson, In-situ characterization technique to increase robustness of imaging approaches in structural health monitoring using guided waves, *Structural Health Monitoring*, 2014 (à paraître)
- [6] A. Le Duff, S.E. Hamdi, G. Plantier, A. Sourice and R. Feron, Cramer-Rao Bounds for Acoustic Emission Events Localization in a Flat Plate, *Acoustics 2012*, Nantes, France, april 2012.

4 – Supervisors

- Alain Le Duff –ESEO Group, Angers - LAUM
- Mathieu Chekroun – LAUM, Le Mans
- Roberto Longo –ESEO Group, Angers - LAUM

5 – Work place and beginning period

The proposed PhD thesis will take place in Angers (France) at the ESEO graduate school of engineering, starting from September 2014. Periodic visits to the LAUM, Le Mans, should also be taken into account.

6 – Candidate profile

The ideal candidate should have a master degree in electronic engineering, with an orientation in signal processing.

A general knowledge of continuum mechanics and ultrasonic waves will be appreciated.

The candidate should also have experience in programming with MATLAB/ Simulink; knowledge of LabVIEW will be a plus.

Good interpersonal and communication skills (both in English and French) are also required.

7 – How to apply

Applicants should send a cover letter, CV, and recommendation letter to:

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