Improving efficiency and robustness of SHM techniques based on Lamb wave detection– SMART 2019

J. Rebufa*, G. Jaussaud*, F. Claeyssen*, M. Fournier*, M. Logeais*, N. Bencheikh*

M. Rébillat and M. Guskov****

* Cedrat Technologies
59 Chemin du Vieux Chêne - Inovallée - 38246 Meylan cedex – France
Email: jocelyn.rebufa@cedrat-tec.com, https://www.cedrat-technologies.com

** PIMM Laboratory, ENSAM-CNAM-CNRS
151 Bd de l'Hôpital 75013 Paris - France
Email: marc.rebillat@ensam.eu - https://artsetmetiers.fr/

ABSTRACT

Ultrasonic waves generated by piezo-electric patches offer a very promising way to perform Structural Health Monitoring (SHM) of composite aeronautic structures. Permanently bonded sensor arrays are interesting for on-demand interrogation of the structure in order to localize damages (pits), or to follow damage progression (cracks). In this paper, improvements of the piezo-electric system efficiency and robustness are introduced as a critical feature for SHM applications. This work takes part of the H2020 REMAP project about adaptive aircraft maintenance planning.

On one hand, Lamb waves detection techniques have been enhanced by developing a dedicated electronic system called Lamb Wave Detection System (LWDS). This module allows to use each piezo element in an array either in emission or reception mode with a high frequency of commutation between these two states. Each sensor can not only be used in the usual pitch-catch method, (i.e. one sensor is emitting and the other sensors are receiving the propagated wave information), but also in pulse-echo (i.e. emitting a lamb wave and listening to the echo simultaneously). This feature can drastically improve PZT network efficiency for SHM purposes as one additional information source (the signal received back by the exciter) is made available.

On the other hand, the robustness of the sensor integration has been improved by focusing on a fine study of coupling efficiency between the piezoelectric patches and Lamb wave propagation through so-called tuning curves. As a result, coupling dispersion curves are proposed in accordance with FEM modelling and experimental testing and help in selecting the correct frequency range for ultrasonic SHM interrogation.

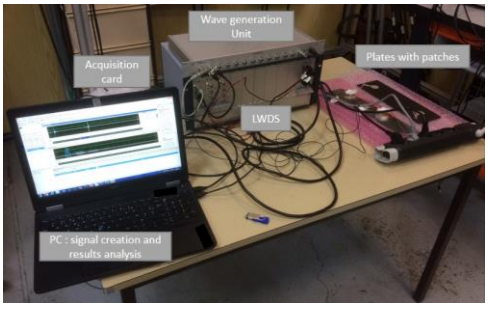

Figure 1 – Test bench of Lamb wave emission and acquisition with LWDS

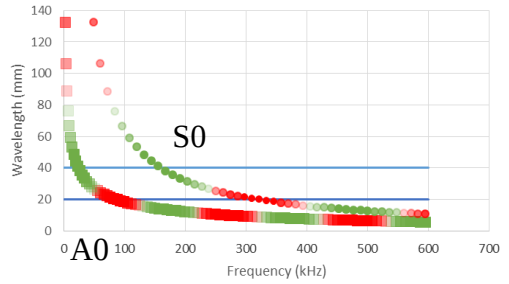

Figure 2 - Dispersion curves of Lamb waves for a patch diameter 20 mm. Good coupling shown in green, low coupling in red

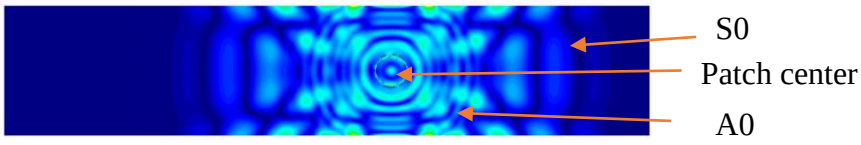

Figure 3 - FEM modelling of a patch on a board sample in transient modelling (top view)

[1] E. Balmes, M. Guskov, and J.-P. Bianchi, "Validation and verification of FE models of piezo based SHM systems,", ISMA International Conference on Noise and Vibration Engineering, Sep. 2016

[2] Fendzi C., Rébillat M., Mechbal N., Guskov M. & Coffignal G., "A data-driven temperature compensation approach for Structural Health Monitoring using Lamb waves", Structural Health Monitoring, 2016, 15 (5), pp.525-540.