Application of a Dual PZT Sparse Array with Lamb Wave Mode Decomposition for Damage Localization in an Aluminum Aircraft Wing

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ABSTRACT

Dual lead zirconate titanate (PZT) transducers have recently been developed for structural health monitoring (SHM) applications. These transducers have been shown to be a suitable option for decomposing a guided Lamb wave response that contains a mixture of the fundamental symmetric (S0) and antisymmetric (A0) modes[1]. This ability to decompose the wave response, or more accurately, to highlight an individual mode, is applied in this experimental work for damage localization using a sparse transducer array. For this paper, studies were performed on a section of an aluminum alloy skin plate of a Piper Cherokee wing. The skin plate is supported by structural features common to most aircraft such as stringers, ribs, and rivets. Such features often pose a challenge to guided wave SHM over a large area due to scattering effects, mode conversion, and attenuation of the guided waves[2]. Damage was simulated using magnets of various strengths and shapes placed on either side of the wing skin. Sparse array images were constructed using baseline-subtracted signals from all possible sensor actuator pairs using ellipse summation and correlation algorithms[3]. This work shows that dual PZTs can potentially be used to improve sparse array imaging techniques due to the transducers' mode decomposition capability. Specifically, preliminary results suggest that the decomposed S0 mode can be used at certain frequencies and farther damage locations where neither the A0 or S0 mode are as effective with single element transducers. Also, this study provides a general comparison between the A0 and S0 modes and their damage localization capability with the given experimental setup. Furthermore, this work demonstrates that if a baseline is used, structural features such as stringers and ribs in the present configuration do not significantly affect the localization capabilities of the proposed sparse array method, as shown in Fig. 1.

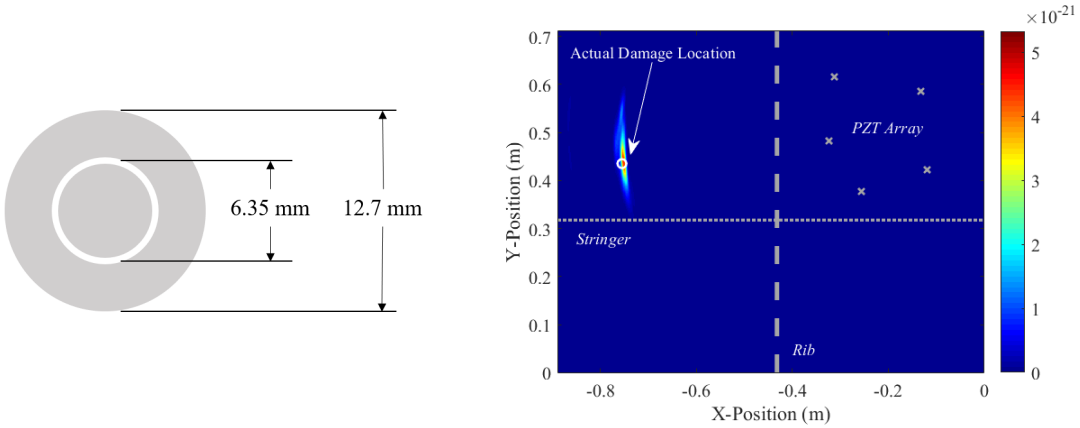

Fig. 1 – Dual PZT diagram with approximate dimensions (left), and sparse array damage image using the S0 decomposed differential signal and correlation algorithm (right).

REFERENCES

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