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SH1 GUIDED WAVE TOMOGRAPHY

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ABSTRACT

It is vital for the petrochemical industry to be able to accurately quantify wall loss, especially for the case of corrosion under pipe support, where limited access to the corroded area increases inspection difficulty. Guided wave tomography has been proposed as a solution, as it can provide thickness maps of the region of interest by utilizing the dispersive nature of certain guided wave modes. The maps are generated by transmitting guided waves through the corrosion patch and applying tomographic reconstruction methods to the measured signals. Previously, fundamental Lamb wave-mode based approaches have been shown to be able to reconstruct the thickness of corrosion patches [1]. However, they suffered from poor resolution as they operate at low frequencies and differ in their scattering behaviour from pure acoustic scattering [2].
In this study, the SH1 guided wave mode was investigated as it exists at higher frequencies and features the dispersive nature necessary for thickness inversion. It was found that SH1 guided waves follow the scattering behaviour of the acoustic case to a greater extent than Lamb waves, promising a great improvement of resolution. Using the Pogo finite element package [3] for 3d simulations of plates with various defects, high resolution thickness maps were generated by applying HARBUT, the Hybrid Algorithm for Robust Breast Ultrasound Tomography [4] to the simulation data. Initial experimental results using EMAT transducers for SH signal generation corroborate the numerical results in showing the great potential of utilising SH1 for guided wave tomography.

Keywords: guided waves, tomography, corrosion mapping, imaging, finite-element simulations

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REFERENCES

[1] Huthwaite P., Simonetti F., "*High-resolution guided wave tomography*", WAVE MOTION, Vol: 50, Pages: 979-993, ISSN: 0165-2125, 2013

[2] Huthwaite, P. "*Guided wave tomography with an improved scattering model*", Proceedings of the Royal Society . Series A: Mathematical Physical and Engineering Sciences, Vol: 472, ISSN: 1364-5021, 2016

[3] Huthwaite, P. "*Accelerated finite element elastodynamic simulation using the GPU*", Journal of Computational Physics, Vol: 257, Part A, Pages: 687-707, ISSN: 0021-9991, 2014

[4] Huthwaite P., Simonetti F., *"High-resolution imaging without iteration: a fast and robust method for breast ultrasound tomography"*, The Journal of the Acoustical Society of America, Vol: 130, 3, Pages: 1721-1734, 2011

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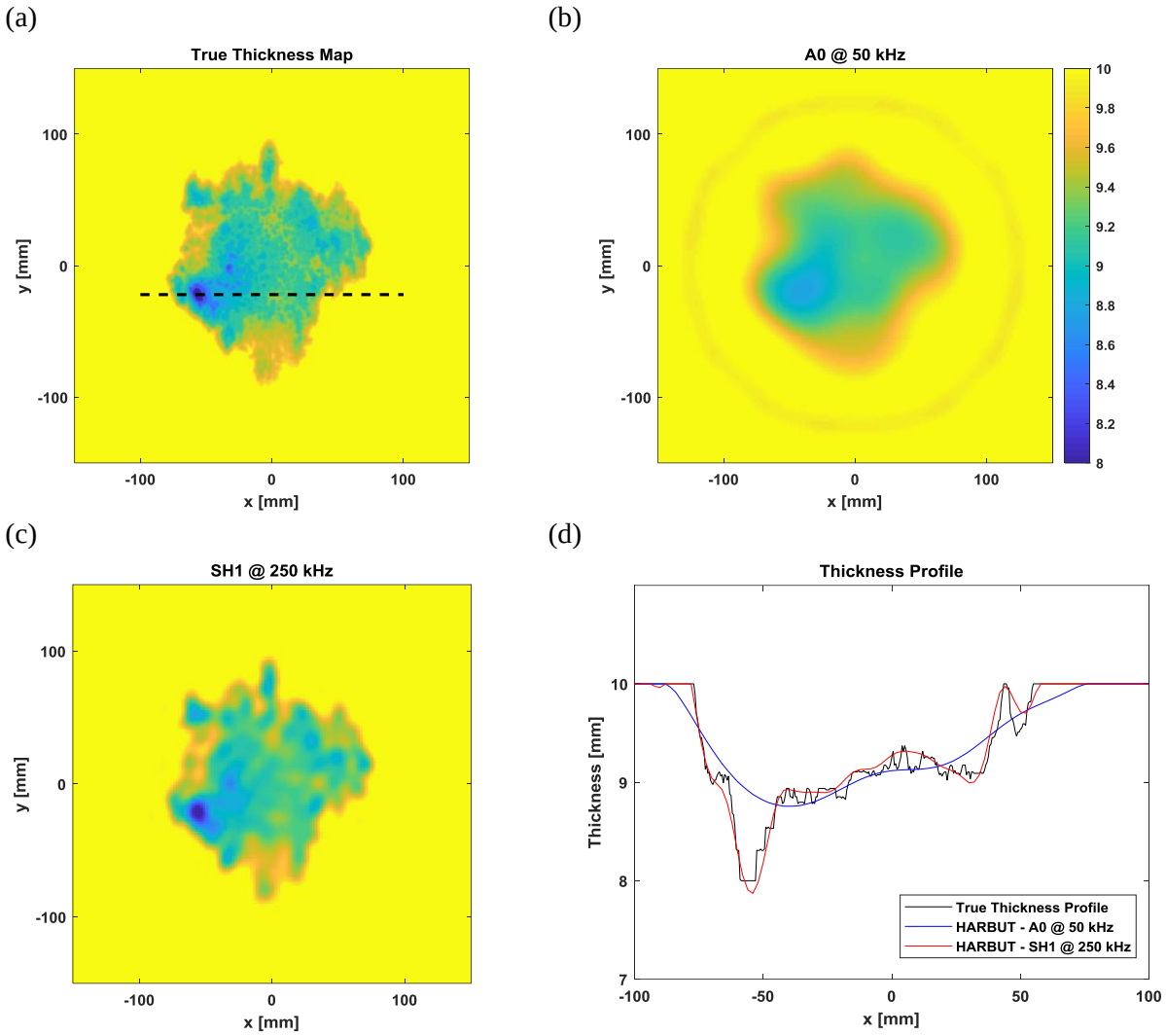

Figure 1. Thickness maps and thickness profiles reconstructed using HARBUT from FE data. (a) The true thickness map, generated from a laser scan of a corrosion patch and adapted to 80% remnant wall thickness. (b) The HARBUT reconstruction of the thickness using the Lamb wave mode A0. (c) The same reconstruction but using pure SH1 data. (d) Thickness profile along the black line marked in (a). Colourbar in b) applies to (a),(b) and (c).

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