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High frequency (>15 MHz) ultrasound arrays have gained significant attention in recent years for their ability to provide higher resolution images, allowing detection of smaller defects in materials and structures. This helps identify potential issues before they become critical, preventing costly repairs or even catastrophic failure in some cases. However, the limited penetration depth of high-frequency sound waves can hinder the inspection of thicker components, particularly with complex surface geometries. Therefore, an advanced approach to overcome this limitation combining a high-frequency flexible ultrasonic array and specific patterns of excitation is presented.

In this investigation, a novel 20-MHz 64-element 1 mm-element spacing flexible linear array, developed by Novosound Ltd, was evaluated using two different signal excitation techniques to enhance the signal-to-noise ratio (SNR) and sensor performance on flat and complex-geometry components. An arbitrary waveform generator was used to excite the array with these excitation techniques and a pulse compression technique consisting of a matched filter was implemented on received signals.

Preliminary results were acquired with the array deployed on a 20 mm-thick flat aluminium sample with sided-drilled holes. An SNR improvement of over 65% for the backwall refection compared to a conventional pulse excitation was observed. The array offers flexibility to conform to complex-geometry surface profiles (Figure 1). A curved sample, representative of piping found in nuclear industry, was next investigated using both direct coupling and through an attenuating rubber material, that is suitable to scan the array over rough surfaces. For all experimental scenarios, both excitation schemes were optimised and compared in terms of capability for defect detection.

Figure 1: Problem in surface contact with a conventional rigid wedge transducer (left) [1]. Demonstration of the flexible Kelpie array inspecting a curved component (right).

This innovative transducer system approach has the capability to enhance the efficiency, accuracy, and reliability of industrial inspection. What makes this approach particularly noteworthy is its potential translation to medical ultrasound, thus bridging the gap between the two seemingly disparate fields.

References

[1] S. J. Lim, Y. L. Kim, S. Cho, and I. K. Park, “Ultrasonic Inspection for Welds with Irregular Curvature Geometry Using Flexible Phased Array Probes and Semi-Auto Scanners: A Feasibility Study,” *Applied Sciences (Switzerland)*, vol. 12, no. 2, Jan. 2022, doi: 10.3390/app12020748.