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[Poster] Acoustic velocity mapping of multi-metallic components using laser-induced ultrasonic time-of-flight tomography and neural data interpretation

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Multi-metallic components are designed to harness the differing mechanical, thermal, chemical, or electromagnetic properties of two or more metals within a continuous solid structure to achieve higher performance than is possible when a single material is used. Depending on the requirements of the component, dissimilar metal parts may be joined using a wide variety of fusion, flow, or solid-state welding techniques. The acoustic transmissivity of these joints makes such components theoretically suitable for ultrasonic testing (UT). However, many established UT inspection methods require an acoustic velocity map of the component as a separate corrective input in order to return accurate results. Such velocity maps may be acquired with destructive methods, which are not suitable for *in situ* deployment, e.g. during manufacturing or welding. This study presents the results of applying non-destructive, laser-ultrasonic time-of-flight tomography to the challenge of mapping acoustic velocity in several different multi-metallic samples. The technique is deployed using laser-induced ultrasonic arrays, and the data obtained is rapidly interpreted using a pre-trained neural network that outputs velocity maps in real time [1]. The velocity maps obtained from the technique are shown to be sufficiently accurate for use as stand-alone inspection data, and are also highly valuable as corrective inputs to other UT techniques or imaging algorithms. Combining the flexibility innate to laser ultrasonic transduction with the reconstruction speed of neural networks enables robust acoustic velocity mapping for a variety of multi-metallic structures and component geometries with high potential for *in situ* deployment during manufacturing. The results motivate further development of the technique toward the mapping of finer-scale acoustic inhomogeneity in metals such as that caused by polycrystalline texture.

References:

1. Singh, J., et al., *Real-time super-resolution mapping of locally anisotropic grain orientations for ultrasonic non-destructive evaluation of crystalline material.* Neural Computing and Applications, 2021: p. 1-18.