Project 3: Deep Learning based automated defect recognition for laser ultrasonic imaging.

Supervisory Team
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Background and motivation

Ultrasonics is a method to image the inner part of an optically opaque component and it has found a wide range of uses in applications ranging from medicine to aerospace. Laser ultrasonics is a technique where a pulsed laser is used to generate a high frequency sound (ultrasound) which propagates through the material and is detected by another laser. Laser ultrasound has the unique advantage of being a remote ultrasonic technique, making it suitable for extreme environments, such as the hot environment of a manufacturing process or even space.
Ultrasonic imaging based on laser ultrasonic data has been made possible however the technique is currently very slow to be of interest to practical applications. Applying automated, ultrasonic imaging analysis, on-the-fly, during the data acquisition stage, would be a game changer, allowing the technique to be applied to situations such as process monitoring during additive manufacturing (metal 3D printing), welding or *in vivo* medical scanning. One way to achieve automated imaging analysis is through machine learning. Deep Learning is a machine learning technique that uses neural networks to identify patterns in data. The research related to this project will help us answer the following question:

> *Can we use Deep Learning to train the system and identify "defects" in the acquired ultrasonic images, without human intervention?*

If we achieved this, we would unlock the application potential of the technique for a wide range of industrial cases.

What will you do?

The project will first review the existing Deep Learning Algorithms and decide on suitability with data provided from laser ultrasonics. You will generate, synthetic ultrasonic data using the existing laser ultrasonic model of a commercial finite element package (Onscale). These synthetic data-sets will be used to compose ultrasonic images, using existing ultrasonic algorithms, implemented through MATLAB. Some of these images will have defects and some will be defect-free and they will be used as the "ground truth" to train the Deep Learning algorithm. Finally, the trained network will be used on experimental data to determine if they are defect free or not. You will be supported, through all these stages, working closely as a member of an active and collaborative research team.

Required skills and experience

We are seeking candidates with enthusiasm for research and data processing. An understanding of machine learning is essential. An understanding of ultrasonic signals and image processing is desirable but not essential. Prior knowledge in programming using MATLAB would be an added advantage. Candidates should enjoy working as part of a team.