**Accelerating Flaw Detection of Ultrasonic C-Scans with Enhanced Data Analytics**

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ABSTRACT

Enhanced data analysis algorithms are a desired tool to assist human inspectors in detecting anomalous indications in ultrasonic data. Assisted data analysis (ADA) algorithms provide an efficient process of parsing long sections of ultrasonic C-scan data and minimize subjectivity under variations in indication geometry, and challenges with data of varying quality. To identify indications, two enhanced data analytic approaches are frequently used. The first approach is unsupervised algorithms which leverage a rule-based design based on expert domain knowledge. The second approach is supervised enhanced data analysis that identify anomalous indications using costly labeled data. We consider two C-scan datasets labeled by expert inspectors, termed “Component 1” with 63 labeled indications and “Component 2” with 209 labeled indications, primarily consisting of disbonds, porosity, and noodle indications. In this work, we present an experimental investigation of two unsupervised algorithms termed Segmentation-ADA and Blob-Detector. Segmentation-ADA operates by determining statistically local and global anomalous regions achieved by segmentation-based zoning of the data. Blob-detector is a traditional technique adopted from the computer vision field which finds connected anomalies by sequential thresholding of the data. Both algorithms utilize a geometric-filtration check to ensure the candidate indications fit reasonable criteria of anomalous behavior. We also present a family of supervised deep learning YOLOv5 architectures for anomaly detection known for its capabilities in real-time-detection. In Component 1, we obtain true call rates (# number of predictions) of 71.43% (1227), 82.54% (4474), and 85.71% (6601) by Segmentation-ADA, Blob-Detector, and YOLOv5 respectively. In Component 2, we obtain true call rates (# number of predictions) of 67.94% (1066), 70.33% (2090), and 87.56% (6085) by Segmentation-ADA, Blob-Detector, and YOLOv5, respectively. Further analysis on the trade-off between true-call rates and precision is provided. We showcase three advantages to assisting human-inspectors: (1) missed calls can be mitigated by marginally increasing the detection radius around each indication, (2) each algorithm can generate effective sizing estimates of each indication and (3) a substantial amount of flaw indications can be evaluated in real time. Our results have implications in improving the efficacy and assurance of non-destructive evaluation techniques and bridging the gap between humans and advanced data analytics.

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1. [↑](#footnote-ref-2)