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Defect Classification of Hydrogen Fuel Pressure Vessels using Deep Learning

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Abstract : Acoustic Emission Testing (AET) is widely used to test the structural integrity of an operational hydrogen storage container, and clustering algorithms are frequently used in pattern recognition methods to interpret AET results. However, the interpretation of AET results can vary from user to user as the tuning of the relevant parameters relies on the user's experience and knowledge of AET. Therefore, it is necessary to use a deep learning model to identify patterns in acoustic emission (AE) signal data that can be used to classify defects instead. In this paper, a deep learning-based model for classifying the types of defects in hydrogen storage tanks, using AE sensor waveforms, is proposed. As hydrogen storage tanks are commonly constructed using carbon fiber reinforced polymer composite (CFRP), a defect classification dataset is collected through a tensile test on a specimen of CFRP with an AE sensor attached. The performance of the classification model, using one-dimensional convolutional neural network (1-D CNN) and synthetic minority oversampling technique (SMOTE) data augmentation, achieved 91.09% accuracy for each defect. It is expected that the deep learning classification model in this paper, used with AET, will help in evaluating the operational safety of hydrogen storage containers.

Keywords : acoustic emission testing, carbon fiber reinforced polymer composite, one-dimensional convolutional neural network, smote data augmentation
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