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A Proposed Convolutional Neural Network for Acoustic Emission-based Damage Localization in Concrete Structures

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ABSTRACT

In the construction industry, the deterioration of structures poses a significant challenge, particularly when it comes to detecting cracks in concrete structures. Acoustic emission sensors have been commonly employed for this purpose. However, traditional approaches relying on measuring the time of arrival, time difference of arrival, and received signal strength indicator are prone to errors, especially in the presence of inhomogeneous materials. In this research, we present a novel method that leverages deep learning techniques to enhance the accuracy of crack detection using acoustic emission sensors. Our objective is to automate the detection process while achieving improved precision. The proposed method involves several steps. First, signals from acoustic emission sensors are captured, and then they are transformed into a time-frequency representation using the continuous wavelet transform. These representations are then input into a convolutional neural network specifically designed for crack localization. The network is trained to predict the coordinates of the detected crack. To validate the effectiveness and advancements of our approach, we conducted experiments using a concrete block with an artificially created crack achieved by pencil-lead breaks. Through our experiments, we confirmed the effectiveness of the proposed method in accurately detecting cracks. By employing deep learning and the time-frequency analysis provided by the continuous wavelet transform, our approach offers an automated and precise solution for crack detection, overcoming the limitations of traditional methods. This research contributes to the field by providing a robust framework for improving the assessment and maintenance of concrete structures, ultimately enhancing their durability and safety.

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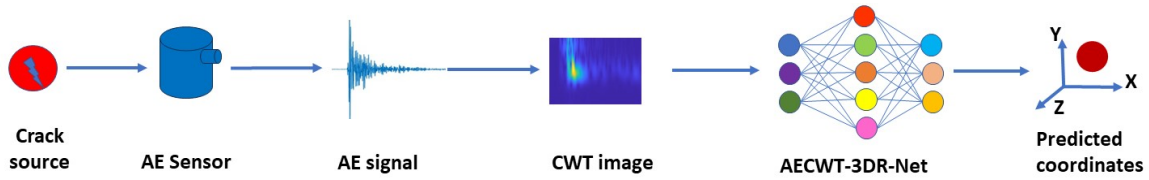

Fig. 1 The overview of the proposed method

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