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AI-based Structural Damage Detection with Customized Neural Network for Seismically-Excited Buildings

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ABSTRACT

Structures may encounter exceeding loadings and result in significant damage during strong earthquakes. Thus, one of the urgent issues is the preliminary assessment of structural safety after earthquakes. Maximum inter-story drifts, referring to the design codes, can serve as a primary damage index to evaluate structural damage preliminarily. However, recent studies demonstrate that variations in stiffness can also cause characteristic changes in frequency responses during seismic events or damage scenarios. This study proposes a novel strategy utilizing a multi-target neural network to predict both story drift and remaining stiffness ratio based on story accelerations as input. The story drift related to temporal problems is successfully estimated through the introduction of the Long Short-Term Memory layer, while the Short-time Fourier Transform (STFT) layer is used to extract frequency features for calculating the remaining stiffness ratio. In this study, the effectiveness and accuracy of the proposed neural network are investigated using a three-story numerical model and validated through experimentation on a full-scale structure. As a result, the proposed neural network accurately estimates story drifts and remaining stiffness ratios, showcasing the potential of the machine learning application for damage detection in structural health monitoring.

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