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Physics-informed deep learning-based model for generating equivalent loads from measured responses

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ABSTRACT

Structural dynamics-based damage detection methods have rapidly advanced with the integration of deep learning. Previous studies have used Deep SAD, a semi-supervised extension of Deep SVDD, for vibration-based damage detection, yet acquiring actual damaged-structure response data remains infeasible. In this study, a physics-informed one-dimensional convolutional neural network framework is presented to infer an equivalent load time history from measured acceleration responses. The network is configured with a large kernel size of 41 and ReLU activation, and the output load sequences are applied to a finite-element simulator to reproduce the original response measurements. Training is conducted using mean squared error loss. Validation on a 20 m reinforced-concrete girder model with virtual loads resulted in an average reconstruction error of 0.28%. These findings confirm the potential of physics-informed learning to generate realistic damaged-structure response data for training purposes and highlight its promise for enhancing domain adaptation techniques in vibration-based damage detection.

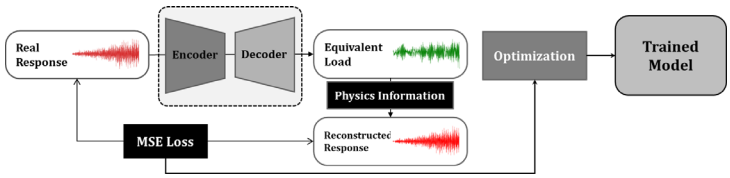

Fig. 1 Framework of training the physics-informed deep learning model

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