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Pointwise vibration classification of long-span bridges using a sequence-to-sequence regression model

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ABSTRACT

Harmful vibrations for long-span bridges are determined based on thresholds for vibrational amplitude or wind speed. Such a one-size-fits-all approach is not feasible for assessing the complex vibration patterns in different structural systems and fails to work properly. In this regard, this study proposes the pointwise multiclass classification of vibrations by leveraging the signal segmentation deep network. Time-frequency analysis is first carried out to extract the time-varying frequency characteristics of the dynamic acceleration responses. Time-frequency representations were then used to establish input tensors for training deep learning networks, classifying sample points as either traffic-induced vibration or vortex-induced vibrations instantaneously. The applicability of the proposed framework was finally demonstrated using the actual monitoring dataset collected from the cable-stayed bridge in South Korea.

1. INTRODUCTION

The vibrational serviceability of long-span bridges (LSBs) has been considered essential for their operation and maintenance. In this regard, the hazardous vibrations of LSBs are typically determined by whether the vibrational amplitude or wind speed exceeds a predefined threshold [1]. However, such a one-size-fits-all method is not feasible for in-situ applications due to the complex vibration patterns in different structures. For example, the amplitude of weakly developed vortex-induced vibrations (VIVs) could be similar to that of typical ambient vibrations, such as traffic-induced vibrations (TIVs) [2]. In this situation, a threshold-based approach may fail to detect VIVs properly. To overcome this limitation, this study proposed the pointwise multiclass classification of vibrations by leveraging a signal segmentation deep network. Pointwise classification has been utilized in acoustic classification or electrocardiogram (ECG) recognition [3,4]. This study applied a pointwise classification for the instantaneous classification of structural vibrational responses collected from structural health monitoring (SHM) systems. To this end, a time-frequency analysis was first carried out

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