Long-term Missing Wind Data Recovery for Bridge Health Monitoring Using Deep Learning

Zhiwei Wang, Wenming Zhang

Key Laboratory of Concrete and Prestressed Concrete Structures of the Ministry of Education, Southeast Univ., Nanjing, China

Yufeng Zhang

State Key Laboratory of Safety and Health for In-service Long Span Bridges, Jiangsu Transportation Institute Co. Ltd., Nanjing, China

Contact: zwm@seu.edu.cn

Abstract

As the performance of the electronic equipment for bridge SHM system deteriorates, wind data often suffer from long-term data missing, which creates barriers for safety monitoring of the bridge structures. Therefore, we proposed a framework for long-term missing wind data recovery based on a deep neural network (DNN) utilizing a free access database (ECMWF). This framework consisted of one regression task (Task 1) and one temporal super-resolution task (Task 2). In Task 1, the hourly wind data provided by ECMWF were learned to the hourly ones of the SHM system. In Task 2, the low-resolution wind data were upsampled to high-resolution ones (10-min averages). The U-net architecture provided the basis for the DNNs in both tasks. The proposed framework's feasibility was verified through a case study of Sutong Bridge. The proposed methodology provides a new perspective for recovering long-term continuous missing SHM data.

Keywords: wind speed; missing data recovery; deep learning; convolutional neural network (CNN); structural health monitoring (SHM); free access database.

1 Introduction

Wind speed is an essential parameter in the bridges' structural health monitoring. The wind monitoring data (in combination with other monitoring data) can be used to obtain the wind field characteristics at the bridge site, evaluate the serviceability and safety of the bridge structure under wind action, and investigate the correlations between the wind action and other environmental actions on the bridge [1-3]. However, dysfunction of the sensors or data acquisition/transmission system and power failure of the structural health monitoring system (SHMS) usually lead to the missing wind monitoring data. Therefore, some researchers have attempted to recover the lost data to improve the usability of the wind monitoring data [4-6].

The wind data missing in the bridge SHMS falls into two types: discrete missing and continuous missing. Conventional interpolation techniques can be used to interpolate the first type of lost data. However, for the second type, the missing information duration may vary from several minutes to several

https://doi.org/10.2749/nanjing.2022.1138
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