Time-Frequency Features of Smartphone Accelerometer Data Collected from Bridges via a Passing Vehicle

Ekin Ozer*, and Thanh Tran†

* School of Civil Engineering
University College Dublin
Belfield, Dublin 4, Ireland
e-mail: ekin.ozer@ucd.ie, web page: https://people.ucd.ie/ekin.ozer

† School of Civil Engineering
University College Dublin
Belfield, Dublin 4, Ireland
e-mail: thanh.tran@ucd.ie

Key Words: Structural Health Monitoring, Drive-by Sensing, Modal Identification, Smartphone Sensors

ABSTRACT

This research presents preliminary vibration data characteristics indirectly collected from a bridge structure, i.e., vibration data obtained through smartphones placed in a vehicle. Repetitive vehicle trips are performed over a long-span bridge under an operational environment, while a smartphone located between the passenger and driver seat takes continuous vibration measurements. The features obtained from the smartphone are subject to a series of digital signal processing operations to investigate the possibility of capturing bridge-specific data from short-term smartphone signals. Practical aspects such as locating the smartphone without a Global Positioning System (GPS) trigger are discussed. The smartphone accelerometer data is evaluated according to its time, frequency, and time-frequency characteristics to comment on the identifiability of the bridge modal parameters with limited data. The vibration measurements obtained from smartphones are compared with those from micro-electro-mechanical-system-based reference sensors which are placed at the same location of the vehicle. The early-stage findings show that a single vehicle passage has insufficient content to reveal modal features; however, the repetitive low-frequency content observed on vehicular data indicates promising spectral characteristics. Moreover, the repetitive measurements reflect compatible spectral characteristics with the reference data, indicating that a larger dataset has the potential for a clear interpretation of modal identification from passing vehicles. Further testbeds will be employed, and more repetitive tests will be performed to see how long-term data accumulation can improve the spectral characteristics of vehicular smartphone data from a bridge modal identification point of view. A smartphone-driven drive-by structural health monitoring approach is a challenging but promising step to reduce the reliance on dedicated instrumentation and open the possibility of crowdsourcing-based condition assessment strategies.