Abstract

Bridges are an integral part of infrastructure, but their susceptibility to damage poses threats to public safety and leads to significant economic losses. This paper proposes a system that integrates neural networks with wireless sensor networks (WSNs) for structural damage detection and localization in bridges. This system uses vibration frequency data obtained from accelerometer sensors, focusing on the first three natural frequencies (f1, f2, and f3) as key indicators of structural integrity. In this paper, preprocessing techniques such as normalization and encoding are applied to prepare the data, enabling a neural network to classify and localize damage with high precision. The system achieves high performance in detecting major structural damages at an accuracy of 93.82% and 100% in localizing damages of such kind, which proves the effectiveness of both the chosen features and the balanced dataset. While minor misclassifications were found at intermediate damage levels, the system is still practical and efficient for real-time monitoring and implementation. Class imbalances should be handled, and advanced feature extraction techniques should be integrated in order to enhance applicability. Besides, the framework should be extended to other types of structures for wide adaption in further research.

Keywords: Structural health monitoring, Wireless Sensor Network, Neural Network, Damage Detection, Damage Localization.