Evaluation method of defects in concrete structures using hammer test by time-frequency analysis and neural networks

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Abstract

The hammer test is generally used as one of the non-destructive methods for detecting defects such as voids and delamination in concrete structures like tunnels and bridges. It is necessary to eliminate human mistakes and improve quantitative analysis so that Impact Acoustics Method (IAM) was proposed and studied. IAM helps human decision of the defective concrete parts through comparing waveform and frequency distribution between healthy and defective parts which are taken from sensor or microphone. Hence, artificial intelligence (AI) is expected to replace or assist the human labor inspection by quantifying the defects. This research aims to inspect defects quickly and efficiently the only microphone through promoting a machine learning AI analysis system flow which mainly includes neural networks. Two experiments were held to achieve the purpose.

Keywords: concrete; defects; hammer test; time frequency analysis; neural networks.

1 Introduction

The hammer test inspection depends on each inspector's experience and skills by hearing the sound responses from a concrete surface, which may cause a difference in judgment and turn, result in high labor costs. Therefore, IAM was proposed to analyze defects that are different from the normal hammer test which relies solely on human hearing. It helps human decision of the defective concrete parts through comparing waveform and frequency distribution between healthy and defective parts which are taken from sensor or microphone. Recently, AI is expected to replace or assist the analysis in IAM by quantifying the defects. So far, diagnosis of defects such in different depth at the striking position has been targeted in many studies. However, the labor-saving and efficient inspection were not focused although they were important problems to be solved practically. Through proposing a data analysis AI system for IAM, data is analyzed by a suitable algorithm and the defect condition is presented.

This study aims to inspect defects quickly and efficiently through promoting an AI analysis system flow. The detection of defect areas by only using the sound pressure response is focused to achieve the purpose. The first objective of this study is to explore the efficient features of sound pressure by focusing on time-frequency analysis. To simplify data collection only through analyzing the sound pressure information from a microphone in real-world environments, deep neural networks show a strong capacity to enhance effective information from environmental noise. Another aspect of this study includes detecting deeper defects and obtaining detailed information on the defect state through building classification neural networks.

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