Study on rapid traffic disruption-free bridge deck evaluation and imaging for large-scale stream data using AI

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This paper presents an innovative signal and image processing algorithm designed for the efficient real-time inspection of bridge decks, employing multiple excitations. To achieve this, we introduce an automated impactor and air-coupled sensors that enable the reliable generation and detection of mechanical waves. This technology holds the promise of addressing the challenges associated with rapid damage assessment without disrupting traffic flow. During the inspection process, a substantial amount of data is generated, including complex excitation signals in real-time, alongside unwanted signals that occur between excitations. Extracting individual excitation signals from this data proves to be a formidable task. Furthermore, the assessment of bridge deck conditions is subject to changes in infrastructure conditions. In response to these challenges, we propose a two-fold algorithm comprising signal extraction and damage identification and visualization using AI. The first step involves the extraction of single excitation signals from the vast field inspection data, utilizing a threshold-based wave extraction technique. The subsequent stage is dedicated to the presentation and quantification of various types of damage, such as delamination and surface cracks. Our algorithm is applied to process field inspection data, resulting in the generation of 2D damage maps and damage indices. Furthermore, we discuss the outcomes of 3D tomography verification and share insights from a 3-year TxDOT bridge monitoring project.