Bridge monitoring through a hybrid approach leveraging a modal updating technique and an artificial intelligence (AI) method

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Project Objective

The objective of this project is to develop a post processing damage detecting algorithm by leveraging a modal updating technique and an artificial intelligence (AI) method.

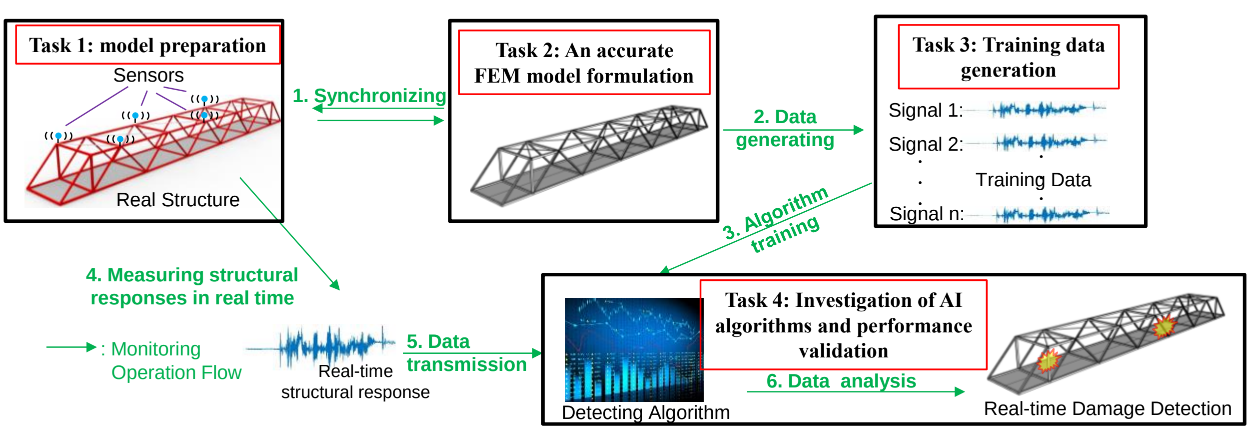
Problem Statement

The proposed project integrated two methods (i.e., a model updating technique and a data-driven prediction method) that can compensate for each other's the weakness that otherwise imposed difficulty in precise real-time application of health monitoring systems. This project leveraged a mode-updating technique with high-fidelity experimental data to obtain an accurate digital model that represents an actual bridge. The drawback of the model updating technique (i.e., high computational time) can be overcome by applying a data-drive method that is known to be computationally efficient. The proposed approach will then result in a fast and accurate method (i.e., a model-based data-driven method) for early damage identification of bridge structures.

Research Methodology

The proposed research is a hybrid method to integrate an AI model with data generation from a model updating technique. The hybrid approach realizes a real-time application of structural health monitoring and the monitoring operation flow of the proposed method with essential research progresses:

1. Model synchronization: using the model updating technique, a real structure and a FEM model are synchronized to obtain an accurate numerical model.
2. Various data generation from the accurate model: with the aid of the accurate model, various extreme scenarios are simulated to extract structural responses (AI training data).
3. AI algorithm train: the data is extracted and transformed feature for AI training.
4. Real structural response measurements from sensors: through a sensing system, real-time structural responses are measured.
5. Data transmission: the captured data is transferred to the developed AI algorithm.
6. Data analysis for early damage detection: the trained AI will decide damage location and its severity.



Results

the project, our findings are as follows: 1) The proposed method integrated with a sensor-based system enables to continuously monitor structural integrity. As a result, when critical structural elements are damaged, the proposed method clearly and informed damage locations (global inspection) and their severity (local inspection) with the accuracy of 97%. 2) Current biannual inspection may miss the critical and dangerous damage growths before the next inspection cycles. The proposed continuous monitoring timely filled the inspection gap by identifying critical damages before out of control. 3) No additional cost for system improvement is required if a sensing system is already installed on a bridge structure.