AI-Driven Multi-factorial Damage Detection for SHM

Yu Hanliang

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【Background】

In engineering design, the reliability of the FEM is widely recognized and FEM-based design and simulation methods are very mature. Damage detection based on AI techniques is lack of visualization effectively makes the model difficult to maintain. In the absence of new damage-response data for a particular structure, it is impossible to update the model.

Meanwhile, data from different sources exhibit varying levels of reliability. In practical engineering applications, data acquisition from sensors such as displacement transducers is not always feasible.

【Objective】

Develop a predictive model that effectively integrates data with varying reliability levels to enhance the accuracy and robustness of the predictions.

Developing an AI-based algorithm for structural health monitoring, with a particular emphasis on solving inverse problems in motion functions.

【Approach】

Sampling: Vehicle–drive-by test
SHM: CVAE model
New algorithm: AI-driven inverse FEM algorithm

【Publication plan】

- CVAE model for SHM using data from multiple sources
- Strain estimation based on acceleration measurement

【Results】

Training data (shown in **Fig.1**) for AI model can be generated based on acceleration measurement, which can greatly simplifies engineering measurements.

In the damage detection, CVAE is trained by minimizing observed data to reconstructed data. And at the same time minimizing the features in higher dimension. In the latent layer, the high-dimensional features of the damage field (damage location, damage extent) were successfully extracted. Prediction results (shown in **Fig.2**) based on a single indicator for damage detection has good accuracy.

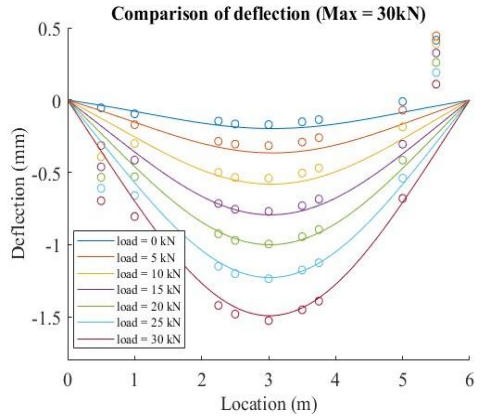

Fig.1

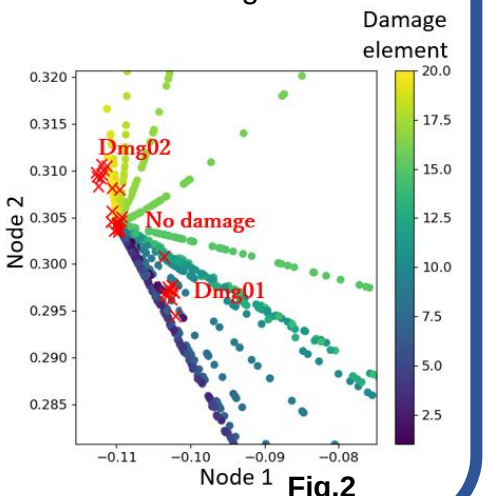

Fig.2