京都大学 KYOTO UNIVERSITY

Research Summary: AY2020

Data-driven pattern recognition in structural health monitoring

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Keywords: variability, EOVs, long-term SHM, SARIMA, LSTM

【Background】

For vibration-based SHM, uncertainty heavily exists in the process and may cause a masking effect to damage signal, which introduced huge difficulty for anomaly detection.

Among various kinds of uncertainty, environmental and operational variables (EOVs) induced variation is considered to be a severe disturbance for anomaly detection in long-term SHM.

【Objective】

This study aims to make some strategies for anomaly detection considering the influence of identification uncertainty and EOVs-related variability in long-term SHM.

By data-driven methods utilizing the correlation, autocorrelation, co-integration or subspace properties, some invariant features are expected to be revealed from the long-term variation of general damage indicators like modal frequency, which can be further used for anomaly detection with higher reliability.

【Approach】

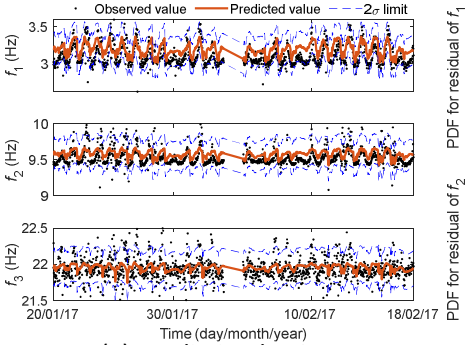
Considering the correlation and autocorrelation patterns as inherent properties which may be robust to the disturbance of EOVs on some damage-sensitive features like modal frequency in long-term SHM, some EOVs-driven models like BLR, GPR, and some non-EOVs models like SARIMA, LSTM, were investigated with a case study. The results indicated a better performance in non-EOVs models without any constraints from deficient measurements of EOVs (latent variable issue in EOVs-driven models).

【Publication plan】

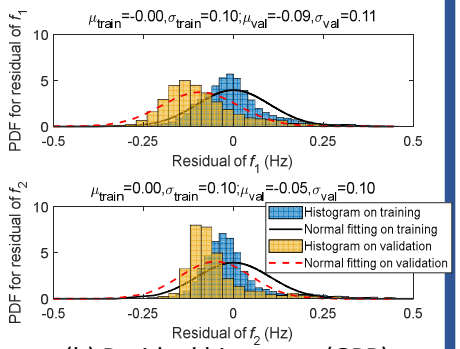
・ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems: Part A. Civil Engineering. (a paper titled “Modeling variability in vibration-based long-term SHM of bridges” has been submitted)

・9th International Conference on Experimental Vibration Analysis for Civil Engineering Structures.

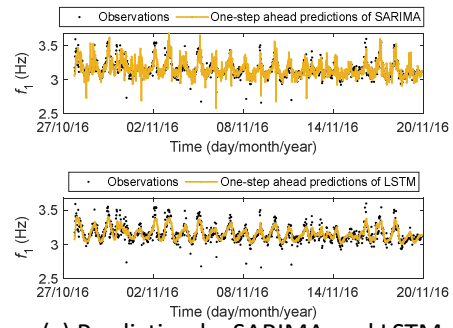
【Results】



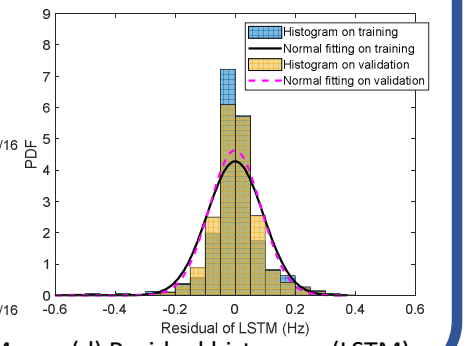
(a) Prediction by GPR



(b) Residual histogram (GPR)



(c) Prediction by SARIMA and LSTM



(d) Residual histogram (LSTM)