Feasibility investigations on applying copula for long-term bridge health monitoring

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【Background】

With the rapid increasing trend of aging bridge structures, many problems occurred, so that it is highly demanded to establish an efficient inspection or monitoring method. Vibration-based long-term bridge health monitoring (BHM) is recognized to be one of the bridge maintenance technologies. After normalizing the environmental effects, a copula-based feature sensitive indicator is proposed for the bridge health monitoring. Changes in the modal parameters with the time are identified by the copula statistical properties.

【Objective】

This study aims to propose a copula-based feature sensitive indicator and judge the applicability and accuracy by utilizing both short-term and long-term monitoring data. For data normalization, the best model for is selected. Both data from target bridge and damage experiment bridge are utilized for decision making: to confirm whether the target bridge is in health condition or not.

【Approach】

For damage experiment bridge, after applying Gaussian copula, the variation of each indicator is observed. When the health condition changes, the correlation between two variables is also changing. The variation can be observed in pseudo observations. The applicability of applying variance of Gaussian copula parameter as damage indicator is proved. For target bridge with long-term bridge health monitoring, data normalization is required. Best fit normalization model is selected based on AIC value. Then Gaussian copula is applied to normalized data. Comparing to the variation trend of parameter, the target bridge can be confirmed. Also, with partly revised data, the strong robustness against noises is confirmed.

【Results】

Feasibility of normalizing the environmental effects in long-term bridge health monitoring by utilizing time series model prediction is investigated. Once damage happened, the variance of Gaussian copula parameter on 1st bending mode will fluctuate rapidly. While for MD, both mean value and variance will show significant fluctuation. The applicability and accuracy of applying variance of Gaussian copula parameter and MD value as damage indicator are confirmed. At last, health condition of target bridge is confirmed.