Automatic method for bridge Digital Twin calibration using genetic algorithms

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Abstract

Calibration of the numerical model is essential to ensure that the bridge's digital twin accurately represents the system it monitors. This provides insight into the bridge's structural health through its FEM model. To ensure that the behaviour of the model and the structure match, it is necessary to perform continuous tuning of the bridge FEM model to make the dynamic behaviour of the model correspond to its real twin.

Performing the manual calibration of the digital twin requires first processing the data provided by the sensors installed on the bridge to extract the dynamic properties of the structure. Once the natural frequencies are identified, it is necessary to adjust the different parameters of the FEM model of the bridge to match the dynamic properties of the digital twin with those of the structure. As it is intuited, performing this process periodically is tedious and costly since investing considerable time and economic resources is necessary.

This paper proposes a method to calibrate the digital twin through the data from the sensors installed on the bridge without requiring this process to be done manually. For this, through an iterative process based on genetic algorithms, the different parameters of the FEM model of the bridge are varied so that the dynamic behaviour of the digital twin is like that of the real structure. The implementation of this improvement drastically reduces the time needed to perform the calibration of the digital twin. Consequently, this process can be performed more frequently, allowing a numerical model that represents the behaviour of its real twin more accurately.

References

[1] Ward, R., Choudhary, R., et al., Continuous calibration of a digital twin: Comparison of particle filter and Bayesian calibration approaches. *Data-Centric Engineering*, 2, 3, 9, 2021.

[2] Song, H., Song, M., et al., Online autonomous calibration of digital twins using machine learning with application to nuclear power plants. *Applied Energy*, 326, 11, 2022.

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