

PROCEEDINGS

A Digital Twin Framework for Structural Strength Monitoring

Ziyu Xu¹ and Kuo Tian^{1,*}

¹Dalian University of Technology, Dalian, 116024, China

*Corresponding Author: Kuo Tian. Email: tiankuo@dlut.edu.cn

ABSTRACT

Considering experimental testing data is costly, and sensor data is often sparse, while simulation analysis provides overall strength information with lower accuracy, a digital twin framework is proposed for full-field structural strength assessment and prediction. The framework is mainly divided into two stages. In the offline stage, the simulation model of the structure is established, and the sensor layouts are completed. Then, the DNN pre-training model is constructed based on the reduced simulation data. In the online stage, the experimentally measured data are predicted to obtain the time-series sensors data, and the traditional transfer learning multi-source data fusion model is constructed. Finally, to obtain the more accurate and robust digital twin model, the prediction error of the transfer learning model is fixed. To demonstrate the effectiveness of the proposed digital twin strength monitoring framework, two different engineering examples involving the plate with hole and the hierarchical stiffened plate are studied. The results indicate that the proposed method can establish an accurate digital twin model, achieve accurate interpolation of the sensor data, and provide a better prediction for the next loading step of the experiment. This provides a solution for achieving accurate real-time monitoring and predicting structural strength trends during the test.

KEYWORDS

Digital twin model; data fusion; transfer learning; real-time monitoring; strength assessment

Funding Statement: This work was supported by National Key Research and Development Program project of China [No. 2022YFB3404700], the Fundamental Research Funds for the Central Universities [No. DUT23BK054], and National Natural Science Foundation of China [No. U21A20429, No. 11825202].

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.



This work is licensed under a Creative Commons Attribution 4.0 International License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.