Identification Of Traffic Load On Bridges Using Machine Learning Method

Yuhui ZHOU, He ZHANG

Since traffic overloading on bridges may accelerate the fatigue and deterioration of bridge components, decrease the carrying capacity of structure, and even cause collapse of bridges in some extreme circumstances, traffic loading information is of great significance for early warning of overloaded vehicles and traffic control in the structural management and maintenance of bridges. Identification approaches to traffic load through solving differential equations of motion inversely always encounter ill-condition problems, inaccurate load identification at the bridge support and difficulties in multiple-parameter identification. To address these problems, we propose here a novel strategy based on smart sensing combing intelligent algorithm for real-time traffic load monitoring. An array of lead zirconium titanate sensors are applied to capture the dynamic responses of a beam bridge, while the Long Short-Term Memory (LSTM) neural network is employed to establish both short- and long-term mapping between the dynamic responses of the bridge and the traffic load through data mining. Then both the speed and magnitude of the loading could be identified simultaneously with high precision by the LSTM network. Further, to obtain the correlation expression of traffic load due to the dynamic strain of the bridge, we propose an intelligent algorithm based on Legendre neural network (LNN), in which the Legendre orthogonal basis functions are employed to construct the governing equation of the multi-parameters of traffic load. Then the approximate explicit expression of traffic load could be determined by training the LNN. In general, the currently established intelligent algorithms may provide efficient tools for simultaneous identification of multiple parameters of moving loads with high efficiency, and thus may provide rational accordance for early warning of overloaded vehicles and structural maintenance of in-service bridges.
This work is supported by the National Key R&D Program of China (No.2018YFB1600200), the National Natural Science Foundation of China for Outstanding Young Scientists (No. 52122801), the NSFC General Program (No. 51978609), and the Zhejiang Provincial Natural Science Foundation for Distinguished Young Scientists (No. LR20E080003).