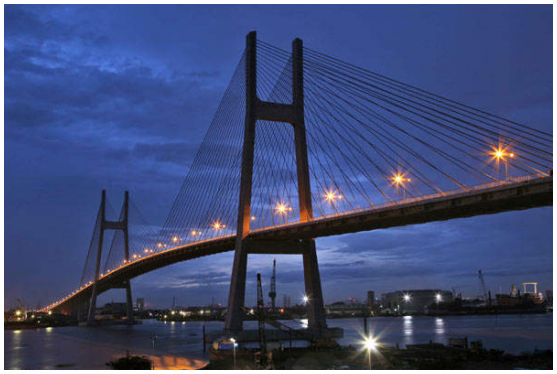
Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)

Deep learning-based signal processing for evaluating energy dispersal in bridge structures

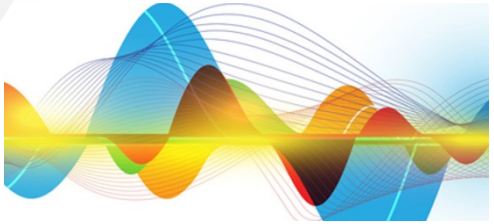
Nhi Ngo-Kieu, Thao Nguyen-Da, Toan Pham-Bao, Tam Nguyen-Nhat, Hung Nguyen-Xuan

Cite this as: Nhi Ngo-Kieu, Thao Nguyen-Da, Toan Pham-Bao, Tam Nguyen-Nhat, Hung Nguyen-Xuan, 2021. Deep learning-based signal processing for evaluating energy dispersal in bridge structures. *Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)* , 22(8):672-680. https://doi.org/10.1631/jzus.A2000414

Structural Health Monitoring (SHM)



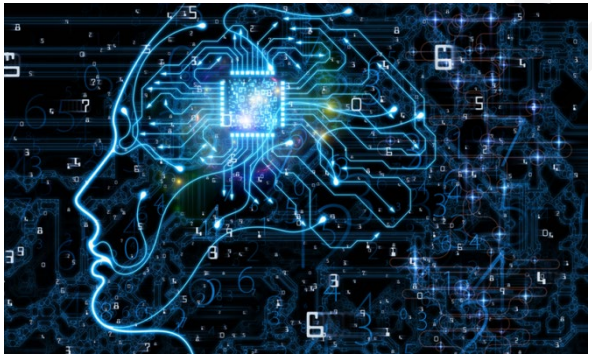
Measurement,
signal processing



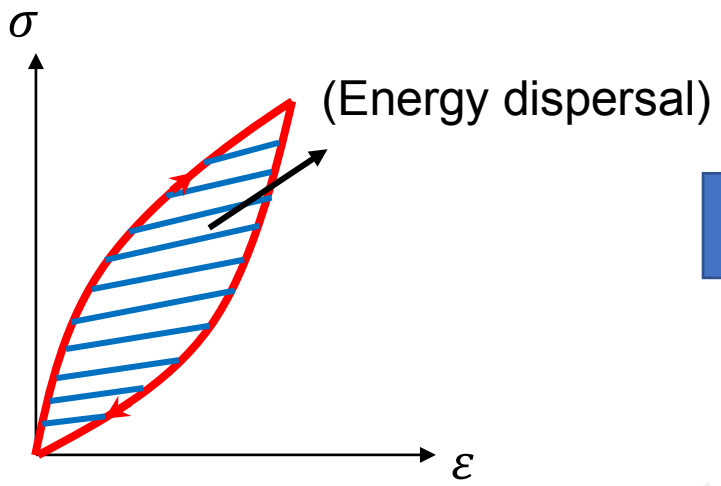
Infrastructure

SHM

Modern
algorithm



Idea and method: Deep learning-based energy dispersal evaluation



Changing mechanical properties of the material

Changing energy dispersal

Measurement → Processing → Deep learning → Monitoring

Vibration signal	• Power Spectral Density (PSD) • Loss Factor function (LF)	Convolutional Neural Network (CNN)	Mechanical properties

Innovation

Generality

Evaluating parameter:
Loss Factor function (LF)
Vibration data:
Power Spectral Density (PSD)

Modernity

Deep learning:
Convolutional Neural Network (CNN)
Measurement:
Acceleration sensor

Automation

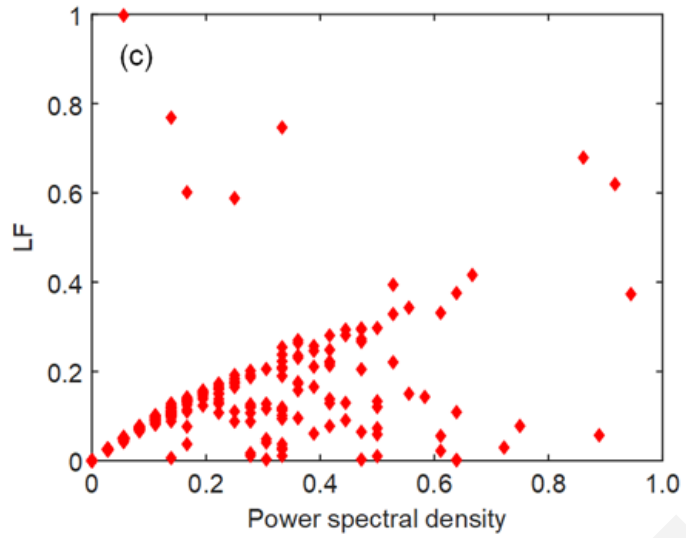
Requested excitation:
Randomly moving load
Procedure:
Automatic feature extraction and classification

Object

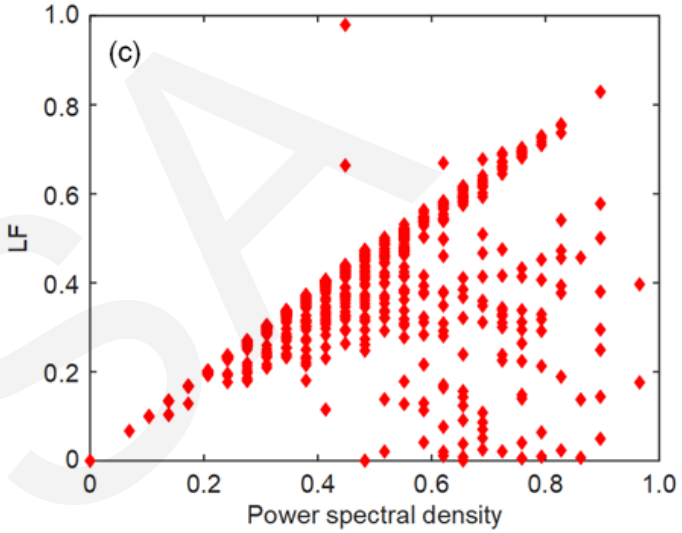
Assessment:
Mechanical properties of material
Monitoring:
Bridge structure

JZUSA

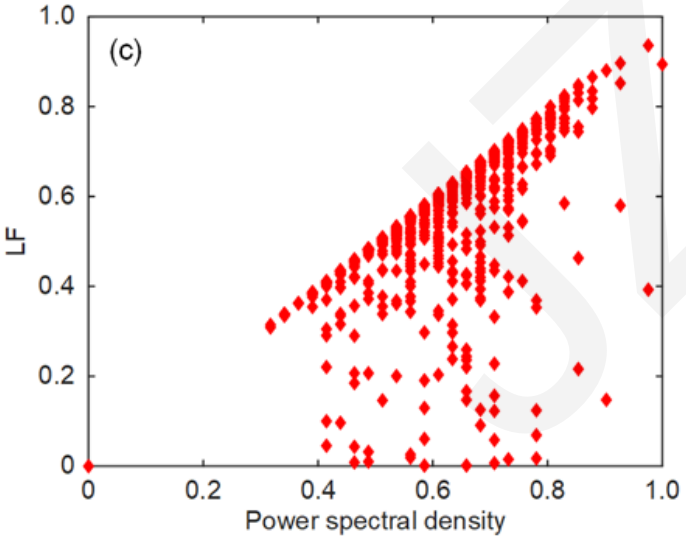
Main results: LF of some bridges



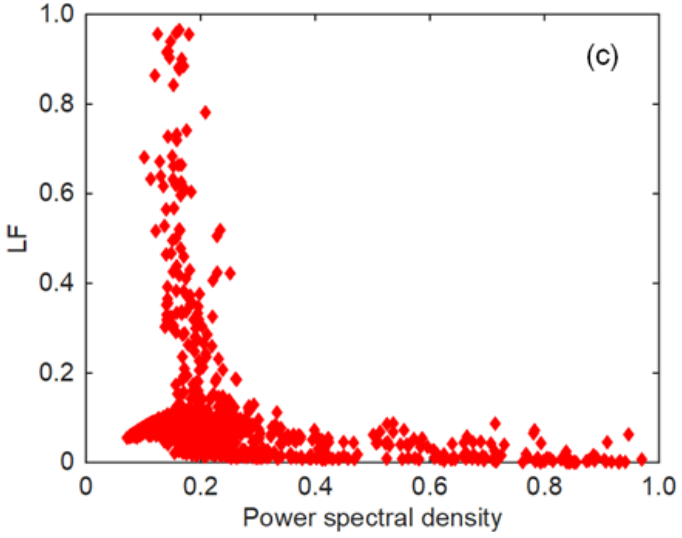
LF of point ½ -span 17 in Phu My Bridge



LF of point ½ -span 3 in Giong Ong To 2 Bridge

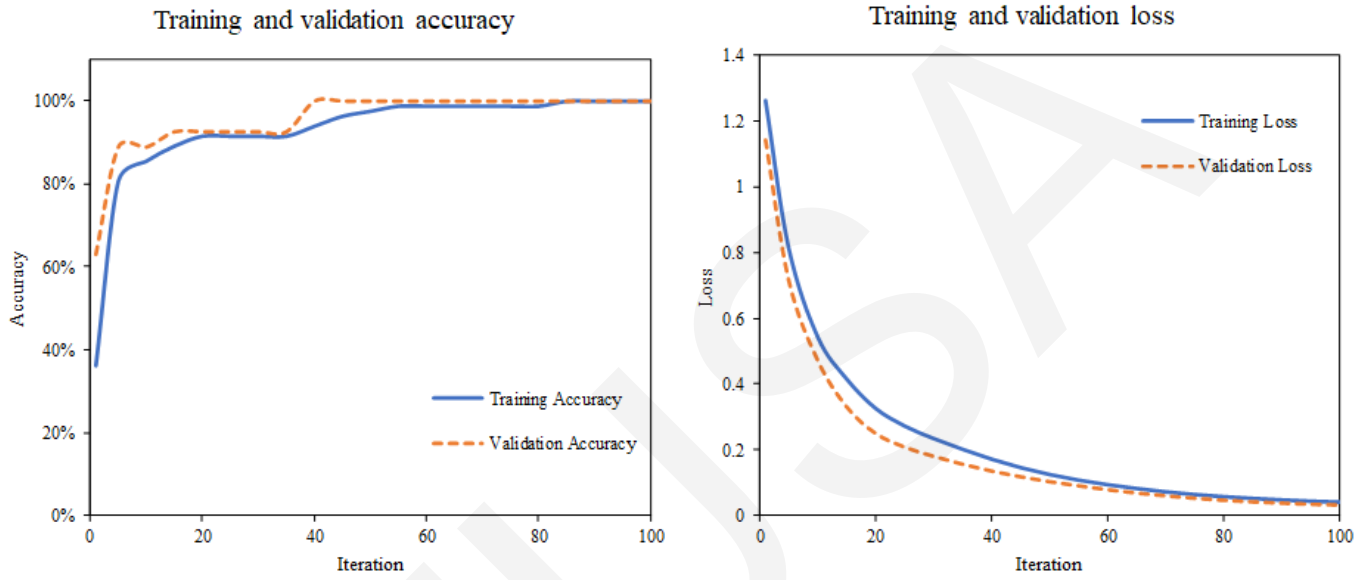


LF of point ½ -span 3 in Sai Gon Bridge

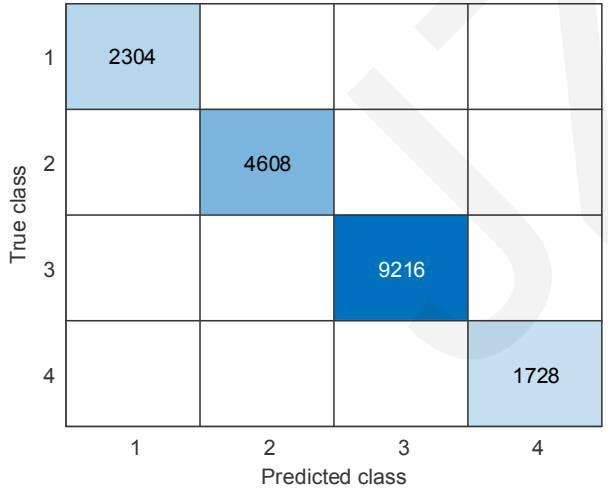


LF of point ½ -span 3A in Cong Dap Rach Chiec Bridge

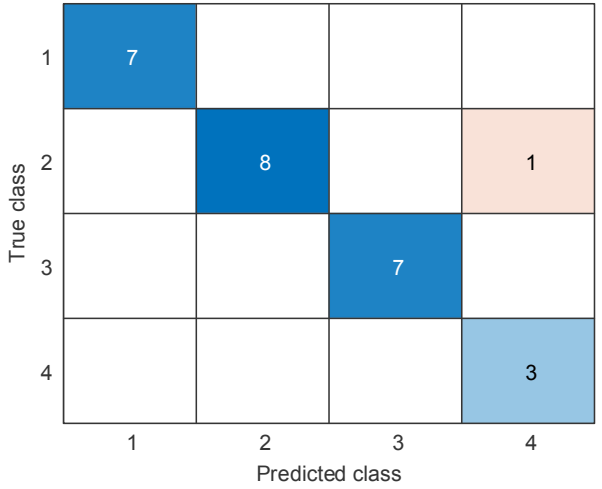
Main results: Training and application



Training and validation performance of the proposed CNN



The confusion matrix of the predicted and actual class categories



The confusion matrix of testing process

Conclusions

- In all real structures, energy dispersal always occurs. Based on the change of vibration energy loss evaluated by the Loss Factor function (LF), health monitoring of bridge can be performed.

- Deep learning-based energy dispersal evaluation is appropriate and highly applicable.

- The testing of the proposed method with several actual bridges derives acceptable results.