THESIS INFORMATION

Title: ***Identification and prediction beam's damage based on neural networks and fuzzy logic***

Specialty: Technical Mechanics
Code: 62 52 02 01
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1. Abstract Beam is a mainly loaded subject of a lot of bridge systems, so the main causes of bridge damage are flaws appearing in beam. The objective of the thesis is to establish beam's damage prediction and identification algorithms which are going to be used for bridge regularly managing system (BRMS) next studies. The thesis has 5 chapters:

Chapter 1: Overview
Chapter 2: Neural Networks, Fuzzy Logic, Adaptive Neuro-Fuzzy Inference System
Chapter 3: Damage Prediction and Identification
Chapter 4: Application
Chapter 5: Conclusion

2. The results of the thesis

1/ Database We established the database of the adaptive neuro-fuzzy inference system using for structure's damage prediction and identification. In which *mean wavelet coefficient* $W^{(k)}$ created by acceleration or variation signal of vibration structure that can easily be measured in the bridge is a parameter used for building the database. $W^{(k)}$ is not sensitive with style of vibration excitation. Moreover, $W^{(k)}$ and damage degree of structure vary in direct proportion. For this reason, $W^{(k)}$ can be used for damage prediction and identification system (DPIS) using vibration signal of traffic-load-vibrated bridge (VSTLVB).

2/ Damage Identification Three new algorithms used for beam damage identification were presented, named VTKT-NL, VTKT-NF, and KTKT-WL, based on vibration potential energy, wavelet, and adaptive neuro-fuzzy inference system:

- VTKT-NL is based on potential energy of vibration beam. The effect of algorithm is quite good for numerical simulations but it becomes difficult for reality beams. In addition, VSTLVB can really not be used for this method. Therefore, VTKT-NL is only used for model survey.
- KTKT-WL is built based on wavelet analysis of structure vibration signal. This algorithm can use of VSTLVB for damage identification. Effect of the algorithm becomes better when it is combined with VTKT-NF.
- The change in dynamic signal is identified by the adaptive neuro-fuzzy inference system. This is solution of damage location identification presented in the algorithm VTKT-NF. Some main characteristics of VTKT-NF:
  - It can use many different signal types. So effect of the algorithm is better when more sensitive signal is used.
  - It is conformity with VSTLVB when the *mean wavelet coefficient* $W^{(k)}$ is used.

3/ Prediction A beam damage prediction algorithm, named TSPA, based on the adaptive neuro-fuzzy inference system, was presented. TSPA can be used for prediction multiple nonlinear parameters. Moreover, the algorithm is suitale for VSTLVB when the *mean wavelet coefficient* $W^{(k)}$ is used.

4/ Building mathematical tools In order to improve effect of the damage prediction and identification systems above, we proposed mathematical tools used for them. They are new algorithms named TT*, CSHL, HLM1, HLM2, CBMM và HLM:

- TT* is built based on the conjugate gradient method. Convergent speed and stability are its advantage. It is quite suitable to neural networks having large weight matrix.
- CBMM and CSHL are used to separate data space, create hyperbox-shaped data clusters. The using these algorithms can increase accurate degree and convergent speed of the fuzzy system. These are efficiencies of the proposed approach.
- Based on using CBMM, CSHL and TT*, we built 3 new algorithms, named HLM1, HLM2 and HLM, used to establish adaptive neuro-fuzzy inference systems. These are good tools for beam damage prediction and identification systems.

3. Prospect of thesis Based on applying close mathematical basics and satisfactory experiment results, author of the thesis has confidence in VTKT-NF, KTKT-WL and TSPA, that they can be used for BRMS using VSTLVB.

4. Some matters for next study

- As demonstrated above, KTKT-WL can combine with VTKT-NF to build wavelet neural fuzzy inference system having much advantage. Therefore, we are going to establish the wavelet neural fuzzy inference system for BRMS.
- We are going to improve database to increase accurate degree of DPIS.
- We are going to study technology solutions in order to build BRMS using VSTLVB.

Certifying of the scientific instructor	**The researcher**
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