Neural Network Model for Automatic Traffic Incident Detection

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Executive Summary

Automatic freeway incident detection is an important component of advanced transportation management systems (ATMS) that provides information for emergency relief and traffic control and management purposes. In this research, a multi-paradigm intelligent system approach and several innovative algorithms were developed for solution of the freeway traffic incident detection problem employing advanced signal processing, pattern recognition, and classification techniques. The methodology effectively integrates fuzzy, wavelet, and neural computing techniques to improve reliability and robustness. The specific accomplishments of this research are

- Development of an effective traffic feature extraction model using discrete wavelet transform and linear discriminant analysis.
- Development of a computational model for automatic traffic incident detection using discrete wavelet transform, linear discriminant analysis, and adaptive conjugate gradient neural network of Adeli and Hung.
- Development of a fuzzy wavelet radial basis function neural network (RBFNN) model for automatic detection of freeway incidents.
- Development of a two-stage single-station freeway incident detection model based on energy representation of the traffic pattern in the wavelet domain.
- A comprehensive parametric study of the performance of the single-station fuzzy-wavelet RBFNN freeway incident detection model and comparison with the benchmark California algorithm #8 based on three quantitative measures of detection rate, false alarm rate, and detection time, and the qualitative measure of algorithm portability using both real and simulated data. The new algorithm outperformed the California algorithm consistently under various scenarios.
- A comprehensive evaluation of the single-station wavelet energy neural network freeway incident detection algorithm and comparison with the California algorithm #8.
- Evaluation of the wavelet energy neural network freeway incident detection algorithm on rural freeways where flow rates are low and detector stations are spaced further apart.

It is demonstrated that both fuzzy-wavelet RBFNN and wavelet energy neural network freeway incident detection algorithms are computationally efficient, produce excellent detection rates and very low false alarm rates on urban freeways, and can readily be implemented on-line in any ATMS without any need for re-calibration and without any performance deterioration. Considering the difficulty in automatic detection of incidents on rural freeways, the wavelet energy algorithm performs well on rural freeways as well. The algorithm is fast as it detects an incident on urban freeways in less than two minutes and on rural freeways in less than three minutes.