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Road pavement performance prediction using a time series long short-term memory (LSTM) model

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Raw PI data for pavements

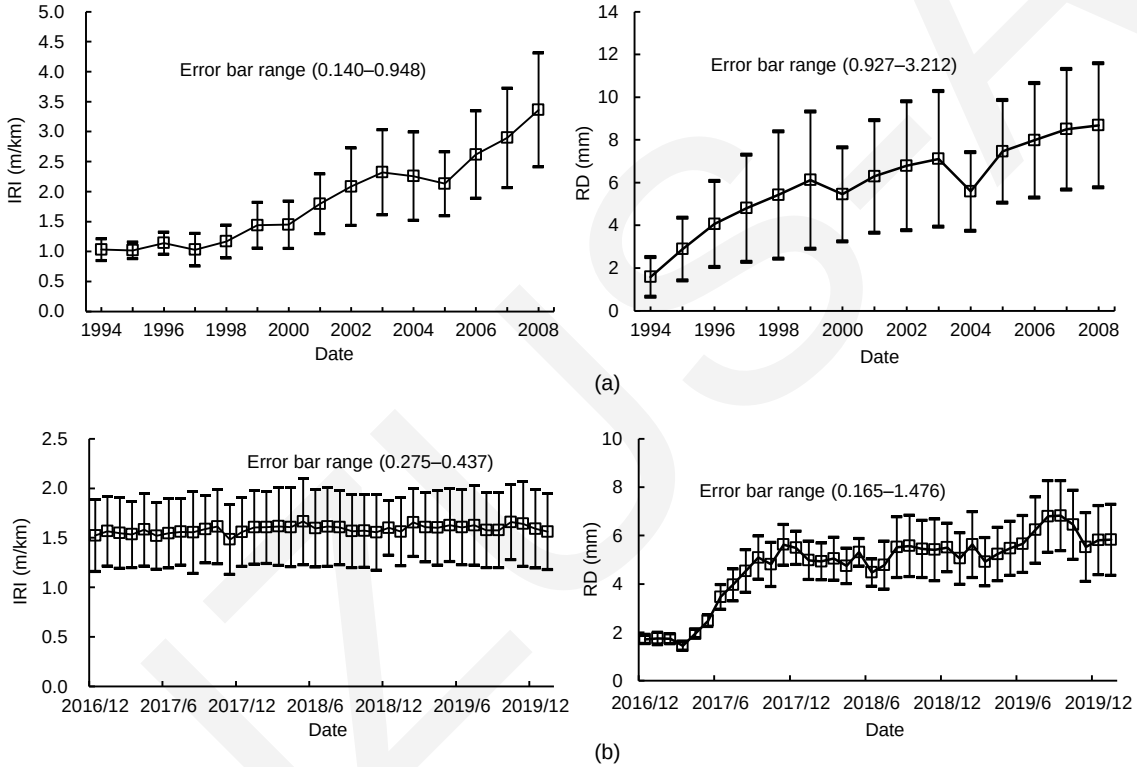


Fig. 1 PI data for pavement sections: (a) MnRoad (27 samples); (b) RIOHTrack (19 samples)

Predictors for PIs of pavements

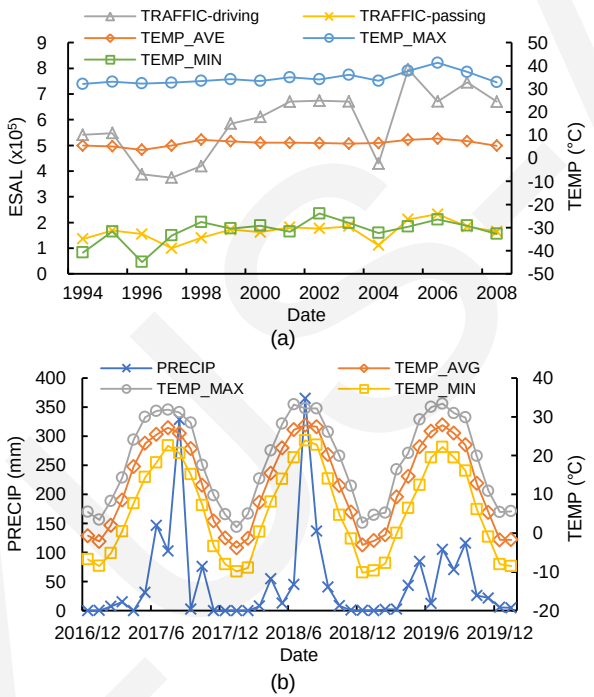


Fig. 2 Representative predictors for pavement sections: (a) MnRoad; (b) RIOHTrack

Method: Wavelet denoising

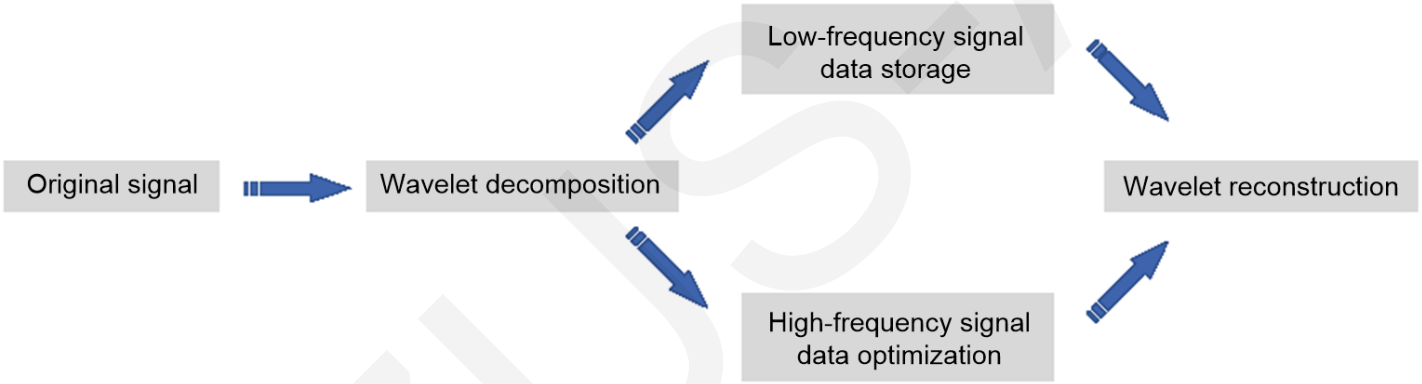


Fig. 3 Process of wavelet denoising

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Result: PI predictions

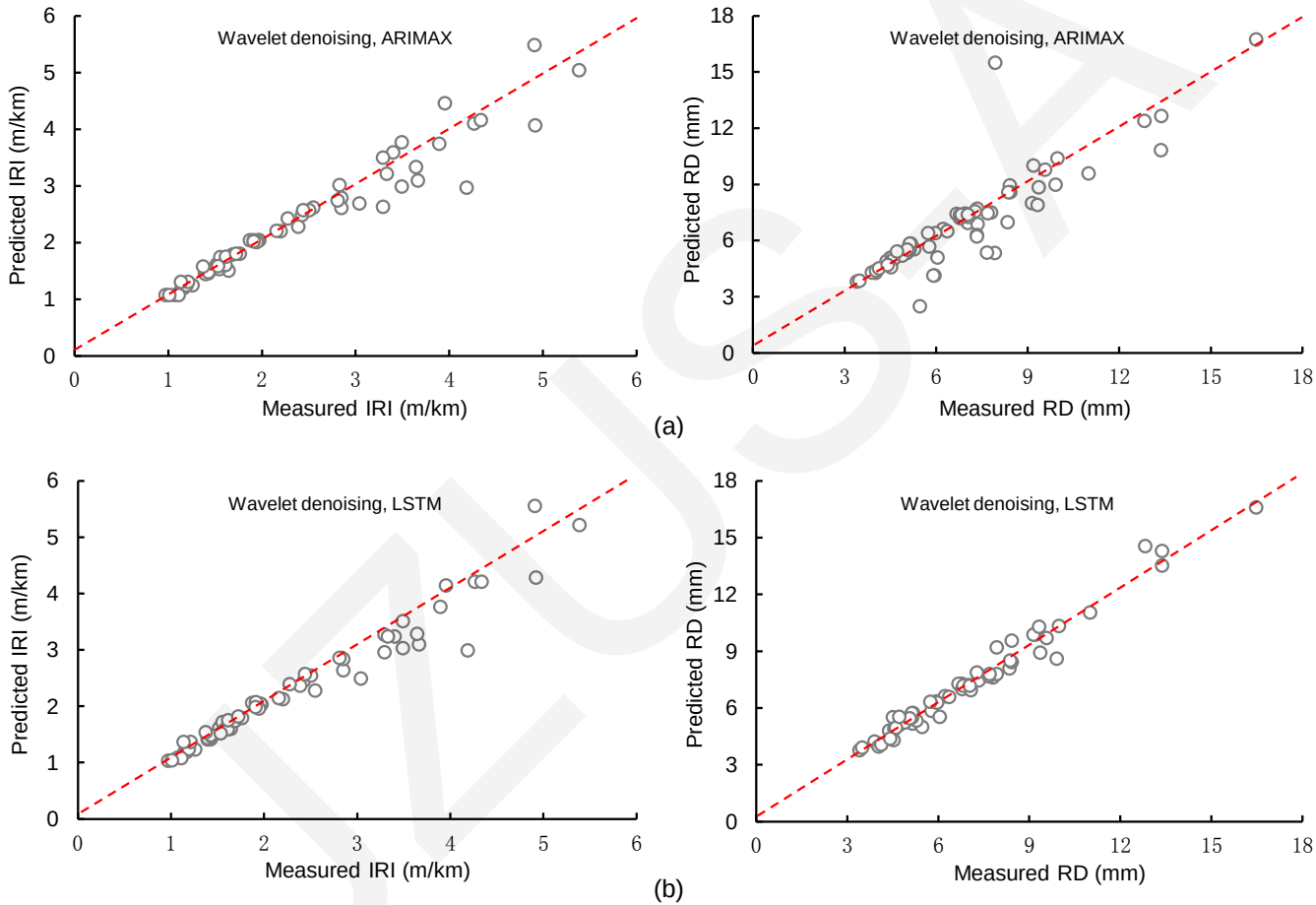


Fig. 9 Model performance for denoised PI prediction: (a) ARIMAX; (b) LSTM

Result: Comprehensive performance predictions

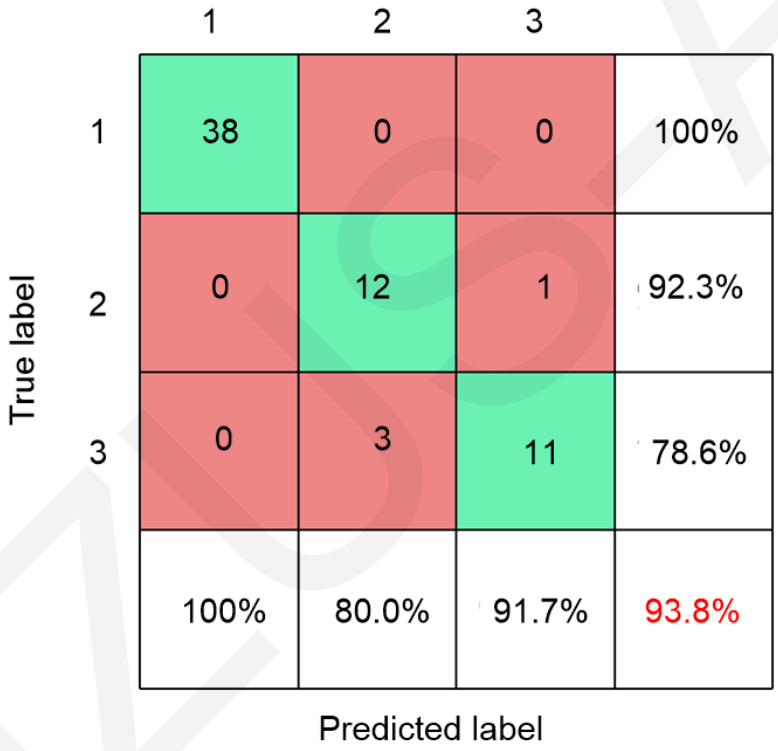


Fig. 10 Confusion matrix of the BPNN prediction model for comprehensive performance

Conclusions

- A method based on a time series LSTM model was developed to predict the PIs of asphalt pavements (specifically IRI and RD), and a comprehensive performance indicator PQI was proposed to evaluate the condition of the pavement.
- LSTM model outperforms the ARIMAX model in PI prediction.
- LSTM model is particularly suitable for application scenarios with missing/noisy data or frequent maintenance operations.
- PQI proposed in this study has an overall prediction accuracy of 93.8%, which may serve as a reference for more sophisticated pavement management and maintenance strategies.