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Development of Confidence-Weighted Phase-Based Displacement Estimation and Virtual Sensor-Based Full-Field Vibration Measurement for Vision-Based Structural Analysis

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Abstract

This dissertation develops a confidence-based framework for vision-based structural vibration analysis to improve the accuracy, robustness, and scalability of full-field displacement measurement. The proposed framework addresses measurement uncertainty and noise by integrating phase nonlinearity–weighted optical flow, pixel-wise confidence estimation, superpixel-based virtual sensing, and graph-structured virtual sensor networks. These methods enable reliable displacement estimation, stable full-field vibration representation, interpretable virtual sensor construction, and unsupervised structural anomaly detection. Numerical and experimental validations demonstrate that the proposed framework enhances vision-based vibration measurement and provides an effective foundation for structural dynamics analysis and structural health monitoring.

[사용언어: 한국어]