20th WCNDT 20th World Conference on Non-Destructive Testing
Songdo Convensia, Incheon, Korea, 27-31 May 2024

Deep Learning based Phase Unwrapping for Precise 3D Surface Profiling in Holography

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Abstract

We explore the transformative application of deep learning-based phase unwrapping method in the context of surface profiling with holographic data. Holography, which is known for its ability to capture complicated 3D structures, provides an abundance of information through recorded interference patterns. However, accurate surface profiling depends on the precise unwrapping of the phase information, that is affected by noise and discontinuities. Hence, this study introduces a new approach that harnesses the capabilities of deep learning for robust phase unwrapping.

The proposed method employs advanced convolutional neural networks (CNNs) to learn and distinguish complex patterns within holographic data, enabling the unwrapping with high accuracy. The CNN architecture is specifically tailored to handle challenges such as noise and discontinuities inherent in holographic information, ensuring the fidelity of the reconstructed 3D surfaces. Training the network involves datasets comprising of synthetic data paired with true and wrapped phase, facilitating the learning of relationships crucial for unwrapping in diverse scenarios.

Experimental validation showcases the superiority of the deep learning-based method over traditional algorithms, demonstrating enhanced resilience to noise and improved accuracy in surface profiling. The integration of deep learning not only refines surface reconstruction but also holds promise for real-time application in the field where precise 3D information is imperative, such as non-destructive testing and material characterization. This research thus signifies a significant leap forward in advancing the capabilities of holography for accurate surface profiling through deep learning based phase unwrapping methodology.

Keywords: 3D Surface Profiling, Holography, Phase Unwrapping, Deep Learning