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

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This abstract explores the transformative application of deep learning-based phase unwrapping in the context of surface profiling using holographic data. Holography, renowned for its ability to capture intricate 3D structures, provides a wealth of information through recorded interference patterns. However, accurate surface profiling relies on the precise unwrapping of phase information, a task often hindered by noise and discontinuities. In response, this study introduces a pioneering approach that harnesses the capabilities of deep learning for robust phase unwrapping. The proposed method employs advanced convolutional neural networks (CNNs) to learn and discern complex patterns within holographic data, enabling the unwrapping of phase maps with unprecedented 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 curated datasets comprising holograms paired with accurately unwrapped phase maps, facilitating the learning of nuanced relationships crucial for unwrapping in diverse scenarios. Experimental validation showcases the superiority of the deep learning-based phase unwrapping 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 applications in fields where precise 3D information is imperative, such as non-destructive testing and materials characterization. This research thus signifies a significant leap forward in advancing the capabilities of holography for nuanced and accurate surface profiling through the synergy of deep learning and phase unwrapping methodologies.