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Hybrid CNN-SAR and Lee Filtering for Enhanced InSAR Phase Unwrapping and Coherence Optimization

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Abstract : Interferometric Synthetic Aperture Radar (InSAR) coherence is a crucial parameter for accurately monitoring ground deformation and environmental changes. However, coherence can be degraded by various factors such as temporal decorrelation, atmospheric disturbances, and geometric misalignments, limiting the reliability of InSAR measurements (Omar Hadj-Sahraoui and al. 2019). To address this challenge, we propose an innovative hybrid approach that combines artificial intelligence (AI) with advanced filtering techniques to optimize interferometric coherence in InSAR data. Specifically, we introduce a Convolutional Neural Network (CNN) integrated with the Lee filter to enhance the performance of radar interferometry. This hybrid method leverages the strength of CNNs to automatically identify and mitigate the primary sources of decorrelation, while the Lee filter effectively reduces speckle noise, improving the overall quality of interferograms. We develop a deep learning-based model trained on multi-temporal and multi-frequency SAR datasets, enabling it to predict coherence patterns and enhance low-coherence regions. This hybrid CNN-SAR with Lee filtering significantly reduces noise and phase unwrapping errors, leading to more precise deformation maps. Experimental results demonstrate that our approach improves coherence by up to 30% compared to traditional filtering techniques, making it a robust solution for challenging scenarios such as urban environments, vegetated areas, and rapidly changing landscapes. Our method has potential applications in geohazard monitoring, urban planning, and environmental studies, offering a new avenue for enhancing InSAR data reliability through AI-powered optimization combined with robust filtering techniques.

Keywords : CNN-SAR, Lee Filter, hybrid optimization, coherence, InSAR phase unwrapping, speckle noise reduction
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