An Automated Hybrid Fusion Network for Poisson Noise Reduction in X-Ray Osteoarthritis Images

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Abstract:
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Abstract:
Denoising X-ray images is essential for improving medical image quality, especially in diagnosing conditions like knee osteoarthritis in Computer-Aided Diagnosis (CAD) systems. The presence of statistical noise, such as Poisson noise, can degrade X-ray image quality. While increasing radiation intensity and detector exposure time can help reduce this corruption, certain scenarios require low-dose detection and rapid response, such as security checks and urgent medical imaging assessments. Balancing noise reduction with preserving essential edge details poses a complex challenge in the denoising process. This study introduces a hybrid approach that combines two distinct denoising techniques: Fused Wavelet Transform and Autoencoder networks. The fusion strategy aims to leverage the strengths of both methods to enhance denoising performance and accuracy. Standard image quality metrics including Mean Absolute Error (MAE), Mean Squared Error (MSE), Peak Signal-to-Noise Ratio (PSNR), Frequency Based Error (FBE), Mean Squared Error (MSE), Structural Similarity Index Matrix (SSIM), and Contrast-to-Noise Ratio (CNR) are employed to evaluate performance. The proposed framework is rigorously evaluated, demonstrating significant improvements in denoising performance. Thus, the hybrid fusion method produces denoised images with higher detail and accuracy compared to conventional Convolutional Neural Network (CNN) based methods.

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