

Research on enhancing medical image quality using complex nonlinear diffusion equations

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Abstract: This study investigates the enhancement of medical image quality through the application of complex nonlinear diffusion equations. Traditional linear diffusion methods, while effective at noise reduction, often compromise critical edge information and fine anatomical details. By extending the diffusion process into the complex domain, this approach leverages both the real and imaginary components to achieve a more adaptive filtering mechanism. The proposed model integrates a complex diffusion coefficient that responds to local image features, enabling robust noise suppression while preserving and even enhancing edges and textures. Numerical experiments were conducted on various medical imaging modalities, including MRI and CT scans, with quantitative evaluations using metrics such as Peak Signal-to-Noise Ratio (PSNR) and Structural Similarity Index (SSIM). Results demonstrate that the complex nonlinear diffusion method significantly outperforms conventional techniques, yielding superior contrast and detail preservation. This research provides a promising framework for improving diagnostic image quality, with potential applications in clinical settings where accurate feature delineation is critical.

Keywords: Nonlinear diffusion equation, image enhancement, medical image, image processing