Adaptive Thresholded Physics-Informed CNN for Mixed Noise Removal Using Anisotropic Diffusion

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Abstract

Many image restoration tasks are modeled using partial differential equations (PDEs) of different classes. Images are often degraded by various types of noise, and in practice, mixed noise occurs more frequently than a single type [1, 2]. This work proposes an adaptive, pixel-dependent thresholding strategy for the anisotropic diffusion equation to remove mixed speckle–Gaussian noise. In this approach, the image gradient is used to design the thresholding function, making the process adaptive to local image structures [3]. Furthermore, the potential of CNN-based solvers to handle mixed noise is explored. In this context, two CNN-based solvers—namely, the Soft-Constrained Physics-Informed Convolutional Neural Network (SPICN) and the Hard-Constrained Physics-Informed Convolutional Neural Network (HPICN)—are employed to implement the Perona–Malik model as a representative case. Additionally, the stability analysis of neural network-based approximations for such diffusion equations is investigated. The experimental results demonstrate that the proposed strategy enhances the denoising capability of the diffusion equation and that the CNN-based solvers have the potential to outperform the traditional finite difference method in image denoising tasks.

References

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