Adaptive Image Diffusion in Wavelet Domain

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Objectives
- two Methods, same Purpose
- Noisy Image
- Wavelet Shrinkage
- Non-Linear Diffusion Filtering

- Removing noise without sacrificing important structures
- Nonlinear strategies: Wavelet shrinkage and Nonlinear diffusion filtering based on features
- Clustering based wavelet diffusion

Background
Perona-Malik’s Idea
Isotropic diffusion
\[ \frac{\partial I(x, y, t)}{\partial t} = \text{div}[\nabla I] \]

edge stopping function
\[ g(x) = \frac{1}{1 + (x/K)^2} \]

Discrete Implementation
\[ \nabla_N I = I_{i+1,j} - I_{i,j} \]
\[ \nabla_S I = I_{i+1,j} - I_{i,j} \]
\[ \nabla_E I = I_{i+1,j} - I_{i,j} \]
\[ \nabla_W I = I_{i+1,j} - I_{i,j} \]
\[ c_d = g(\|\nabla_d I\|), d = N, S, E, W \]
\[ I_{i,j}^{t+1} = I_{i,j}^t + \lambda(c_N \nabla_N I + c_S \nabla_S I + c_E \nabla_E I + c_W \nabla_W I) \]

2D Haar Wavelet Transform
2-Level Dyadic Wavelet Transform
2-Level Stationary Wavelet Transform

Model # 1
- Noisy Image
- Forward Haar Transform
- Ratio Energy
- Detail Coefficients Diffusion based on Energy
- Inverse Haar Transform
- Denoised Image

Model # 2
- Noisy Image
- Forward Haar Transform
- K-Means Clustering And Blob Detection
- Diffusion of each blob based on Region
- Inverse Haar Transform
- Denoised Image

Results

2D Wavelet Shrinkage

Conclusion
- Clustering: group together similar points and represent them with a single token which helps in better denoising.
- For all experiments, we observed better results based on a clustering based wavelet transform compared to other wavelet denoising.

References