E9 241 Digital Image Processing Project Proposal

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Tejash More, Dwaipayan Haldar

Project Topic and Problem Statement

- **Title**: Wavelet-Based Image Denoising using Thresholding Techniques.
- **Problem Statement:** Noise is an inevitable part of image acquisition and transmission, degrading visual quality. Traditional spatial domain filters (like Gaussian, Median, or Bilateral filters) often blur edges while removing noise. Wavelet-based denoising offers a multi resolution framework where noise and signal can be effectively separated using thresholding of wavelet coefficients [1]. However, the performance of denoising depends heavily on the choice of thresholding rule and type of noise. This project aims to analyze and compare three key wavelet thresholding strategies VisuShrink [2], SUREShrink [3, 4], and BayesShrink [5] under various noise conditions to understand their effectiveness and limitations.

Team Members

- Dwaipayan Haldar, M.Tech Signal Processing
  SR No.: 04-03-01-10-42-25-1-27128
- Tejash More, M.Tech Signal Processing
  SR No.: 04-03-01-10-42-25-1-27077

Project Objectives

- **Theory of Wavelet Transform:** We want to understand Discrete Wavelet Transform(DWT) [1], its application in image denoising methods.
- **Thresholding Techniques:** We want to employ different non adaptive and adaptive traditional thresholding algorithms like VisuShrink [2], SUREShrink

[3,4], and BayesShrink [5] and also understand the rationale why thresholding in Wavelet domain leads to denoising in spatial domain.

- **Evaluate Robustness:** Though most of the thresholding techniques are done modelling Additive Gaussian Noise (AGN), we want to experiment with different Noise like Salt-and-Pepper Noise and Random Noise and also compare the performance with traditional space domain denoising algorithms on standard test images.

- **Limitations:** Explore cases where Wavelet Based Image Denoising methods fails and why it does so.

Methodology

- **Theoretical Background:** We would first understand the basics of Discrete Wavelet Transform and its advantages over other transform techniques.

- **Algorithmic Implementation:** Main flowchart of our implementation consist of 3 main steps: (i) Apply DWT (Division into different subbands) (ii) Thresholding (VisuShrink [2], SUREShrink [3,4], and BayesShrink [5]) (iii) Apply inverse DWT to get back the denoised image. Fig.1 shows the overall flowchart of the algorithm.

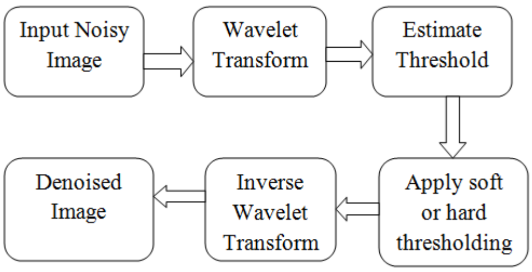

Figure 1: Flowchart of the Overall Algorithm

- **Evaluation and Comparative Analysis:** We would experiment on the set of standard test images and compare results adding different types of noise of varying intensities and also with different types of mother wavelets. We would carry out both quantitative analysis via the evaluation metrics like MSE, PSNR and SSIM and qualitative analysis via Visual Inspection.

References

[1] S. Mallat, *A Wavelet Tour of Signal Processing.* San Diego, CA, USA: Academic Press, 1999.

[2] D. L. Donoho, “De-noising by soft-thresholding,” *IEEE Trans. Inf. Theory*, vol. 41, no. 3, pp. 613–627, 1995.

[3] D. L. Donoho and I. M. Johnstone, “Adapting to unknown smoothness via wavelet shrinkage,” *J. Amer. Stat. Assoc.*, vol. 90, no. 432, pp. 1200–1224, 1995.

[4] D. L. Donoho and I. M. Johnstone, “Threshold selection for wavelet shrinkage of noisy data,” in *Proc. 16th Annu. Int. Conf. IEEE Eng. Med. Biol. Soc.*, vol. 1, 1994, pp. A24–A25.

[5] S. G. Chang, B. Yu, and M. Vetterli, “Adaptive wavelet thresholding for image denoising and compression,” *IEEE Trans. Image Process.*, vol. 9, no. 9, pp. 1532–1546, 2000.