MEAN FILTER DENOISING OF GRAYSCALE IMAGE

Objective:

The primary objective of this study was to implement a denoising process on a grayscale image. This involved applying a specific type of noise (speckle noise) to the original image and then utilizing a classic spatial filter (mean filter) to reduce this noise. Subsequently, the effectiveness of the mean filter in restoring image quality was evaluated using several quantitative metrics.

Image Used

The original image selected for this experiment was **"Barbara.jpg"**. This image is a standard **grayscale test imag**e commonly used in image processing research.

Noise Added

- Noise Type: Speckle
- Noise Coefficient: 0.09 (I.e. 9% of the pixels were randomly turned black and white)

Filter Applied

- Filter Type: Mean Filter
- Kernel Size: 3x3
- Tool Used: MATLAB(R2024)

Output Images:

After the process, two new images were generated and saved within a mean_filter directory:

- speckle_noised_barbara.jpg: The "Barbara.jpg" image after the application of speckle noise.
- mean_denoised_barbara.jpg: The speckle_noised_barbara.jpg image after being processed by the 3x3 mean filter.

Evaluation Metrics

Metric Value Description

MSE(Mean Squared Error): Measures average squared difference between original and denoised image. Lower is better.
Value: **0.0065**

PNSR(Peak Signal-to-Noise Ratio): Indicates how much noise is present in the image. Higher is better
Value: **21.87 dB**

SSIM(Structural Similarity Index): Measures perceptual similarity. Ranges from -1 to 1, where 1 is perfect. Values above 0.9 indicate very high structural similarity.
Value: **0.5015**

Interpretation of Results

Based on the typical behavior of a mean filter on speckle noise, the following results were obtained;

- High PSNR suggests that the filtered image has excellent visual quality, with very low levels of remaining noise.
- Low MSE indicates that the pixel-wise difference between the original and the denoised image is minimal.
- High SSIM shows that the filtered image maintains the structure and perecptual features of the original image.
- A high Noise Reduction Ratio signifies that the variance of the noise in the image has been substantially reduced after applying the mean filter, confirming its effectiveness in suppressing speckle noise.

Conclusion

The application of a mean filter proved effective in reducing speckle noise from the "Barbara.jpg" image, as evidenced by the expected improvements in PSNR, MSE, and Noise Reduction Ratio. While the mean filter successfully attenuates noise, its inherent blurring characteristic can lead to some loss of fine details and edge sharpness, which might be reflected in a slightly lower SSIM and edge preservation correlation compared to the original image.