Median Filter Denoising of Salt-and-Pepper Noised Image

Objective:

To evaluate the effectiveness of a classic filter (median filter) in denoising an image corrupted by salt-and-pepper noise.

Image Used

- Filename: barbara.jpg
- Description: Standard test image in grayscale, used for image processing benchmarking.

Noise Added

- Noise Type: Salt-and-pepper noise
- Noise Density: 0.09 (i.e. 9% of the pixels were randomly turned black or white)

Filter Applied

- Filter Type: Median filter
- Kernel Size: 3x3
- Tool Used: MATLAB (R202x)
- Function: medfilt2(noisy_img, [3 3])

Output Images

- noised_barbara.jpg — image after salt-and-pepper noise was added
- median_denoised_barbara.jpg — image after median filtering

Evaluation Metrics

Metric Value Description

MSE (Mean Squared Error) 23.8224 Measures average squared difference between original and denoised image. Lower is better.

PSNR (Peak Signal-to-Noise Ratio) 34.36 dB Indicates how much noise is present in the image. Higher is better. Values above 30 dB indicate good quality.

SSIM (Structural Similarity Index) 0.9604 Measures perceptual similarity. Ranges from -1 to 1, where 1 is perfect. Values above 0.9 indicate very high structural similarity.

Interpretation of Results:

The median filter performed very well in removing salt-and-pepper noise:

- Low MSE indicates that the pixel-wise difference between the original and the denoised image is minimal.
- High PSNR (34.36 dB) suggests that the filtered image has excellent visual quality, with very low levels of remaining noise.
- High SSIM (0.9604) shows that the filtered image maintains the structure and perceptual features of the original image.

Conclusion:

The median filter is highly effective in denoising images corrupted by salt-and-pepper noise. In this task, it restored the barbara.jpg image with high accuracy and minimal information loss, making it a suitable choice for basic image restoration tasks.