Department of Computer Engineering

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Digital image processing Course

Digital image processing technique for image enhancement , assignment 2

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Fall 2024

1 INTRODUCTION

This report investigates several image processing techniques, including noise reduction, edge detection, and image enhancement. Various filters and operators like averaging, median, Sobel, Laplacian, Prewitt, and Roberts-Cross were applied to analyze their effects on different sample images. The goal is to demonstrate how these techniques improve image quality, clarify details, and detect edges.

2 METHODOLOGY

Noise Reduction and Sharpening

- **Averaging Filters**: Three different kernel sizes (3x3, 5x5, and 7x7) were applied to the image 'bridge.gif' to reduce noise. The averaging filter computes the mean of the neighboring pixels within the kernel to smooth the image and suppress random noise. - **Laplacian Sharpening**: A Laplacian mask was used to sharpen the blurred image, which enhances edges and fine details. The Laplacian filter emphasizes rapid intensity changes in the image, making it useful for sharpening.

Noise Reduction with Different Filters

- **Averaging Filters**: Averaging filters with different kernel sizes (3x3, 5x5, 7x7) were applied to the noisy image 'brain.png' to assess their effectiveness in noise reduction. - **Median Filters**: Median filtering was also tested with the same kernel sizes. The median filter replaces each pixel with the median value of its neighboring pixels, preserving edges while removing noise more effectively than averaging filters.

Edge Detection

- **Sobel Operator**: The Sobel operator was applied to 'Edge.jpg' to compute the gradient in both the x and y directions. This operator is useful for detecting edges by highlighting areas of rapid intensity change. - **Laplacian Operator**: The Laplacian operator was applied to detect edges by computing the second-order derivative, which detects rapid intensity changes in all directions. - **Roberts-Cross and Prewitt Operators**: These operators were used to detect edges in different ways. The Roberts-Cross operator uses a 2x2 kernel, while Prewitt uses a 3x3 kernel. High-boost filtering was also applied to enhance the results.

Image Enhancement

- **Histogram Equalization**: The technique was applied to 'skeleton.png' to enhance its contrast. This method redistributes the intensity values across the image, improving the visibility of details, especially in areas with low contrast.

EXPERIMENTAL RESULTS

Noise Reduction and Sharpening

Averaging Filters

Figures 1 show the results of the averaging filters applied to the image 'bridge.gif' with different kernel sizes (3x3, 5x5, 7x7).

- The **3x3 filter** reduces noise slightly while retaining more details.
- The **5x5 filter** strikes a balance between noise reduction and detail preservation, with a noticeable reduction in noise without excessive blurring.
- The **7x7 filter** reduces noise most effectively but causes significant blurring, especially in finer details.

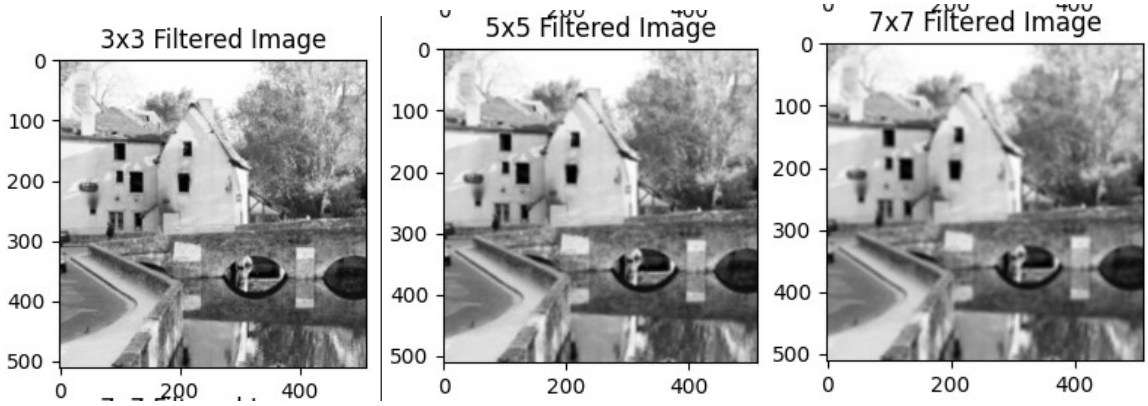

Figure 1: Noise reduction with 3x3, 5x5, and 7x7 averaging filters.

Sharpening Effects

The Laplacian sharpening results are shown in Figure 2. The sharpening process enhances details but also accentuates some of the original noise.

- The **first sharpening** step enhances fine details but also emphasizes existing noise in the image.
- The **second sharpening** step further enhances the edges but increases noise and may distort the image due to over-sharpening.

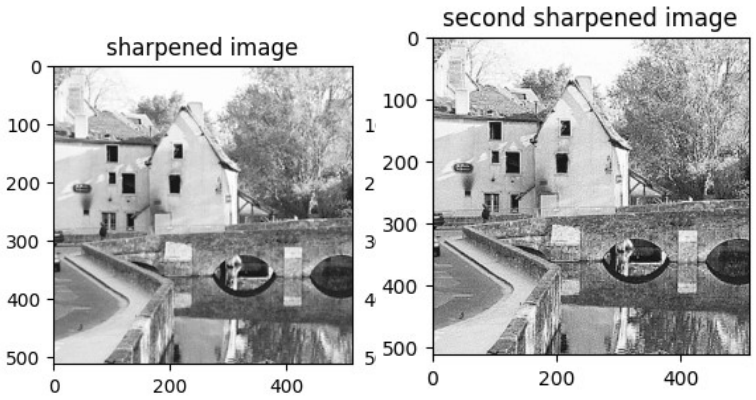

Figure 2: Sharpening effects (once and twice).

Noise Reduction with Different Filters

Averaging Filters

Figures 3 show the results of the averaging filter applied to the noisy image 'brain.png'. The results indicate that the noise reduction improves with larger kernel sizes but also introduces more blurring.

- The **3x3 averaging filter** reduces noise but still leaves some visible artifacts.
- The **5x5 averaging filter** provides better noise reduction while causing moderate blurring.
- The **7x7 averaging filter** results in the least visible noise, but details become blurred.

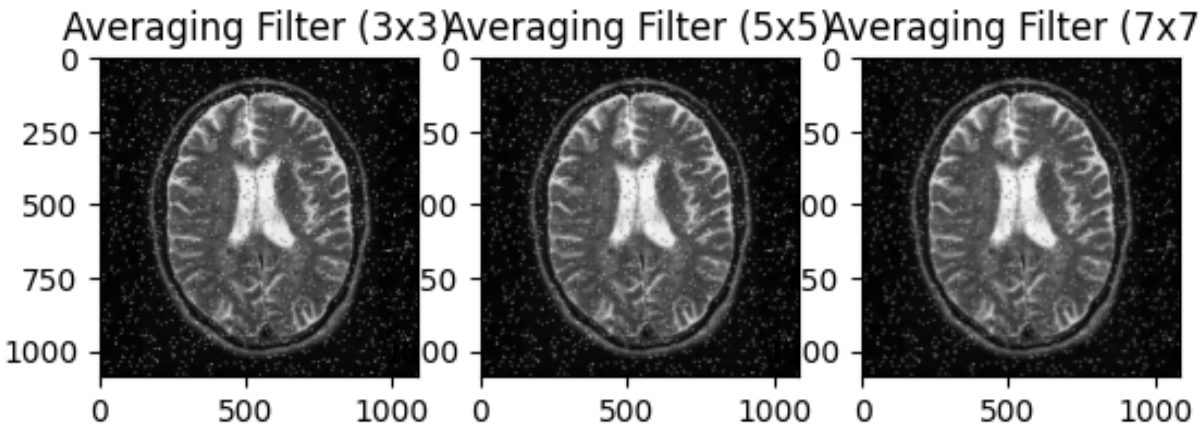

Figure 3: Averaging filter results.

Median Filters

Figures 4 show the results of applying median filters. The median filter preserves edges better than the averaging filter, with the 5x5 and 7x7 kernel sizes providing better noise reduction.

- The **3x3 median filter** effectively removes small noise but might blur some finer details.
- The **5x5 median filter** provides a better trade-off between noise reduction and detail preservation.
- The **7x7 median filter** is highly effective at removing noise, but it starts to blur the image's finer details.

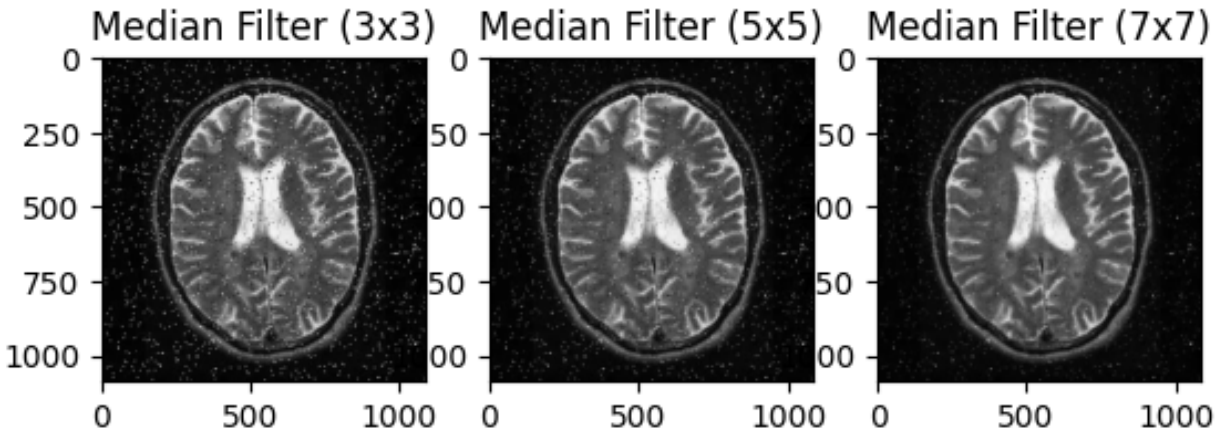

Figure 4: Median filter results.

Edge Detection

Sobel and Laplacian Operators

Figures 5 show the edge detection results using the Sobel and Laplacian operators on the 'Edge.jpg' image. Both operators detect edges but in different ways.

- The **Sobel operator** detects edges in the horizontal and vertical directions, which is useful for detecting boundaries in images.
- The **Laplacian operator** detects all edges in the image by calculating second-order derivatives, but it is more sensitive to noise.

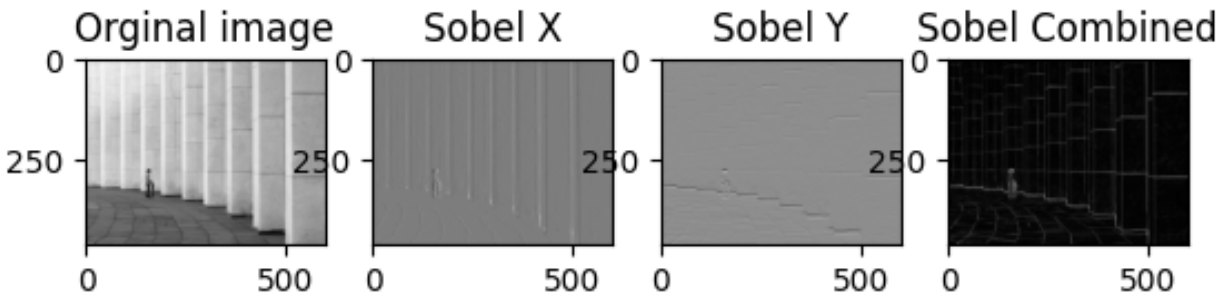

Figure 5: Edge detection using Sobel and Laplacian operators.

Roberts-Cross and Prewitt Operators

Edge Detection

Figures 6 display the results of the Roberts-Cross and Prewitt edge detection operators. The high-boost filter enhances the detected edges in the Prewitt operator result.

- The **Roberts-Cross operator** provides sharper edges but is more sensitive to noise due to its smaller 2x2 kernel.
- The **Prewitt operator** uses a 3x3 kernel, providing smoother edges and better noise resistance.
- The **high-boost filter** applied to the Prewitt result enhances the edges and highlights the boundaries in the image.

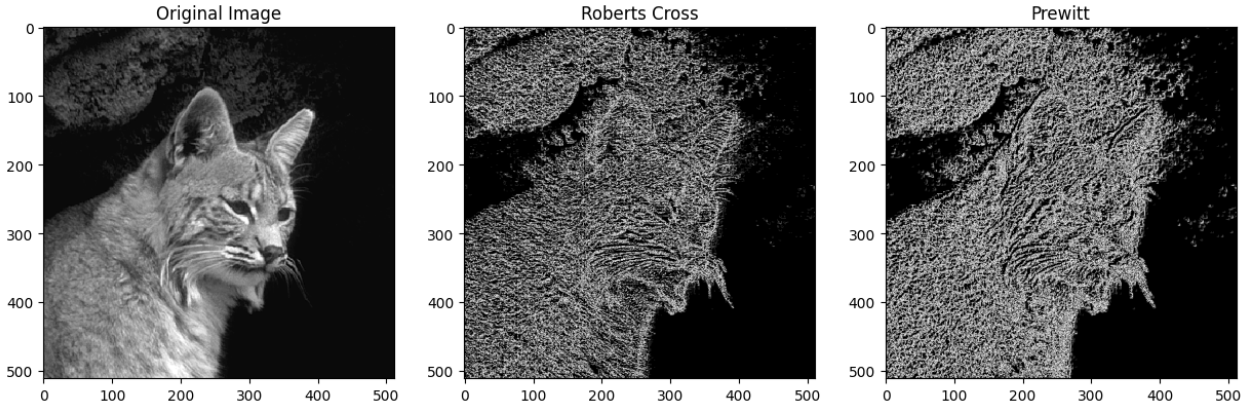

Figure 6: Roberts-Cross, Prewitt, and high-boost filter results.

Image Enhancement

Histogram Equalization

Figure 7 shows the comparison between the original and enhanced images of ‘skeleton.png‘ using histogram equalization. The enhancement improves the contrast, making the skeleton more visible.

- The **original image** has low contrast, making the bones hard to distinguish.
- The **enhanced image** shows improved contrast, with clearer boundaries and details of the skeleton.

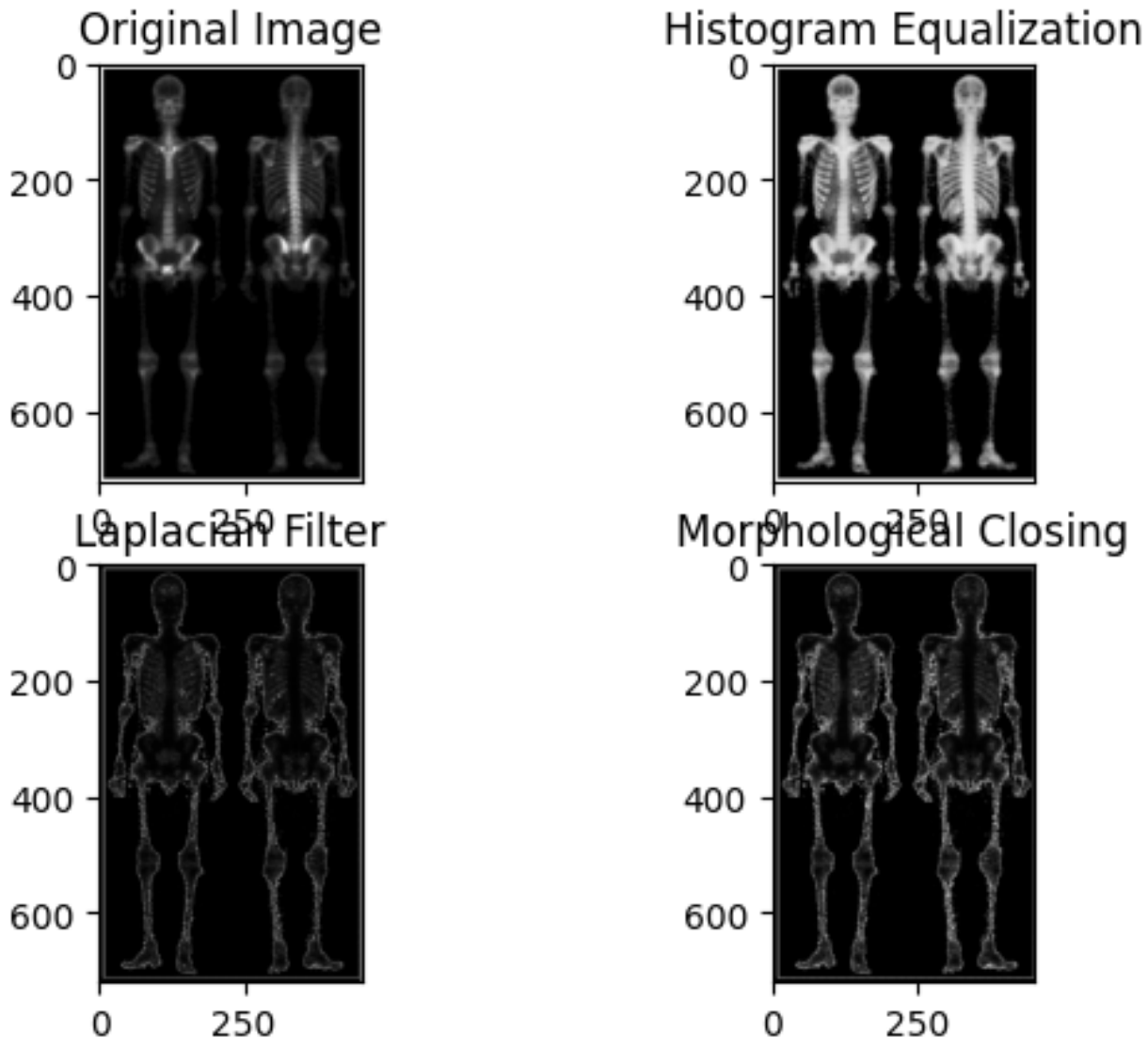

Figure 7: Original (left) and enhanced (right) skeleton images.

CONCLUSION

This assignment demonstrated the effectiveness of various image processing techniques. Noise reduction techniques like averaging and median filters significantly improved image quality, with median filtering being more effective at preserving edges. The sharpening process with the Laplacian mask enhanced details, but repeated sharpening introduced noise. Edge detection methods like Sobel, Laplacian, and Prewitt highlighted image boundaries effectively, with high-boost filtering enhancing edge visibility. Finally, histogram equalization improved the contrast of the skeleton image, revealing more details.