IVP LAB-5 ASSIGNMENT REPORT

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Objective:

This report explains the application of five spatial domain filters (Average, Gaussian, Laplacian, Sobel, and Median) to a facial grayscale image.

1. Original Grayscale Image:

The image is initially converted into grayscale by taking a weighted combination of the Red, Green, and Blue (RGB) color channels:

$$Gray = 0.2989 \times R + 0.5870 \times G + 0.1140 \times B.$$

This results in a single-channel image that simplifies further processing using various filters.

2. Average Filter:

The **Average filter** smooths the image by computing the mean of the surrounding 3x3 pixel neighborhood for each pixel. This reduces noise and produces a blurred image.

$$\text{Average Filter} = \frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

3. Gaussian Filter:

The **Gaussian filter** smooths the image using a weighted average, giving more importance to pixels closer to the center of the 3x3 window. This filter helps reduce noise while maintaining edge details:

$$G(x,y) = (1/ 2 *pi (sigma) ^2) * e^((-x^2-y^2)/2*sigma^2)$$

Here, σ\sigmaσ determines the spread of the weights.

4. Laplacian Filter:

The **Laplacian filter** highlights regions of sharp intensity change by calculating the second derivative of the image. This filter is primarily used for edge detection:

$$\text{Laplacian Filter} = \begin{bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{bmatrix}$$

This filter emphasizes areas where there is a significant difference in pixel intensity..

5. Sobel Filter:

The **Sobel filter** detects edges by computing the gradient of the image intensity. It calculates both horizontal and vertical edges using separate filters:

$$\text{Sobel X} = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

$$\text{Sobel Y} = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

The final result combines the horizontal and vertical gradients to detect edges in all directions.

6. Median Filter:

The **Median filter** is effective at removing "salt-and-pepper" noise while preserving edges. It works by replacing each pixel with the median value of its surrounding 3x3 neighborhood, which helps reduce noise without blurring edges.

1. Extract the 3x3 neighborhood of the current pixel.
2. Sort the pixel values in the window.
3. Replace the current pixel with the median of these values.

Conclusion:

Each filter serves a different purpose in image processing:

- **Average**: Basic smoothing.
- **Gaussian**: Advanced smoothing with edge preservation.
- **Laplacian**: Edge detection.
- **Sobel**: Gradient-based edge detection.
- **Median**: Noise removal while preserving edges.

By applying these filters, we can better understand image features and enhance visual information for further processing.