Course Name:	**Digital Signal & Image Processing Laboratory**	**Semester:**	**VI**
Date of Performance:	**09 / 04 / 2025**	**Batch No.:**	**B - 2**
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Experiment No.: 8

Title: Apply neighborhood processing techniques: low pass, high pass and median filtering in spatial domain on a digital image

Objective:
To learn and understand the effects of filtering in spatial and frequency domain on images using Matlab.

i. Low-pass filter
ii. High-pass filter
iii. Median filter

COs to be achieved:

CO5: Implement the morphological operations and image compression.

Materials Required: MATLAB software

Books/ Journals/ Websites referred:

1. http://www.mathworks.com/support/
2. www.math.mtu.edu/~msgocken/intro/intro.html.
3. R. C.Gonsales R.E.Woods, “Digital Image Processing”, Second edition, Pearson Education
4. S.Jayaraman, S Esakkirajan, T Veerakumar “Digital Image Processing “Mc Graw Hill.
5. S.Sridhar,”Digital Image processing”, oxford university press, 1st edition."

Theory:

Filtering in Spatial Domain:

Low pass filtering as the name suggests removes the high frequency content from the image. It is used to remove noise present in the image. Mask for the low pass filter is:

1/9	1/9	1/9
1/9	1/9	1/9
1/9	1/9	1/9

One important thing to note from the spatial response is that all the coefficients are positive. We could also use 5 x 5 or 7 x 7 mask as per our requirement. We place a 3 x 3 mask on the image. We start from the left hand top corner. We cannot work with the borders and hence are normally left as they are. We then multiply each component of the image with the corresponding value of the mask. Add these values to get the response. Replace the centre pixel of the o/p image with these responses. We now shift the mask towards the right till we reach the end of the line and then move it downwards.

High pass filtering as the name suggests removes the low frequency content from the image. It is used to highlight fine detail in an image or to enhance detail that has been blurred. Mask for the high pass filter is:

-1/9	-1/9	-1/9
-1/9	8/9	-1/9
-1/9	-1/9	-1/9

One important thing to note from the spatial response is that sum of all the coefficients is zero. We could also use 5 x 5 or 7 x 7 mask as per our requirement. We place a 3 x 3 mask on the image. We start from the left hand top corner. We cannot work with the borders and hence are normally left as they are. We then multiply each component of the image with the corresponding value of the mask. Add these values to get the response. Replace the centre pixel of the o/p image with these responses. We now shift the mask towards the right till we reach the end of the line and then move it downwards.

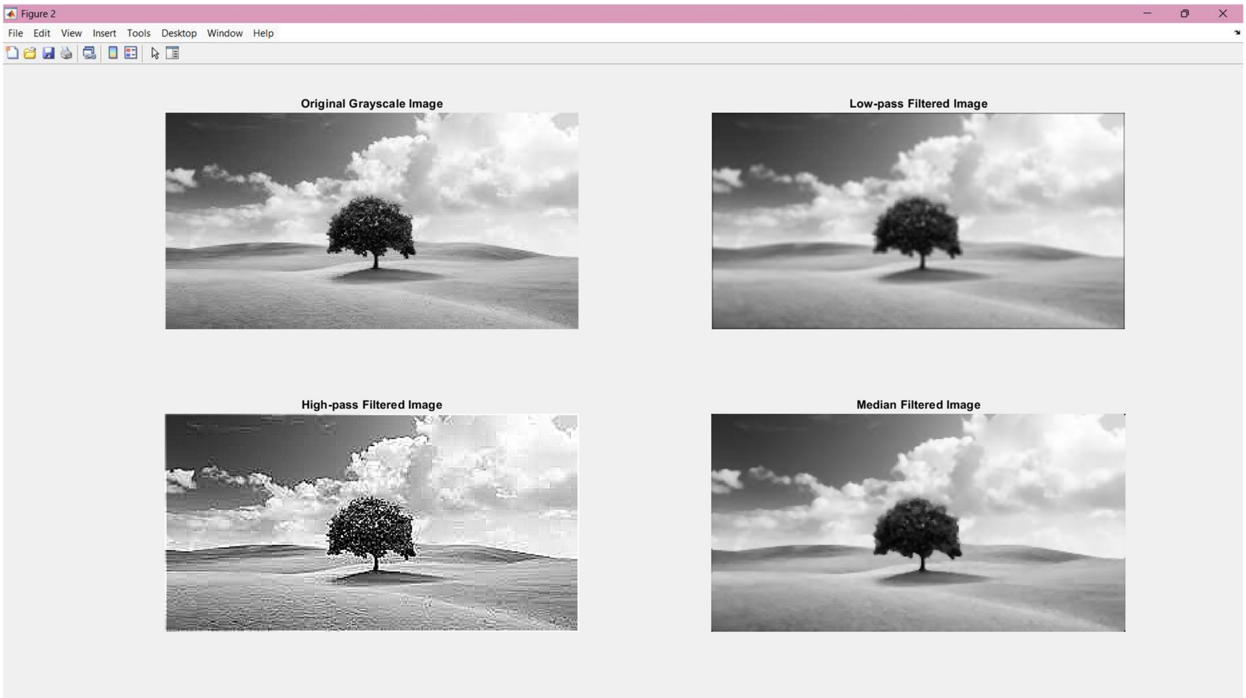
Median filtering is a signal processing technique developed by tukey that is useful for noise suppression in images. Here the input pixel is replaced by the median of the pixels contained in the window around the pixel. The median filter disregards extreme values and does not allow them to influence the selection of a pixel value which is truly representative of the neighbourhood.

<u>Write Algorithm and Matlab commands used</u>:

```
I = imread('tree.jpg');

I_gray = rgb2gray(I);

figure;

subplot(2,2,1), imshow(I_gray), title('Original Grayscale Image');

low_pass_filter = fspecial('average', [3 3]);
I_low_pass = imfilter(I_gray, low_pass_filter);
subplot(2,2,2), imshow(I_low_pass), title('Low-pass Filtered Image');

high_pass_filter = fspecial('unsharp');
I_high_pass = imfilter(I_gray, high_pass_filter);
subplot(2,2,3), imshow(I_high_pass), title('High-pass Filtered Image');

I_median = medfilt2(I_gray, [3 3]);
```

```
    subplot(2,2,4), imshow(I_median), title('Median Filtered Image');
```

Output:



Conclusion:

Neighborhood processing techniques like low-pass, high-pass, and median filtering effectively enhance image quality by reducing noise and highlighting important features. These spatial domain filters improve visual clarity and are essential tools in digital image processing.

Post Lab Question:

1. **List & explain different types of noise associated with a digital signal.**
   In digital signal processing, noise refers to unwanted variations or disturbances that degrade the quality of a signal or image. These disturbances can originate from various sources such as transmission errors, sensor limitations, or environmental conditions. Different types of noise have distinct characteristics, and understanding them is essential for selecting the appropriate filtering technique.

   Common Types of Noise:
   Gaussian Noise:
   - Caused by random fluctuations in electronic circuits or sensors.
   - Follows a normal distribution (bell curve).
   - Appears as grainy variations in brightness across the image.

Salt-and-Pepper Noise:

- Appears as random black and white pixels in an image.
- Often caused by faulty memory locations or errors during transmission.
- Characterized by sharp intensity spikes.

Speckle Noise:

- Common in radar and medical imaging (e.g., ultrasound).
- Caused by random interference patterns.
- Appears as granular noise across the image.

Poisson Noise (Shot Noise):

- Arises due to the discrete nature of photons or electrons.
- Related to the image intensity and often appears in low-light conditions.

Quantization Noise:

- Occurs during analog-to-digital conversion.

2. Explain with the help of an example how filtering helps in enhancing the quality of an image.

Filtering is a powerful technique in image processing used to remove noise, enhance edges, or highlight important features. Different filters are used depending on the type of noise and the desired enhancement. For example, if an image is affected by salt-and-pepper noise, applying a median filter can significantly improve image quality.

Example:
Consider a grayscale image of a tree with visible salt-and-pepper noise (random white and black spots). By applying a median filter with a 3×3 window, each pixel is replaced with the median value of its neighborhood. This effectively removes the noise while preserving the edges and details of the tree, resulting in a much clearer and visually pleasing image.

Key Benefits of Filtering:

- Noise Reduction: Removes unwanted disturbances (e.g., Gaussian or salt-and-pepper noise).
- Edge Preservation: Especially with median and high-pass filters.
- Detail Enhancement: Sharpens important image features using high-pass filters.
- Smoothing: Reduces image variation using low-pass filters for better visual quality.

Signature of faculty in-charge with Date: