Questions:

1. What is convolution?
2. Why a LPF is called smoothing filter?
3. Enlist three applications of Median Filter?
4. Explain the need of zero padding in filtering operation.

D.O.P.: **L.D.O.S.:**

Roll No: D084	Name:Somish Jain
Branch:ce	Batch:2
Date of Experiment: 14/08/2025	Date of Submission: 14/08/2025
Grade:	Faculty:

Experiment No. 5:

Aim:

Apply the following sharpening filters to remove the blur in the image.

i. Gradient.

ii. Laplacian

Analyze the effect on various blur images and comprehend your findings.

Prerequisite:

1. Image Processing command.
2. Matlab.
3. Basics of Filters.

Objective:

a. Processing an image using sharpening filter.

Outcome:

1. Outline the fundamentals of digital image processing system, and observing the results of filter.

Theory:

Edge:

Edges are abrupt changes in intensity, discontinuity in image brightness or contrast.

Edge Detection Operators are of two types:

Gradient – based operator which computes first-order derivations in a digital image like, Sobel operator, Prewitt operator, Robert operator

Laplacian– based operator which computes second-order derivations in a digital image like, Canny edge detector, Laplacian of Gaussian

High Pass Filter:

High pass filtering eliminates the low frequency regions while retaining or enhancing the high frequency components. An image, which is high passed, would have no background and would have enhanced edges.

A high pass filter is the basis for most sharpening methods. An image is sharpened when contrast is enhanced between adjoining areas with little variation in brightness or darkness. A high pass filter tends to retain the high frequency information within an image while reducing the low frequency information. The kernel of the high pass filter is designed to increase the brightness of the center pixel relative to neighboring pixels. The kernel array usually contains a single positive value at its center, which is completely surrounded by negative values. The following array is an example of a 3 by 3 kernel for a high pass filter:

$$\begin{bmatrix} -1/9 & -1/9 & -1/9 \\ -1/9 & 8/9 & -1/9 \\ -1/9 & -1/9 & -1/9 \end{bmatrix}$$

Procedure for LPF:

1. Read the input image.
2. Apply Laplacian for sharpening the image
3. Also find the edges using Gradient filters (Sobel, Prewitt)
4. Display the original and the output images.
5. Observe the output and write observations in conclusion section.

Code:

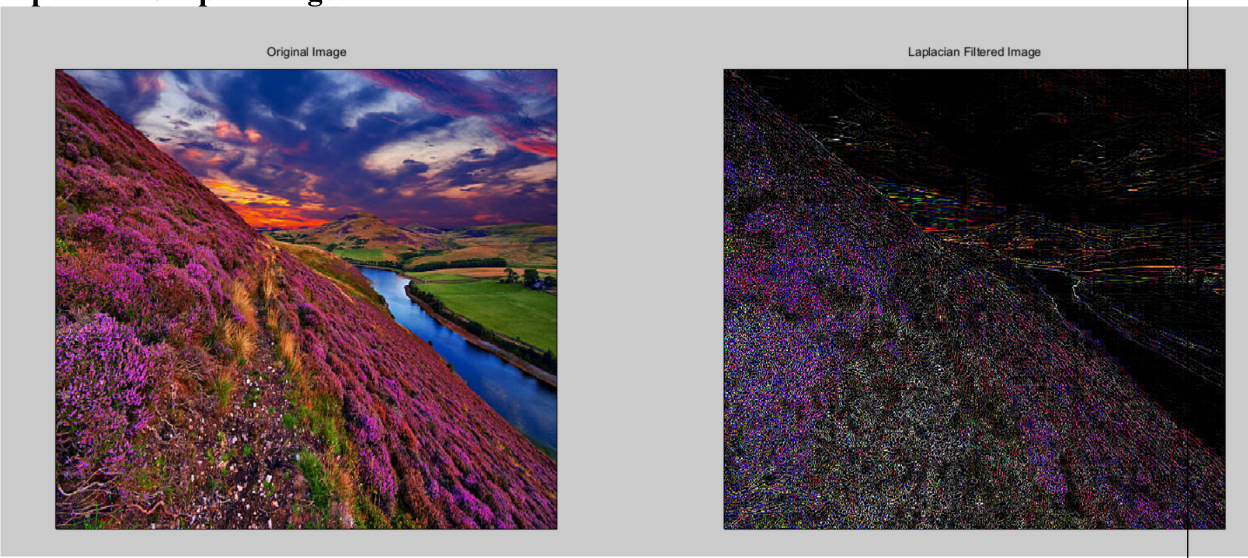
i. Gradient

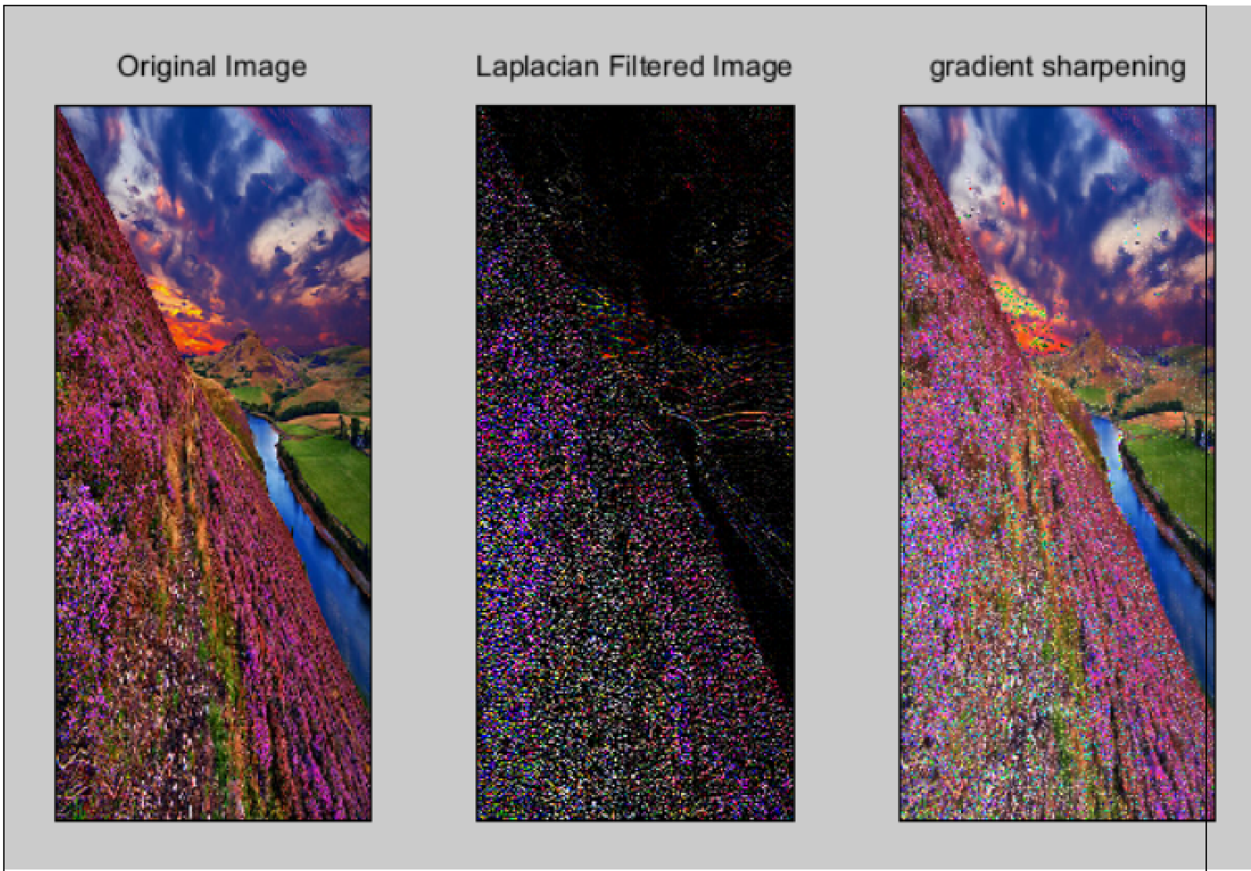
```
img= "D:\ivp\exp5image.jpg";
I= imread(img);
laplacian_mask = [0  1  0;
                  1 -4  1;
                  0  1  0];
a=imfilter(I,laplacian_mask)
figure;
subplot(1,3,1);
imshow(I);
title("Original Image");
subplot(1,3,2);
imshow(a);
title("Laplacian Filtered Image");
B=I+a;
subplot(1,3,3);
imshow(B);
title("gradient sharpening");
```

ii. Laplacian

```
img= "D:\ivp\exp5image.jpg";
I= imread(img);
laplacian_mask = [0  1  0;
                  1 -4  1;
                  0  1  0];
a=imfilter(I,laplacian_mask)
figure;
subplot(1,2,1);
imshow(I);
title("Original Image");
subplot(1,2,2);
imshow(a);
title("Laplacian Filtered Image");
```

Input and Output Images:





Gradient (Edge Detection using Gradient Operators)

Observation

- Applying gradient operators (like Sobel, Prewitt, or Roberts) highlights regions in the image with rapid intensity changes.
- Edges and boundaries of objects become clearly visible, while smooth regions remain dark.
- Horizontal and vertical edges can be detected separately or combined to show overall edge structure.

Conclusion

Gradient operators are effective in detecting edges by measuring intensity changes in an image. They are essential for feature extraction, object detection, and image segmentation tasks in image processing.

2. Laplacian (Second-Derivative Edge Detection)

Observation

- Applying the Laplacian operator enhances regions of rapid intensity change (edges), producing sharper edges than simple gradient methods.
- Both horizontal and vertical intensity changes are detected simultaneously.
- Noise can be amplified, so sometimes smoothing is applied before using the Laplacian.

Conclusion

The Laplacian operator uses the second derivative to highlight edges and fine details in an image. It is highly sensitive to abrupt intensity changes and is widely used for edge detection, image sharpening, and feature enhancement.

Questions:

1. Why a HPF is called sharpening filter?

A **High-Pass Filter (HPF)** emphasizes the **high-frequency components** of an image, which correspond to **edges and fine details**. By enhancing these high-frequency regions, the image appears **sharper**, making edges more prominent. Hence, HPF is called a **sharpening filter**.

2. Enlist three applications of edge detection?

Object recognition – Identifying objects in images for computer vision.

Image segmentation – Separating regions of interest from the background.

Feature extraction – Detecting boundaries and shapes in medical or satellite images.

3. Enlist the applications of sharpening?

Improving image clarity – Makes blurred or low-contrast images clearer.
Medical imaging – Highlights fine details in X-rays, MRI, or CT scans.
Industrial inspection – Detects defects or cracks in manufactured parts.
Photography – Enhances details in digital photos.

4. Compare first order and second order derivatives.

Feature	First-order derivative (Gradient)	Second-order derivative (Laplacian)
Definition	Measures **rate of change of intensity** (edges)	Measures **rate of change of the gradient**
Edge detection	Detects edges where intensity changes abruptly	Detects edges and fine details, sharper than first-order
Operators	Sobel, Prewitt, Roberts	Laplacian
Noise sensitivity	Less sensitive	More sensitive to noise
Directionality	Can detect horizontal or vertical edges separately	Detects edges in all directions simultaneously