

# Laplacian Filter

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## How they work

The story of the Laplacian filter starts from the Laplacian matrix in Graph theory which is the simplest method of representation of a graph in the matrix. The Laplacian of an image highlights regions of rapid intensity change. Any feature with a sharp discontinuity will be enhanced by a Laplacian operator. The Laplacian filter comes under the derivative filter category. It is a second-order filter used in image processing for edge detection and feature extraction. When we use first-order derivative filters, we must apply separate filters to detect vertical and horizontal edges and then combine both. But the Laplacian filter detects all the edges irrespective of directions.

### Laplacian Filter Mask Types

- Positive Laplacian
- Negative Laplacian

Positive Laplacian operator uses a mask with center element as a negative value and corner elements as 0. This filter identifies the outward edges from an image.

<b>0</b>	<b>1</b>	<b>0</b>
<b>1</b>	<b>-4</b>	<b>1</b>
<b>0</b>	<b>1</b>	<b>0</b>

Figure 1 Positive Laplacian Mask

Negative Laplacian operator is used to find the inward edges of the image. It uses a standard mask with the center element as positive, corners as 0 and all other elements as -1.

<b>0</b>	<b>-1</b>	<b>0</b>
<b>-1</b>	<b>4</b>	<b>-1</b>
<b>0</b>	<b>-1</b>	<b>0</b>

Figure 2 Negative Laplacian Mask

## What it is Used for and Examples

The Laplacian operator is used in image processing to detect edges in many applications. Here is an example of it:

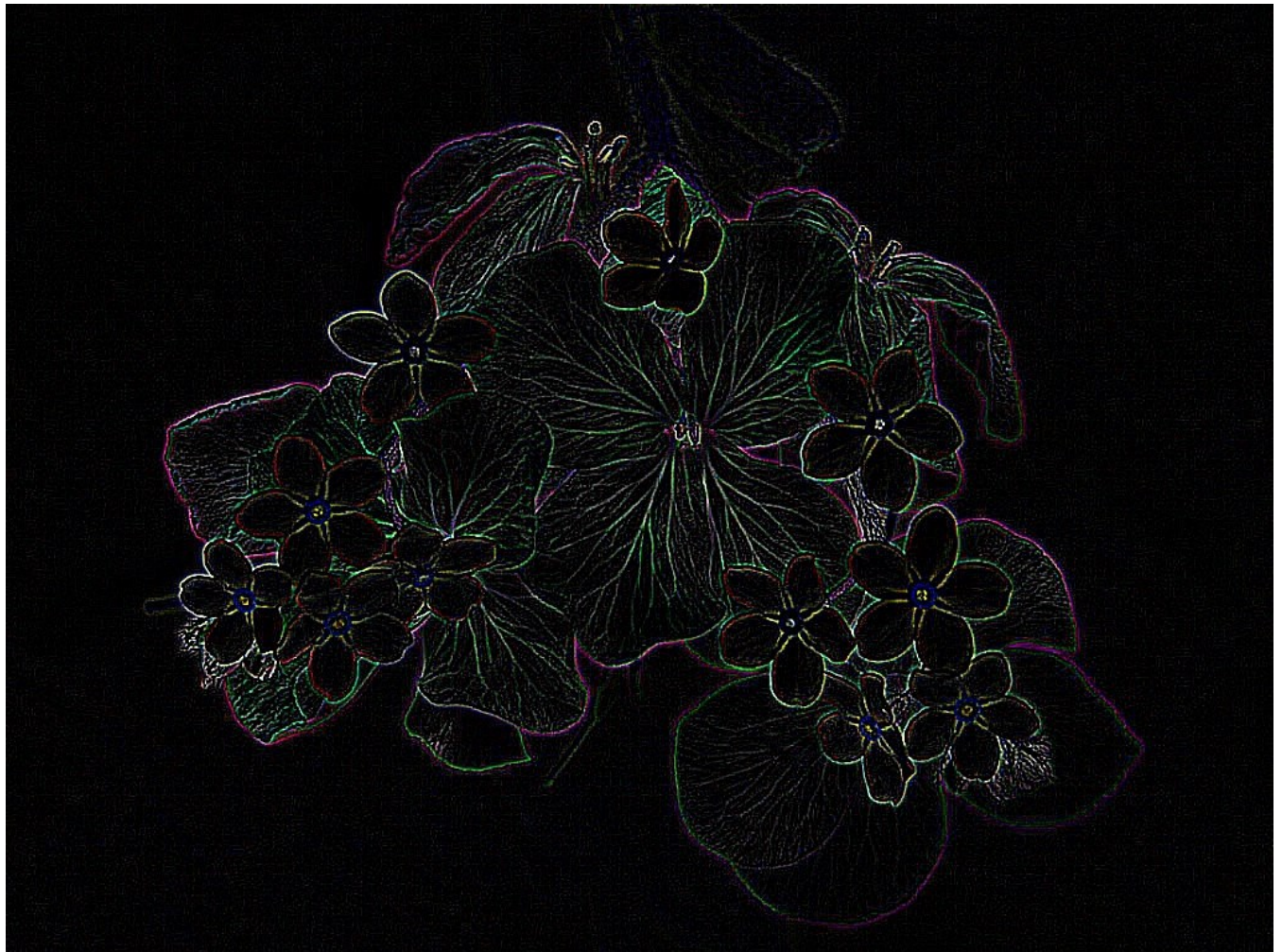


Figure 3 Laplacian Filter Example

## Python Code

```
import cv2
import matplotlib.pyplot as plt
image = cv2.imread(r"E:\eye.png", cv2.IMREAD_COLOR)
image = cv2.GaussianBlur(image, (3, 3), 0)
image_gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
filtered_image = cv2.Laplacian(image_gray, cv2.CV_16S, ksize=3)
# Plot the original and filtered images
plt.figure(figsize=(10, 5))
plt.subplot(121)
plt.imshow(image, cmap='gray')
plt.title('Original Image')

plt.subplot(122)
plt.imshow(filtered_image, cmap='gray')
plt.title('LoG Filtered Image')

plt.show()
```