1. Implementation of Relationships between Pixels Neighbour of 4,8 and Diagonal point.

```
import numpy as np


# Create a sample matrix (using a magic square for demonstration)
a = np.array([[17, 24, 1, 8, 15],
[23, 5, 7, 14, 16],
[4, 6, 13, 20, 22],
[10, 12, 19, 21, 3],
[11, 18, 25, 2, 9]])


print("a =")
print(a)


# Get the row and column input from the user
b = int(input("Enter the row < size of the Matrix: "))
c = int(input("Enter the column < size of matrix: "))
print("Element:", a[b, c])


# 4-Point Neighbours
N4 = [a[b+1, c] if b+1 < a.shape[0] else None, # Below
a[b-1, c] if b-1 >= 0 else None, # Above
a[b, c+1] if c+1 < a.shape[1] else None, # Right
a[b, c-1] if c-1 >= 0 else None] # Left
```

```
print("N4 =")

print(N4)


# 8-Point Neighbours

N8 = [a[b+1, c] if b+1 < a.shape[0] else None, # Below

a[b-1, c] if b-1 >= 0 else None, # Above

a[b, c+1] if c+1 < a.shape[1] else None, # Right

a[b, c-1] if c-1 >= 0 else None, # Left

a[b+1, c+1] if b+1 < a.shape[0] and c+1 < a.shape[1] else None, # Below-Right

a[b+1, c-1] if b+1 < a.shape[0] and c-1 >= 0 else None, # Below-Left

a[b-1, c-1] if b-1 >= 0 and c-1 >= 0 else None, # Above-Left

a[b-1, c+1] if b-1 >= 0 and c+1 < a.shape[1] else None] # Above-Right

print("N8 =")

print(N8)


# Diagonal Neighbours

ND = [a[b+1, c+1] if b+1 < a.shape[0] and c+1 < a.shape[1] else None, # Below-Right

a[b+1, c-1] if b+1 < a.shape[0] and c-1 >= 0 else None, # Below-Left

a[b-1, c-1] if b-1 >= 0 and c-1 >= 0 else None, # Above-Left

a[b-1, c+1] if b-1 >= 0 and c+1 < a.shape[1] else None] # Above-Right

print("ND =")

print(ND)
```

Output:

```
N4 =
[5, None, 1, 17]
```

```
N8 =
[5, None, 1, 17, 7, 23, None, None]
```

```
ND =
[7, 23, None, None]
```

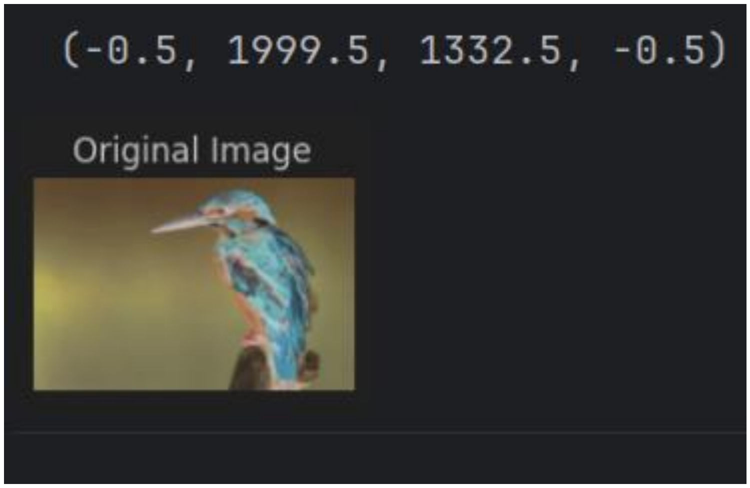
2 a. Simulation and Display of an Image, Negative of an Image(Binary & Gray Scale.

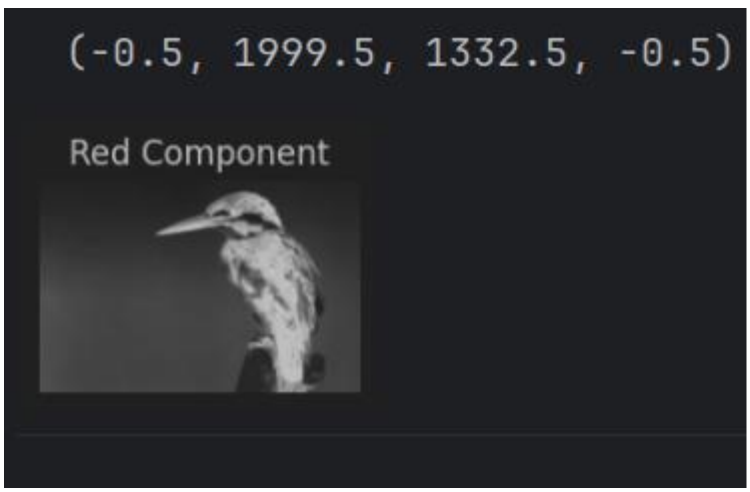
```
import cv2

import matplotlib.pyplot as plt


# Read the image

i = cv2.imread('C:/Users/anuam/Downloads/apple.jpg')


# Convert BGR to RGB (OpenCV reads images in BGR format)

i = cv2.cvtColor(i, cv2.COLOR_BGR2RGB)


# Plot original image

plt.subplot(3, 2, 1)

plt.imshow(i)

plt.title('Original Image')

plt.axis('off')


# Red Component

r = i[:, :, 0]

plt.subplot(3, 2, 2)

plt.imshow(r, cmap='gray') # Displaying in grayscale

plt.title('Red Component')
```

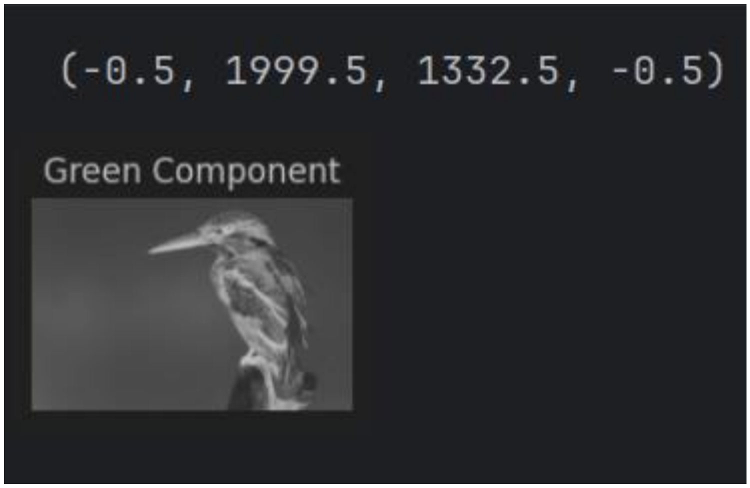
```
plt.axis('off')

# Green Component
g = i[:, :, 1]
plt.subplot(3, 2, 3)
plt.imshow(g, cmap='gray') # Displaying in grayscale
plt.title('Green Component')
plt.axis('off')

# Blue Component
b = i[:, :, 2]
plt.subplot(3, 2, 4)
plt.imshow(b, cmap='gray') # Displaying in grayscale
plt.title('Blue Component')
plt.axis('off')

# Convert to grayscale
rg = cv2.cvtColor(i, cv2.COLOR_RGB2GRAY)
plt.subplot(3, 2, 5)
plt.imshow(rg, cmap='gray')
plt.title('Gray Image')
plt.axis('off')

plt.tight_layout()
```

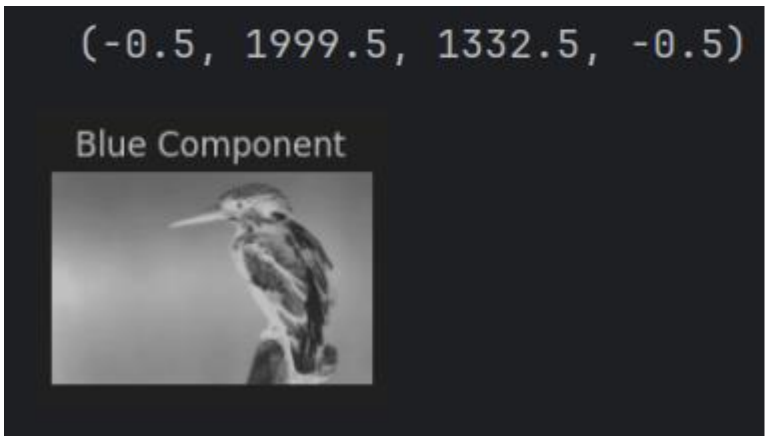
plt.show()

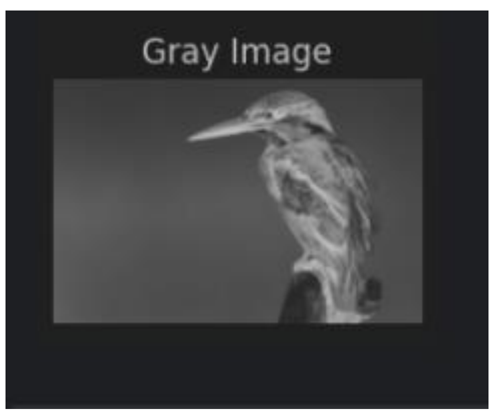
Output:











2 b. Display color Image, find its complement and convert to gray scale.

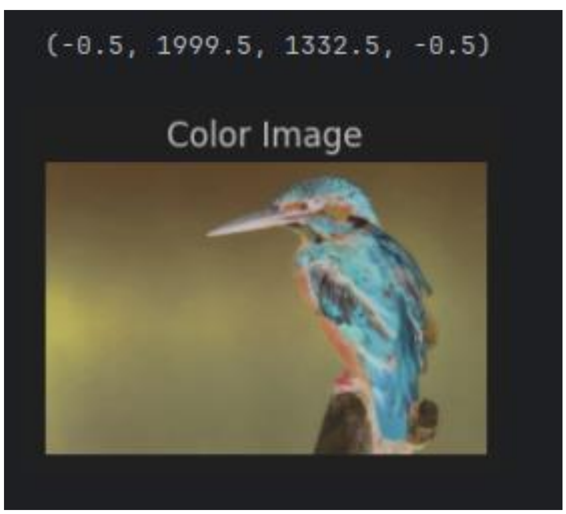
```
import cv2

import numpy as np

import matplotlib.pyplot as plt
```

```
# Read the color image
I = cv2.imread('C:/Users/anuam/Downloads/apple.jpg')

# Convert BGR to RGB (OpenCV reads images in BGR format)
I_rgb = cv2.cvtColor(I, cv2.COLOR_BGR2RGB)

# Plot original color image
plt.subplot(2, 2, 1)
plt.imshow(I_rgb)
plt.title('Color Image')
plt.axis('off')

# Find complement of color image
c = cv2.bitwise_not(I_rgb)
plt.subplot(2, 2, 2)
plt.imshow(c)
plt.title('Complement of color Image')
plt.axis('off')

# Convert color image to grayscale
r = cv2.cvtColor(I_rgb, cv2.COLOR_RGB2GRAY)
plt.subplot(2, 2, 3)
plt.imshow(r, cmap='gray')
```

```python
plt.title('Gray scale of color Image')
plt.axis('off')

# Find complement of grayscale image
b = cv2.bitwise_not(r)
plt.subplot(2, 2, 4)
plt.imshow(b, cmap='gray')
plt.title('Complement of Gray Image')
plt.axis('off')

# Simulation of an Image (Arithmetic & Logic Operation)
a = np.ones((40, 40), dtype=np.uint8)
b = np.zeros((40, 40), dtype=np.uint8)
c = np.hstack((a, b))
d = np.hstack((b, a))
e = np.vstack((c, d))
A = 10 * (c + d)
M = c * d
S = np.abs(c - d)
D = c / 4

plt.figure()
plt.subplot(3, 2, 1)
plt.imshow(c, cmap='gray')
```

```
plt.subplot(3, 2, 2)
plt.imshow(d, cmap='gray')
plt.subplot(3, 2, 3)
plt.imshow(A, cmap='gray')
plt.subplot(3, 2, 4)
plt.imshow(M, cmap='gray')
plt.subplot(3, 2, 5)
plt.imshow(S, cmap='gray')
plt.subplot(3, 2, 6)
plt.imshow(D, cmap='gray')

plt.show()
```

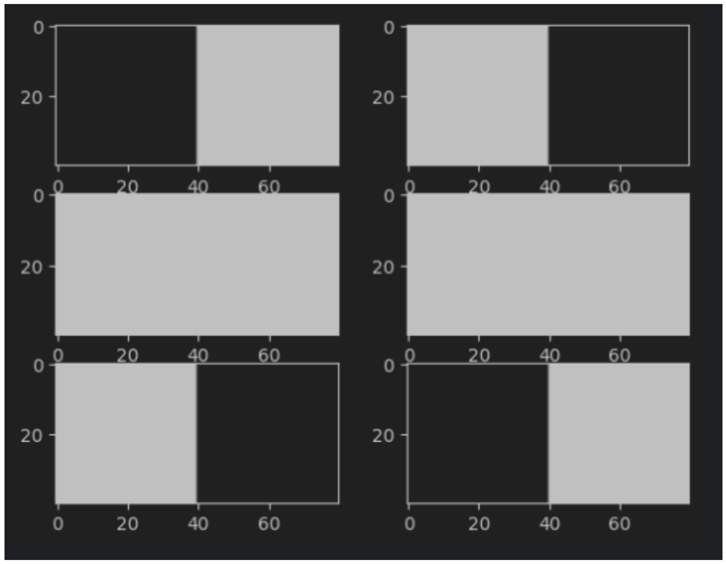
Output:



```
(-0.5, 1999.5, 1332.5, -0.5)
```


```
(-0.5, 1999.5, 1332.5, -0.5)
```


```
(-0.5, 1999.5, 1332.5, -0.5)
```

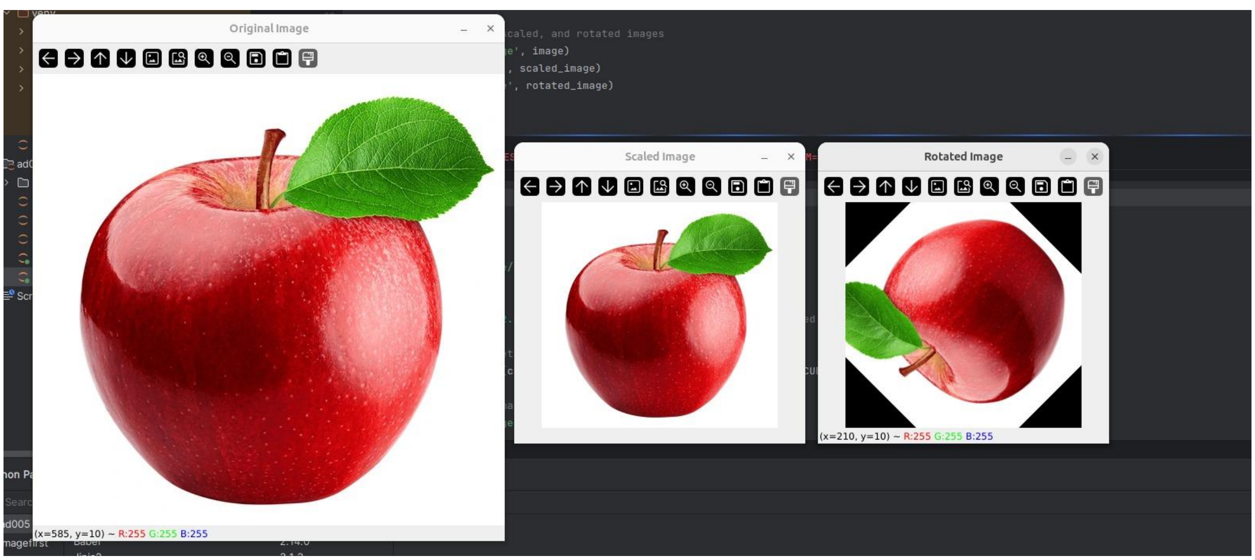


3. a) Implementation of Transformations of an Image i)Scaling & Rotation.

```
import cv2

import numpy as np


# Load the image

image = cv2.imread('C:/Users/anuam/Downloads/apple.jpg')


# Define scaling factor

scaling_factor = 0.5  # You can change this value


# Perform scaling

scaled_image = cv2.resize(image, None, fx=scaling_factor, fy=scaling_factor,
interpolation=cv2.INTER_LINEAR)


# Define rotation angle (in degrees)

rotation_angle = 45  # You can change this value
```

```
# Perform rotation
height, width = scaled_image.shape[:2]
rotation_matrix = cv2.getRotationMatrix2D((width/2, height/2), rotation_angle, 1)
rotated_image = cv2.warpAffine(scaled_image, rotation_matrix, (width, height))

# Display the original, scaled, and rotated images
cv2.imshow('Original Image', image)
cv2.imshow('Scaled Image', scaled_image)
cv2.imshow('Rotated Image', rotated_image)
cv2.waitKey(0)
cv2.destroyAllWindows()
```

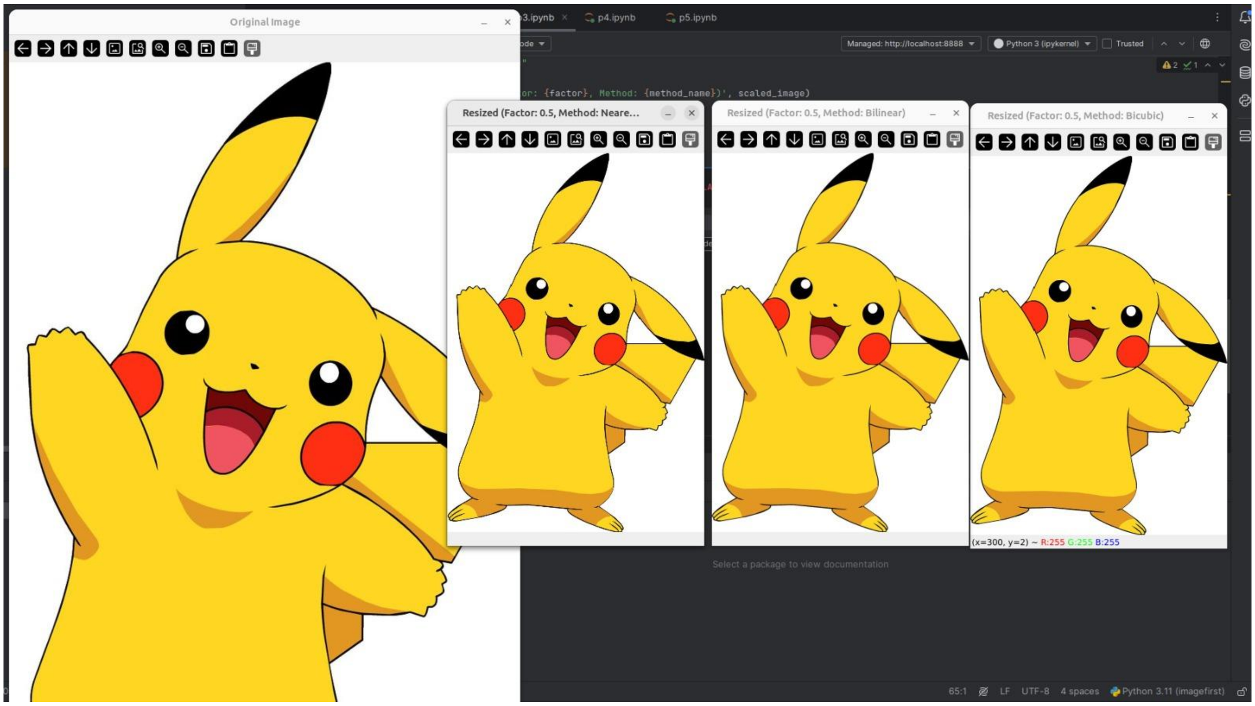
<u>Output:</u>



3. b) Display the color image and its Resized images by different methods.

```
import cv2
import numpy as np

# Load the image
image = cv2.imread('/home/aids5a1-32/Downloads/pika.jpg')

# Define scaling factors
scaling_factors = [0.5, 2.0]  # You can add more scaling factors as needed

# Define interpolation methods
interpolation_methods = [cv2.INTER_NEAREST, cv2.INTER_LINEAR, cv2.INTER_CUBIC]

# Display the original image
cv2.imshow('Original Image', image)

# Perform resizing with different methods
for factor in scaling_factors:
    for method in interpolation_methods:
        # Perform scaling
        scaled_image = cv2.resize(image, None, fx=factor, fy=factor, interpolation=method)

        # Display the resized image
        method_name = ""
        if method == cv2.INTER_NEAREST:
            method_name = "Nearest Neighbor"
        elif method == cv2.INTER_LINEAR:
            method_name = "Bilinear"
        elif method == cv2.INTER_CUBIC:
            method_name = "Bicubic"

        cv2.imshow(f'Resized (Factor: {factor}, Method: {method_name})', scaled_image)

# Wait for a key press and close all windows
cv2.waitKey(0)
cv2.destroyAllWindows()
```

Output:

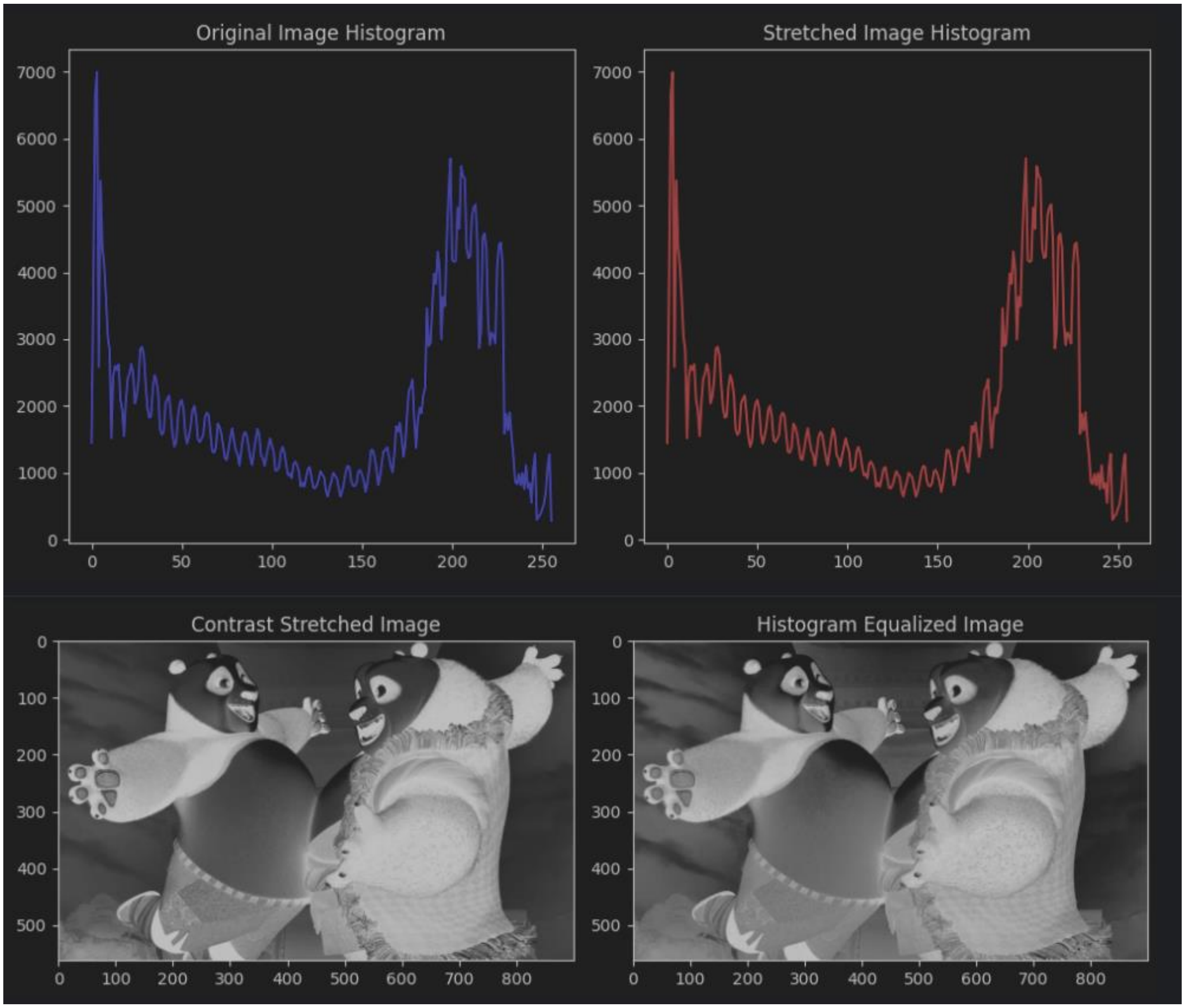


4. Contrast stretching of a low contrast image, Histogram, and Histogram Equalization.

```
import cv2
import numpy as np
import matplotlib.pyplot as plt

# Load the image
image = cv2.imread('/home/aids5a1-37/Downloads/po.jpg', cv2.IMREAD_GRAYSCALE)

# Apply contrast stretching
min_intensity = np.min(image)
max_intensity = np.max(image)
stretched_image = cv2.normalize(image, None, 0, 255, norm_type=cv2.NORM_MINMAX)

# Calculate and plot histograms
hist_original = cv2.calcHist([image], [0], None, [256], [0, 256])
hist_stretched = cv2.calcHist([stretched_image], [0], None, [256], [0, 256])
```

```
plt.figure(figsize=(10, 5))
plt.subplot(1, 2, 1)
plt.plot(hist_original, color='b')
plt.title('Original Image Histogram')

plt.subplot(1, 2, 2)
plt.plot(hist_stretched, color='r')
plt.title('Stretched Image Histogram')

plt.tight_layout()
plt.show()

# Apply histogram equalization
equalized_image = cv2.equalizeHist(image)

# Calculate and plot histograms for equalized image
hist_equalized = cv2.calcHist([equalized_image], [0], None, [256], [0, 256])

plt.figure(figsize=(10, 5))
plt.subplot(1, 2, 1)
plt.imshow(stretched_image, cmap='gray')
plt.title('Contrast Stretched Image')

plt.subplot(1, 2, 2)
plt.imshow(equalized_image, cmap='gray')
plt.title('Histogram Equalized Image')

plt.tight_layout()
plt.show()
```

Output:

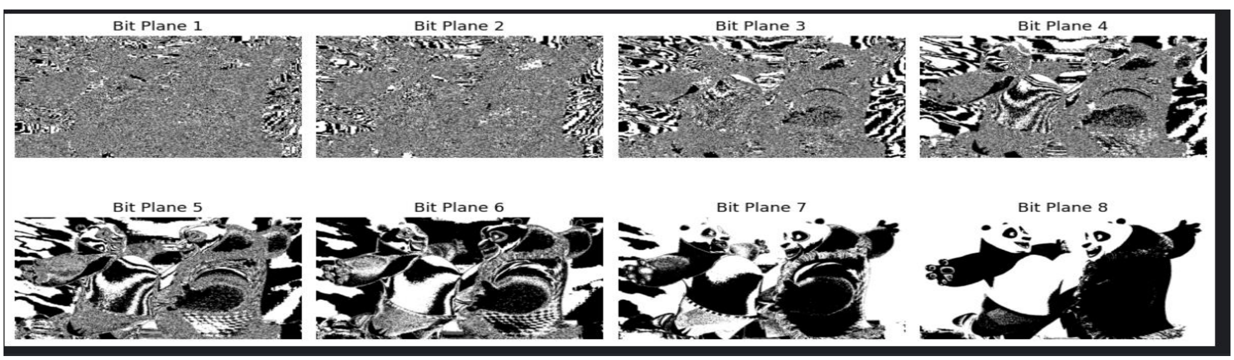


5. Display of bit planes of an Image.

```
import cv2
import numpy as np
import matplotlib.pyplot as plt

# Load the image in grayscale
image = cv2.imread('/home/aids5a1-37/Downloads/po.jpg', cv2.IMREAD_GRAYSCALE)

# Get the dimensions of the image
height, width = image.shape
```

```
# Create an array to store the bit planes
bit_planes = np.zeros((8, height, width), dtype=np.uint8)

# Calculate the bit planes
for i in range(8):
    bit_planes[i] = (image >> i) & 1  # Extract ith bit plane

# Display the bit planes
plt.figure(figsize=(12, 6))
for i in range(8):
    plt.subplot(2, 4, i+1)
    plt.imshow(bit_planes[i], cmap='gray')
    plt.title(f'Bit Plane {i+1}')
    plt.axis('off')

plt.tight_layout()
plt.show()
```

Output:

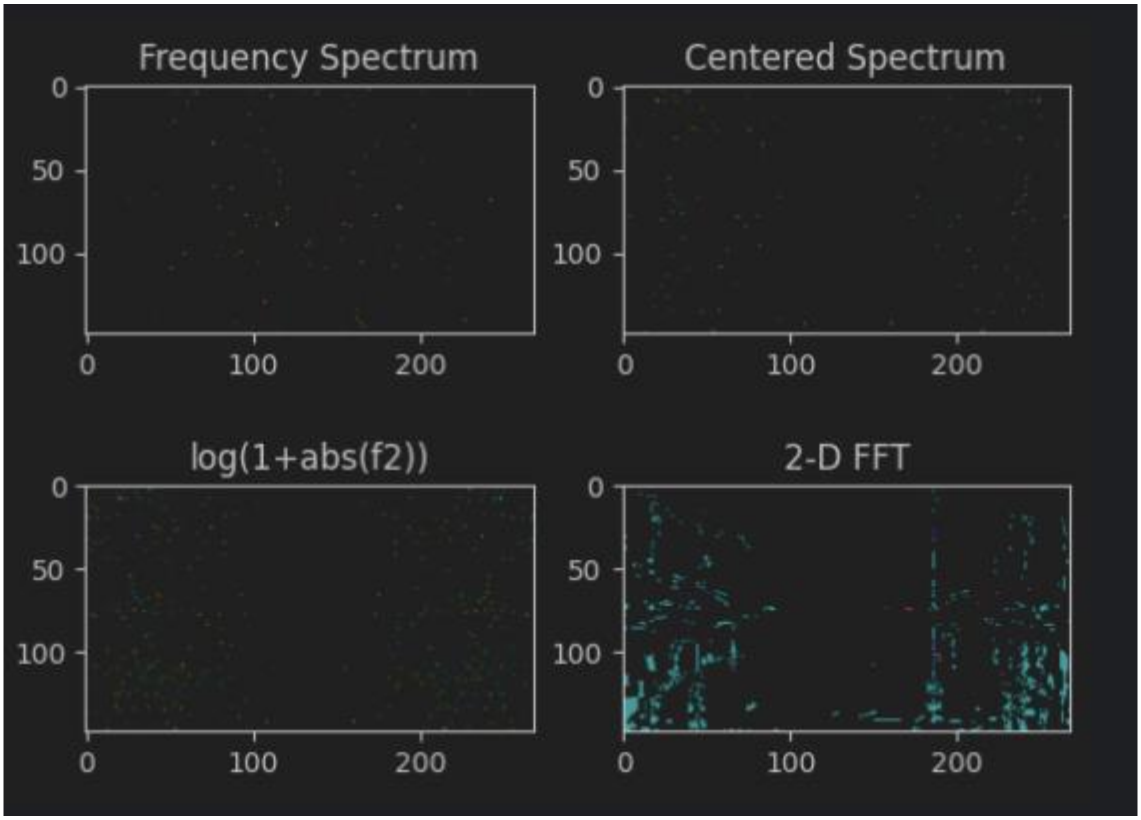


6. Display of FTT(1D, 2D) of an image.

```
import numpy as np
import matplotlib.pyplot as plt
from scipy.fftpack import fft2, fftshift

# Read the image and convert to double precision array
I = plt.imread('/home/aids5a2-32/Downloads/download.jpeg').astype(float)
```

```
# Perform 2-D FFT
f1 = np.fft.fft2(l)

# Shift zero frequency component to the center
f2 = np.fft.fftshift(f1)

# Display magnitude of frequency spectrum
plt.subplot(2, 2, 1)
plt.imshow(np.abs(f1))
plt.title('Frequency Spectrum')

# Display magnitude of centered spectrum
plt.subplot(2, 2, 2)
plt.imshow(np.abs(f2))
plt.title('Centered Spectrum')

# Compute log(1 + abs(f2))
f3 = np.log(1 + np.abs(f2))

# Display log(1 + abs(f2))
plt.subplot(2, 2, 3)
plt.imshow(f3)
plt.title('log(1+abs(f2))')

# Perform 2-D FFT on f1
l_fft = fft2(f1)

# Take real part of the result
l1 = np.real(l_fft)

# Display real part of 2-D FFT
plt.subplot(2, 2, 4)
plt.imshow(l1)
plt.title('2-D FFT')

plt.show()
```

Output:



7. Computation of mean, Standard Deviation, Correlation coefficient of the given Image.

```
import numpy as np
import matplotlib.pyplot as plt
```

```
from skimage import io, color
from scipy.stats import pearsonr

# Read the image
i = io.imread('/home/aids5a2-32/Downloads/panda.jpg')

# Display original image
plt.subplot(2, 2, 1)
plt.imshow(i)
plt.title('Original Image')

# Convert to grayscale
g = color.rgb2gray(i)

# Display grayscale image
plt.subplot(2, 2, 2)
plt.imshow(g, cmap='gray')
plt.title('Gray Image')

# Crop the image
c = g[100:300, 100:300]

# Display cropped image
plt.subplot(2, 2, 3)
plt.imshow(c, cmap='gray')
plt.title('Cropped Image')

# Calculate mean and standard deviation of the cropped image
m = np.mean(c)
s = np.std(c)
print('m:', m)
print('s:', s)

# Generate checkerboard patterns
checkerboard = np.indices((400, 400)).sum(axis=0) % 2

# Create checkerboard images with different thresholds
k = checkerboard > 0.8
```

```
k1 = checkerboard > 0.5

# Display checkerboard images
plt.figure()
plt.subplot(2, 1, 1)
plt.imshow(k, cmap='gray')
plt.title('Image1')

plt.subplot(2, 1, 2)
plt.imshow(k1, cmap='gray')
plt.title('Image2')

# Calculate Pearson correlation coefficient between the two images
r, _ = pearsonr(k.flatten(), k1.flatten())
print('r:', r)

plt.show()
```

<u>Output:</u>

8. Implementation of Image Smoothening Filters(Mean and Median filtering of an

Image.

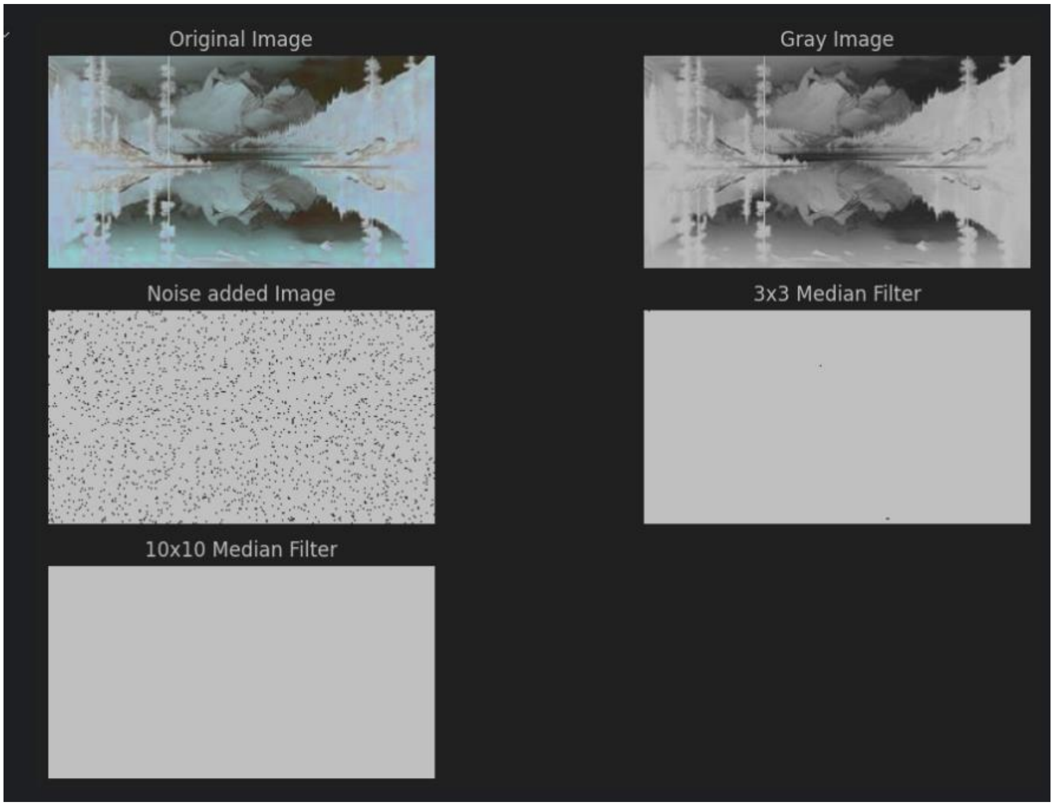
```
import cv2
import numpy as np
import matplotlib.pyplot as plt
from scipy.ndimage import convolve
from scipy.ndimage import median_filter

# Read the image
I = cv2.imread('/home/aids5a2-32/Downloads/download.jpeg')
K = cv2.cvtColor(I, cv2.COLOR_BGR2GRAY)

# Add salt and pepper noise
J = cv2.randu(K.copy(), 0, 255)
noise = np.random.choice([0, 255], K.shape, p=[0.95, 0.05])
J[noise == 255] = 255
J[noise == 0] = 0

# Apply median filters
f = median_filter(J, size=(3, 3))
f1 = median_filter(J, size=(10, 10))

# Display results
plt.figure(figsize=(12, 8))
plt.subplot(3, 2, 1)
plt.imshow(cv2.cvtColor(I, cv2.COLOR_BGR2RGB))
plt.title('Original Image')
plt.axis('off')

plt.subplot(3, 2, 2)
plt.imshow(K, cmap='gray')
plt.title('Gray Image')
plt.axis('off')

plt.subplot(3, 2, 3)
```

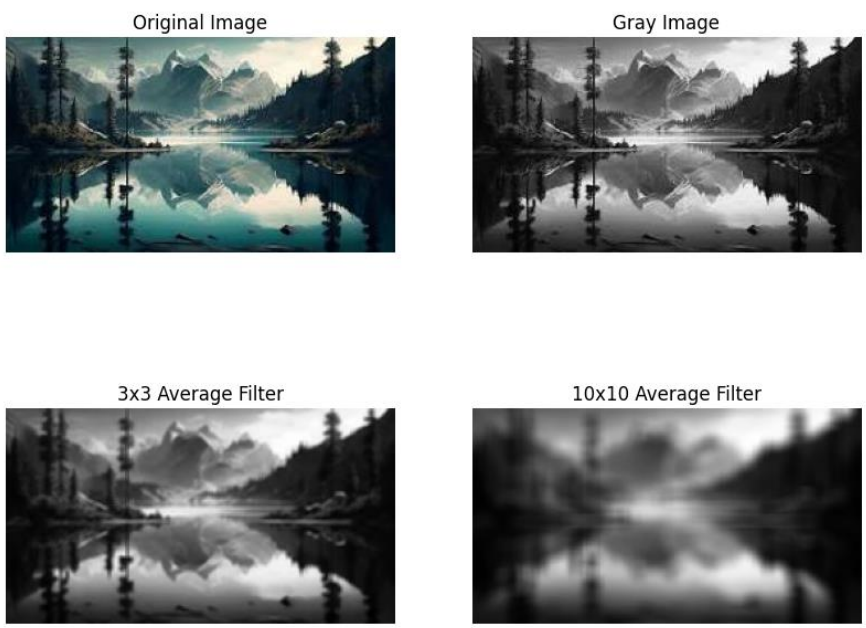
```
plt.imshow(J, cmap='gray')
plt.title('Noise added Image')
plt.axis('off')

plt.subplot(3, 2, 4)
plt.imshow(f, cmap='gray')
plt.title('3x3 Median Filter')
plt.axis('off')

plt.subplot(3, 2, 5)
plt.imshow(f1, cmap='gray')
plt.title('10x10 Median Filter')
plt.axis('off')

# Mean Filter and Average Filter
plt.figure(figsize=(10, 8))

i = cv2.imread('/home/aids5a2-32/Downloads/download.jpeg')
g = cv2.cvtColor(i, cv2.COLOR_BGR2GRAY)

# 3x3 Average filter
g1 = np.ones((3, 3)) / 9.0
b1 = convolve(g, g1)

plt.subplot(2, 2, 1)
plt.imshow(cv2.cvtColor(i, cv2.COLOR_BGR2RGB))
plt.title('Original Image')
plt.axis('off')

plt.subplot(2, 2, 2)
plt.imshow(g, cmap='gray')
plt.title('Gray Image')
plt.axis('off')

plt.subplot(2, 2, 3)
plt.imshow(b1, cmap='gray')
plt.title('3x3 Average Filter')
plt.axis('off')
```

```
# 10x10 Average filter
g2 = np.ones((10, 10)) / 100.0
b2 = convolve(g, g2)

plt.subplot(2, 2, 4)
plt.imshow(b2, cmap='gray')
plt.title('10x10 Average Filter')
plt.axis('off')

# Implementation of filter using Convolution
plt.figure(figsize=(10, 8))

I = cv2.imread('/home/aids5a2-32/Downloads/download(4).jpeg',
cv2.IMREAD_GRAYSCALE)
plt.subplot(2, 2, 1)
plt.imshow(I, cmap='gray')
plt.title('Original Image')
plt.axis('off')

# Convolution with filter a
a = np.array([[0.001, 0.001, 0.001], [0.001, 0.001, 0.001], [0.001, 0.001, 0.001]])
R = convolve(I, a)

plt.subplot(2, 2, 2)
plt.imshow(R, cmap='gray')
plt.title('Filtered Image')
plt.axis('off')

# Convolution with filter b
b = np.array([[0.005, 0.005, 0.005], [0.005, 0.005, 0.005], [0.005, 0.005, 0.005]])
R1 = convolve(I, b)

plt.subplot(2, 2, 3)
plt.imshow(R1, cmap='gray')
plt.title('Filtered Image 2')
plt.axis('off')
```

```
plt.tight_layout()
plt.show()
```

Output:


Original Image
Gray Image
Noise added Image
3x3 Median Filter
10x10 Median Filter


Original Image
Gray Image
3x3 Average Filter
10x10 Average Filter

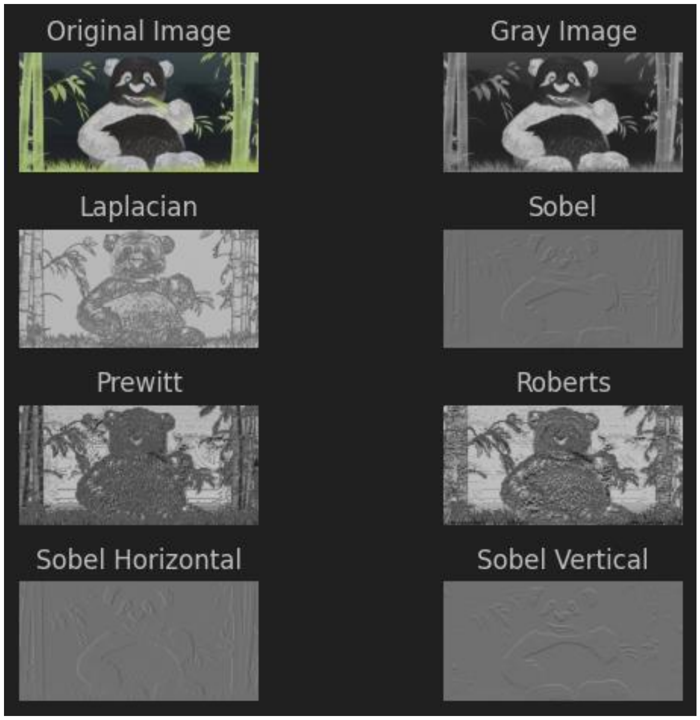
9. Implementation of image sharpening filters and Edge Detection using Gradient Filters.

```
import cv2
import numpy as np
import matplotlib.pyplot as plt
from scipy.ndimage import convolve
from scipy import ndimage
import os

# Define function to read image safely
def safe_imread(filename):
    if not os.path.exists(filename):
        raise FileNotFoundError(f"File '{filename}' not found.")
    return cv2.imread(filename)

# Define the Laplacian filter
def laplacian_filter(img, alpha=0.05):
    kernel = np.array([[0, 1, 0], [1, -4 + alpha, 1], [0, 1, 0]])
    return convolve(img, kernel)

# Main script
try:
     Read the image
    i = safe_imread('/home/aids5a2-32/Downloads/panda.jpg')

   # Display the original image
    plt.subplot(4, 2, 1)
    plt.imshow(cv2.cvtColor(i, cv2.COLOR_BGR2RGB))
    plt.title('Original Image')
    plt.axis('off')

    # Convert to grayscale
    g = cv2.cvtColor(i, cv2.COLOR_BGR2GRAY)

   # Display the grayscale image
    plt.subplot(4, 2, 2)
    plt.imshow(g, cmap='gray')
```

```
plt.title('Gray Image')
plt.axis('off')

# Apply Laplacian filter
f = laplacian_filter(g, alpha=0.05)

# Display the Laplacian filtered image
plt.subplot(4, 2, 3)
plt.imshow(f, cmap='gray')
plt.title('Laplacian')
plt.axis('off')

# Apply Sobel edge detection
s = cv2.Sobel(g, cv2.CV_64F, 1, 0, ksize=3) + cv2.Sobel(g, cv2.CV_64F, 0, 1, ksize=3)

# Display the Sobel edge detected image
plt.subplot(4, 2, 4)
plt.imshow(s, cmap='gray')
plt.title('Sobel')
plt.axis('off')

# Apply Prewitt edge detection
kernelx = np.array([[1, 0, -1], [1, 0, -1], [1, 0, -1]])
kernely = np.array([[1, 1, 1], [0, 0, 0], [-1, -1, -1]])
px = convolve(g, kernelx)
py = convolve(g, kernely)
p = np.sqrt(px*2 + py*2)

# Display the Prewitt edge detected image
plt.subplot(4, 2, 5)
plt.imshow(p, cmap='gray')
plt.title('Prewitt')
plt.axis('off')

# Apply Roberts edge detection
kernelx = np.array([[1, 0], [0, -1]])
kernely = np.array([[0, 1], [-1, 0]])
rx = convolve(g, kernelx)
```

```
    ry = convolve(g, kernely)
    r = np.sqrt(rx*2 + ry*2)

    # Display the Roberts edge detected image
    plt.subplot(4, 2, 6)
    plt.imshow(r, cmap='gray')
    plt.title('Roberts')
    plt.axis('off')

    # Apply Sobel edge detection (horizontal)
    sobel_horizontal = cv2.Sobel(g, cv2.CV_64F, 1, 0, ksize=3)

    # Display the Sobel horizontal edge detected image
    plt.subplot(4, 2, 7)
    plt.imshow(sobel_horizontal, cmap='gray')
    plt.title('Sobel Horizontal')
    plt.axis('off')

    # Apply Sobel edge detection (vertical)
    sobel_vertical = cv2.Sobel(g, cv2.CV_64F, 0, 1, ksize=3)

    # Display the Sobel vertical edge detected image
    plt.subplot(4, 2, 8)
    plt.imshow(sobel_vertical, cmap='gray')
    plt.title('Sobel Vertical')
    plt.axis('off')

    plt.tight_layout()
    plt.show()

except FileNotFoundError as e:
    print(e)
```

Output:



Original Image
Gray Image
Laplacian
Sobel
Prewitt
Roberts
Sobel Horizontal
Sobel Vertical