Step1: Install OpenCV

```
!pip install opencv-python-headless
```

```
Requirement already satisfied: opencv-python-headless in /usr/local/lib/python3.10/dist-packages (4.10.0.84)
Requirement already satisfied: numpy>=1.21.2 in /usr/local/lib/python3.10/dist-packages (from opencv-python-headless) (1.26.4)
```

Step 2 : Import Libraries

```
import cv2
import numpy as np
import matplotlib.pyplot as plt
from google.colab import files
from io import BytesIO
from PIL import Image
# Function to display an image using matplotlib
def display_image(img, title="Image"):
  plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
  plt.title(title)
  plt.axis('off')
  plt.show()
# Function to display two images side by side
def display_images(img1, img2, title1="Image 1", title2="Image 2"):
  plt.subplot(1, 2, 1)
  plt.imshow(cv2.cvtColor(img1, cv2.COLOR_BGR2RGB))
  plt.title(title1)
  plt.axis('off')
  plt.subplot(1, 2, 2)
  plt.imshow(cv2.cvtColor(img2, cv2.COLOR_BGR2RGB))
  plt.title(title2)
  plt.axis('off')
  plt.show()
```

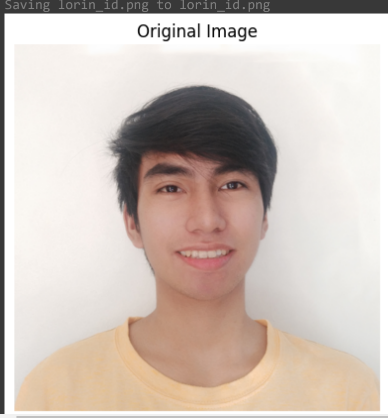
Step 3: Load an Image

```
# Upload an image
uploaded = files.upload()
# Convert to OpenCV format
image_path = next(iter(uploaded)) # Get the image file name
image = Image.open(BytesIO(uploaded[image_path]))
image = cv2.cvtColor(np.array(image), cv2.COLOR_RGB2BGR)
display_image(image, "Original Image")
```

Choose Files lorin_id.png

- **lorin_id.png**(image/png) - 375308 bytes, last modified: 9/16/2024 - 100% done

Saving lorin_id.png to lorin_id.png

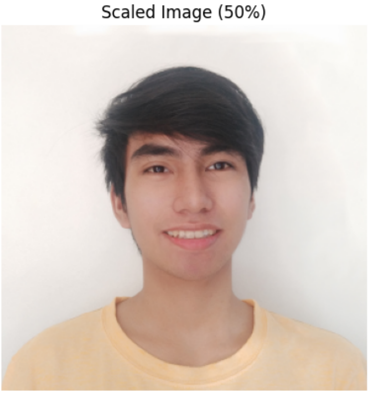


Exercise 1: Scaling and Rotation

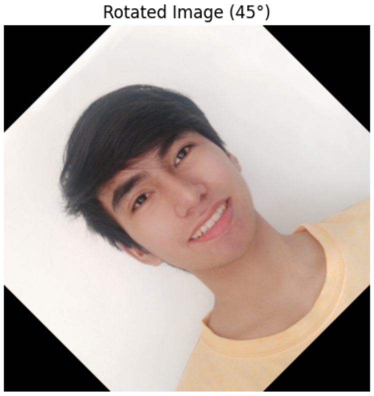
```
# Scaling
def scale_image(img, scale_factor):
  height, width = img.shape[:2]
  scaled_img = cv2.resize(img,
  (int(width * scale_factor), int(height * scale_factor)), interpolation=cv2.INTER_LINEAR)
  return scaled_img
"""
scale_image(): This function scales the image by a given factor.
The cv2.resize() function takes the original dimensions of the image,
multiplies them by the scale_factor, and resizes the image accordingly.
INTER_LINEAR is a common interpolation method for resizing.
"""
# Rotate
def rotate_image(img, angle):
  height, width = img.shape[:2]
  center = (width // 2, height // 2)
  matrix = cv2.getRotationMatrix2D(center, angle, 1.0)
  rotated_img = cv2.warpAffine(img, matrix, (width, height))
  return rotated_img
"""
rotate_image(): Rotates the image around its center. cv2.getRotationMatrix2D() creates
```

```
a transformation matrix for rotation, and cv2.warpAffine() applies this transformation.
The angle parameter controls the degree of rotation.
"""
# Scale image by 0.5
scaled_image = scale_image(image, 0.5)
display_image(scaled_image, "Scaled Image (50%)")
# Rotate image by 45 degrees
rotated_image = rotate_image(image, 45)
display_image(rotated_image, "Rotated Image (45°)")

"""
These lines apply the scaling and rotation functions to the uploaded image and display the results.
"""
```

Scaled Image (50%)



Rotated Image (45°)



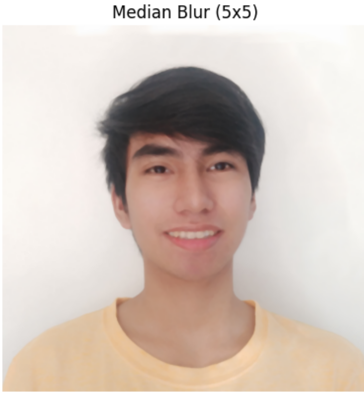
```
'\nThese lines apply the scaling and rotation functions to the uploaded image and display the results.\n'
```

Exercise 2: Blurring Techniques

```
# Gaussian Blur
gaussian_blur = cv2.GaussianBlur(image, (5, 5), 0)
display_image(gaussian_blur, "Gaussian Blur (5x5)")

"""
cv2.GaussianBlur(): Applies a Gaussian blur to the image, which smooths it by averaging
the pixel values in a 5x5 kernel (a small matrix). This is useful for reducing noise in an image.
"""

# Median Blur
median_blur = cv2.medianBlur(image, 5)
display_image(median_blur, "Median Blur (5x5)")

"""
cv2.medianBlur(): Applies a median blur, which replaces each pixel's value with the
median value of its neighbors in a 5x5 kernel. This method is particularly effective in
removing salt-and-pepper noise.
"""
```

Gaussian Blur (5x5)

Median Blur (5x5)

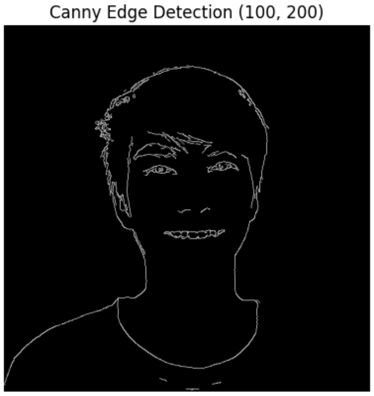


```
'\ncv2.medianBlur(): Applies a median blur, which replaces each pixel's value with the\nmedian value of its neighbors in a 5x5 kernel. This method is particularly effective in\nremoving
salt-and-pepper noise.\n'
```

Exercise 3: Edge Detection using Canny

```
# Canny Edge Detection
edges = cv2.Canny(image, 100, 200)
display_image(edges, "Canny Edge Detection (100, 200)")

"""
cv2.Canny(): Detects edges in the image by calculating the gradient (rate of intensity change)
between pixels. The two threshold values (100 and 200) define the edges'
sensitivity. Lower thresholds detect more edges, while higher thresholds detect only the
most prominent edges.
"""
```

Canny Edge Detection (100, 200)



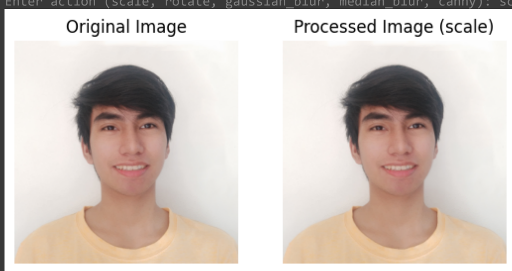
```
'\ncv2.Canny(): Detects edges in the image by calculating the gradient (rate of intensity change)\nbetween pixels. The two threshold values (100 and 200) define the edges'\nsensitivity.
Lower thresholds detect more edges, while higher thresholds detect only the\nmost prominent edges.\n'
```

Exercise 4: Basic Image Processor (Interactive)

```
def process_image(img, action):
    if action == 'scale':
        return scale_image(img, 0.5)
    elif action == 'rotate':
        return rotate_image(img, 45)
    elif action == 'gaussian_blur':
        return cv2.GaussianBlur(img, (5, 5), 0)
    elif action == 'median_blur':
        return cv2.medianBlur(img, 5)
    elif action == 'canny':
        return cv2.Canny(img, 100, 200)
```

```python
    else:
        return img

"""
process_image(): This function allows users to specify an image transformation (scaling,
rotation, blurring, or edge detection). Depending on the action passed, it will apply the
corresponding image processing technique and return the processed image.
"""

action = input("Enter action (scale, rotate, gaussian_blur, median_blur, canny): ")
processed_image = process_image(image, action)
display_images(image, processed_image, "Original Image", f"Processed Image ({action})")

"""
This allows users to enter their desired transformation interactively (via the
input() function). It processes the image and displays both the original and transformed
versions side by side.
"""
```

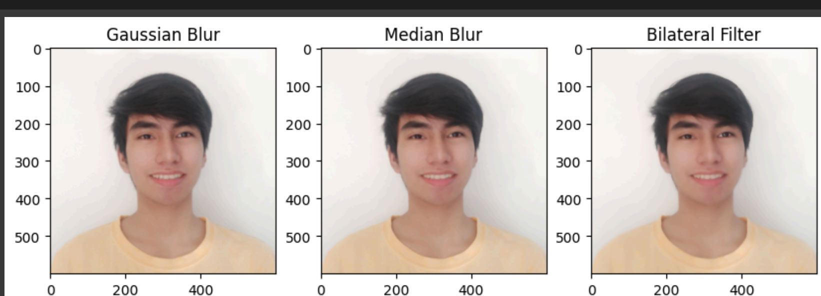
```
Enter action (scale, rotate, gaussian_blur, median_blur, canny): scale
```




```
'\nThis allows users to enter their desired transformation interactively (via the\ninput() function). It processes the image and displays both the original and transformed\nversions sid
e by side.\n'
```

Exercise 5: Comparison of Filtering Techniques

```python
# Applying Gaussian, Median, and Bilateral filters
gaussian_blur = cv2.GaussianBlur(image, (5, 5), 0)
median_blur = cv2.medianBlur(image, 5)
bilateral_filter = cv2.bilateralFilter(image, 9, 75, 75)

"""
cv2.bilateralFilter(): This filter smooths the image while keeping edges sharp, unlike
Gaussian or median filters. It's useful for reducing noise while preserving details.
"""

# Display the results for comparison
plt.figure(figsize=(10, 5))
plt.subplot(1, 3, 1)
plt.imshow(cv2.cvtColor(gaussian_blur, cv2.COLOR_BGR2RGB))
plt.title("Gaussian Blur")

plt.subplot(1, 3, 2)
plt.imshow(cv2.cvtColor(median_blur, cv2.COLOR_BGR2RGB))
plt.title("Median Blur")

plt.subplot(1, 3, 3)
plt.imshow(cv2.cvtColor(bilateral_filter, cv2.COLOR_BGR2RGB))
plt.title("Bilateral Filter")

plt.show()

"""
Explanation: This displays the images processed by different filtering techniques (Gaussian,
Median, and Bilateral) side by side for comparison.
"""
```

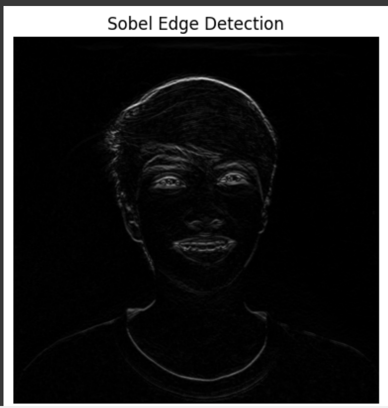



```
'\nExplanation: This displays the images processed by different filtering techniques (Gaussian,\nMedian, and Bilateral) side by side for comparison.\n'
```

Sobel Edge Detection

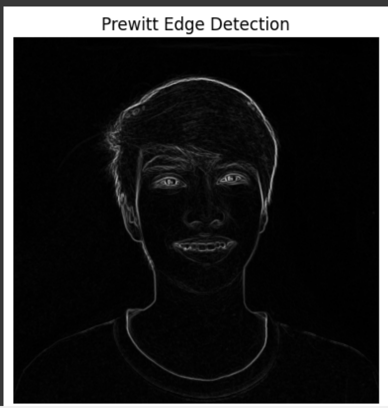
```python
def sobel_edge_detection(img):
  #convert to gratscale
  gray = cv2.cvtColor(img,cv2.COLOR_BGR2GRAY)
  #Sobel edge detection in the x direction
  sobelx = cv2.Sobel(gray,cv2.CV_64F,0,1,ksize=5)
  #Sobel edge detection in the y direction
  sobely =  cv2.Sobel(gray,cv2.CV_64F,0,1,ksize=5)
  #Combine the two gradients
  sobel_combined=cv2.magnitude(sobelx,sobely)
```

```
  return sobel_combined

#Apply Sobel edge detection to the uploaded image
sobel_edges = sobel_edge_detection(image)
plt.imshow(sobel_edges,cmap='gray')
plt.title('Sobel Edge Detection')
plt.axis('off')
plt.show()
```



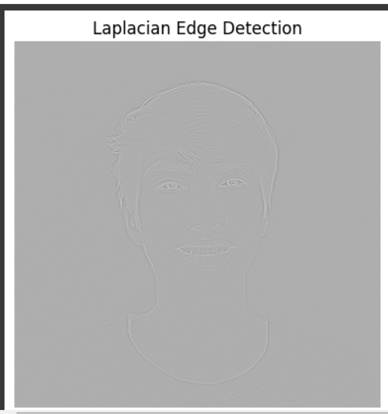
Prewitt Edge Detection

```
def prewitt_edge_detection(img):
  #convert to grayscale
  gray = cv2.cvtColor(img,cv2.COLOR_BGR2GRAY)
  #prewitt operator kernels for x and y directions
  kernelx = np.array([[1, 0, -1], [1, 0, -1], [1, 0, -1]], dtype=int)
  kernely = np.array([[1, 1, 1], [0, 0, 0], [-1, -1, -1]], dtype=int)
  # Applying the Prewitt operator
  prewittx = cv2.filter2D(gray, cv2.CV_64F, kernelx)
  prewitty = cv2.filter2D(gray, cv2.CV_64F, kernely)
  # Combine the x and y gradients by converting to floating point
  prewitt_combined = cv2.magnitude(prewittx, prewitty)
  return prewitt_combined
# Apply Prewitt edge detection to the uploaded image
prewitt_edges = prewitt_edge_detection(image)
plt.imshow(prewitt_edges, cmap='gray')
plt.title("Prewitt Edge Detection")
plt.axis('off')
plt.show()
```



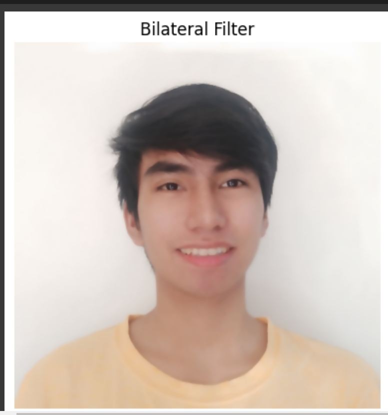
Laplacian Edge Detection

```
def laplacian_edge_detection(img):
  # Convert to grayscale
  gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
  # Apply Laplacian operator
  laplacian = cv2.Laplacian(gray, cv2.CV_64F)
  return laplacian
# Apply Laplacian edge detection to the uploaded image
laplacian_edges = laplacian_edge_detection(image)
plt.imshow(laplacian_edges, cmap='gray')
plt.title("Laplacian Edge Detection")
plt.axis('off')
plt.show()
```



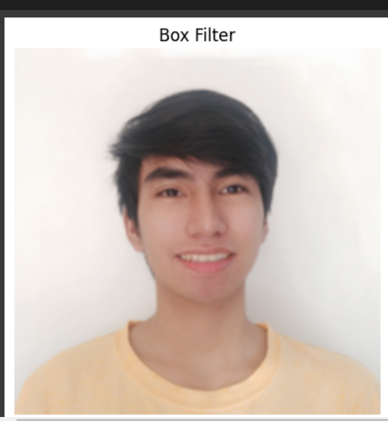
Bilateral Filter

```
def bilateral_blur(img):
  bilateral = cv2.bilateralFilter(img, 9, 75, 75)
  return bilateral
# Apply Bilateral filter to the uploaded image
bilateral_blurred = bilateral_blur(image)
plt.imshow(cv2.cvtColor(bilateral_blurred, cv2.COLOR_BGR2RGB))
plt.title("Bilateral Filter")
plt.axis('off')
plt.show()
```



Box Filter

```
def box_blur(img):
  box = cv2.boxFilter(img, -1, (5, 5))
  return box
# Apply Box filter to the uploaded image
box_blurred = box_blur(image)
plt.imshow(cv2.cvtColor(box_blurred, cv2.COLOR_BGR2RGB))
plt.title("Box Filter")
plt.axis('off')
plt.show()
```



Motion Blur

```
def motion_blur(img):
```

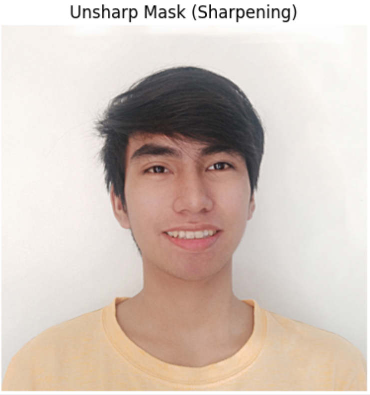
```
# Create motion blur kernel (size 15x15)
  kernel_size = 15
  kernel = np.zeros((kernel_size, kernel_size))
  kernel[int((kernel_size - 1) / 2), :] = np.ones(kernel_size)
  kernel = kernel / kernel_size
  # Apply motion blur
  motion_blurred = cv2.filter2D(img, -1, kernel)
  return motion_blurred
# Apply Motion blur to the uploaded image
motion_blurred = motion_blur(image)
plt.imshow(cv2.cvtColor(motion_blurred, cv2.COLOR_BGR2RGB))
plt.title("Motion Blur")
plt.axis('off')
plt.show()
```

Motion Blur

Unsharp Masking (Sharpening)

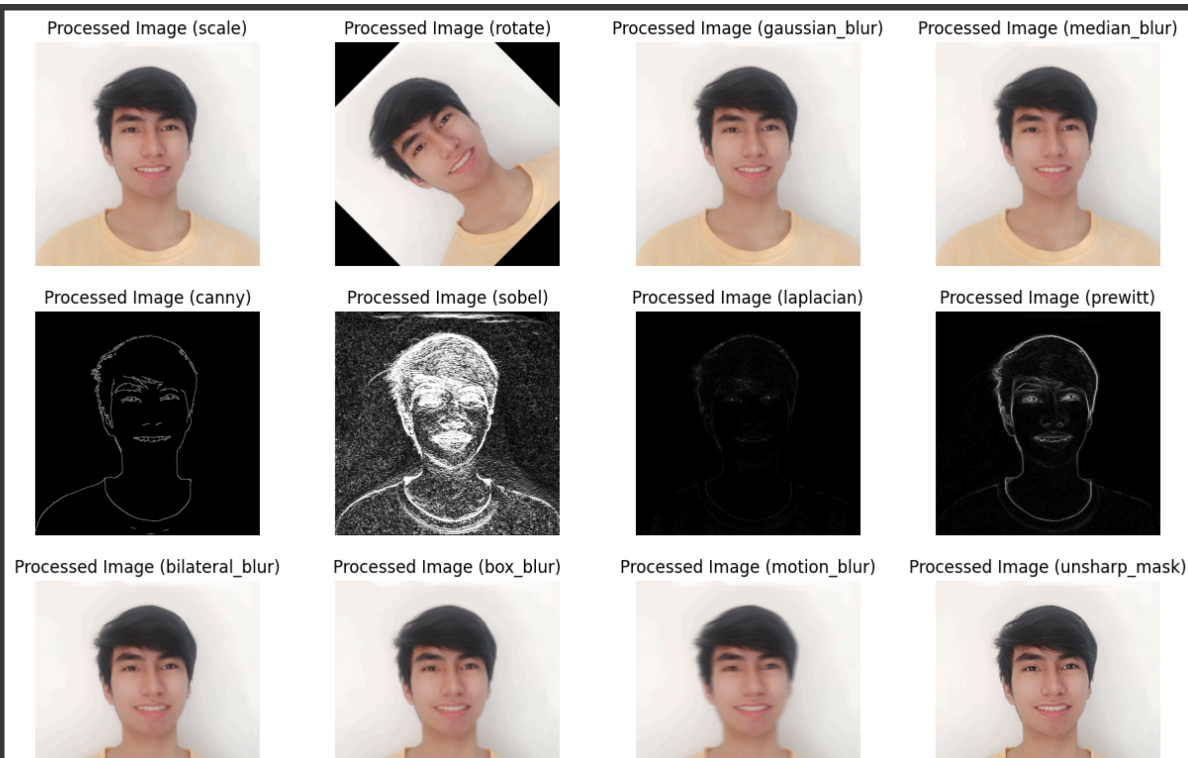
```
def unsharp_mask(img):
  # Create a Gaussian blur version of the image
  blurred = cv2.GaussianBlur(img, (9, 9), 10.0)
  # Sharpen by adding the difference between the original and the blurred image
  sharpened = cv2.addWeighted(img, 1.5, blurred, -0.5, 0)
  return sharpened
# Apply Unsharp Masking to the uploaded image
sharpened_image = unsharp_mask(image)
plt.imshow(cv2.cvtColor(sharpened_image, cv2.COLOR_BGR2RGB))
plt.title("Unsharp Mask (Sharpening)")
plt.axis('off')
plt.show()
```

Unsharp Mask (Sharpening)



All Output

```
actions = ['scale', 'rotate', 'gaussian_blur', 'median_blur', 'canny', 'sobel', 'laplacian', 'prewitt', 'bilateral_blur', 'box_blur', 'motion_blur', 'unsharp_mask']

plt.figure(figsize=(15, 10))

for i, action in enumerate(actions):
    processed_image = process_image(image, action)

    # Ensure the processed image is in the correct format for display
    if processed_image.dtype != 'uint8':  # Convert to uint8 if not already
        processed_image = cv2.convertScaleAbs(processed_image)

    # Display the processed image
    plt.subplot(3, 4, i + 1)
    plt.imshow(cv2.cvtColor(processed_image, cv2.COLOR_BGR2RGB))
    plt.title(f"Processed Image ({action})")
    plt.axis('off')

plt.show()
```


Processed Image (scale)
Processed Image (rotate)
Processed Image (gaussian_blur)
Processed Image (median_blur)
Processed Image (canny)
Processed Image (sobel)
Processed Image (laplacian)
Processed Image (prewitt)
Processed Image (bilateral_blur)
Processed Image (box_blur)
Processed Image (motion_blur)
Processed Image (unsharp_mask)