Apply image processing techniques(Scaling, Rotation, Blurring, Edge Detection) OpenCV

Step 1: 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 Necessary Libraries

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

def display_image(img, title="Image"):

plt.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
plt.title(title)
    plt.axis('off')
    plt.show()

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()
```

- **cv2:** This imports OpenCV, which provides functions for image processing.

- **numpy (np):** This library is used for handling arrays and matrices, which images are represented as.
- **matplotlib.pyplot (plt):** This is used to display images in a Jupyter notebook or Google Colab environment.

Step 3: Load an Image

```
from google.colab import files
from io import BytesIO
from PIL import 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 No file chosen     Upload widget is only available when the cell has been executed in the current browser session. Please rerun this cell to enable.
Saving MENDOZA.png to MENDOZA (1).png
```

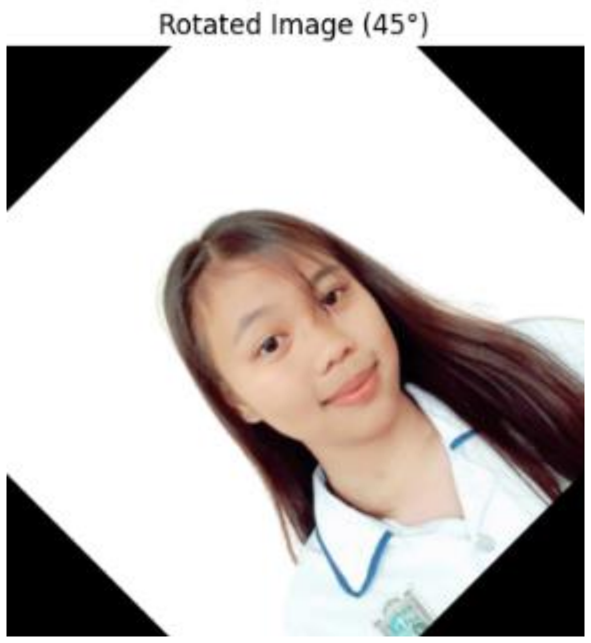
Original Image

- display_image(): Converts the image from BGR (OpenCV's default color format) to RGB (the format expected by matplotlib) and displays it using imshow().
- display_images(): This function allows two images to be displayed side by side for comparison. We use subplot to create a grid of plots (here, 1 row and 2 columns).

Exercise 1: Scaling and Rotating

```
# 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.
```

```
"""
```



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

Exercise 2: Blurring Techniques

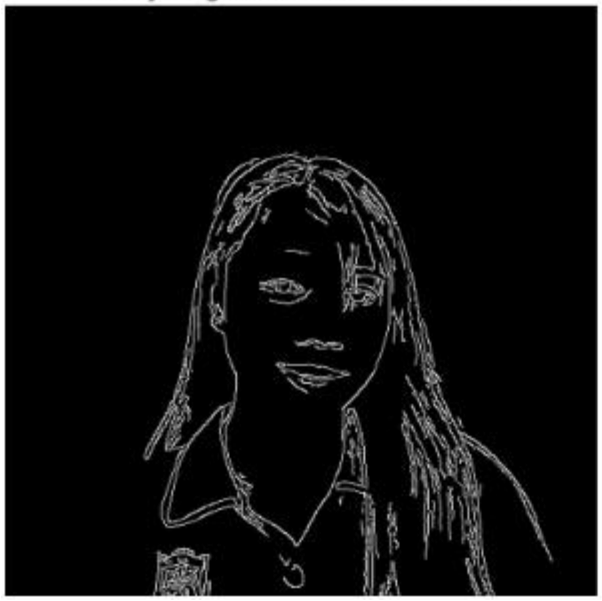
```python
# Gaussian Blur
gaussian_blur = cv2.GaussianBlur(image, (5, 5), 0)
display_image(gaussian_blur, "Gaussian Blur (5x5)")

"""
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.
"""
```

```
          \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)

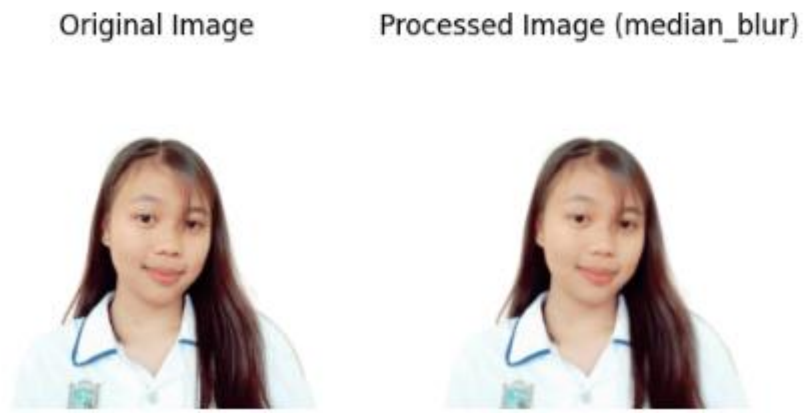


```
\ncv2.Canny(): Detects edges in the image by calculating the gradient (rate of
intensity change)\nbetween pixels. The two threshold values (100 and 200) define the
edges'\nsensitivity. Lower thresholds detect more edges, while higher thresholds detect
only the\nmost prominent edges.\n
```

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)
    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.
"""
```

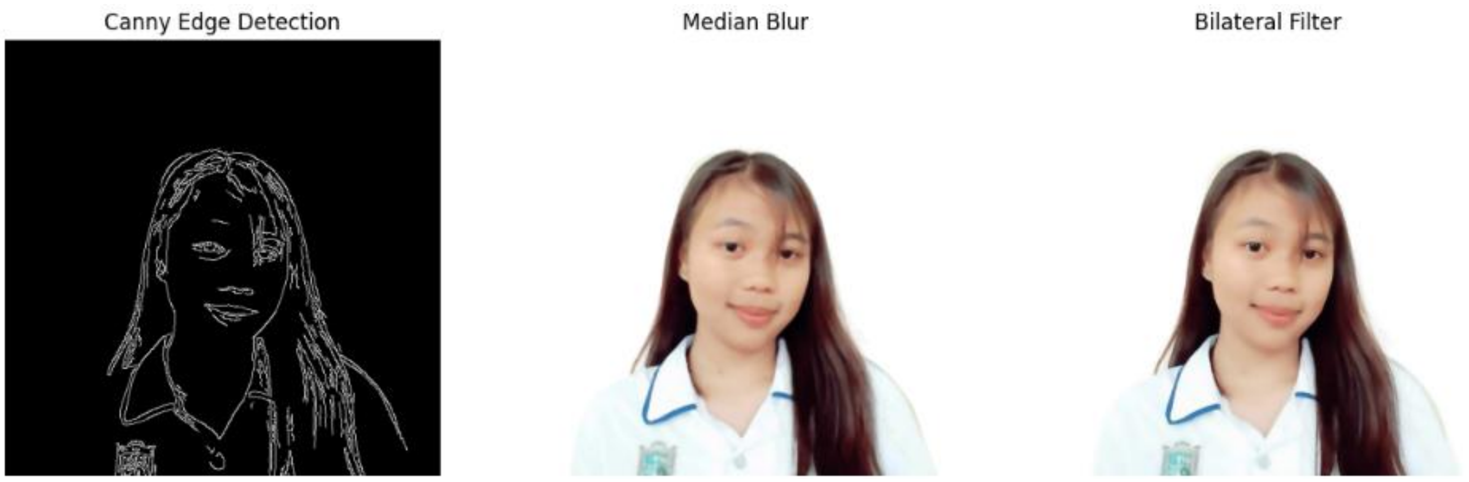
```
Enter action (scale, rotate, gaussian_blur, median_blur, canny): median_blur
```



```
\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 side by side.\n
```

Exercise 5: Comparison of Filtering Techniques

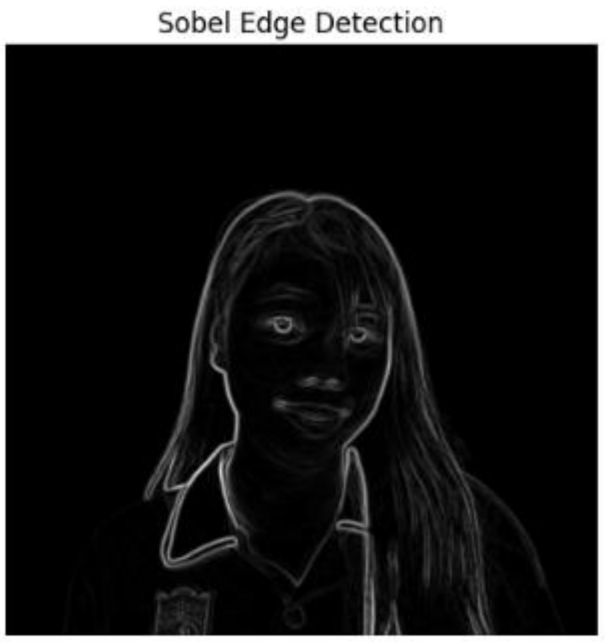
```
# Apply Canny Edge Detection
canny_edge = cv2.Canny(image, 100, 200)  # Replace 100 and 200 with appropriate
thresholds

# Apply Median Blur
median_blur = cv2.medianBlur(image, 5)

# Apply Bilateral Filter
bilateral_filter = cv2.bilateralFilter(image, 9, 75, 75)

# Display the results for comparison
plt.figure(figsize=(15, 5))

plt.subplot(1, 3, 1)
plt.imshow(canny_edge, cmap='gray')  # Canny Edge Detection is grayscale
plt.title("Canny Edge Detection")
plt.axis('off')

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

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

plt.show()

"""
Explanation: This displays the images processed by different filtering techniques
(Canny Edge Detection,
Median, and Bilateral) side by side for comparison. Canny Edge Detection highlights
edges, the Median
Blur removes noise while preserving edges, and the Bilateral Filter smooths the image
while keeping
edges sharp.
"""
```



```
\nExplanation: This displays the images processed by different filtering techniques (Canny
Edge Detection,\nMedian, and Bilateral) side by side for comparison. Canny Edge Detection
highlights edges, the Median\nBlur removes noise while preserving edges, and the Bilateral
Filter smooths the image while keeping\nedges sharp.\n
```

Exercise 6: Sobel Edge Detection

```python
# Sobel Edge Detection
def sobel_edge_detection(img):
    # Convert to grayscale
    gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

    # Sobel edge detection in x and y directions
    sobelx = cv2.Sobel(gray, cv2.CV_64F, 1, 0, ksize=5)  # Sobel in x direction
    sobely = cv2.Sobel(gray, cv2.CV_64F, 0, 1, ksize=5)  # Sobel in y direction

    # Combine the two gradients using the magnitude
    sobel_combined = cv2.magnitude(sobelx, sobely)

    return sobel_combined

# Example of using the sobel_edge_detection function
# Load the image (replace with your actual image path)
image = cv2.imread('/content/MENDOZA.png')

# Check if the image is loaded properly
if image is None:
    print("Error: Image not loaded. Check the file path.")
else:
    # Apply Sobel Edge Detection
    sobel_edges = sobel_edge_detection(image)
    # Display Sobel Edge Detection result
    plt.imshow(sobel_edges, cmap='gray')
    plt.title("Sobel Edge Detection")
    plt.axis('off')
    plt.show()
```



Conclusion

The exercises explore common image manipulation techniques in computer vision. Scaling and rotation operations demonstrate geometric transformations, while Gaussian and Median Blur filters reduce noise in images. The Canny and Sobel Edge Detection methods provide insight into how edges in an image can be emphasized, which is critical for applications like object detection and image segmentation. Comparing different filtering techniques further highlights how each method balances noise reduction and edge preservation. By combining these tools, one can build robust image-processing systems for a wide variety of real-world tasks, from facial recognition to medical imaging.

Original Image

Scaled Image (50%)

Rotated Image (45°)

Gaussian Blur (5x5)

Median Blur (5x5)

Canny Edge Detection (100, 200)

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

Original Image

Processed Image (median_blur)

Sobel Edge Detection

Canny Edge Detection

Median Blur