EE7204: COMPUTER VISION AND IMAGE PROCESSING

TAKE HOME ASSIGNMENT - 02

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1 GitHub Link

https://github.com/KalinduLakshan/EE7204_EG_2019_3649_TakeHomeAssignment_02.git

2 Coding Answers

2.1 Consider an image with 2 objects and a total of 3-pixel values (1 for each object and one for the background). Add Gaussian noise to the image. Implement and test Otsu's algorithm with this image.

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

# Define image dimensions
height, width = 100, 100

# Create a blank image with a background and two objects
image = np.zeros((height, width), dtype=np.uint8)

# Define pixel values for the objects and background
object1_pixel = 50
object2_pixel = 200
background_pixel = 255

# Draw the objects
cv2.rectangle(image, (20, 20), (40, 40), object1_pixel, -1)  # Object 1
cv2.rectangle(image, (60, 60), (80, 80), object2_pixel, -1)  # Object 2

# Display the original image
plt.imshow(image, cmap='gray')
plt.title('Original Image')
plt.axis('off')
plt.show()


# Adding Gaussian noise to the original image
def add_gaussian_noise(img, mean, sigma):
    h, w = img.shape  # Image dimensions
    noise = np.random.normal(mean, sigma, (h, w))  # Generate Gaussian noise
    noisy_img = np.clip(img + noise, 0, 255).astype(np.uint8)  # Add noise to
the image
    return noisy_img


# Apply Gaussian noise with mean=0 and different sigma values
noisy_image_sigma_10 = add_gaussian_noise(image, 0, 10)
noisy_image_sigma_20 = add_gaussian_noise(image, 0, 20)
```

```python
# Define Otsu's thresholding algorithm
def otsu_threshold(img):
    _, otsu_threshold_image = cv2.threshold(img, 0, 255, cv2.THRESH_BINARY +
cv2.THRESH_OTSU)
    return otsu_threshold_image


# Apply Otsu's algorithm to noisy images with sigma=10
otsu_image_sigma_10 = otsu_threshold(noisy_image_sigma_10)
otsu_image_sigma_20 = otsu_threshold(noisy_image_sigma_20)

# Plotting the images
fig, axs = plt.subplots(1, 3, figsize=(15, 5))

# Original image
axs[0].imshow(image, cmap='gray')
axs[0].set_title('Original Image')
axs[0].axis('off')

# Noisy image with sigma=10
axs[1].imshow(noisy_image_sigma_10, cmap='gray')
axs[1].set_title('Noisy Image (sigma=10)')
axs[1].axis('off')

# Otsu's image with sigma=10
axs[2].imshow(otsu_image_sigma_10, cmap='gray')
axs[2].set_title("Otsu's Algorithm (sigma=10)")
axs[2].axis('off')

# Show the plots
plt.tight_layout()
plt.show()
```

2.2 Implement a region-growing technique for image segmentation. The basic idea is to start from a set of points inside the object of interest (foreground), denoted as seeds, and recursively add neighboring pixels as long as they are in a pre-defined range of the pixel values of the seeds.

```
# Import the necessary libraries
import cv2
import numpy as np
import matplotlib.pyplot as plt


def get_eight_neighbour(x, y, shape):
    # Returns the coordinates of the 8-neighbors of a point within a given
shape
    output = []
    max_x = shape[1] - 1
    max_y = shape[0] - 1

    # Define the eight possible neighbors and constrain them within the image
boundaries.
    neighbors = [
        (x - 1, y - 1), (x, y - 1), (x + 1, y - 1),  # Top row
        (x - 1, y),                 (x + 1, y),      # Middle row (left and
right)
        (x - 1, y + 1), (x, y + 1), (x + 1, y + 1)  # Bottom row
    ]

    for nx, ny in neighbors:
        # Constrain the coordinates within the image boundaries
        output_x = min(max(nx, 0), max_x)
        output_y = min(max(ny, 0), max_y)
        output.append((output_x, output_y))

    return output


def region_growing(im, seed):
    # Performs region growing from a given seed point
    seed_points = [seed]  # Start with the initial seed point
    output_img = np.zeros_like(im)  # Output image initialized to zeros
(black)
    processed = set()  # A set to track processed points

    while seed_points:
        pix = seed_points.pop(0)  # Get the next seed point to process
        if pix in processed:
            continue  # If already processed, skip

        output_img[pix[0], pix[1]] = 255  # Mark the point as white in the
output image
        processed.add(pix)  # Add to the set of processed points
```

```
        # Add neighbors to the seed points if they haven't been processed
        for coord in get_eight_neighbour(pix[0], pix[1], im.shape):
            if im[coord[0], coord[1]] == 255 and coord not in processed:
                seed_points.append(coord)

    return output_img


# Define the predefined seed point
predefined_seed = (100, 10)  # (y, x) coordinate for the seed point

# Load the image and convert to grayscale
image = cv2.imread('apple.jpg', 0)

# Apply a binary threshold to create a binary image
ret, img = cv2.threshold(image, 128, 255, cv2.THRESH_BINARY)

# Use the predefined seed point for region growing
rg_out = region_growing(img, predefined_seed)

# Create subplots to display the original and the region-grown image
plt.figure(figsize=(10, 5))  # Set the figure size

# Original image subplot
plt.subplot(1, 2, 1)  # 1 row, 2 columns, 1st subplot
plt.imshow(image, cmap='gray')  # Display the original image in grayscale
plt.title('Original Image')
plt.axis('off')  # Hide axis

# Region growing result subplot
plt.subplot(1, 2, 2)  # 1 row, 2 columns, 2nd subplot
plt.imshow(rg_out, cmap='gray')  # Display the region-grown image in
grayscale
plt.title('Region-Grown Image')
plt.axis('off')  # Hide axis

# Show the plot
plt.show()
```

3 Results

3.1 Consider an image with 2 objects and a total of 3-pixel values (1 for each object and one for the background). Add Gaussian noise to the image. Implement and test Otsu's algorithm with this image.

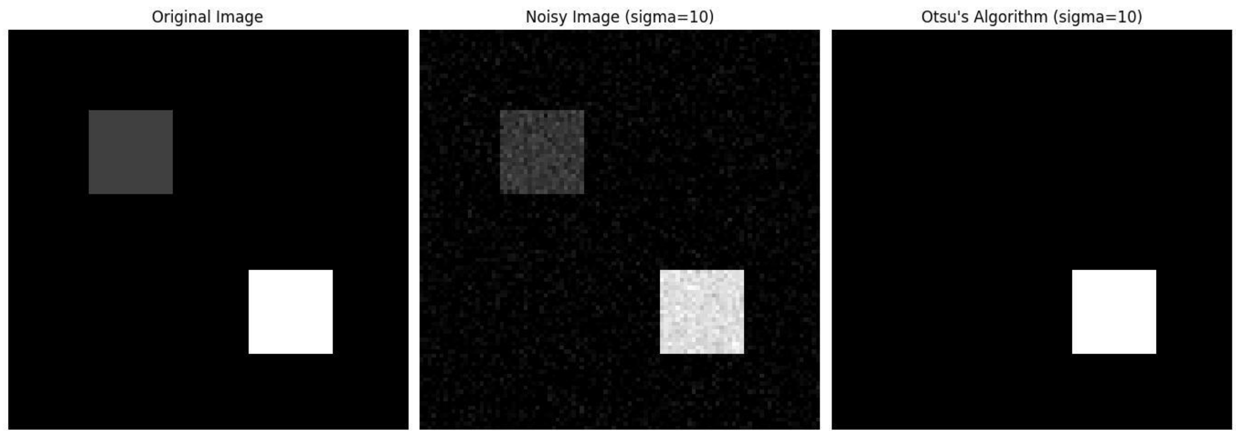

FIGURE 3.1: ORIGINAL IMAGE, GAUSSIAN NOISE ADDED IMAGE AND IMAGE AFTER PERFORMING OTSU'S ALGORITHM

3.2 Implement a region-growing technique for image segmentation. The basic idea is to start from a set of points inside the object of interest (foreground), denoted as seeds, and recursively add neighboring pixels as long as they are in a pre-defined range of the pixel values of the seeds.

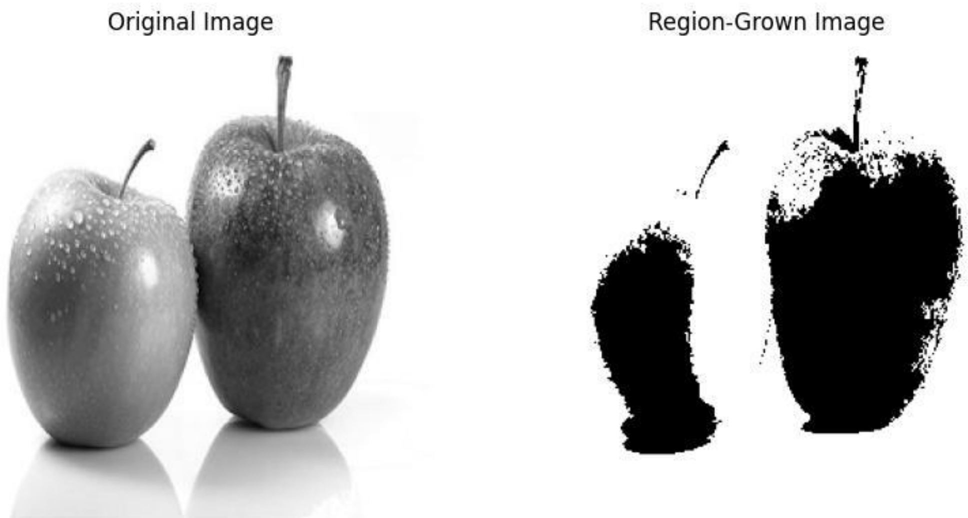

FIGURE 3.2: ORIGINAL IMAGE AND THE REGIONAL-GROWN IMAGE