Programming Assignment 10 Report

November 25, 2020

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Importing prerequisites

[1]:
```
import cv2
import numpy as np
import matplotlib.pyplot as plt
import os
import time
```

[2]:
```
def plotter(img_list, r, w, gray, wr, hr, fig_name = None):
    '''
    Plots images' list with its' caption and saves result image if you want.

    Parameters:
        img_list (list): The list of tuples of image and its' caption.
        r (int): The number of row(s).
        w (int): The number of colunm(s).
        gray (bool): The flag for plotting images in grayscale mode.
        wr (int): The width of one figure.
        hr (int): The height of one figure.
        fig_name (str): The name of the image of the plot. if not set this␣
↪parameter the plot doesn't save.
    '''

    plt.rcParams['figure.figsize'] = (wr, hr)
    for i in range(len(img_list)):
        plt.subplot(r, w, i + 1)
        if img_list[i][2] == 'img':
            if gray:
                plt.imshow(img_list[i][0], cmap = 'gray')
            else:
                plt.imshow(img_list[i][0])
            plt.xticks([])
            plt.yticks([])
        elif img_list[i][2] == 'hist':
            plt.bar(np.arange(len(img_list[i][0])), img_list[i][0], color = 'c')
        else:
```

```
            raise Exception("Only image or histogram. Use third parameter of␣
↪tuples in img_list and set it to img or hist.")
        plt.title(img_list[i][1])
    if fig_name is not None:
        plt.savefig(fig_name + '.png')
    plt.show()
```

1 Shape and Color Detection

We will be performing shape and color detection using contours and LAB color space.

`detect_shape(contour)`: Gets a contour as input, predicts the shape of the contour by calculating primeter. Returns the label of shape predicted.

`detect_color(image, contour)`: Gets image and a contour as input, predicts the color of the region determined by contour using distanmce comparison between mean of color intensities and LAB color space. Returns the label of color predicted.

[3]:
```
from scipy.spatial import distance as dist

def detect_shape(contour):

    shape = "unidentified"
    perimeter = cv2.arcLength(contour, True)
    approx = cv2.approxPolyDP(contour, 0.05 * perimeter, True)

    if len(approx) == 3:
        shape = 'triangle'

    elif len(approx) == 4:
        (x, y, w, h) = cv2.boundingRect(approx)
        ratio = w / float(h)

        if ratio >= 0.95 and ratio <= 1.05:
            shape = 'square'
        else:
            shape = 'rectangle'

    elif len(approx) == 5:
        shape = 'pentagon'

    else:
        shape = 'circle'

    return shape

def detect_color(image, contour):
```

```python
    colors = np.array([
        [[255, 0, 0]],
        [[0, 255, 0]],
        [[0, 0, 255]],
    ], dtype="uint8")

    color_names = ['red', 'green', 'blue']

    lab = cv2.cvtColor(colors, cv2.COLOR_RGB2LAB)

    mask = mask = np.zeros(image.shape[:2], np.uint8)
    cv2.drawContours(mask, [contour], -1, 255, -1)
    mask = cv2.erode(mask, None, iterations=1)

    mean = cv2.mean(image, mask=mask)[:3]

    min_dist = (np.inf, None)

    for (i, row) in enumerate(lab):

        d = dist.euclidean(row[0], mean)

        if d < min_dist[0]:
            min_dist = (d, i)

    return color_names[min_dist[1]]
```

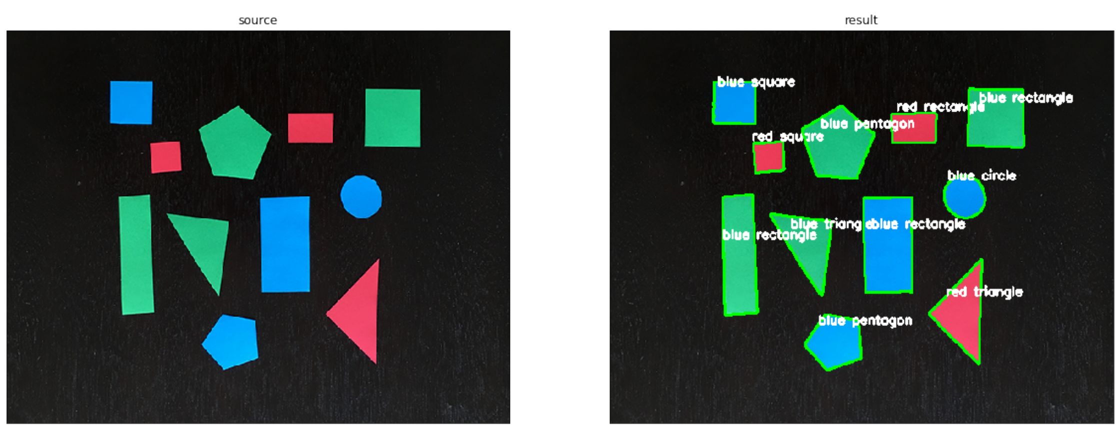
`detect_shape_color(image)`: Gets image as input. Detects the shapes and colors of the shapes in the image, draws contour borders and `(color + shape)` labels on the shapes in the image.

[4]:
```python
def detect_shape_color(image):
    '''
    Detects shapes and their color in the input image.

    Parameters:
        image (numpy.ndarray): The input image.

    Returns:
        numpy.ndarray: The result image.
    '''

    result = image.copy()

    gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
    blurred = cv2.GaussianBlur(gray, (5, 5), 0)
    thresh = cv2.threshold(blurred, 60, 255, cv2.THRESH_BINARY)[1]
```

```
    contours, _ = cv2.findContours(thresh.copy(), cv2.RETR_EXTERNAL, cv2.CHAIN_APPROX_SIMPLE)

    for contour in contours:
        if cv2.contourArea(contour) > 0:

            M = cv2.moments(contour)

            cX = int(M["m10"] / M["m00"])
            cY = int(M["m01"] / M["m00"])

            cv2.drawContours(image, [contour], -1, (0, 255, 0), 2)

            shape = detect_shape(contour)

            color = detect_color(image, contour)

            text = color + " " + shape
            cv2.putText(image, text, (cX - 20, cY - 20), cv2.FONT_HERSHEY_SIMPLEX, 0.5, (255, 255, 255), 2)

    return image
```

Test of implementation.

[5]:
```
image_list = []
image = cv2.imread(os.path.join('images', 'q3.png'))
image_list.append([cv2.cvtColor(image, cv2.COLOR_BGR2RGB), 'source', 'img'])
image_list.append([cv2.cvtColor(detect_shape_color(image), cv2.COLOR_BGR2RGB), 'result', 'img'])
plotter(image_list, 1, 2, False, 20, 10, 'Q3')
```



2 Erosion and Dilation

`make_slice(image, offset, i, j)`: Slices the image using the coordinates and offset provided.

`get_indices(shape, offset)`: Returns the valid indices for a particular kernel offset to be sliding over the image.

[6]:
```
def make_slice(image, offset, i, j):
    return image[i - offset : i + offset + 1, j - offset : j + offset + 1]

def get_indices(shape, offset):
    indices = []
    for val in range(shape):
        if val - offset >= 0 and val + offset + 1 < shape:
            indices.append(val)
    return indices
```

[7]:
```
structuring_element = np.ones((25, 25))
```

[8]:
```
def your_dilate(image, structuring_element):
    '''
    Applies your dilation.

    Parameters:
        image (numpy.ndarray): The input image.
        structuring_element (numpy.ndarray): The structuring element must be␣
 ↪square.

    Returns:
        numpy.ndarray: The result image.
    '''


    offset = structuring_element.shape[0] // 2

    rows = get_indices(image.shape[0], offset)
    cols = get_indices(image.shape[1], offset)

    dilated_image = np.zeros_like(image)

    for i in rows:
        for j in cols:
            image_slice = make_slice(image, offset, i, j)
            if np.logical_and(structuring_element, image_slice).any():
                dilated_image[i, j] = 1

    return dilated_image
```

[9]:
```
def your_erode(image, structuring_element):
    '''
    Applies your erosion.

    Parameters:
        image (numpy.ndarray): The input image.
        structuring_element (numpy.ndarray): The structuring element must be␣
↪square.

    Returns:
        numpy.ndarray: The result image.
    '''
    offset = structuring_element.shape[0] // 2

    rows = get_indices(image.shape[0], offset)
    cols = get_indices(image.shape[1], offset)

    eroded_image = np.zeros_like(image)

    for i in rows:
        for j in cols:
            image_slice = make_slice(image, offset, i, j)
            logical_and = np.logical_and(structuring_element, image_slice)

            if np.array_equal(logical_and, structuring_element):
                eroded_image[i, j] = 1

    return eroded_image
```

[10]:
```
def cv_dilate(image, structuring_element):
    '''
    Applies OpenCV dilation.

    Parameters:
        image (numpy.ndarray): The input image.
        structuring_element (numpy.ndarray): The structuring element must be␣
↪square.

    Returns:
        numpy.ndarray: The result image.
    '''

    return cv2.dilate(image, structuring_element, iterations=1)
```

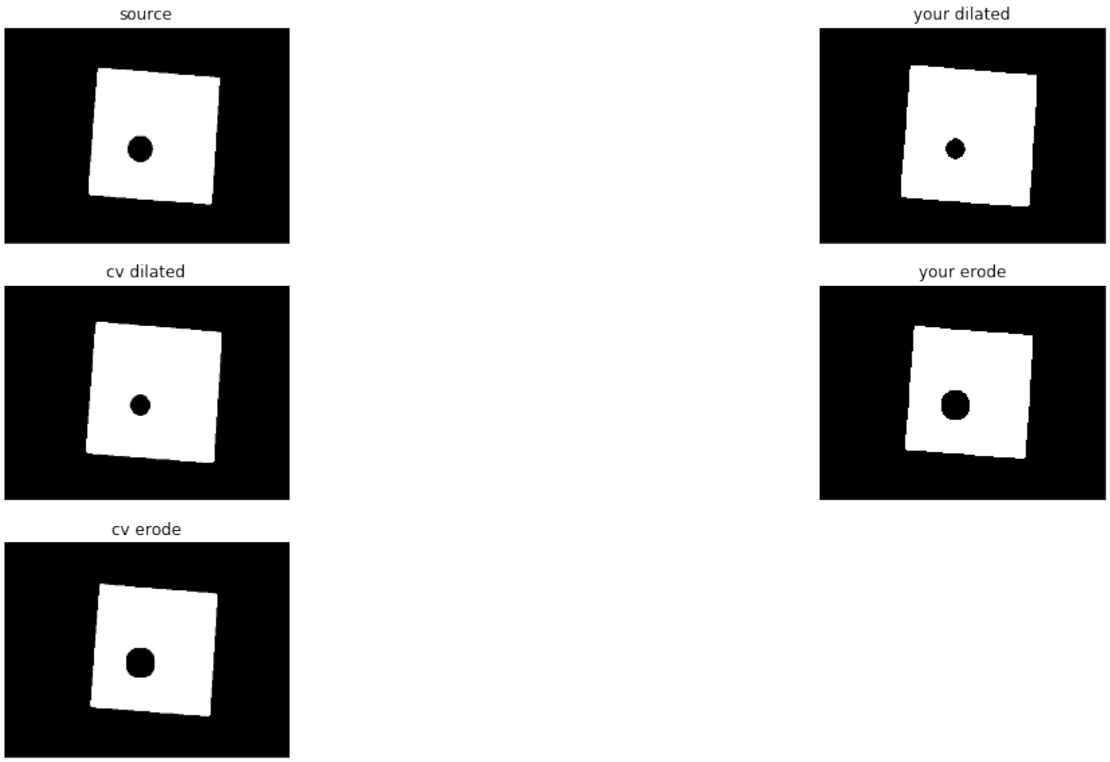
[11]:
```
def cv_erode(image, structuring_element):
    '''
    Applys OpenCV erosion.
```

```
    Parameters:
        image (numpy.ndarray): The input image.
        structuring_element (numpy.ndarray): The structuring element must be␣
↪square.

    Returns:
        numpy.ndarray: The result image.
    '''

    return cv2.erode(image, structuring_element, iterations=1)
```

Test of implementation.

[12]:
```
image_list = []
image = cv2.imread(os.path.join('images', 'q4.png'), cv2.IMREAD_GRAYSCALE)
image_list.append([image, 'source', 'img'])
t1 = time.time()
y_dilate = your_dilate(image, structuring_element)
t2 = time.time()
print('time for your_dilate: %f s' % (t2 - t1))
t1 = time.time()
c_dilate = cv_dilate(image, structuring_element)
t2 = time.time()
print('time for cv_dilate: %f s' % (t2 - t1))
t1 = time.time()
y_erode = your_erode(image, structuring_element)
t2 = time.time()
print('time for your_erode: %f s' % (t2 - t1))
t1 = time.time()
c_erode = cv_erode(image, structuring_element)
t2 = time.time()
print('time for cv_erode: %f s' % (t2 - t1))
image_list.append([y_dilate, 'your dilated', 'img'])
image_list.append([c_dilate, 'cv dilated', 'img'])
image_list.append([y_erode, 'your erode', 'img'])
image_list.append([c_erode, 'cv erode', 'img'])
plotter(image_list, 3, 2, True, 20, 10, 'Q4')
```

```
time for your_dilate: 12.550562 s
time for cv_dilate: 0.001987 s
time for your_erode: 21.180147 s
time for cv_erode: 0.002227 s
```



in terms of speed, the OpenCV implememntation is much much faster than the regular naive manual approach. The naive approach has two nested for loops which increases the order of iterations. **in terms of result** both implementations use 1 iteration, and we can see the results are pretty similar.