Implementation of Morphology Filters and Segmentation for Improving the Simple Python Optical Character Recognition (OCR) System

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Description

In this assignment, I implemented a simple Python Optical Character Recognition (OCR) system using Tesseract. Then, I applied and compared several types of morphology filters and segmentation in the image to improve OCR results.

Tools

- Tesseract
- Python 3.7
- Some Python libraries:
    - Open-CV
    - PyTesseract

Installation

Tesseract

Tesseract is an open-source OCR engine. It began as a Ph.D. research project in HP Labs Bristol, then developed by **HP** between 1984 and 1994. In 2005, HP released Tesseract as an open-source software. Since 2006 it is developed by **Google**.

1. Using Homebrew to install Tesseract in Mac

    ```
    $ brew install tesseract

     # This formula contains only the "eng", "osd", and "snum" language data files.
     # If you need any other supported languages, run `brew install tesseract-lang`.

     # To install other languages
     $ brew install tesseract-lang
    ```

    Installation of Tesseract in other OS will be different.

Implementation

In [1]:

```
# import libraries
from PIL import Image
import cv2
import pytesseract
import matplotlib.pyplot as plt
import numpy as np
import os
from math import ceil
```

In [2]:

```
# constant global variables

IMG_PATH = "img/"
IMG_NAME = "teks.png"
DEST_PATH = "preprocessed_img/" + IMG_NAME.split('.')[0] + "/"
OCR_PATH = "result/" + IMG_NAME.split('.')[0] + "/"
```

In [3]:

```
# OS Handler

def get_list(path, list_type='img'):
    my_list = []
    if list_type == 'img':
        valid_list = ['.jpg', '.png', '.jpeg']
    elif list_type == 'txt':
        valid_list = ['.txt']
    # get all image name
    for f in os.listdir(path):
        ext = os.path.splitext(f)[1]
        if not (ext.lower() in valid_list):
            continue
        my_list.append(f)
    return my_list

def check_dir(path):
    # make directory
    if not os.path.exists(path):
        os.makedirs(path)
```

1. Preprocessing

In [4]:

```
# Preprocessing
# get grayscale image
def get_grayscale(image):
    return cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)

# # noise removal - using median filter
# def remove_noise(image, kernel=5):
#     return cv2.medianBlur(image, kernel)

# # skew correction
# def deskew(image):
#     coords = np.column_stack(np.where(image > 0))
#     angle = cv2.minAreaRect(coords)[-1]
#     if angle < -45:
#         angle = -(90 + angle)
#     else:
#         angle = -angle
#     (h, w) = image.shape[:2]
#     center = (w // 2, h // 2)
#     M = cv2.getRotationMatrix2D(center, angle, 1.0)
#     rotated = cv2.warpAffine(image, M, (w, h), flags=cv2.INTER_CUBIC,
borderMode=cv2.BORDER_REPLICATE)
#     return rotated

# # template matching
# def match_template(image, template):
#     return cv2.matchTemplate(image, template, cv2.TM_CCOEFF_NORMED)
```

1.1 Morphology Filters

In [5]:

```
# 1. Dilation
def dilate(image, kernel=np.ones((5,5),np.uint8)):
    return cv2.dilate(image, kernel, iterations = 1)

# 2. Erosion
def erode(image, kernel=np.ones((5,5),np.uint8)):
    return cv2.erode(image, kernel, iterations = 1)

# 3. Opening - erosion followed by dilation
def opening(image, kernel=np.ones((5,5),np.uint8)):
    return cv2.morphologyEx(image, cv2.MORPH_OPEN, kernel)

# 4. Closing - dilation followed by erosion
def closing(image, kernel=np.ones((5,5),np.uint8)):
    return cv2.morphologyEx(image, cv2.MORPH_CLOSE, kernel)
```

```
# 5. Canny edge detection
def canny(image):
    return cv2.Canny(image, 100, 200)
```

1.2 Segmentation - Thresholding

In [6]:

```
# 1. Thresholding
def thresholding(image):
    return cv2.threshold(image, 0, 255, cv2.THRESH_BINARY + cv2.THRESH_OTSU)[1]

# 2. Adaptive Thresholding using mean value
def adaptive_mean_thresholding(image):
    return cv2.adaptiveThreshold(image, 255, cv2.ADAPTIVE_THRESH_MEAN_C, cv2.THRESH_BINARY, 199, 5)

# 2. Adaptive Thresholding using gaussian value
def adaptive_gaussian_thresholding(image):
    return cv2.adaptiveThreshold(image, 255, cv2.ADAPTIVE_THRESH_GAUSSIAN_C, cv2.THRESH_BINARY, 199
, 5)
```

1.3 Applying Morphology and Segmentation

In [7]:

```
def apply_filter(image):
    gray_image = get_grayscale(image)
    scenarios = {
        'thresholding': thresholding,
        'adp-mean-thresholding': adaptive_mean_thresholding,
        'adp-gaussian-thresholding': adaptive_gaussian_thresholding,
        'opening': opening,
        'closing': closing,
        'dilate': dilate,
        'erode': erode,
        'canny': canny
    }
    for key, function in scenarios.items():
        prep_image = function(gray_image)
        filename = key + '_' + IMG_NAME
        # save file
        try:
            cv2.imwrite(DEST_PATH + filename, prep_image[:,:,::-1])
        except IndexError:
            cv2.imwrite(DEST_PATH + filename, prep_image)
```

2. Processing

2.1 Optical Character Recognition (OCR)

In [8]:

```
def ocr(image, image_name):
    filename = image_name + '_output.txt'
    # Adding custom options
    custom_config = r'--oem 3 --psm 6'
    with open(OCR_PATH + filename, 'w') as f:
        f.write(pytesseract.image_to_string(image, config=custom_config))
```

2.2 Displaying Results

In [9]:

```
def generate_plot(total_img, num_img_each_row=2):
    row = ceil(total_img / num_img_each_row) * 100
    col = num_img_each_row * 10
    return row + col

def display_img(dest_path, fig_size=(17, 20)):
    imgs_name = [IMG_NAME] + get_list(dest_path)
    # generate plot
    plot = generate_plot(len(imgs_name))
    # plotting
    fig = plt.figure(figsize=fig_size)
    for i in range(plot, plot + len(imgs_name)):
        title = imgs_name[i - plot].split('_')[0]
        img_path = IMG_PATH + imgs_name[i - plot] if i == plot else dest_path + imgs_name[i - plot]
        img = cv2.imread(img_path)[:,:,::-1]
        plt.subplot(i + 1), plt.imshow(img)
        plt.title(title)
        plt.xticks([]), plt.yticks([])
    plt.show()

def display_ocr_result():
    files = get_list(OCR_PATH, 'txt')
    for filename in files:
        f = open(OCR_PATH + filename, 'r')
        file_contents = f.read()
        print ('=========================')
        print (filename)
        print ('=========================')
        print (file_contents)
        print ('=========================')
        f.close()



# compare file
# files = get_list(OCR_PATH, 'txt')
# ori_file = 'original_' + IMG_NAME.split('.')[0] + '_output.txt'
# files.remove(ori_file)
# for file_name in files:
#     with open(OCR_PATH + ori_file, 'r') as file1:
#         with open(OCR_PATH + file_name, 'r') as file2:
#             same = set(file1).intersection(file2)
#     same.discard('\n')
#     with open(OCR_COMPARE_PATH + 'ori_' + file_name.split('_')[0] + '.txt', 'w') as file_out:
#         total_char = 0
#         for line in same:
#             file_out.write(line)
#             total_char += len(line)
#         print('ori_{}.txt ===> {}'.format(file_name.split('_')[0], total_char))
```

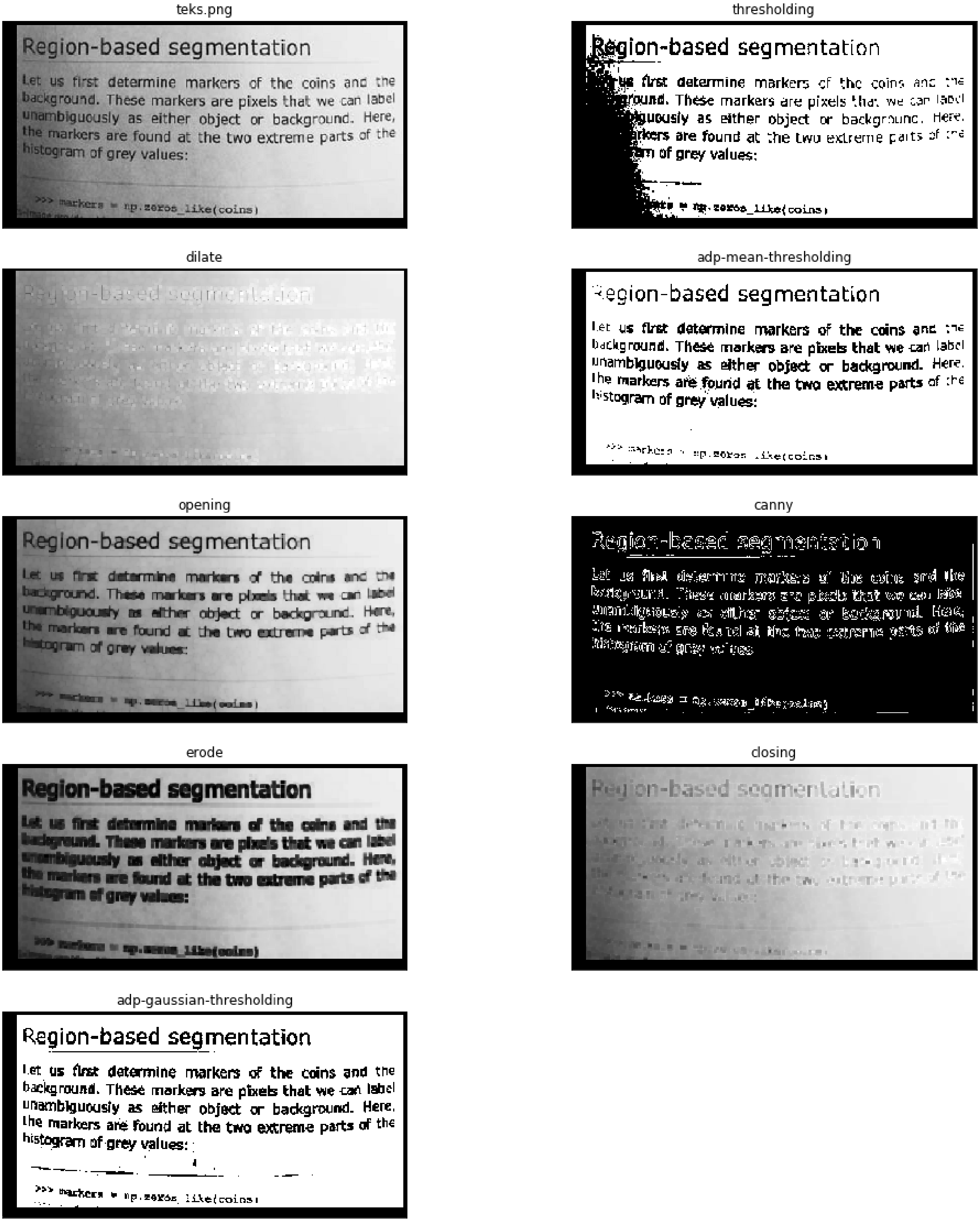
2.3 Main Program

In [10]:

```
# check and create all dirs
check_dir(DEST_PATH)
check_dir(OCR_PATH)

# preprocessing
image = cv2.imread(IMG_PATH + IMG_NAME)[:,:,::-1]
apply_filter(image)

# OCR original img
image = cv2.imread(IMG_PATH + IMG_NAME)[:,:,::-1]
ocr(image, 'original_' + IMG_NAME.split('.')[0])

# OCR preprocessed img
imgs = get_list(DEST_PATH)
for img_name in imgs:
    image = cv2.imread(DEST_PATH + img_name)[:,:,::-1]
    ocr(image, img_name.split('.')[0])
```

In [11]:

```
# display preprocessed image
display_img(DEST_PATH)
```



In [12]:

```
# display text
display_ocr_result()
```

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adp-mean_thres_teks_output.txt
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Region-based segmentation
Let us first determine markers of the coins and the
background. These markers are pixels that we can labe!
Unambiguously as either object or background. Here.
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