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In [10]: #!/usr/bin/env python
# coding: utf-8
# NTU CSIE, Computer Vision HW2, R08922024, Alfons Hwu

import cv2
import math, sys
import matplotlib.pyplot as plt

'''notes
savefig should be done before show
see: https://blog.csdn.net/u010099080/article/details/52912439
'''

##### IO and the first 2 problems #####
##### hist #####
def img_hist(img_in):
    hist = [0 for i in range(256)]

    row, col = img_in.shape
    for i in range(0, row):
        for j in range(0, col):
            hist[img_in[i, j]] += 1

    print('image histogram')
    plt.bar(range(0, 256), hist)
    plt.savefig('histogram.png')
    plt.show()
    return 0

##### binarize #####
def img_binarize(img_in):
    return (img_in > 0x7f) * 0xff

##### driver functions the first 2 problems ####
img = cv2.imread('lena.bmp', cv2.IMREAD_GRAYSCALE)
print('original image')
plt.imshow(img, cmap = 'gray')
plt.show()

img_binarized = img_binarize(img)
print('binarized image')
plt.imshow(img_binarized, cmap = 'gray')
plt.savefig('lena_binarized.png', cmap = 'gray')
plt.show()

img_hist(img)

##### the 3rd problem #####
parent_label = []
cc_img = (img_binarized == 0xff) * 1
rgb_img = cv2.imread('lena.bmp', cv2.IMREAD_COLOR)

##### disjoint set union and find algorithm ###
def union_find(label):
    original_label = label
    cnt = 0
    row, col = cc_img.shape

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while label != parent_label[label] and cnt < row * col:
    label = parent_label[parent_label[label]]
    cnt += 1

parent_label[original_label] = label # path compression to avoid TLE
return label

##### draw the result rectangle #####
def draw_rect(u, d, l, r, color):
    cv2.rectangle(rgb_img, (l, u), (r, d), color, 2)

##### draw the result centroid #####
SHIFT = 10
def draw_cent(cen_i, cen_j, color):
    cv2.line(rgb_img, (cen_j - SHIFT, cen_i), (cen_j + SHIFT, cen_i), color, 2)
)
    cv2.line(rgb_img, (cen_j, cen_i - SHIFT), (cen_j, cen_i + SHIFT), color, 2)
)

##### CC main function #####
LABEL_THRESHOLD = 500
def connected_components():
    # set parent label
    row, col = cc_img.shape
    for i in range(row * col):
        parent_label.append(i)

    # do connected components
    label = 2
    for i in range(row):
        for j in range(col):
            ok1 = 0
            ok2 = 0
            if cc_img[i, j] == 1:
                if j - 1 >= 0 and cc_img[i, j - 1] > 1: # left has already labeled
                    cc_img[i, j] = union_find(cc_img[i, j - 1])
                    ok1 = 1

                if i - 1 >= 0 and cc_img[i - 1, j] > 1: # up has already labeled
                    if ok1: # set the connected component to make left = up as the same group
                        parent_label[cc_img[i, j]] = union_find(cc_img[i - 1, j])
                    else:
                        cc_img[i, j] = cc_img[i - 1, j]

                ok2 = 1

            if ok2 == 0 and ok1 == 0:
                cc_img[i, j] = label
                label += 1

    # union and find merging
    for i in range(row):
        for j in range(col):

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        if cc_img[i, j] > 1:
            cc_img[i, j] = union_find(cc_img[i, j])

mymap = [0 for i in range (row * col)]

# statistical data for label threshold > 500
for i in range(0, row):
    for j in range(0, col):
        mymap[cc_img[i, j]] += 1

cc_pos = {}
cc_value = []
for i in range(0, row):
    for j in range(0, col):
        if cc_img[i, j] and cc_img[i, j] not in cc_value and mymap[cc_img[
i, j]] > LABEL_THRESHOLD:
            cc_value.append(cc_img[i, j])

print('cc area: ', cc_value)
for i in cc_value:
    cc_pos[i] = []

# rainbow colors for different image segmentations
rainbow = [(255, 0, 0), (255, 127, 0), (148, 0, 211), (0, 255, 0), (0, 0,
255), (255, 255, 0)]
rainbow_idx = 0

# change the rgb image to black and white
for i in range(0, row):
    for j in range(0, col):
        if cc_img[i, j] and mymap[cc_img[i, j]] > LABEL_THRESHOLD:
            cc_pos[cc_img[i, j]].append((i, j))
            if cc_img[i, j]:
                rgb_img[i, j] = (255, 255, 255)
            else:
                rgb_img[i, j] = (0, 0, 0)

# draw the rectangles and centroid
print('bounding box coordinate')
print('%6s %6s %6s %6s %6s %6s' %('up', 'down', 'left', 'right', 'cent_i',
'cent_j'))
for each_cc_value in cc_value:
    u = min(cc_pos[each_cc_value], key = lambda i : i [0])[0]
    d = max(cc_pos[each_cc_value], key = lambda i : i [0])[0]
    l = min(cc_pos[each_cc_value], key = lambda i : i [1])[1]
    r = max(cc_pos[each_cc_value], key = lambda i : i [1])[1]

    cen_i = (u + d) // 2
    cen_j = (l + r) // 2

    print('%6d %6d %6d %6d %6d %6d' %(u, d, l, r, cen_i, cen_j))

    for (i, j) in cc_pos[each_cc_value]:
        rgb_img[i, j] = rainbow[rainbow_idx % 6]

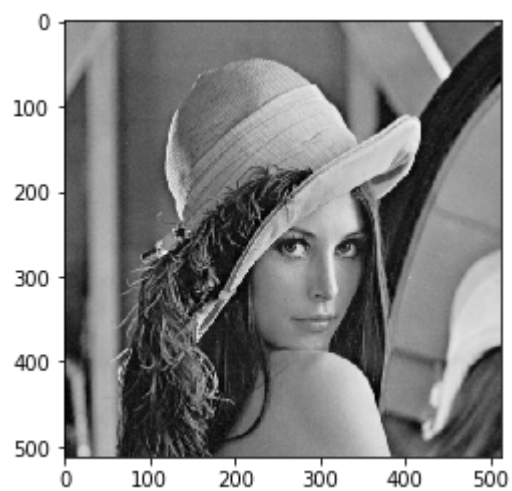
    draw_rect(u, d, l, r, rainbow[rainbow_idx % 6])
    draw_cent(cen_i, cen_j, (255, 255, 255))

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rainbow_idx += 1

##### driver functions the 3rd problem #####
connected_components()
print('\nconnected components with color segmentations')
plt.imshow(rgb_img)
plt.savefig('lena_connected_components.png')
plt.show()
```

original image



binarized image

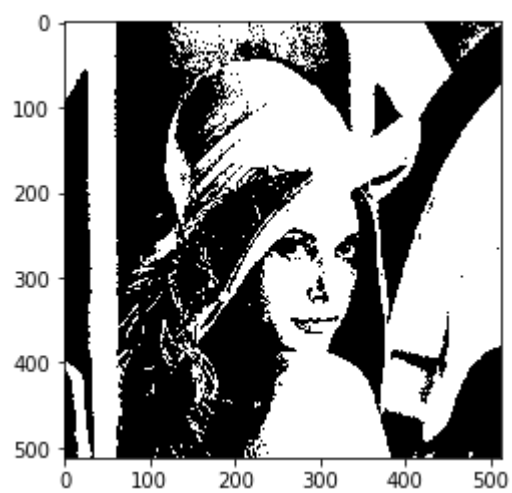
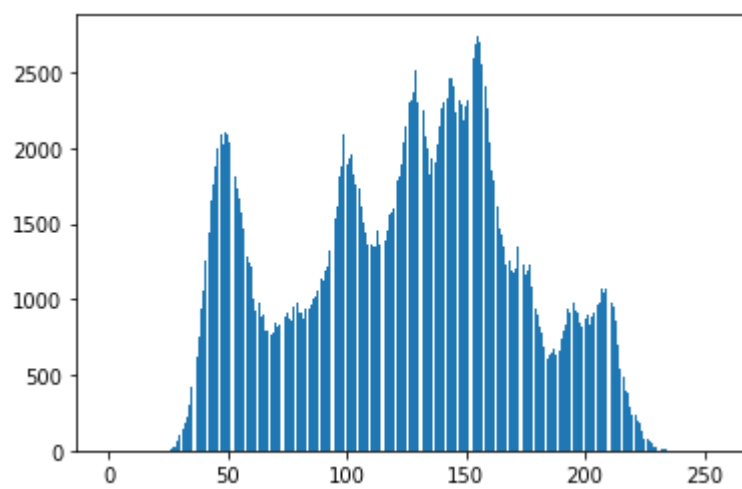
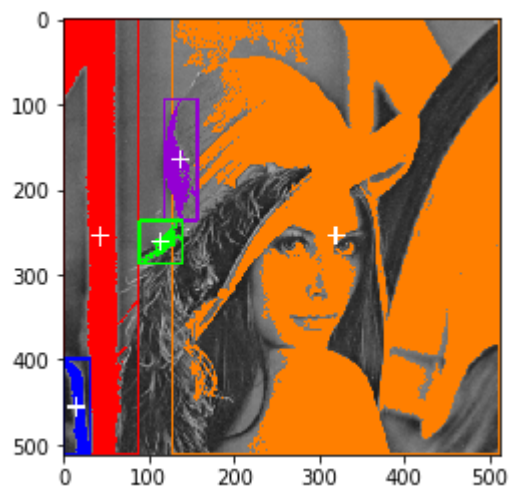


image histogram



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cc area: [2688, 2683, 1420, 1678, 2351]
bounding box coordinate
  up    down    left    right  cent_i  cent_j
    0    511      0     87    255     43
    0    511    127    511    255    319
   94   237    118    157    165    137
  237   287     89    139    262    114
  399   511      0     31    455     15
```

connected components with color segmentations



In []: