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Course: CS GY 6643 (Computer Vision)

Project 1

Instructions for executing the code:

1) Make a new folder ‘img’ in the same directory as the file ‘otsu.py’ exists.
2) Add the input images to the img folder.
3) Open the terminal and navigate to the directory that contains the source code.
4) Enter the command ‘python3 otsu.py’.
5) The output images will be generated and added to the img folder.

Source code:

```
# importing all the required libraries
import math
import numpy as np
from matplotlib import pyplot as plt
from matplotlib import image as mpimg
from PIL import Image

# declaring a dictionary that will store all the threshold values along with the calculated
variances.
threshold_values = {}
h = [1]


# function to convert rgb to gray values
def rgb2gray(rgb):
    return np.dot(rgb[...,:3], [0.2989, 0.5870, 0.1140])


# computing the histogram using the intensity values of the pixels
def Histo(img):
   row, col = img.shape
   y = np.zeros(256)
   for i in range(0,row):
      for j in range(0,col):
         y[int(round(img[i,j]))] += 1
   x = np.arange(0,256)
   plt.bar(x, y, color='b', width=5, align='center', alpha=0.25)
```

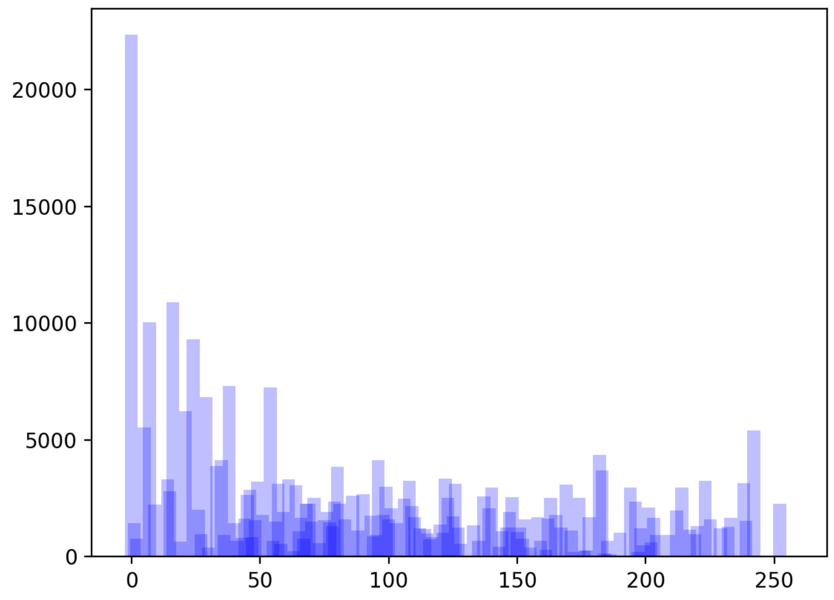
```
  plt.show()
  return y


# Function for assigning the intensity values to pixels by comparing with the thresholds and thereby computing the output image
def get_output_img(img, threshold):
   row, col = img.shape
   y = np.zeros((row, col))
   for i in range(0,row):
      for j in range(0,col):
         if img[i,j] >= threshold[2]:
            y[i,j] = 200
         elif img[i,j] >= threshold[1]:
            y[i,j] = 150
         elif img[i,j] >= threshold[0]:
            y[i,j] = 100
         else:
            y[i,j] = 0
   return y



# function for counting the number of pixels of foreground
def countPixel(h):
   count = 0
   for i in range(0, len(h)):
      if h[i]>0:
         count += h[i]
   return count


# function for calculating the weight, i.e, number of pixels belonging to foreground
def weight(s, e):
   w = 0
   for i in range(s, e):
      w += h[i]
   return w


# function for calculating mean of the intensities of the pixels
def mean(s, e):
   m = 0
   w = weight(s, e)
```

```
    for i in range(s, e):
        m += h[i] * i

    return m/float(w)


# function for calculating the variance of intensities of the pixels
def variance(s, e):
    v = 0
    m = mean(s, e)
    w = weight(s, e)
    for i in range(s, e):
        v += ((i - m) **2) * h[i]
    v /= w
    return v




# function for generating the three thresholds using 3 for loops which calculate and stores
variance for each combination of threshold values
def generate_thresholds(h, filename):
    count = countPixel(h)
    for i in range(1, len(h)):
        for j in range(i+1, len(h)):
            for k in range(j+1, len(h)):

                # variance and weight for pixels with intensities less than 'i'
                v1 = variance(0, i)
                w1 = weight(0, i) / float(count)


                 # variance and weight for pixels with intensities between 'i' and 'j'
                v2 = variance(i, j)
                w2 = weight(i, j) / float(count)


                 # variance and weight for pixels with intensities between 'j' and 'k'
                v3 = variance(j, k)
                w3 = weight(j, k) / float(count)


                 # variance and weight for pixels with intensities more than 'k'
                v4 = variance(k, len(h))
                w4 = weight(k, len(h)) / float(count)


                # calculating the within class variance
                V2w = w1 * (v1) + w2 * (v2) + w3 * (v3) + w4 * (v4)


                # writing the threshold values and the calculated within class variances
                fw = open(filename + ".txt", "a")
                fw.write('T1='+ str(i) + "\n")
                fw.write('T2='+ str(j) + "\n")
                fw.write('T3='+ str(k) + "\n")



                fw.write('within class variance='+ str(V2w) + "\n")
                fw.write("\n")

                # storing the threshold values and the corresponding in class variance in the dictionary
                if not math.isnan(V2w):
                  threshold_values[(i,j,k)] = V2w





# function that calculates optimal thresholds from the dictionary that contains all the
thresholds and their corresponding variances
def get_optimal_thresholds():
    min_V2w = min(threshold_values.values())
    optimal_threshold = [k for k, v in threshold_values.items() if v == min_V2w]
    print('optimal threshold', optimal_threshold[0])
    return list(optimal_threshold[0])




# work for the tiger1 image
image = mpimg.imread('img/tiger1.bmp') # reading the image
gray = rgb2gray(image) # conerting to gray level values
img = np.asarray(gray)
h = Histo(img) # plotting the histogram
generate_thresholds(h, 'tiger1') # generating thresholds
optimal_thresholds = get_optimal_thresholds() # getting optimal thresholds
```

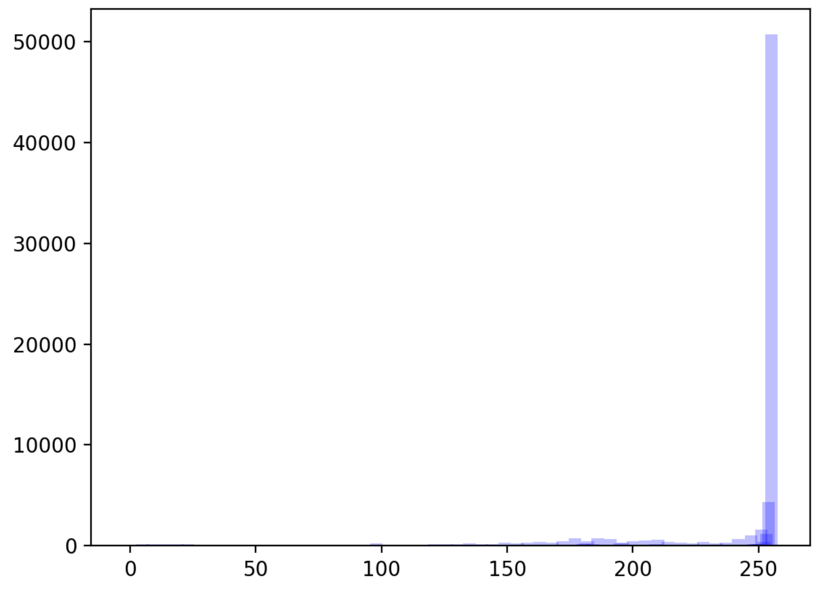
```
res = get_output_img(img, optimal_thresholds) # getting output image
plt.imshow(res) # displaying the output image
plt.savefig("img/tiger1_out.jpg") # saving the output image




# work for the data13 image
image = mpimg.imread('img/data13.bmp') # reading the image
gray = rgb2gray(image) # conerting to gray level values
img = np.asarray(gray)
h = Histo(img) # plotting the histogram
generate_thresholds(h, 'data13') # generating thresholds
optimal_thresholds = get_optimal_thresholds() # getting optimal thresholds
res = get_output_img(img, optimal_thresholds) # getting output image
plt.imshow(res) # displaying the output image
plt.savefig("img/data13_out.jpg") # saving the output image




# work for the fruits2b image
image = mpimg.imread('img/fruits2b.bmp') # reading the image
gray = rgb2gray(image) # conerting to gray level values
img = np.asarray(gray)
h = Histo(img) # plotting the histogram
generate_thresholds(h, 'fruits2b') # generating thresholds
optimal_thresholds = get_optimal_thresholds() # getting optimal thresholds
res = get_output_img(img, optimal_thresholds) # getting output image
plt.imshow(res) # displaying the output image
plt.savefig("img/fruits2b_out.jpg") # saving the output image
```

Generated Histograms:

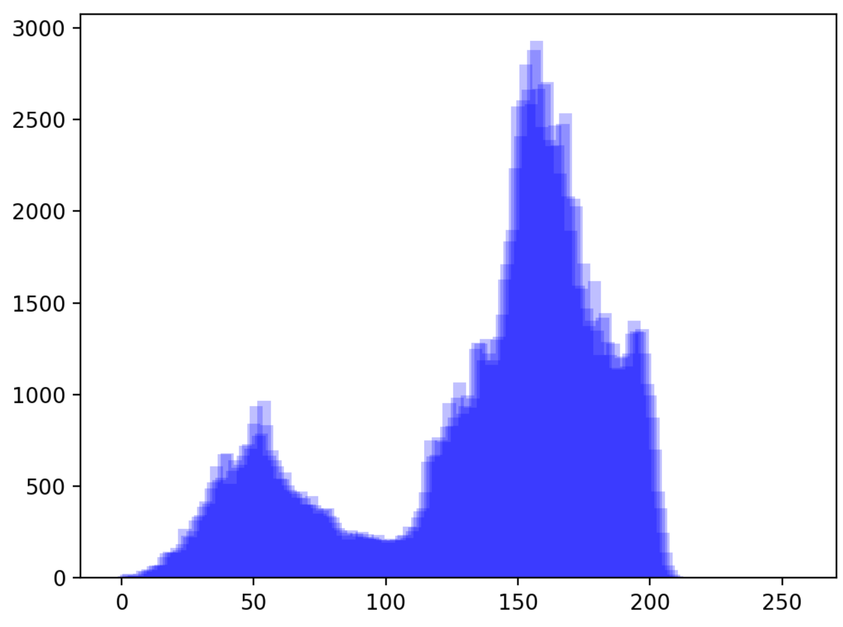
Tiger1:



Data13:



Fruits2b:



Calculated thresholds:

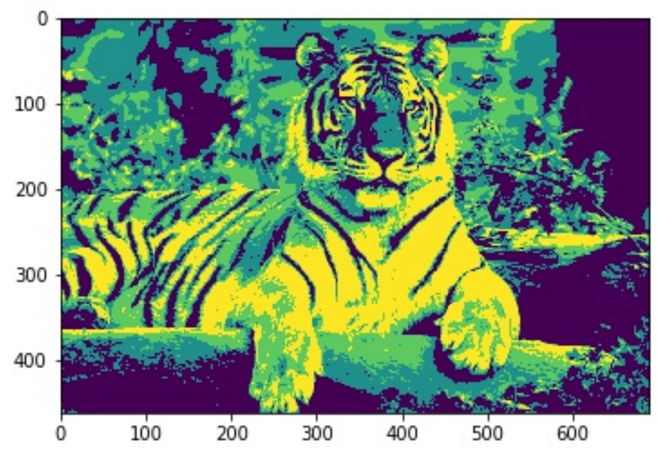
Tiger1: `optimal threshold (45, 105, 175)`

`data13:   optimal threshold (77, 155, 222)`

`fruits2b:   optimal threshold (88, 140, 172)`

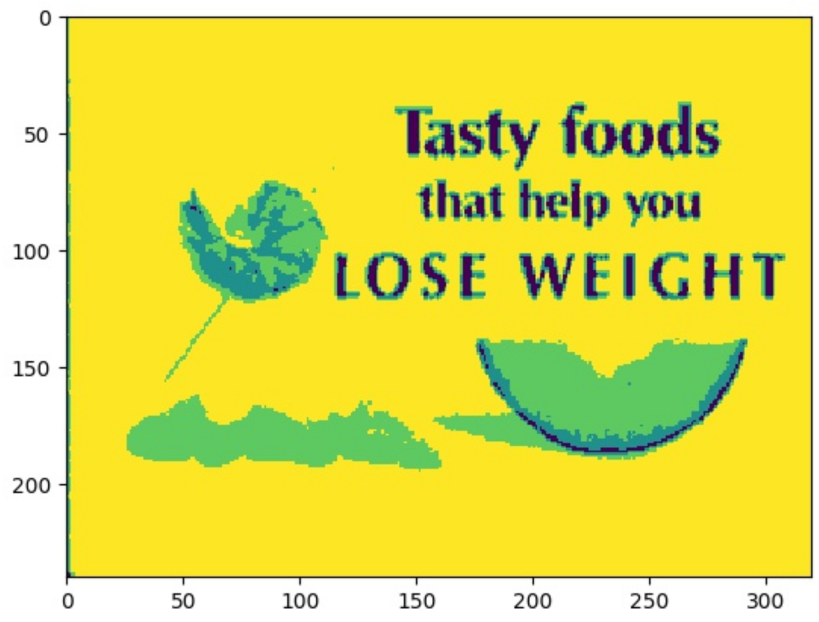
Output Images:

Tiger1:



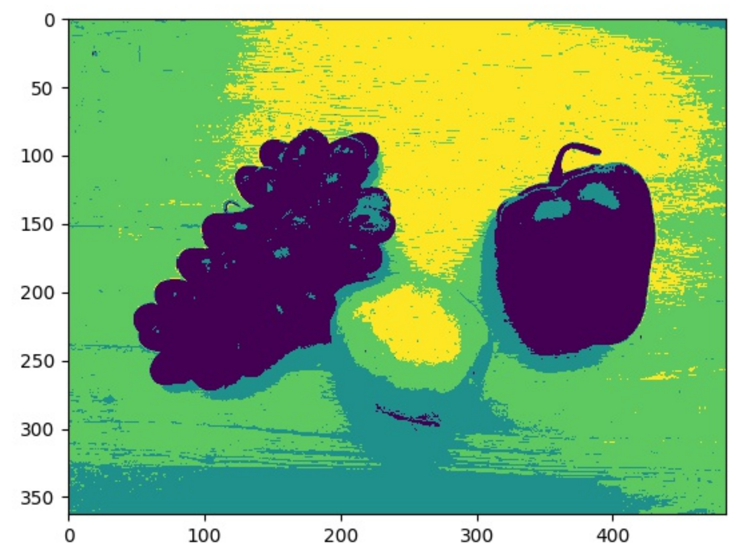
```
optimal threshold (45, 105, 175)
```

Data13:



```
optimal threshold (77, 155, 222)
```

Fruits2b:



```
optimal threshold (88, 140, 172)
```

Additional Information:

The tiger1.txt, fruits2b.txt and data13.txt files contain the list of all the threshold values along with the corresponding within class variances.

The otsu.txt and otsu.py files contain the source code.

The tiger1_out.bmp, data13_out.bmp and fruits2b_out.bmp are the output image files.