IMAGE SEGMENTATION - ASSIGNMENT 01

IS_Thresholding_based_Segmentation

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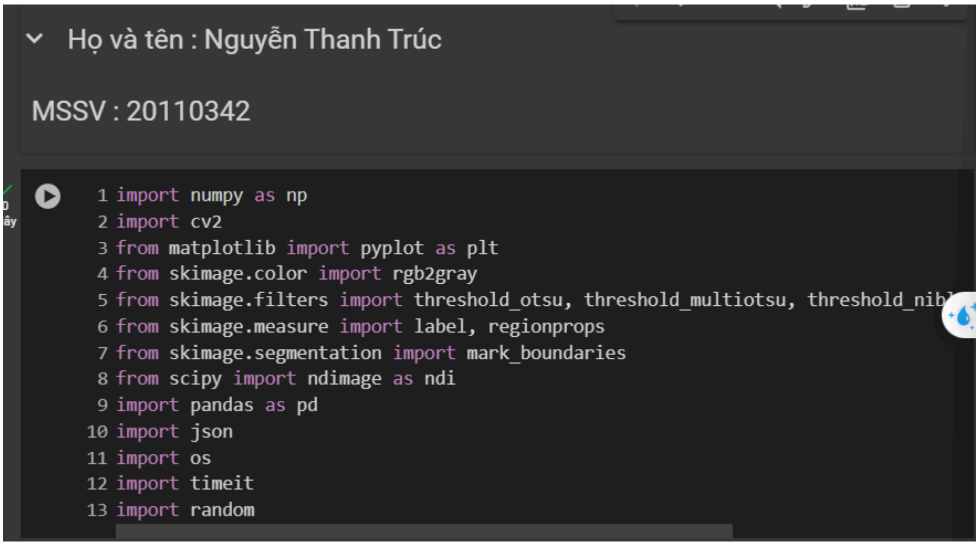
EXERCISE 1:

Requirement *: thực hiện tốt hơn việc segmentation bàn tay với các phần xương, da, và background bằng các thuật toán global, local thresholding như trong file hướng dẫn thực hành*

Code and results:



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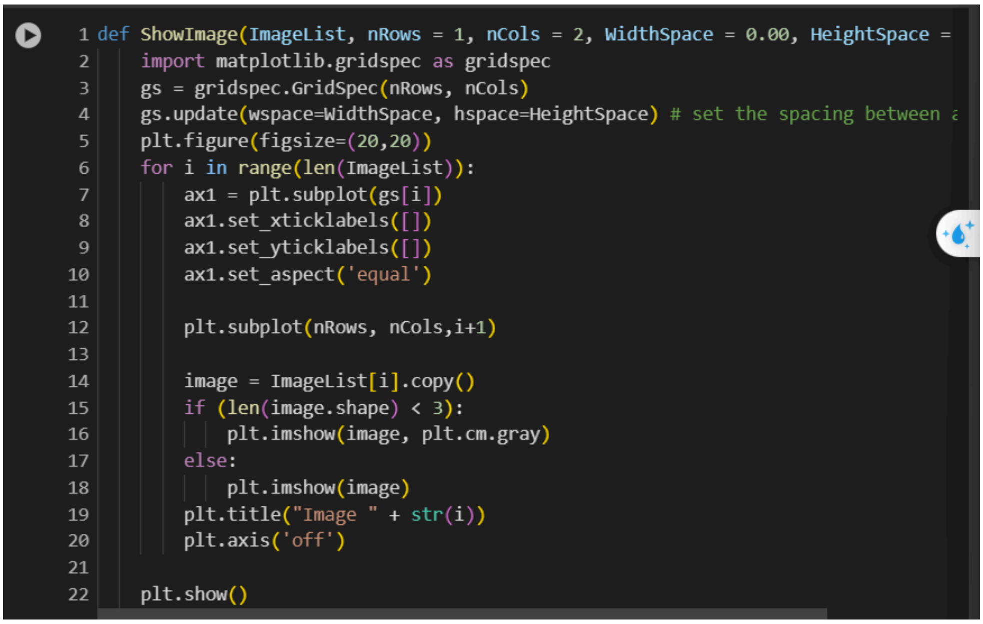
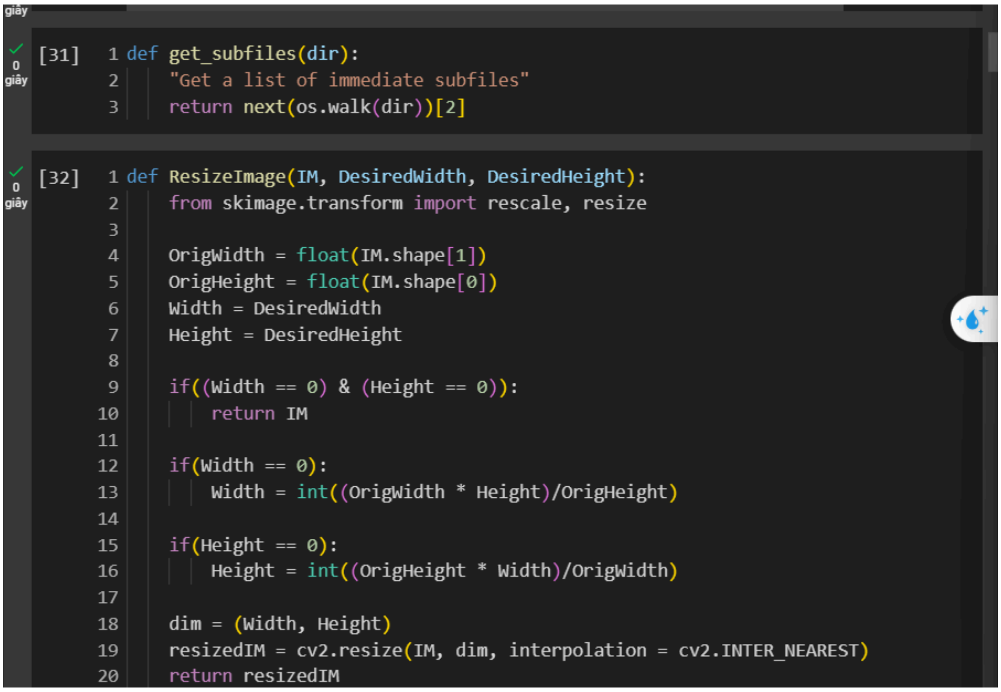
```
import numpy as np
import cv2
from matplotlib import pyplot as plt
from skimage.color import rgb2gray
from skimage.filters import threshold_otsu, threshold_multiotsu, threshold_nib
from skimage.measure import label, regionprops
from skimage.segmentation import mark_boundaries
from scipy import ndimage as ndi
import pandas as pd
import json
import os
import timeit
import random
```

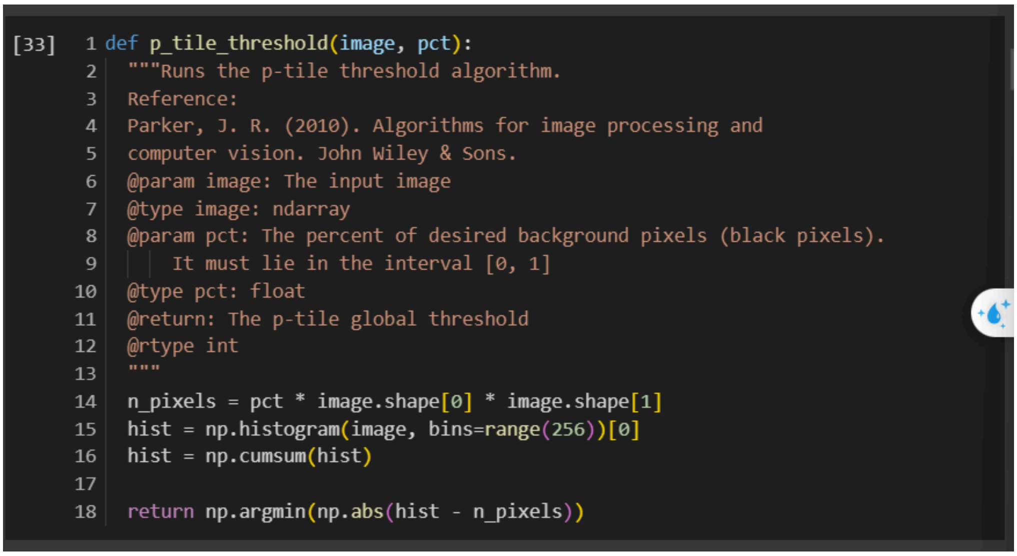


```
def ShowImage(ImageList, nRows = 1, nCols = 2, WidthSpace = 0.00, HeightSpace =
    import matplotlib.gridspec as gridspec
    gs = gridspec.GridSpec(nRows, nCols)
    gs.update(wspace=WidthSpace, hspace=HeightSpace) # set the spacing between a
    plt.figure(figsize=(20,20))
    for i in range(len(ImageList)):
        ax1 = plt.subplot(gs[i])
        ax1.set_xticklabels([])
        ax1.set_yticklabels([])
        ax1.set_aspect('equal')

        plt.subplot(nRows, nCols,i+1)

        image = ImageList[i].copy()
        if (len(image.shape) < 3):
            plt.imshow(image, plt.cm.gray)
        else:
            plt.imshow(image)
        plt.title("Image " + str(i))
        plt.axis('off')

    plt.show()
```

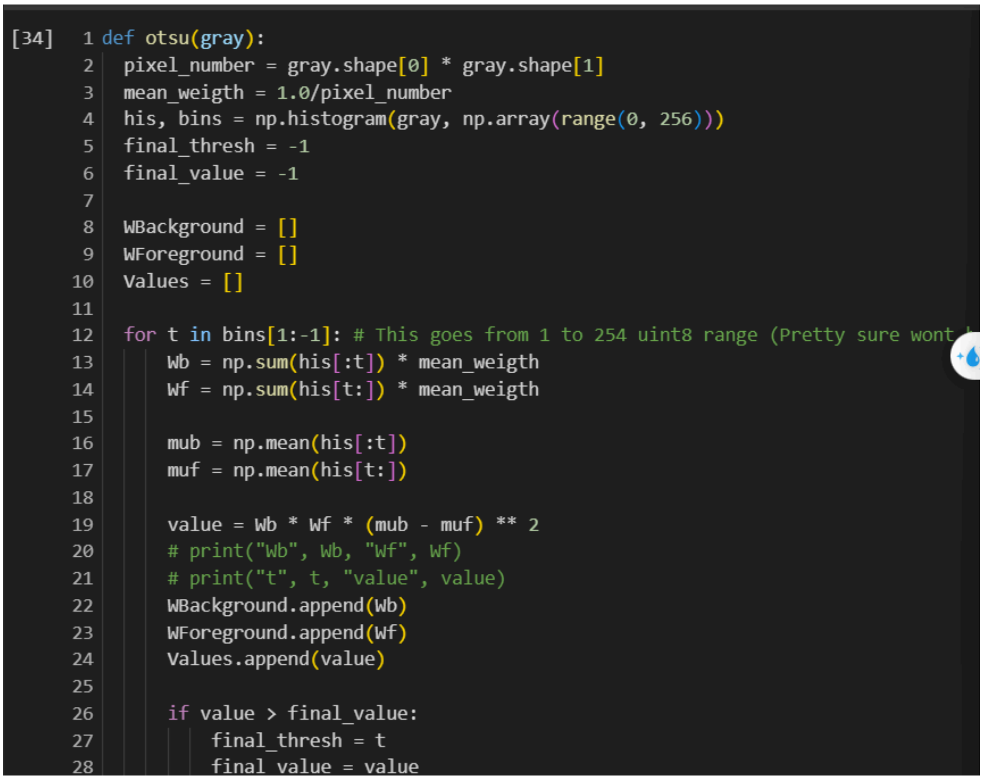


```python
def get_subfiles(dir):
    "Get a list of immediate subfiles"
    return next(os.walk(dir))[2]
```

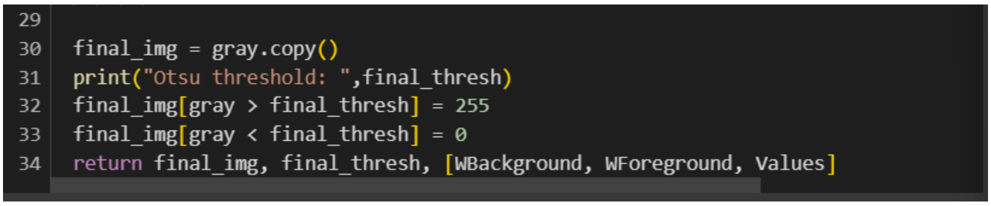
```python
def ResizeImage(IM, DesiredWidth, DesiredHeight):
    from skimage.transform import rescale, resize

    OrigWidth = float(IM.shape[1])
    OrigHeight = float(IM.shape[0])
    Width = DesiredWidth
    Height = DesiredHeight

    if((Width == 0) & (Height == 0)):
        return IM

    if(Width == 0):
        Width = int((OrigWidth * Height)/OrigHeight)

    if(Height == 0):
        Height = int((OrigHeight * Width)/OrigWidth)

    dim = (Width, Height)
    resizedIM = cv2.resize(IM, dim, interpolation = cv2.INTER_NEAREST)
    return resizedIM
```



```python
def p_tile_threshold(image, pct):
    """Runs the p-tile threshold algorithm.
    Reference:
    Parker, J. R. (2010). Algorithms for image processing and
    computer vision. John Wiley & Sons.
    @param image: The input image
    @type image: ndarray
    @param pct: The percent of desired background pixels (black pixels).
        It must lie in the interval [0, 1]
    @type pct: float
    @return: The p-tile global threshold
    @rtype int
    """
    n_pixels = pct * image.shape[0] * image.shape[1]
    hist = np.histogram(image, bins=range(256))[0]
    hist = np.cumsum(hist)

    return np.argmin(np.abs(hist - n_pixels))
```

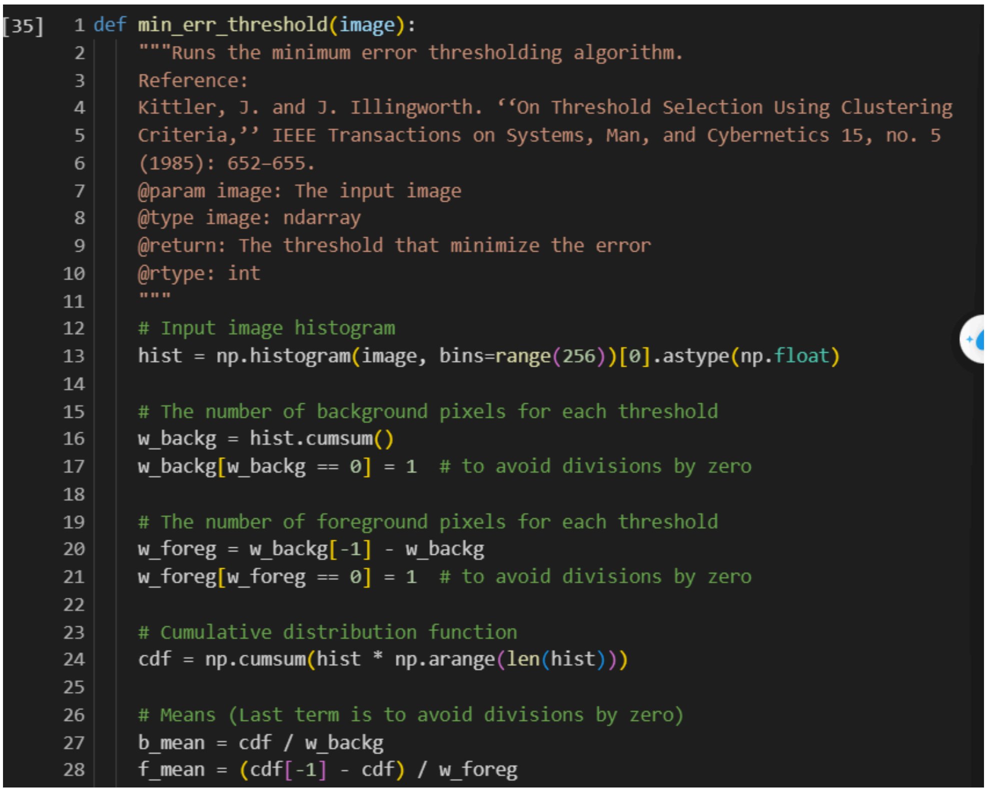


```
[34]
def otsu(gray):
    pixel_number = gray.shape[0] * gray.shape[1]
    mean_weigth = 1.0/pixel_number
    his, bins = np.histogram(gray, np.array(range(0, 256)))
    final_thresh = -1
    final_value = -1

    WBackground = []
    WForeground = []
    Values = []

    for t in bins[1:-1]: # This goes from 1 to 254 uint8 range (Pretty sure wont
        Wb = np.sum(his[:t]) * mean_weigth
        Wf = np.sum(his[t:]) * mean_weigth

        mub = np.mean(his[:t])
        muf = np.mean(his[t:])

        value = Wb * Wf * (mub - muf) ** 2
        # print("Wb", Wb, "Wf", Wf)
        # print("t", t, "value", value)
        WBackground.append(Wb)
        WForeground.append(Wf)
        Values.append(value)

        if value > final_value:
            final_thresh = t
            final_value = value
```

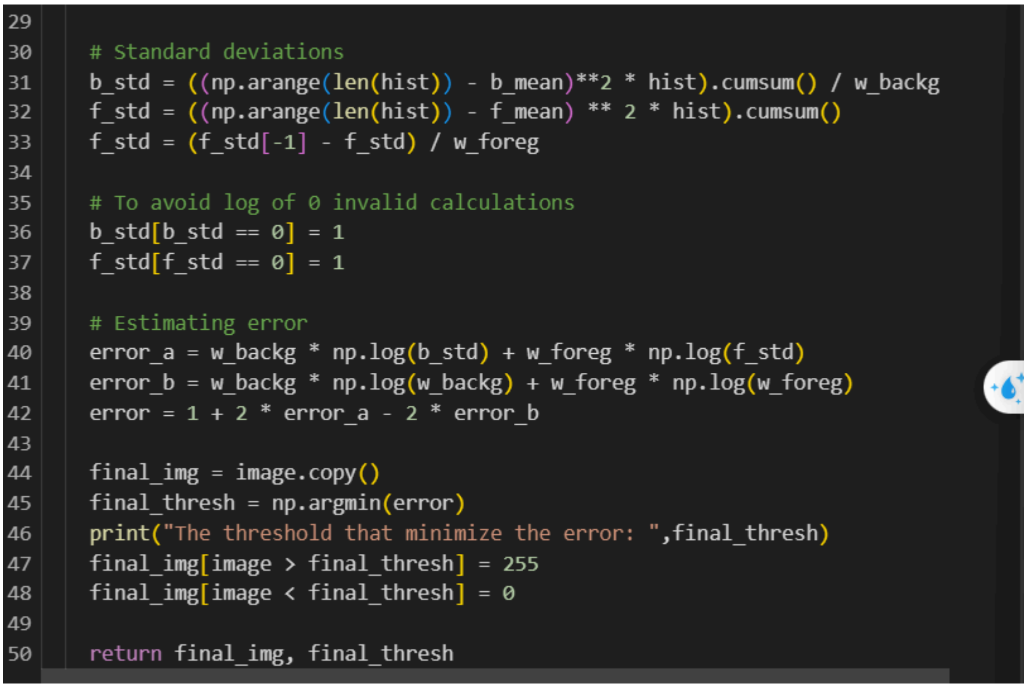


```

    final_img = gray.copy()
    print("Otsu threshold: ",final_thresh)
    final_img[gray > final_thresh] = 255
    final_img[gray < final_thresh] = 0
    return final_img, final_thresh, [WBackground, WForeground, Values]
```

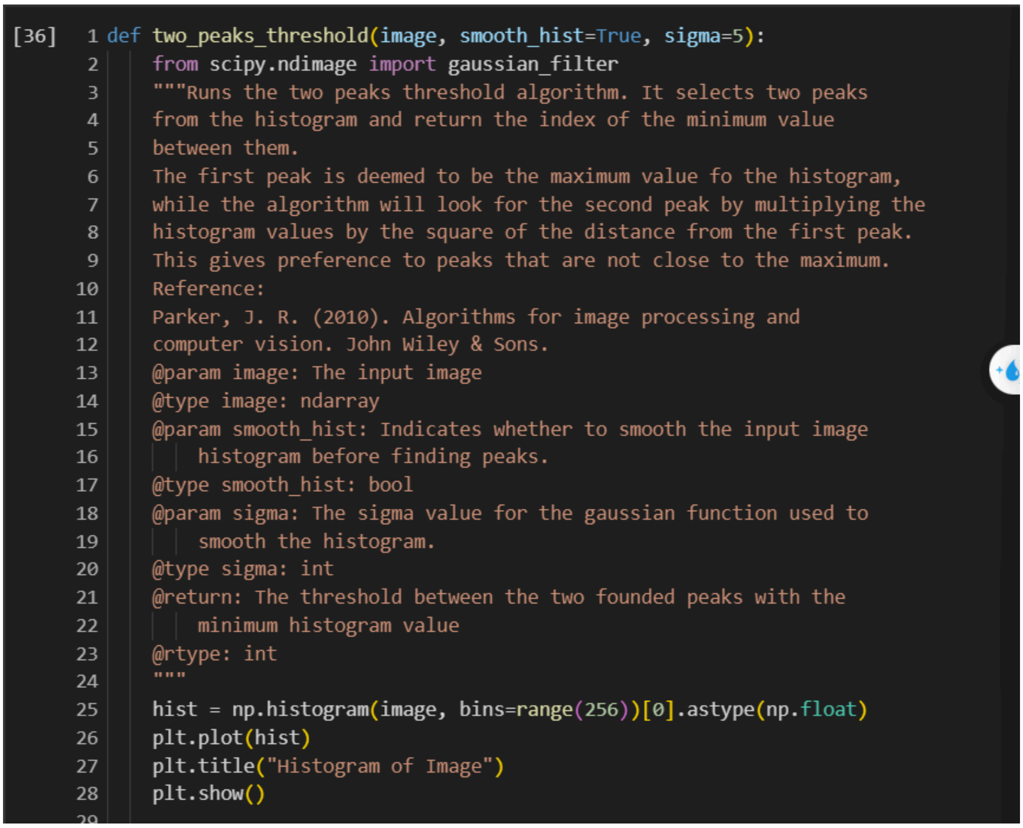
\



```
[35]
def min_err_threshold(image):
    """Runs the minimum error thresholding algorithm.
    Reference:
    Kittler, J. and J. Illingworth. ‘‘On Threshold Selection Using Clustering
    Criteria,’’ IEEE Transactions on Systems, Man, and Cybernetics 15, no. 5
    (1985): 652–655.
    @param image: The input image
    @type image: ndarray
    @return: The threshold that minimize the error
    @rtype: int
    """
    # Input image histogram
    hist = np.histogram(image, bins=range(256))[0].astype(np.float)

    # The number of background pixels for each threshold
    w_backg = hist.cumsum()
    w_backg[w_backg == 0] = 1  # to avoid divisions by zero

    # The number of foreground pixels for each threshold
    w_foreg = w_backg[-1] - w_backg
    w_foreg[w_foreg == 0] = 1  # to avoid divisions by zero

    # Cumulative distribution function
    cdf = np.cumsum(hist * np.arange(len(hist)))

    # Means (Last term is to avoid divisions by zero)
    b_mean = cdf / w_backg
    f_mean = (cdf[-1] - cdf) / w_foreg
```

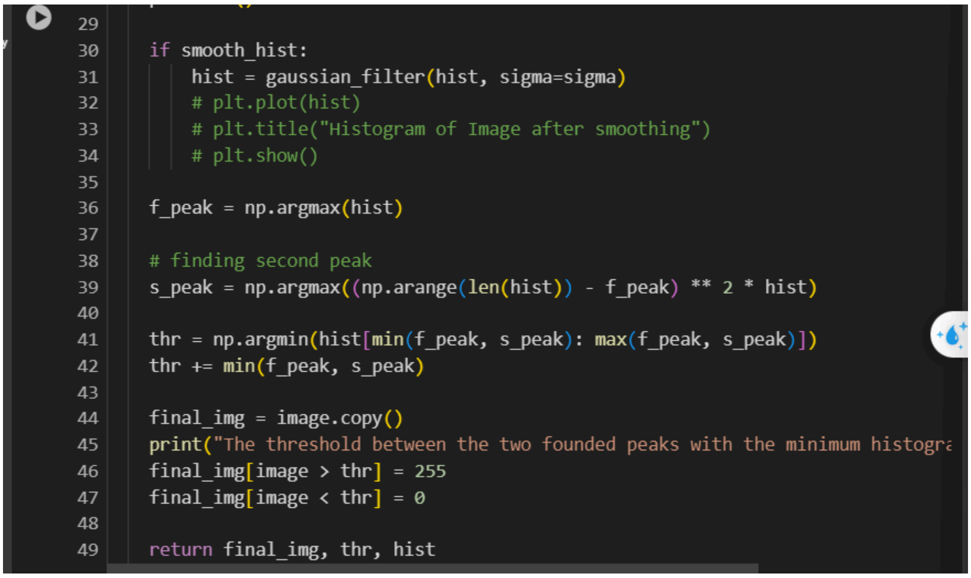


```python

    # Standard deviations
    b_std = ((np.arange(len(hist)) - b_mean)**2 * hist).cumsum() / w_backg
    f_std = ((np.arange(len(hist)) - f_mean) ** 2 * hist).cumsum()
    f_std = (f_std[-1] - f_std) / w_foreg

    # To avoid log of 0 invalid calculations
    b_std[b_std == 0] = 1
    f_std[f_std == 0] = 1

    # Estimating error
    error_a = w_backg * np.log(b_std) + w_foreg * np.log(f_std)
    error_b = w_backg * np.log(w_backg) + w_foreg * np.log(w_foreg)
    error = 1 + 2 * error_a - 2 * error_b

    final_img = image.copy()
    final_thresh = np.argmin(error)
    print("The threshold that minimize the error: ",final_thresh)
    final_img[image > final_thresh] = 255
    final_img[image < final_thresh] = 0

    return final_img, final_thresh
```

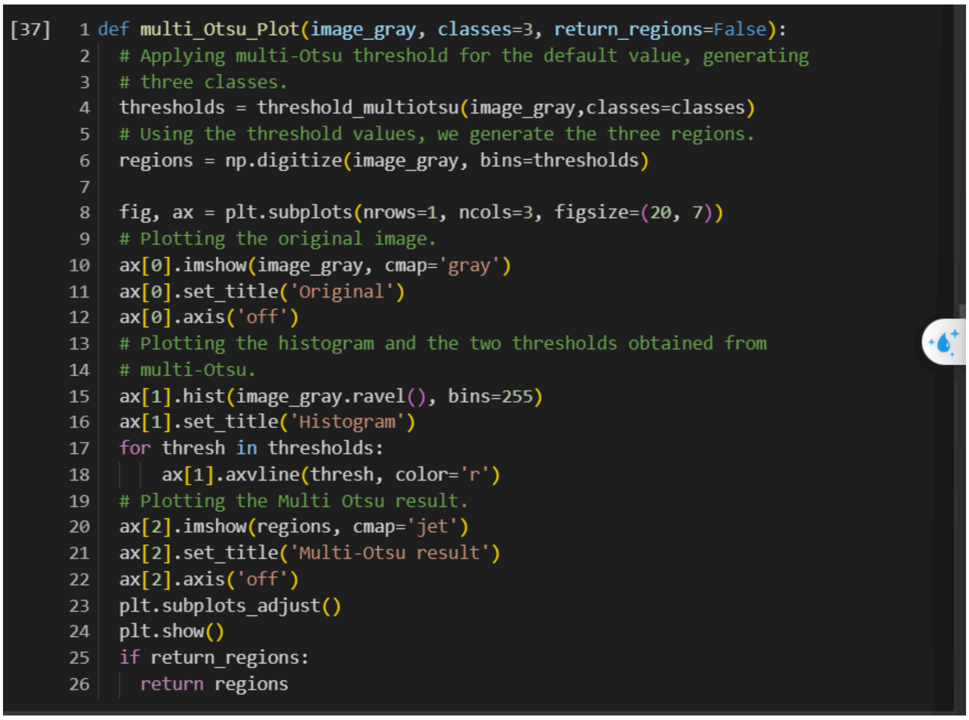


[36]

```python
def two_peaks_threshold(image, smooth_hist=True, sigma=5):
    from scipy.ndimage import gaussian_filter
    """Runs the two peaks threshold algorithm. It selects two peaks
    from the histogram and return the index of the minimum value
    between them.
    The first peak is deemed to be the maximum value fo the histogram,
    while the algorithm will look for the second peak by multiplying the
    histogram values by the square of the distance from the first peak.
    This gives preference to peaks that are not close to the maximum.
    Reference:
    Parker, J. R. (2010). Algorithms for image processing and
    computer vision. John Wiley & Sons.
    @param image: The input image
    @type image: ndarray
    @param smooth_hist: Indicates whether to smooth the input image
        histogram before finding peaks.
    @type smooth_hist: bool
    @param sigma: The sigma value for the gaussian function used to
        smooth the histogram.
    @type sigma: int
    @return: The threshold between the two founded peaks with the
        minimum histogram value
    @rtype: int
    """
    hist = np.histogram(image, bins=range(256))[0].astype(np.float)
    plt.plot(hist)
    plt.title("Histogram of Image")
    plt.show()
```

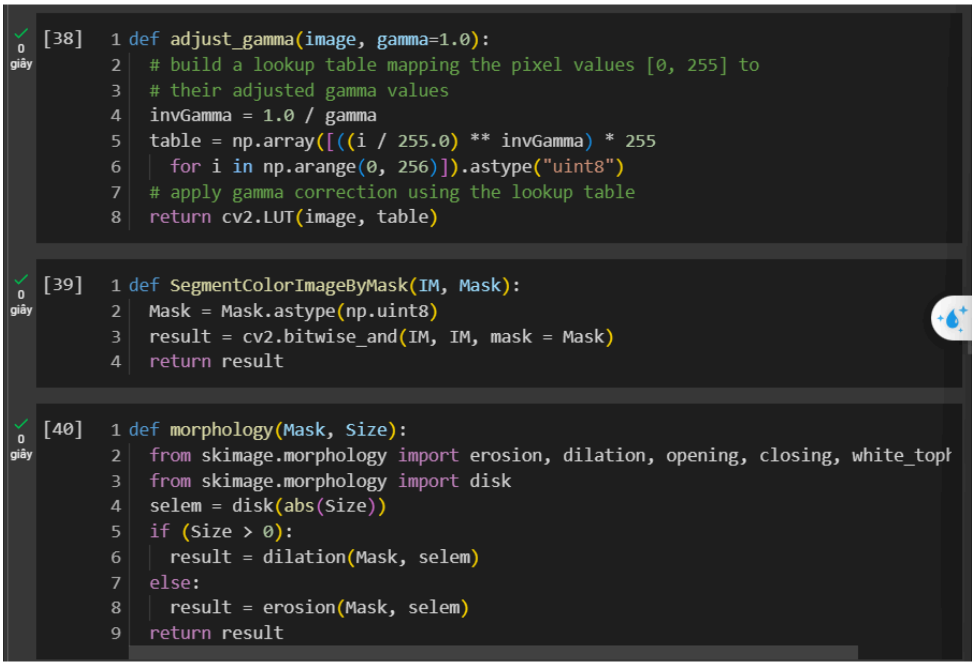


```python

    if smooth_hist:
        hist = gaussian_filter(hist, sigma=sigma)
        # plt.plot(hist)
        # plt.title("Histogram of Image after smoothing")
        # plt.show()

    f_peak = np.argmax(hist)

    # finding second peak
    s_peak = np.argmax((np.arange(len(hist)) - f_peak) ** 2 * hist)

    thr = np.argmin(hist[min(f_peak, s_peak): max(f_peak, s_peak)])
    thr += min(f_peak, s_peak)

    final_img = image.copy()
    print("The threshold between the two founded peaks with the minimum histogra
    final_img[image > thr] = 255
    final_img[image < thr] = 0

    return final_img, thr, hist
```



[37]

```python
def multi_Otsu_Plot(image_gray, classes=3, return_regions=False):
  # Applying multi-Otsu threshold for the default value, generating
  # three classes.
  thresholds = threshold_multiotsu(image_gray,classes=classes)
  # Using the threshold values, we generate the three regions.
  regions = np.digitize(image_gray, bins=thresholds)

  fig, ax = plt.subplots(nrows=1, ncols=3, figsize=(20, 7))
  # Plotting the original image.
  ax[0].imshow(image_gray, cmap='gray')
  ax[0].set_title('Original')
  ax[0].axis('off')
  # Plotting the histogram and the two thresholds obtained from
  # multi-Otsu.
  ax[1].hist(image_gray.ravel(), bins=255)
  ax[1].set_title('Histogram')
  for thresh in thresholds:
      ax[1].axvline(thresh, color='r')
  # Plotting the Multi Otsu result.
  ax[2].imshow(regions, cmap='jet')
  ax[2].set_title('Multi-Otsu result')
  ax[2].axis('off')
  plt.subplots_adjust()
  plt.show()
  if return_regions:
    return regions
```



0 giây [38]

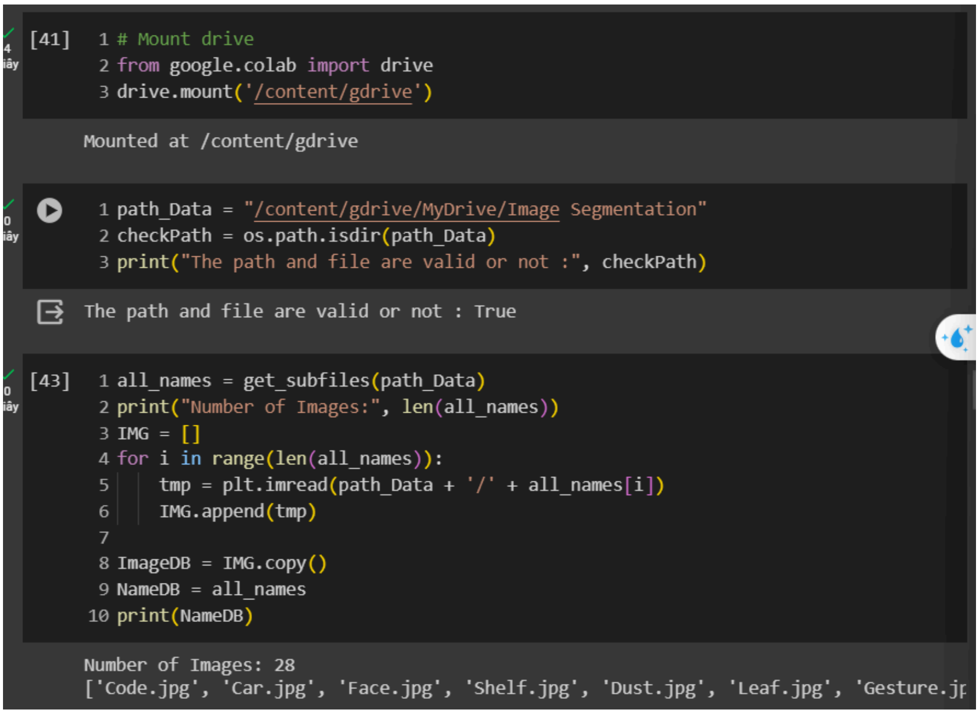
```python
def adjust_gamma(image, gamma=1.0):
  # build a lookup table mapping the pixel values [0, 255] to
  # their adjusted gamma values
  invGamma = 1.0 / gamma
  table = np.array([((i / 255.0) ** invGamma) * 255
    for i in np.arange(0, 256)]).astype("uint8")
  # apply gamma correction using the lookup table
  return cv2.LUT(image, table)
```

0 giây [39]

```python
def SegmentColorImageByMask(IM, Mask):
  Mask = Mask.astype(np.uint8)
  result = cv2.bitwise_and(IM, IM, mask = Mask)
  return result
```

0 giây [40]

```python
def morphology(Mask, Size):
  from skimage.morphology import erosion, dilation, opening, closing, white_toph
  from skimage.morphology import disk
  selem = disk(abs(Size))
  if (Size > 0):
    result = dilation(Mask, selem)
  else:
    result = erosion(Mask, selem)
  return result
```



```
# Mount drive
from google.colab import drive
drive.mount('/content/gdrive')
```

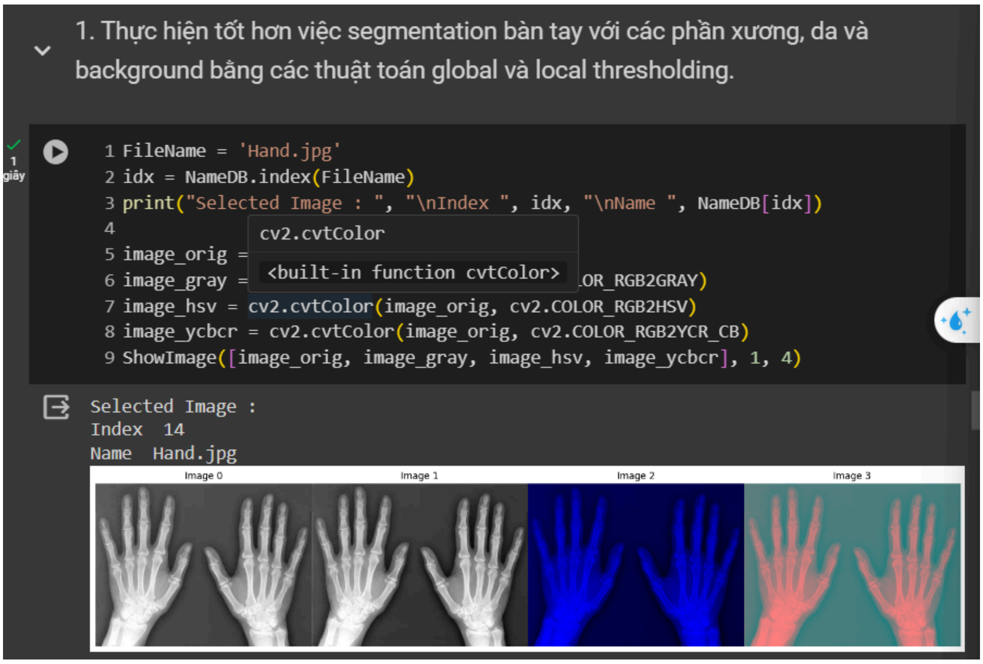
```
Mounted at /content/gdrive
```

```
path_Data = "/content/gdrive/MyDrive/Image Segmentation"
checkPath = os.path.isdir(path_Data)
print("The path and file are valid or not :", checkPath)
```

```
The path and file are valid or not : True
```

```
all_names = get_subfiles(path_Data)
print("Number of Images:", len(all_names))
IMG = []
for i in range(len(all_names)):
    tmp = plt.imread(path_Data + '/' + all_names[i])
    IMG.append(tmp)

ImageDB = IMG.copy()
NameDB = all_names
print(NameDB)
```

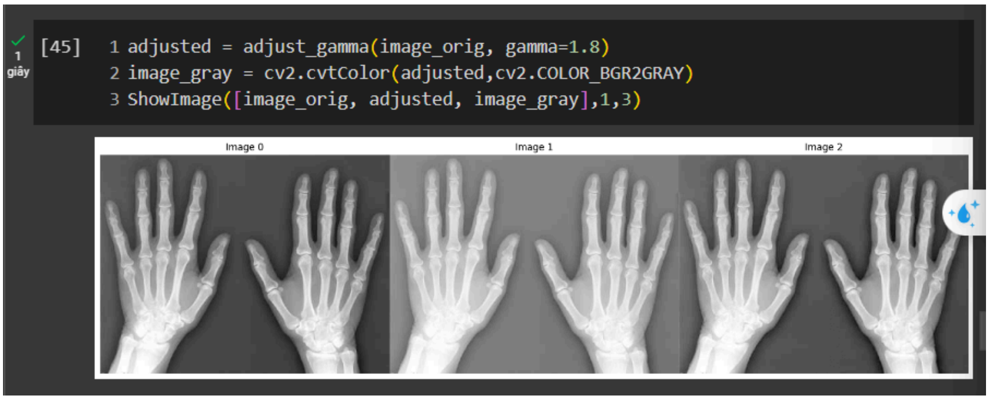
```
Number of Images: 28
['Code.jpg', 'Car.jpg', 'Face.jpg', 'Shelf.jpg', 'Dust.jpg', 'Leaf.jpg', 'Gesture.jp
```



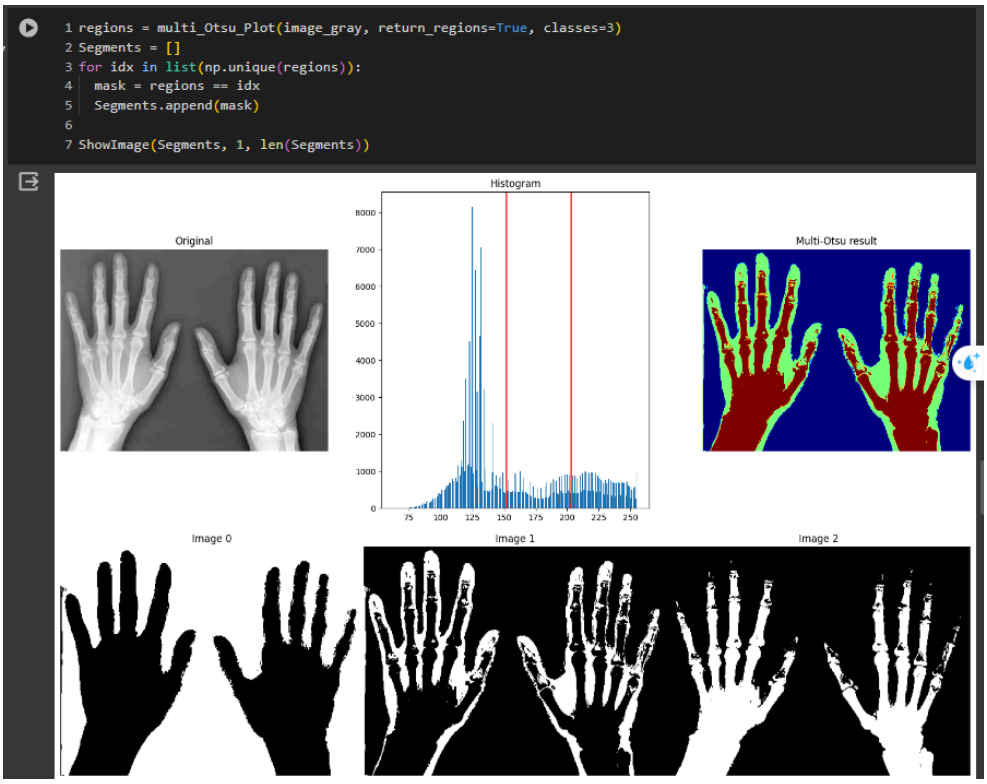
1. Thực hiện tốt hơn việc segmentation bàn tay với các phần xương, da và background bằng các thuật toán global và local thresholding.

```
FileName = 'Hand.jpg'
idx = NameDB.index(FileName)
print("Selected Image : ", "\nIndex ", idx, "\nName ", NameDB[idx])

image_orig =   cv2.cvtColor
image_gray =   <built-in function cvtColor>  OR_RGB2GRAY)
image_hsv = cv2.cvtColor(image_orig, cv2.COLOR_RGB2HSV)
image_ycbcr = cv2.cvtColor(image_orig, cv2.COLOR_RGB2YCR_CB)
ShowImage([image_orig, image_gray, image_hsv, image_ycbcr], 1, 4)
```

```
Selected Image :
Index  14
Name  Hand.jpg
```



```
adjusted = adjust_gamma(image_orig, gamma=1.8)
image_gray = cv2.cvtColor(adjusted,cv2.COLOR_BGR2GRAY)
ShowImage([image_orig, adjusted, image_gray],1,3)
```

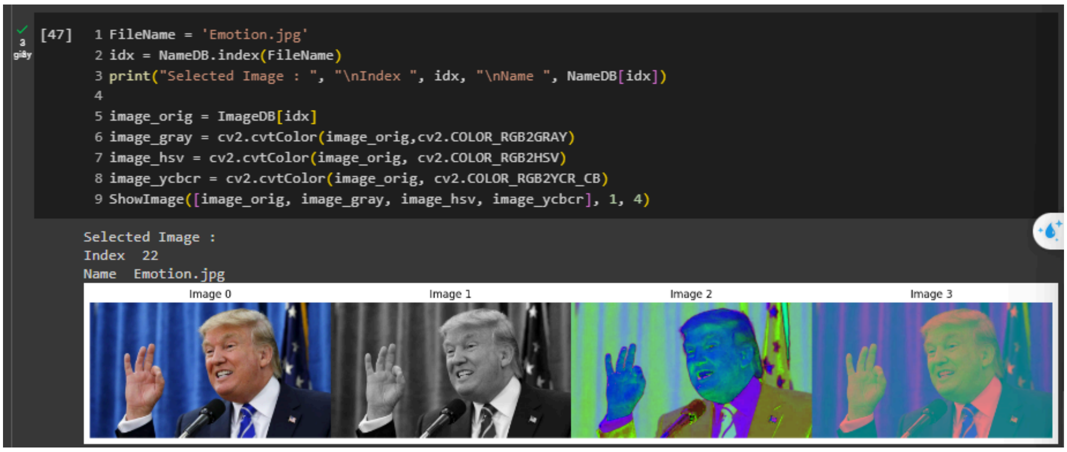


```python
regions = multi_Otsu_Plot(image_gray, return_regions=True, classes=3)
Segments = []
for idx in list(np.unique(regions)):
  mask = regions == idx
  Segments.append(mask)

ShowImage(Segments, 1, len(Segments))
```

EXERCISE 2:

Requirement *: chọn thêm 2 ví dụ trong danh sách hình và định nghĩa object cần segment trong các hình là gì và thực hiện segmentation tốt nhất bằng global và local thresholding*

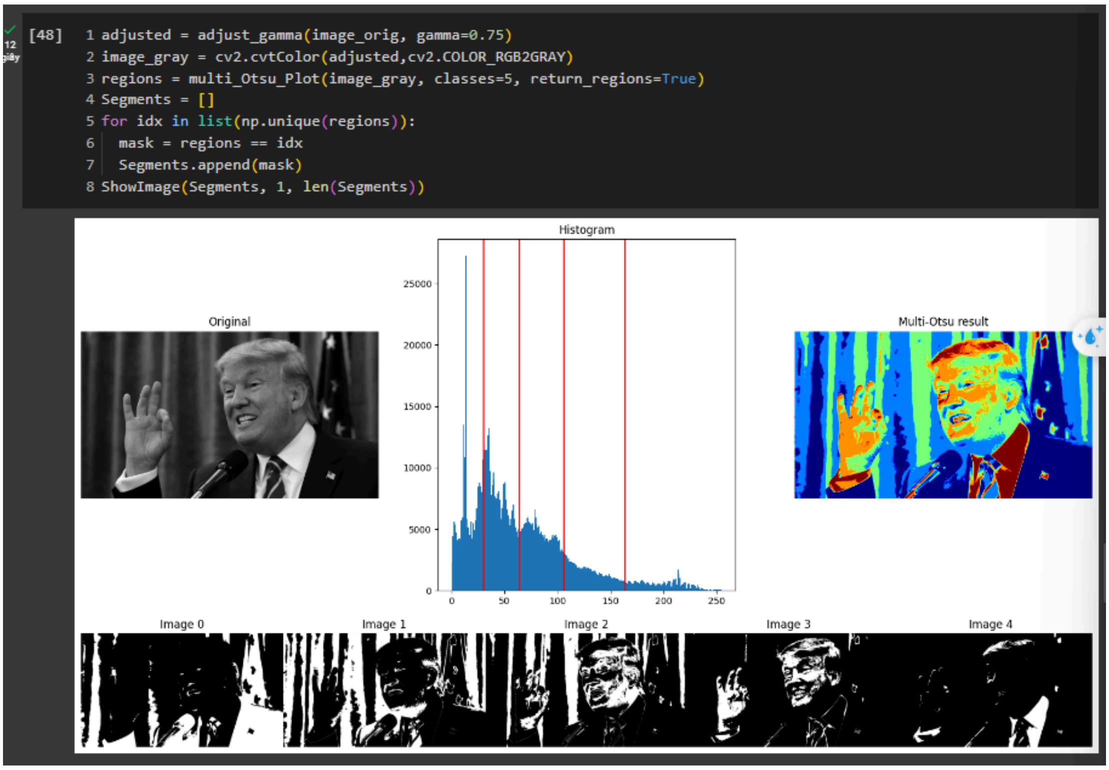
Code and results:



[47]

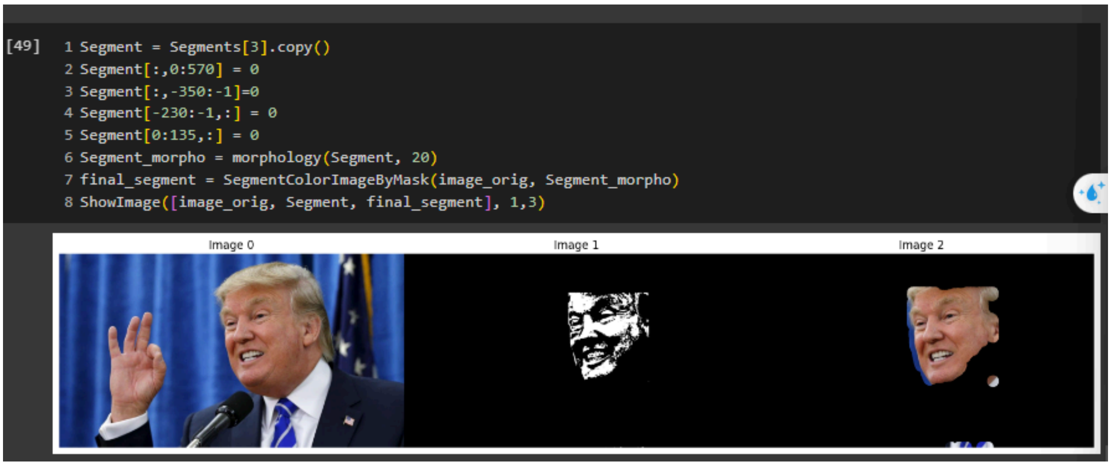
```
FileName = 'Emotion.jpg'
idx = NameDB.index(FileName)
print("Selected Image : ", "\nIndex ", idx, "\nName ", NameDB[idx])

image_orig = ImageDB[idx]
image_gray = cv2.cvtColor(image_orig,cv2.COLOR_RGB2GRAY)
image_hsv = cv2.cvtColor(image_orig, cv2.COLOR_RGB2HSV)
image_ycbcr = cv2.cvtColor(image_orig, cv2.COLOR_RGB2YCR_CB)
ShowImage([image_orig, image_gray, image_hsv, image_ycbcr], 1, 4)
```

```
Selected Image :
Index  22
Name  Emotion.jpg
```



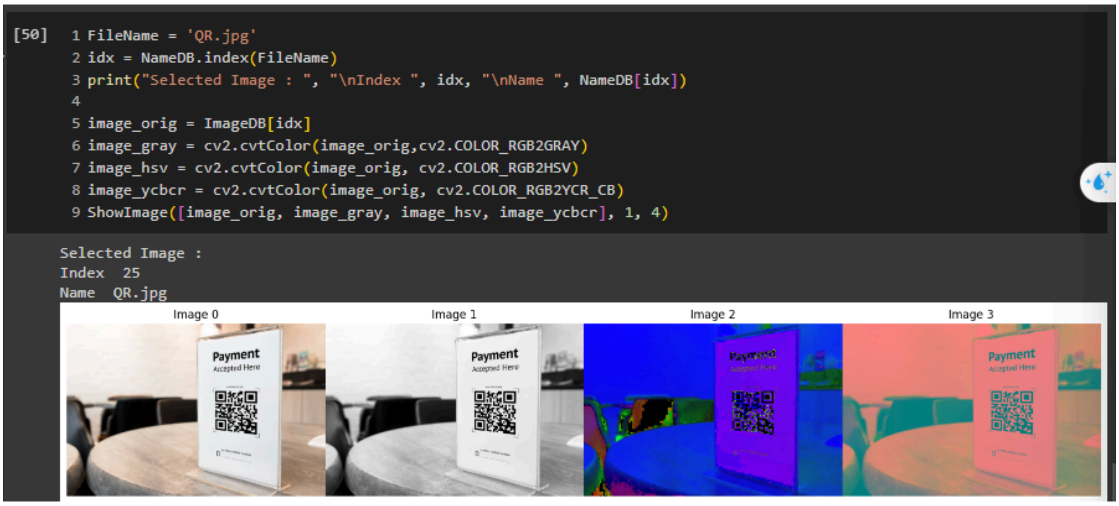
[48]

```
adjusted = adjust_gamma(image_orig, gamma=0.75)
image_gray = cv2.cvtColor(adjusted,cv2.COLOR_RGB2GRAY)
regions = multi_Otsu_Plot(image_gray, classes=5, return_regions=True)
Segments = []
for idx in list(np.unique(regions)):
  mask = regions == idx
  Segments.append(mask)
ShowImage(Segments, 1, len(Segments))
```



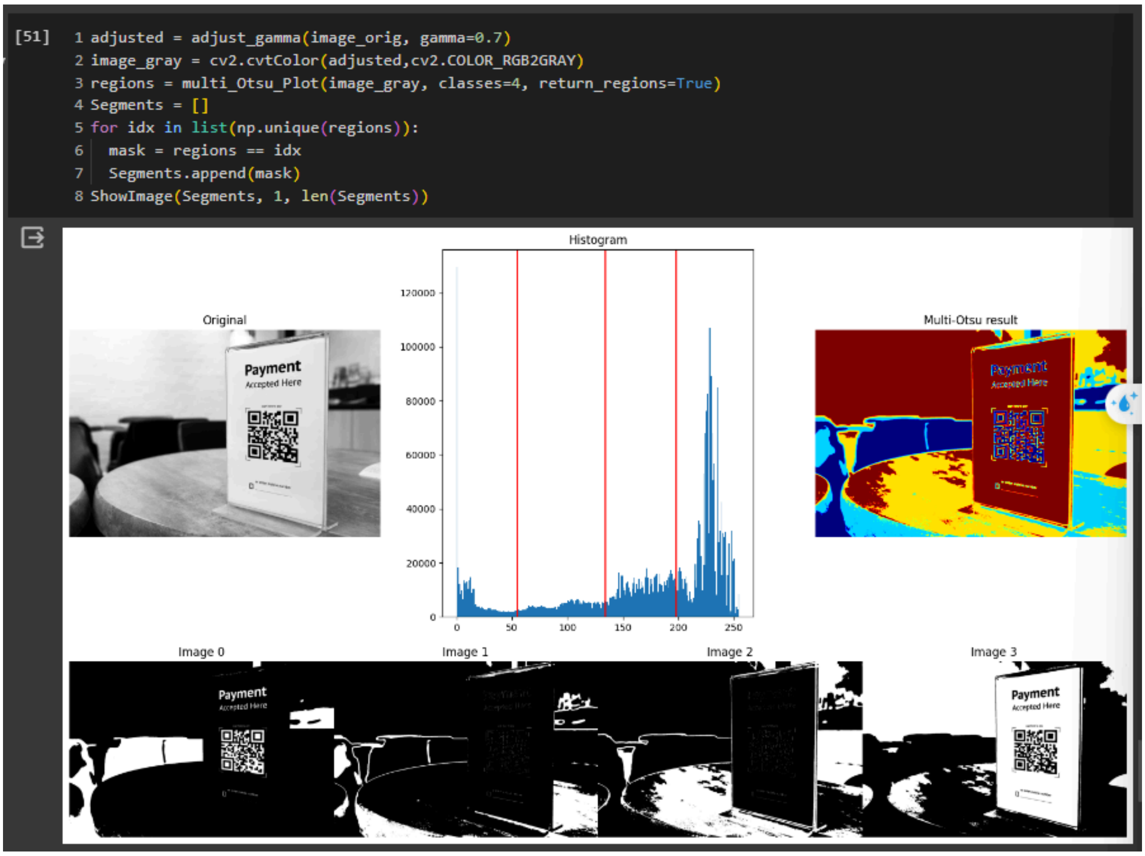
[49]

```
Segment = Segments[3].copy()
Segment[:,0:570] = 0
Segment[:,-350:-1]=0
Segment[-230:-1,:] = 0
Segment[0:135,:] = 0
Segment_morpho = morphology(Segment, 20)
final_segment = SegmentColorImageByMask(image_orig, Segment_morpho)
ShowImage([image_orig, Segment, final_segment], 1,3)
```

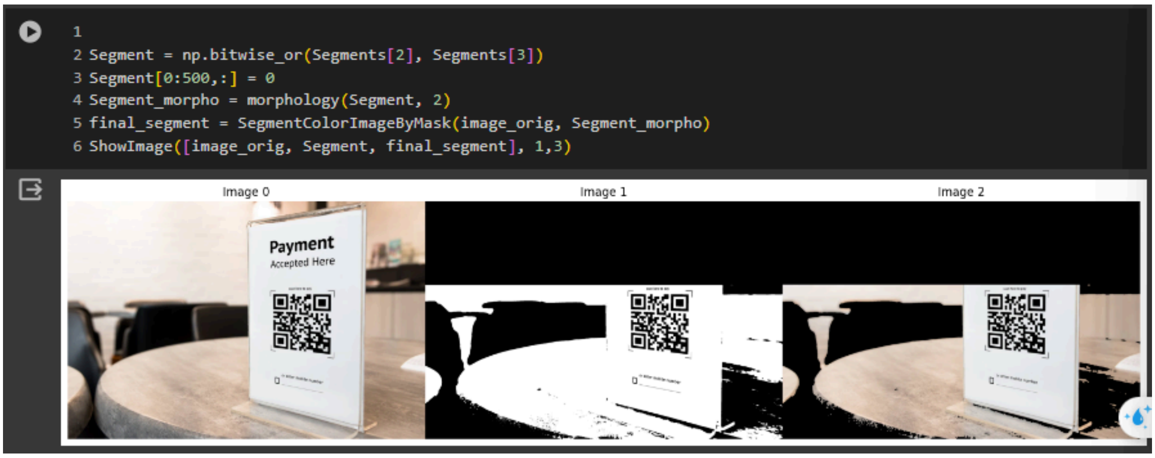


```
FileName = 'QR.jpg'
idx = NameDB.index(FileName)
print("Selected Image : ", "\nIndex ", idx, "\nName ", NameDB[idx])

image_orig = ImageDB[idx]
image_gray = cv2.cvtColor(image_orig,cv2.COLOR_RGB2GRAY)
image_hsv = cv2.cvtColor(image_orig, cv2.COLOR_RGB2HSV)
image_ycbcr = cv2.cvtColor(image_orig, cv2.COLOR_RGB2YCR_CB)
ShowImage([image_orig, image_gray, image_hsv, image_ycbcr], 1, 4)
```

```
Selected Image :
Index  25
Name  QR.jpg
```

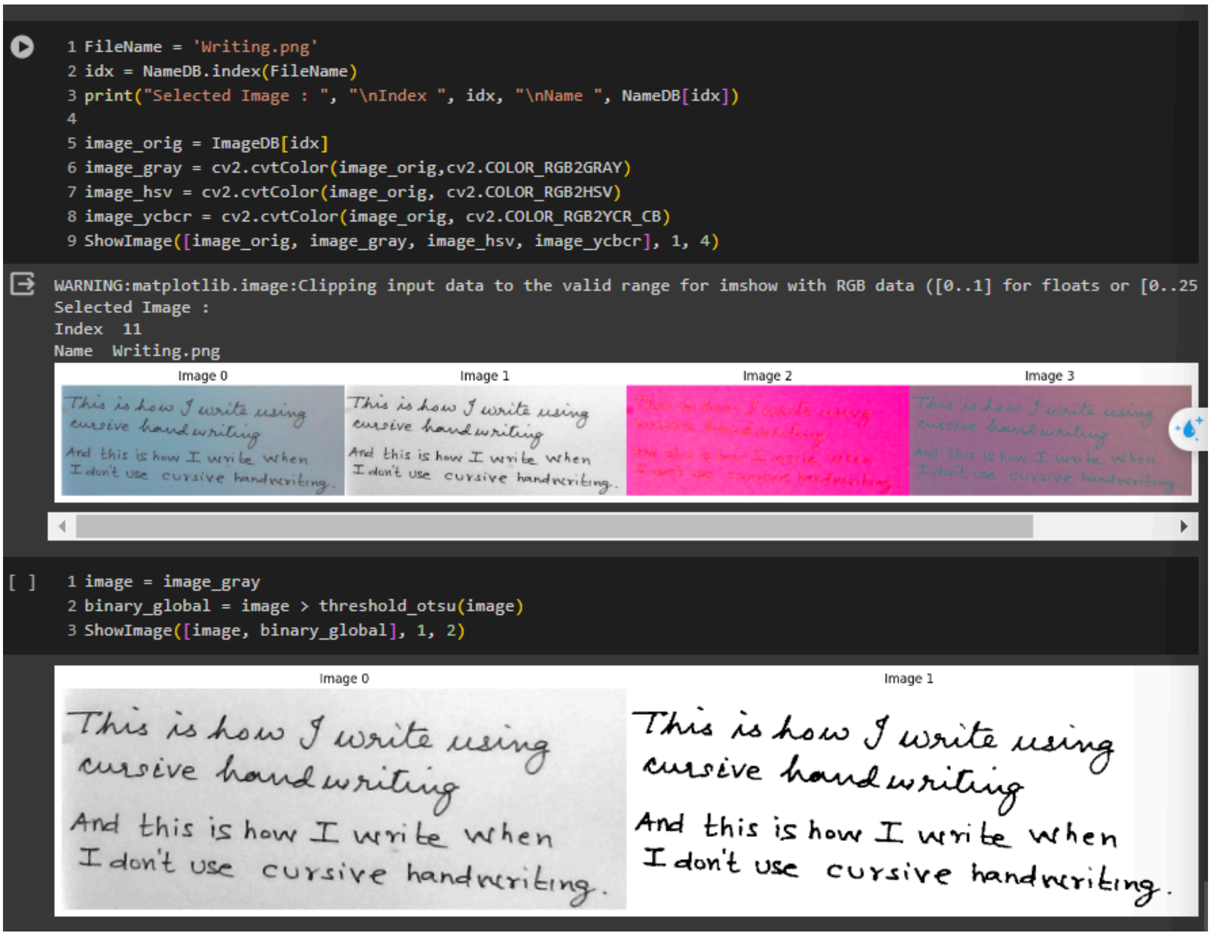


```
adjusted = adjust_gamma(image_orig, gamma=0.7)
image_gray = cv2.cvtColor(adjusted,cv2.COLOR_RGB2GRAY)
regions = multi_Otsu_Plot(image_gray, classes=4, return_regions=True)
Segments = []
for idx in list(np.unique(regions)):
  mask = regions == idx
  Segments.append(mask)
ShowImage(Segments, 1, len(Segments))
```



```

Segment = np.bitwise_or(Segments[2], Segments[3])
Segment[0:500,:] = 0
Segment_morpho = morphology(Segment, 2)
final_segment = SegmentColorImageByMask(image_orig, Segment_morpho)
ShowImage([image_orig, Segment, final_segment], 1,3)
```

PHẦN LÀM THÊM BỔ SUNG ĐỂ LẤY CỘNG



```
FileName = 'Writing.png'
idx = NameDB.index(FileName)
print("Selected Image : ", "\nIndex ", idx, "\nName ", NameDB[idx])

image_orig = ImageDB[idx]
image_gray = cv2.cvtColor(image_orig,cv2.COLOR_RGB2GRAY)
image_hsv = cv2.cvtColor(image_orig, cv2.COLOR_RGB2HSV)
image_ycbcr = cv2.cvtColor(image_orig, cv2.COLOR_RGB2YCR_CB)
ShowImage([image_orig, image_gray, image_hsv, image_ycbcr], 1, 4)
```

```
WARNING:matplotlib.image:Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..25
Selected Image :
Index  11
Name  Writing.png
```

Image 0
Image 1
Image 2
Image 3
This is how I write using cursive handwriting
And this is how I write when I don't use cursive handwriting.

```
[ ]
image = image_gray
binary_global = image > threshold_otsu(image)
ShowImage([image, binary_global], 1, 2)
```

Image 0
Image 1
This is how I write using cursive handwriting
And this is how I write when I don't use cursive handwriting.