LAB01 - Image Segmentation

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In [2]:
```
import numpy as np
import cv2
from matplotlib import pyplot as plt
from skimage.color import rgb2gray
from skimage.filters import threshold_otsu
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
```

In [3]:
```
def ShowImage(ImageList, nRows = 1, nCols = 2, WidthSpace = 0.00, HeightSpace
= 0.00):
    from matplotlib import pyplot as plt
    import matplotlib.gridspec as gridspec

    gs = gridspec.GridSpec(nRows, nCols)
    gs.update(wspace=WidthSpace, hspace=HeightSpace) # set the spacing between
axes.
    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()
```

In [4]:
```
import os
import pandas as pd

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

In [6]:
```
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
```

In [7]:
```
# Mount drive
from google.colab import drive
drive.mount('/content/gdrive')
```

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

In [8]:
```
import os
path_Data = "//content//gdrive//MyDrive//Teaching Class Drive//Bien Hinh va Xu Ly Anh (Image Segmentation)//Object Segmentation Data//"
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
```

In [9]:
```
all_names = get_subfiles(path_Data)
print("Number of Images:", len(all_names))
IMG = []
for i in range(len(all_names)):
    tmp = cv2.imread(path_Data + all_names[i])
    IMG.append(tmp)

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

```
Number of Images: 28
```

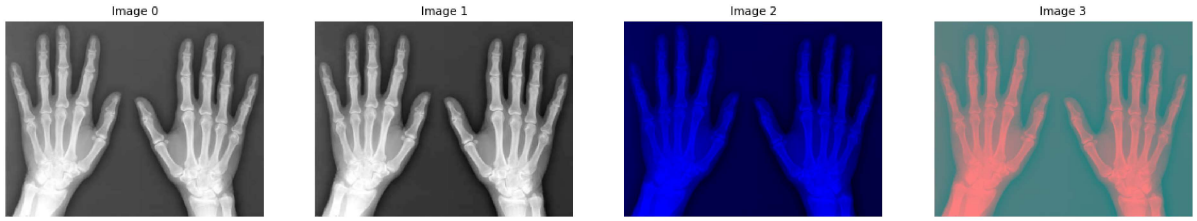
In [11]:
```
NameDB
```

Out[11]:
```
['Lung.png',
 'Iris.jpg',
 'Melanoma.jpg',
 'Retina.jpg',
 'Face.jpg',
 'Fire.jpg',
 'Mask.jpg',
 'Sign.jpg',
 'Cross.jpg',
 'Shelf.jpg',
 'Brain.jpg',
 'Tumor.png',
 'Hand.jpg',
 'Chest.jpg',
 'Bone.jpg',
 'Gesture.jpg',
 'Emotion.jpg',
 'Car.jpg',
 'Activities.jpeg',
 'Crack.jpg',
 'Defect.gif',
 'Code.jpg',
 'Dust.jpg',
 'Barcode.png',
 'QR.jpg',
 'Leaf.jpg',
 'Cloths.jpg',
 'Writing.png']
```

In [86]:
```
FileName = 'Hand.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_BGR2GRAY)
image_hsv = cv2.cvtColor(image_orig, cv2.COLOR_BGR2HSV)
image_ycbcr = cv2.cvtColor(image_orig, cv2.COLOR_BGR2YCR_CB)
ShowImage([image_orig, image_gray, image_hsv, image_ycbcr], 1, 4)
```

```
Selected Image :
Index  12
Name  Hand.jpg
```



In [14]:
```
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))
```

In [49]:
```
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
be those values)
      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(final_thresh)
  final_img[gray > final_thresh] = 255
  final_img[gray < final_thresh] = 0
  return final_img, final_thresh, [WBackground, WForeground, Values]
```

In [18]:
```
T = p_tile_threshold(image_gray, pct = 0.7)
print(T)

class1 = image_gray > T
class2 = image_gray <= T
ShowImage([image_gray, class1, class2], 1, 3)
```

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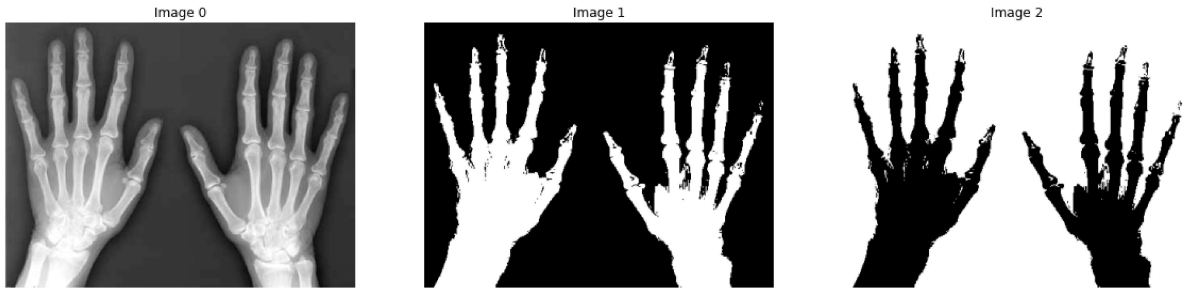

In [50]:
```
final_img, final_thresh, parms = otsu(image_gray)
ShowImage([image_gray, final_img], 1, 2)
```

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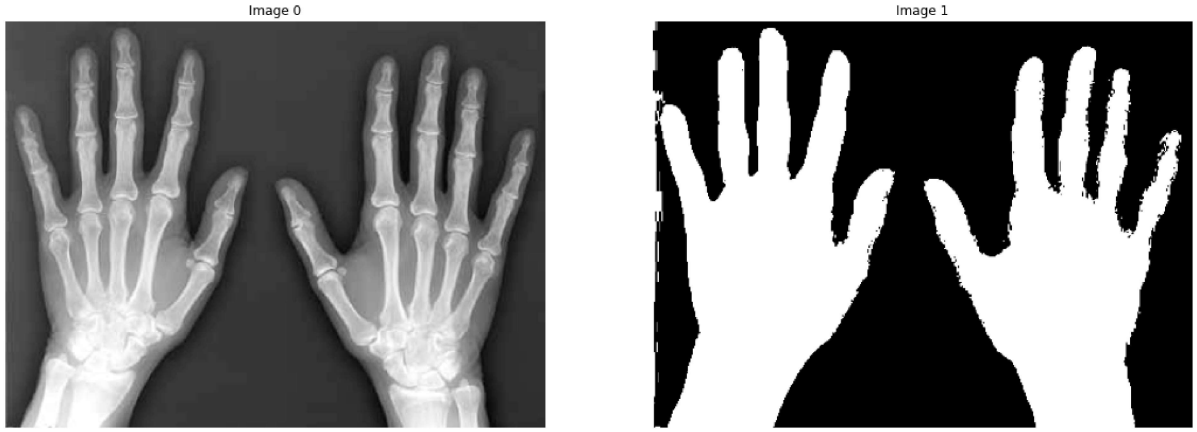

In [37]:
```
WBackground, WForeground, Values = parms[0], parms[1], parms[2]
print(WBackground)
print(WForeground)
print(Values)

plt.plot(Values)
plt.show()
plt.plot(WBackground)
plt.plot(WForeground)
plt.show()
```

```
[0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
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```

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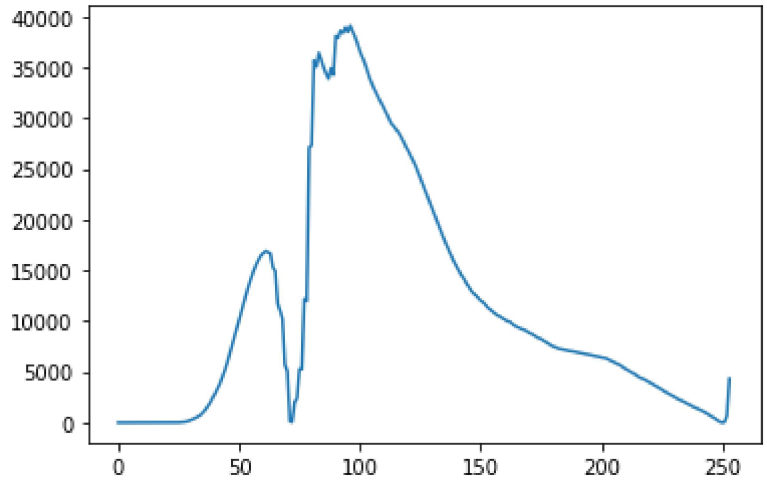
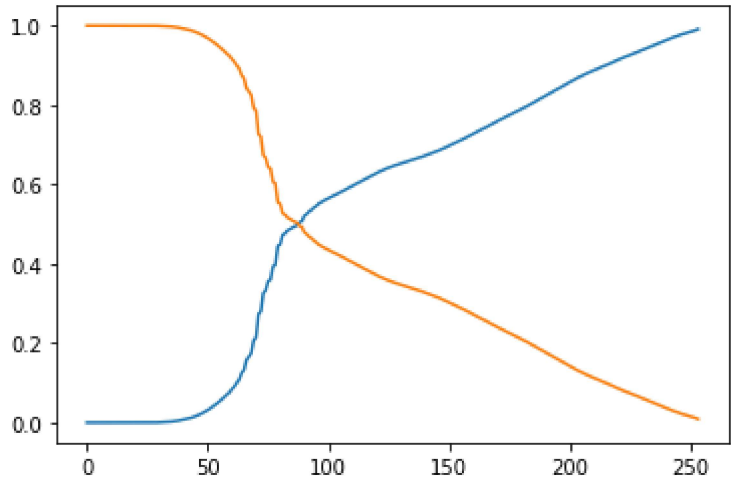
```





In [47]:
```
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

    # 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(final_thresh)
    final_img[image > final_thresh] = 255
    final_img[image < final_thresh] = 0

    return final_img, final_thresh
```

In [48]:
```
final_img, final_thresh = min_err_threshold(image_gray)
ShowImage([image_gray, final_img], 1, 2)
```

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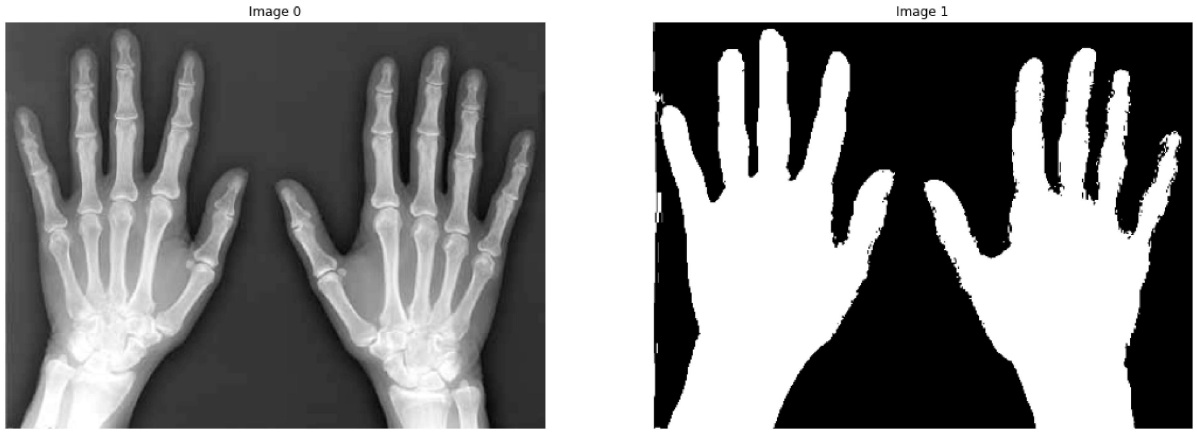


In [59]:
```
def two_peaks_threshold(image, smooth_hist=True, sigma=5):
    from scipy.ndimage import gaussian_filter
    """Runs the two peaks threshold algorithm. It selects two peaks
    from the histogram and return the index of the minimum value
    between them.
    The first peak is deemed to 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.show()

    if smooth_hist:
        hist = gaussian_filter(hist, sigma=sigma)
        plt.plot(hist)
        plt.show()

    f_peak = np.argmax(hist)

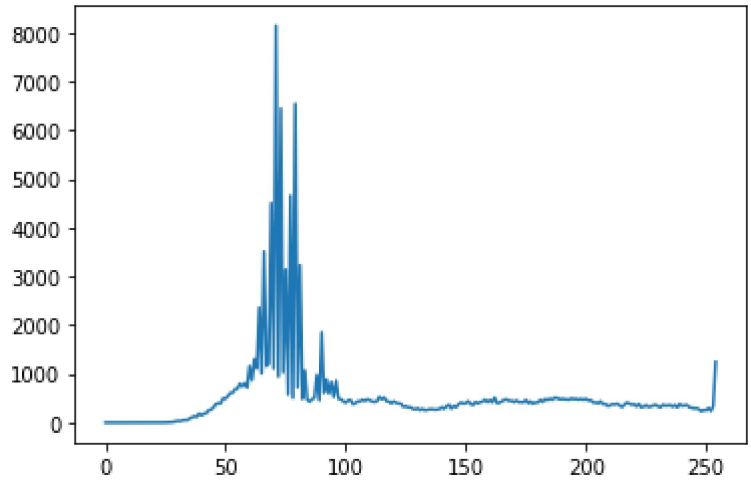
    # finding second peak
    s_peak = np.argmax((np.arange(len(hist)) - f_peak) ** 2 * hist)

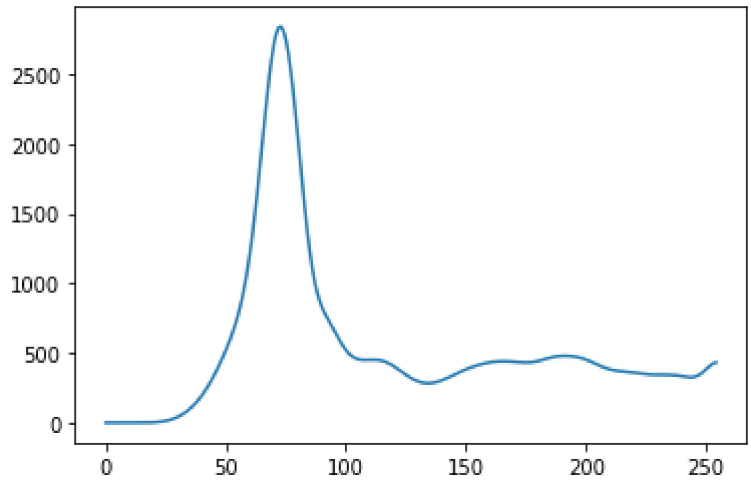
    thr = np.argmin(hist[min(f_peak, s_peak): max(f_peak, s_peak)])
    thr += min(f_peak, s_peak)

    final_img = image.copy()
    print(thr)
    final_img[image > thr] = 255
    final_img[image < thr] = 0

    return final_img, thr, hist
```

In [61]:
```
final_img, final_thresh, hist = two_peaks_threshold(image_gray)
ShowImage([image_gray, final_img], 1, 2)
```





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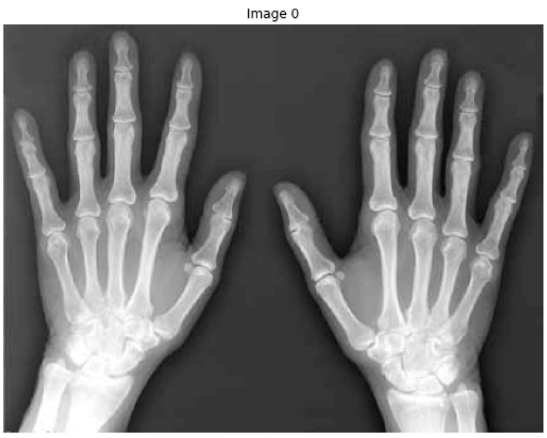
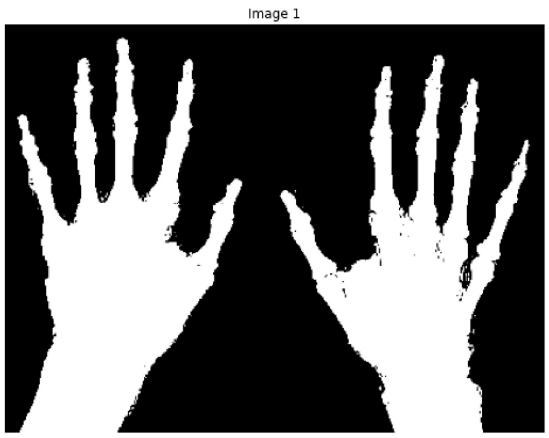
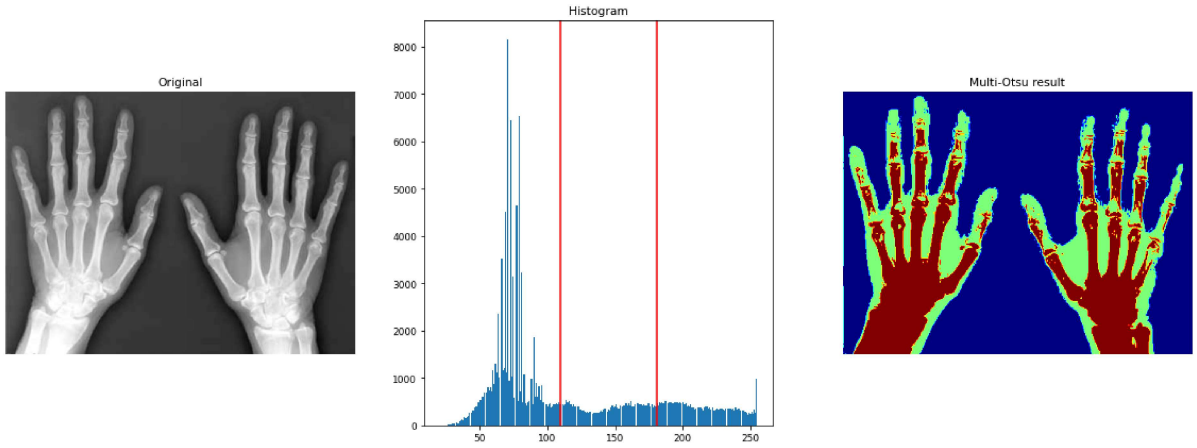




In [67]:
```
from skimage.filters import threshold_multiotsu
# Applying multi-Otsu threshold for the default value, generating
# three classes.
thresholds = threshold_multiotsu(image_gray)
# Using the threshold values, we generate the three regions.
regions = np.digitize(image_gray, bins=thresholds)

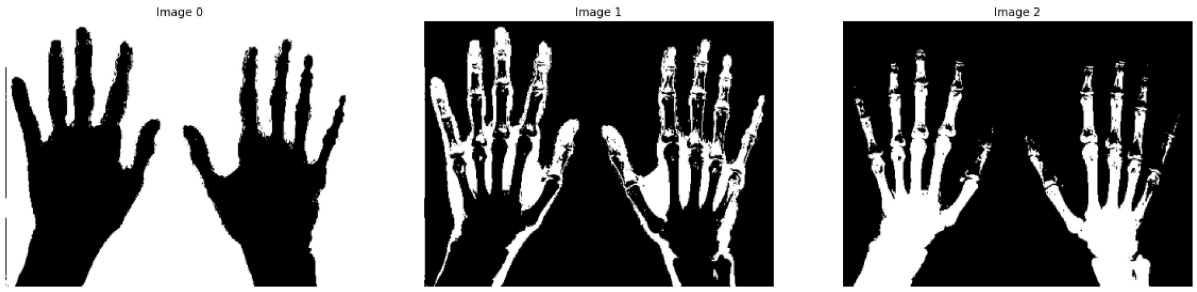
fig, ax = plt.subplots(nrows=1, ncols=3, figsize=(20, 7))
# Plotting the original image.
ax[0].imshow(image_gray, cmap='gray')
ax[0].set_title('Original')
ax[0].axis('off')
# Plotting the histogram and the two thresholds obtained from
# multi-Otsu.
ax[1].hist(image_gray.ravel(), bins=255)
ax[1].set_title('Histogram')
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()
```



In [71]:
```
Segments = []

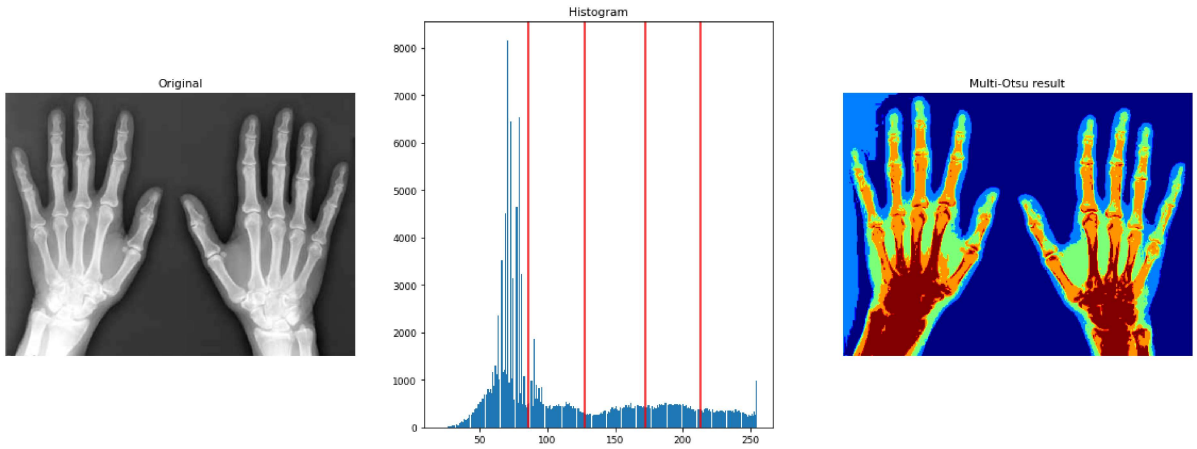
for idx in list(np.unique(regions)):
  mask = regions == idx
  Segments.append(mask)

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



In [87]:
```
thresholds = threshold_multiotsu(image_gray, classes=5)
regions = np.digitize(image_gray, bins=thresholds)

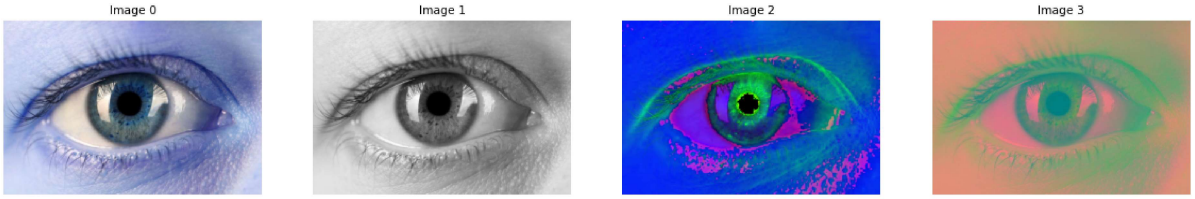
fig, ax = plt.subplots(nrows=1, ncols=3, figsize=(20, 7))
# Plotting the original image.
ax[0].imshow(image_gray, cmap='gray')
ax[0].set_title('Original')
ax[0].axis('off')
# Plotting the histogram and the two thresholds obtained from
# multi-Otsu.
ax[1].hist(image_gray.ravel(), bins=255)
ax[1].set_title('Histogram')
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()
```



In [97]:
```
FileName = 'Iris.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_BGR2GRAY)
image_hsv = cv2.cvtColor(image_orig, cv2.COLOR_BGR2HSV)
image_ycbcr = cv2.cvtColor(image_orig, cv2.COLOR_BGR2YCR_CB)
ShowImage([image_orig, image_gray, image_hsv, image_ycbcr], 1, 4)
```

```
Selected Image :
Index  1
Name  Iris.jpg
```

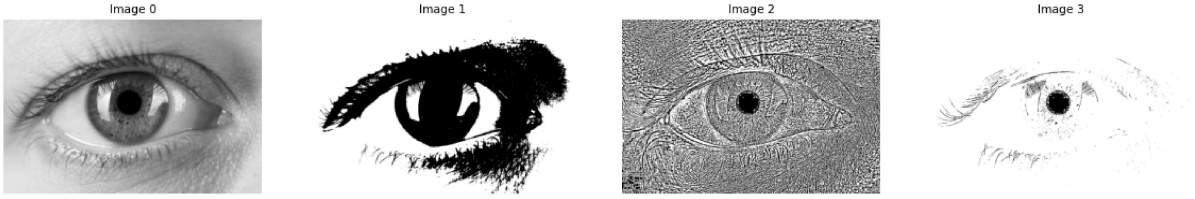


In [107]:
```
from skimage.filters import (threshold_otsu, threshold_niblack, threshold_sauv
ola)
image = image_gray
binary_global = image > threshold_otsu(image)

window_size = 5
thresh_niblack = threshold_niblack(image, window_size=window_size, k=0.1)
thresh_sauvola = threshold_sauvola(image, window_size=window_size)

binary_niblack = image > thresh_niblack
binary_sauvola = image > thresh_sauvola

ShowImage([image, binary_global, binary_niblack, binary_sauvola], 1, 4)
```



In [108]:
```
print("binary_thresh :", threshold_otsu(image))
print("thresh_niblack :", thresh_niblack)
print("thresh_sauvola :", thresh_sauvola)
```

```
binary_thresh : 147
thresh_niblack : [[221.4241177  221.21065476 220.96684648 ... 183.49625049 18
3.297518
  183.297518  ]
 [221.37823964 221.20539082 220.99830894 ... 183.54343146 183.34343146
  183.34343146]
 [221.30120519 221.17108392 221.08435939 ... 183.58428645 183.38286857
  183.38286857]
 ...
 [225.35101021 225.35101021 225.35101021 ... 217.359601   217.56060227
  217.60141247]
 [225.55101021 225.55101021 225.55101021 ... 217.0925908  217.29141429
  217.33071797]
 [225.55101021 225.55101021 225.55101021 ... 217.01726245 217.21354701
  217.29141429]]
thresh_sauvola : [[177.72025228 177.60657352 177.42722048 ... 147.03155859 14
6.86771293
  146.86771293]
 [177.70859224 177.62485159 177.48893483 ... 147.0429174  146.88273993
  146.88273993]
 [177.63411331 177.57298992 177.53214006 ... 147.07248999 146.91639512
  146.91639512]
 ...
 [180.49321255 180.49321255 180.49321255 ... 174.22622682 174.38306075
  174.41234406]
 [180.65336624 180.65336624 180.65336624 ... 173.95762481 174.12184769
  174.15626531]
 [180.65336624 180.65336624 180.65336624 ... 173.87763242 174.05049264
  174.12184769]]
```