German University in Cairo
Faculty of Media Engineering and Technology
Winter 2021

DMET 901 – Computer Vision

Assignment #3

(Due on January 1, 2022, at mid-night – Submit to dmet901.w21@gmail.com)

The main aim of this assignment is to implement histogram equalization and optimal thresholding segmentation, and experiment with their application to multiple gray-scale images.

Histogram Equalization:

In this part, you are asked to implement four functions as follows:

1. CalculateHistogram:
   - Input: Image.
   - Output: Array of the histogram counts.
   - Description: This method is responsible for calculating the normal histogram count at each different gray level with its number of pixels.
2. CalculateCumulativeHistogram:
   - Input: The output array of method CalculateHistogram.
   - Output: Array of the cumulative histogram.
   - Description: In this method, you have to calculate the cumulative histogram by summing up the counts of the pixels ascendingly.
3. CalculateEqualizedHistogram:
   - Input: The output array of method CalculateCumulativeHistogram.
   - Output: Array of the new pixel intensities that correspond to the original ones.
   - Description: In this method, you are required to calculate the equalized histogram upon the following equation using the cumulative histogram calculated above:

     $$T(P) = \frac{255}{(N * M) - [H_c(0)]} * [H_c(P) - H_c(0)]$$

     where $T(P)$ is the new intensity calculated for intensity P, $(N * M)$ is the size of the image rows multiplied by columns, $H_c(P)$ is the cumulative histogram of the pixel intensity and $H_c(0)$ is the cumulative histogram of pixel intensity 0.
4. Calculate Equalized Image:
   - Input: Original image and the output array of method CalculateEqualizedHistogram.
   - Output: The equalized image.
   - Description: In this method, you are required to generate the new equalized image after manipulating the old pixel intensity values by the new values of intensities obtained after calculating the equalized histogram.

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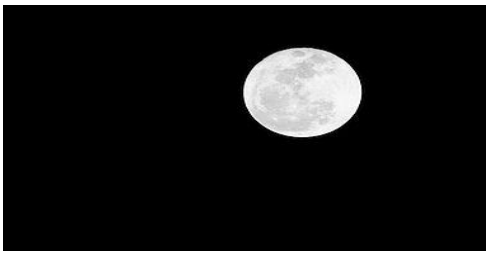
Optimal Thresholding:

In this part, you are asked to implement one function as follows:

SegmentOptimalThresholding

- Input: Image.
- Output: Segmented image.
- Description: Implements the iterative optimal thresholding approach explained in the lecture.

Here is the output of the optimal thresholding on the original image:



Original image

Segmenting the original image

Here is the output of the equalized image and its segmentation:

Equalized image

Segmented equalized Image

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Deliverables:

- Your Python code. You can use the sample image given above (file provided with the assignment) to test your code.
- The following outputs for the other 4 images provided with the assignment:
  1- The output image resulting from applying segmentation to the original image (without histogram equalization)
  2- The output image resulting from applying histogram equalization to the original image
  3- The output image resulting from applying segmentation to the histogram equalized image (i.e., applying segmentation to the image you obtained in 2)
  Note: If an image is colored, convert it to gray-scale first before applying the implemented functions
- Comment on the produced outputs in terms of whether applying histogram equalization before segmentation always enhances the segmented output or not.

Submission Guidelines:

- Send your solution as one zip file to dmet901.w21@gmail.com and name the zip file by the format [Txx_43-xxxx_Txx_43-xxxx].
- This assignment can be done in groups of maximum 2 students. Both students must be from the tutorial groups of the same TA.
- In the subject of your e-mail, write the format [Txx_43-xxxx_Txx_43-xxxx].