

IMAGE PROCESSING

Labwork 1: Histogram and Point Processing

Part A. Pen and paper exercises:

Task A1: Given the following image I:

$$I = \begin{bmatrix} 0 & 1 & 1 & 2 \\ 2 & 3 & 3 & 4 \\ 4 & 5 & 6 & 6 \\ 5 & 6 & 7 & 7 \end{bmatrix}$$

- Compute and draw histogram and normalized histogram of image I.
- Compute and draw equalized histogram from image I. From the equalized histogram infer the new image called M.
- Convert image I into a binary image B using thresholding, where predefined threshold k is selected as the median gray-level value of all pixels in image I.
- Compute negative image of I.

Task A2: Given the following image J:

$$J = \begin{bmatrix} 0 & 2 & 2 & 3 & 6 \\ 1 & 2 & 3 & 3 & 6 \\ 2 & 3 & 3 & 4 & 7 \\ 1 & 2 & 3 & 3 & 7 \\ 0 & 2 & 4 & 5 & 6 \end{bmatrix}$$

- Compute and draw histogram and normalized histogram of image J.
- Identify the gray-level value that appears most frequently in image J. This value is called the mode of the gray-level distribution.
- Convert image J into a binary image B using thresholding, where the predefined threshold k is chosen as the gray level that appears most frequently in image J.

- How many pixels are assigned to the foreground class $B(x,y)=1$? How many pixels are assigned to the background class $B(x,y)=0$?
- Does the selected threshold k separate the low-intensity and high-intensity pixels well? Explain your answer.

Part B. Python/OpenCV Practice:

- Install Anaconda on your computer and use Jupyter Notebook as your programming environment. Make sure that Python, OpenCV, NumPy and Matplotlib are available.
- Download at least two grayscale images from the Internet, or use your own grayscale images, then complete the following tasks.

Task B1: Image reading, resizing, histogram equalization

Read the downloaded images using OpenCV. If an image is a color image, convert it to grayscale. Then perform the following tasks:

(a) Histogram and histogram equalization:

- Compute and display the histogram of the grayscale image.
- Apply histogram equalization to the grayscale image.
- Compute and display the histogram of the equalized image.

(b) Resize the grayscale image to 150% of its original width and height.

(c) Display the following results:

- original image;
- grayscale image;
- resized grayscale image;
- histogram of the grayscale image;
- equalized grayscale image;
- histogram of the equalized grayscale image;
- grayscale image and equalized grayscale image side by side for comparison.

(d) Print the basic information of both the original image and the grayscale image, including:

- image size;
- number of channels;
- data type;
- minimum pixel value;
- maximum pixel value.

Task B2: Brightness and contrast adjustment

Change the brightness and contrast of the downloaded image using the following transformation:

$$\text{img}_{\text{processed}} = a * f(x,y) + b$$

In which, $f(x,y)$ is the pixel value of the original image (*img*) at the coordinate (x, y) ; a is a user-defined contrast control parameter; b is a user-defined brightness control parameter. Apply the four following different pairs of (a,b) :

$$(a,b) = (1.0,50) \text{ or } (1.0,-50) \text{ or } (1.5,0) \text{ or } (0.5,0)$$

Then, complete the following tasks:

- display the original and processed images;
- display the histogram of each processed image;
- compare the effects of different values of a and b ;
- explain how a affects contrast and how b affects brightness.

Task B3: Image Thresholding

Perform image thresholding to convert a grayscale image into a binary image.

- Read and display an image. If the selected image is a color image, convert it to grayscale first.
- Display the histogram of the grayscale image.
- Apply global thresholding using the three predefined following threshold values:

$$T = 80 \text{ or } 120 \text{ or } 160$$

- Display the binary images obtained from different threshold values.