Biometrics
Laboratory Report

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Contents

1 Objective

The objective of the laboratory was to apply certain image processing methods. This study was concerned with the following methods:

- Threshold.
- Histogram Expansion.
- Brightness

In section 2, I will describe in details all the methods and their variations.
The experiments will be conducted in section 3 where I compare and analyse different results for each algorithms.
I will finish with conclusions in section 4

2 Methodology

2.1 Threshold

The first algorithm being described in Thresholding. I assume that the input image is in gray scale, tresholding can be also applied to color images but for simplicity of the experiments I only worked with gray scale. The algorithm is as follows:

a. Choose constant $0 < T < 255$

b. For each pixel in input image (gray scale)

   (a) If pixel intensity is lower than T then set value of that pixel to 0. Otherwise set it to 255.

The most important part of thresholding is finding a proper value for the actual threshold T. The big problem with this algorithm is that we only consider the pixel's intensities, not the relation between pixels. Thus by setting improper constant value of T might lead to loosing important information about the image.
During the laboratories, we did not try other methods of setting the threshold, but it is important to mention them. We can use the adaptive thresholding such as:

- Threshold value is the mean of neighbourhood area.
- Threshold value is the weighted sum of neighbourhood values where weights are a gaussian window.

Later during the experiment we shall test out results for different values of T.

2.2 Histogram Expansion

Also known as Histogram stretching or simply Normalization, this algorithm is a process of changing the range of pixel intensity values.
The new value of intensity of a pixel is changed as follows:

$$I_n = (I - min) * ((desiredMax - desiredMin)/(max - min)) + desiredMin \quad (1)$$

where max, min is the maximum and minimum intensities in the input image respectively. $desiredMax$, $desiredMin$ is the desired range which we want to stretch the histogram to. In our case these variables take the following values: $desiredMax = 255$, $desiredMin = 0$.
During the laboratories we conducted histogram expansion with two variations on finding maximum and minimum intensities.

- The maximum and minimum were computed by taking the average of three channels for each pixel. Let us denote this variation by AVG_MIN/MAX
- The maximum and minimum were computed for each channel individually, thus giving us three maximums and three minimums - each for every channel. This one will be denoted ALL_MIN/MAX

In either case, the equation 1 was applied to each channel individually.
The potential problem with AVG_MIN/MAX algorithm might occur when a certain pixel intensity has a much higher value for one channel than the others. In such case this channel might be considered an outlier.

2.3 Brightness

The last algorithm we consider is the simplest.

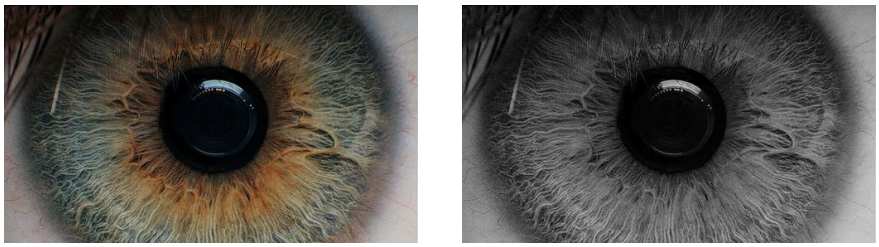
a. Choose a constant brightness B

b. For each pixel of the input image increase the value of pixel's channel by brightness B

It is worth mentioning that when increasing values of pixel's intensity we must be careful with upper bound - do not overflow the maximum value of one byte - namely 255.

3 Experiment

Figure 1 presents the images that will be used in our experiments. First we will show how gray scale image behaves for thresholding with different threshold values. Then both original and grayscale images will be subjected to histogram expansion. Lastly we observe results for brightness filter.

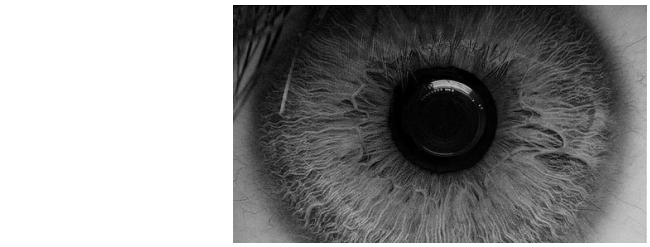


(a) Original image (b) Grayscale image

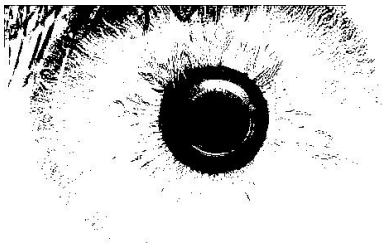
Figure 1: The original and grayscale pictures used in experiments

3.1 Threshold

Figure 2 presents results for thresholding a grayscale image for different values of threshold. It was mentioned in the methodology section that choosing a proper threshold is important or else the information about an image can be lost. This assumption is verified with our results. Looking at the threshold value of 25 we can see that too many pixels became white. On the other hand in the threshold equal to 150 we observe the opposite - most of the pixels are black. In both cases we lose information. The best out of the four tested thresholds seems to be the value 50.



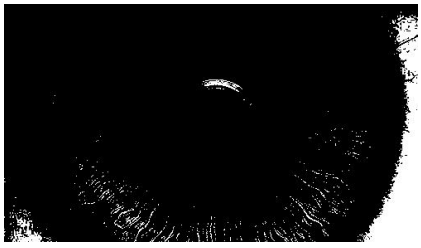
(a) The grayscale image



(b) Threshold 25

(c) Threshold 50

(d) Threshold 100

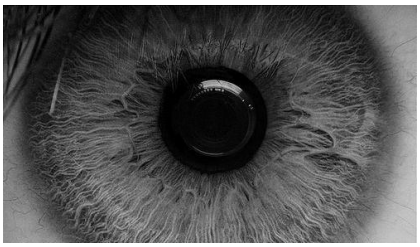


(e) Threshold 150

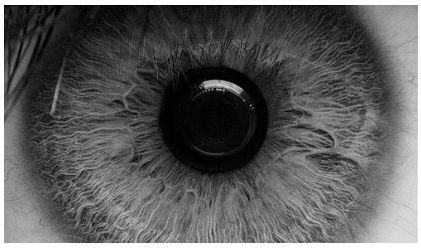
Figure 2: The grayscale image and thresholded images for different threshold values.

3.2 Histogram Expansion

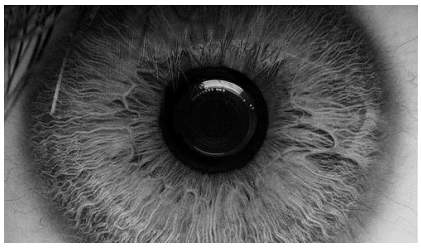
Let us start of by showing the results of stretching a histogram of a grayscale image. Figure 3 is the point of interest in this case. It should not be a surprise that figures 3b and 3c are exactly the same. Recall that in grayscale images, pixels have the same values for each channel. Let us carefully observe between the grayscale image in 3a and the other two. We can clearly see improvement in quality in the normalized images. The nearly white pixels became cleaner - or simply they became even more white. The same happened for black pixels. Overall the image becomes more sharp and detailed.



(a) The grayscale image



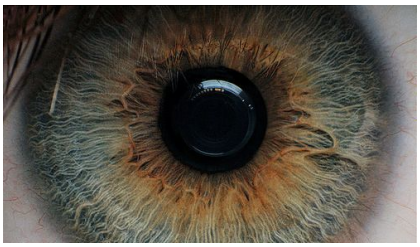
(b) Histogram Expansion ALL_MIN/MAX



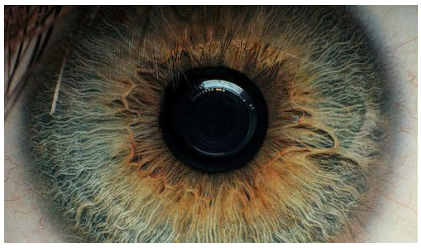
(c) Histogram Expansion AVG_MIN/MAX

Figure 3: The grayscale image and grayscale images after normalization with different methods of finding maximum and minimum pixel intensities.

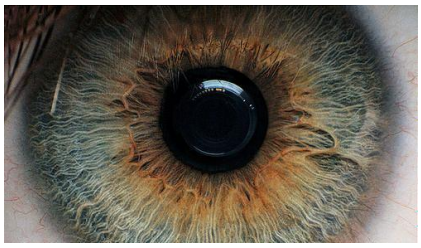
The results for normalization of color image is presented in figure 4. Here we can see that that the normalization in which maximum and minimum was calculated separately (figure 4b) for each channel yields slightly different results than the one with computed the average intensities (figure 4c). The former one appears to be more detailed than the latter one.



(a) The original image



(b) Histogram Expansion ALL_MIN/MAX

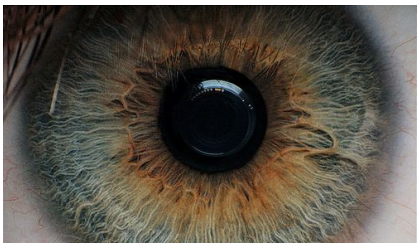


(c) Histogram Expansion AVG_MIN/MAX

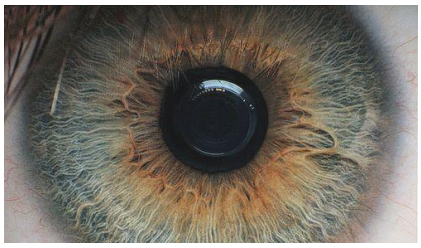
Figure 4: The original image and images after normalization with different methods of finding maximum and minimum pixel intensities.

3.3 Brightness

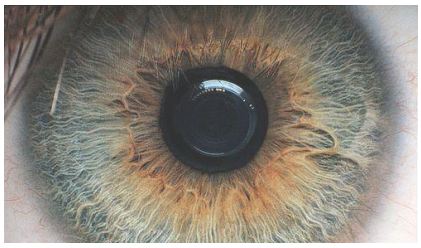
Lastly we consider the process of brightening an image. As before, the original image was subjected to filtering for different values of brightness. This is presented in the figure 5. With bigger brightness, the pixels become more white. Very big value can make the image look unattractive.



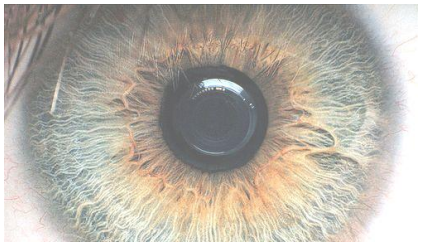
(a) The original image



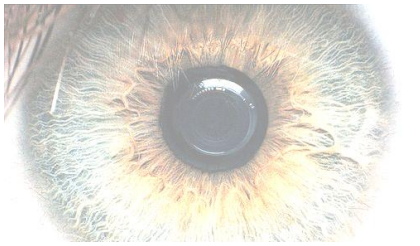
(b) Brightness 25



(c) Brightness 50



(d) Brightness 100



(e) Brightness 150

Figure 5: The original image and images with different brightness values.

4 Conclusions

In our laboratories we tested three different image processing algorithms, the thresholding, histogram expansion and brightness.
We showed that choosing a proper threshold is important as not doing so might lead to information lose.
We applied histogram expansion for two different variations. Choosing the maximum and minimum individually for each channel showed better results.