Digital Image Processing Homework 2

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1 Low-luminosity Enhancement

1.1 Methodology

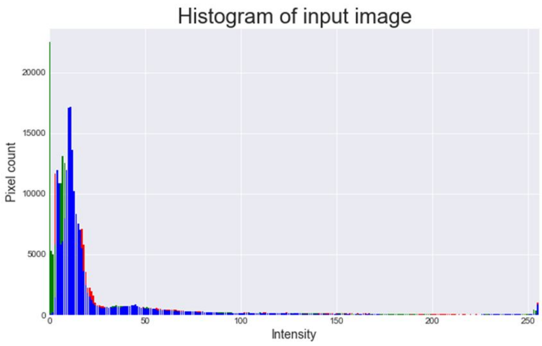
This section aims to enhance the intensity of low-luminosity images (as shown in Fig 2 (a)). In this experiment, two methods are used for intensity enhancement, histogram equalization and Gamma transformation. The first method, histogram equalization, involves first statistically analyzing the intensity values of each pixel in the input image to obtain its histogram. Then, an attempt is made to transform the histogram distribution into a uniform distribution. The second method, Gamma Transformation, applies non-linear amplification to the luminosity values of each pixel in the input image by raising them to the power of gamma. In this experiment, a gamma value of 0.5 is used.

1.2 Results and Discussion

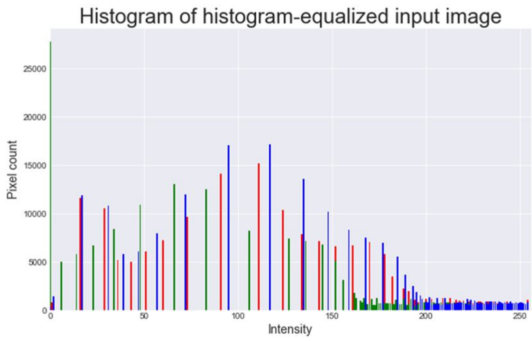
Figure 1 displays the results of the original image and the image after applying two different low-luminosity enhancement methods. From these results, it is evident that the luminosity of the images has significantly improved after low-luminosity enhancement. On the other hand, from the histogram distributions in Figure 2, it is clear that after histogram equalization, the histogram distribution (Fig 2 (b)) tends to become more uniform. In contrast, after Gamma Transformation, while the distribution (Fig 2 (c)) doesn't tend towards uniformity, it exhibits a greater deviation compared to the histogram distribution of the original image.

(a) (b) (c)

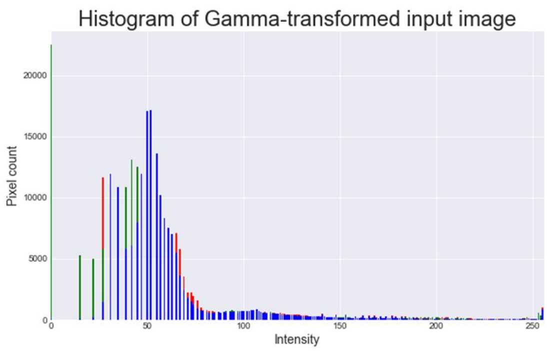
Fig 1. The results of low-luminosity enhancement. (a) The original image, (b) result of histogram equalization and (c) result of Gamma transformation.



(a)



(b)



(c)

Fig 2. The histogram distributions. (a) The original image, (b) histogram equalization and (c) Gamma transformation.

2 Sharpness Enhancement

1.1 Methodology

The primary purpose of this section is to perform sharpness enhancement on images. In this experiment, the method used is Laplacian filtering. Two different levels of Laplacian kernels (as shown in Figure 3) are applied to the input image through convolution operations. The principle of Laplacian filtering is to first extract the edge components (high-frequency components) from the original image and then adds them back to the original image to enhance the high-frequency features.

0	−1	0
−1	5	−1
0	−1	0

(a)

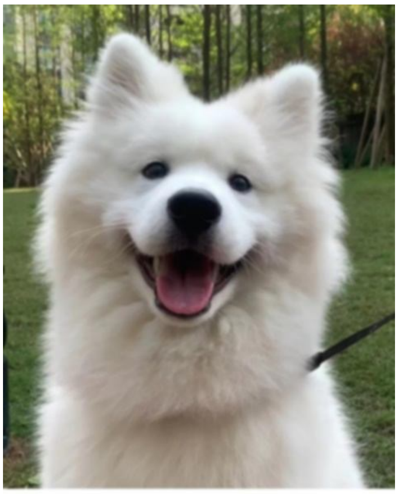
−1	−1	−1
−1	9	−1
−1	−1	−1

(b)

Fig 3. Two type kernels used in Laplacian filtering. (a) type I, (b)type II.

1.2 Results and Discussion

Figure 4 displays the original image and the results of applying Laplacian filtering with different kernels. It can be observed that Laplacian filtering does indeed enhance the sharpness of the image. Moreover, notably the results from the Type II Laplacian filter exhibit a more pronounced improvement in sharpness compared to the Type I Laplacian filter.



(a) (b)

(c)

Fig 4. The results of sharpness enhancement. (a) The original image, (b) result of Laplacian filtering by type-I kernel (c) result of Laplacian filtering by type-II kernel.

3 Denoise

1.1 Methodology

The main purpose of this section is to perform noise reduction on images. In this experiment, two different noise reduction methods are used, Gaussian smoothing and local averaging. The first method, Gaussian smoothing, involves performing convolution operations between the original image and a generalized weighted smoothing kernel. The convolution kernel used for this method is depicted in Figure 5. The second method is local averaging, which operates by applying weighted averaging to each pixel within the kernel's range. The convolution kernel used for this method is also shown in Figure 5.

$$\frac{1}{273}\begin{bmatrix} 1 & 4 & 7 & 4 & 1 \\ 4 & 16 & 26 & 16 & 4 \\ 7 & 26 & 41 & 26 & 7 \\ 4 & 16 & 26 & 16 & 4 \\ 1 & 4 & 7 & 4 & 1 \end{bmatrix} \qquad \frac{1}{16}\times\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$

Fig 5. Two type kernels used in of denoising. (a) Gaussian smoothing and (b) local averaging.

1.2 Results and Discussion

Figure 6 displays the original image and the results obtained after applying the two different noise reduction methods. It is evident from the results that both methods used in this experiment effectively reduce noise. Gaussian smoothing, in particular, produces a more noticeable noise reduction effect, but it also results in a relatively more blurred image.

(a)

(b)

(c)

Fig 6. The results of denoising. (a) The origin image, (b) result of Gaussian filtering and (c) result of weighted-average filtering.