Algorithms For Improving The Quality Of Images Using Histogram Method

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Annotation. This article aims to improve the quality of images taken in foggy and rainy conditions, which are common today and prepare them for digital processing. During the research, the method of removing noise in images using gray scale pixel substitution is explained in detail and an algorithm is developed.
Key words: pixels, gray level, colorless images, algorithms, JPEG file size, digital processing.

Currently, research and development work is being carried out in many countries of the world in the field of digital image processing. In this direction, advanced scientific researches are being conducted in the developed countries of the world such as USA, Germany, India, China, South Korea, Russian Federation, Japan [1],[3]. The methods of image recognition, analysis, and segmentation are becoming more and more advanced. Named differently depending on how the images are taken. For example, in the field of medicine, when human organs are imaged, they are called medical images and other names. Although color images are popular now, some industry representatives use monochrome (black and white) images. This is a field of medicine, and although science and technology have advanced, diseases of the brain, respiratory system, liver, heart and so on are diagnosed using colorless images. In this research paper, an algorithm for cleaning colorless images from various distortions [2],[4].
In a colorless image, the light intensity or brightness of the object shown in the coordinates (x, y) of the image is represented by a number called "gray level" [6]-[9]. The higher the gray level number, the brighter the image at the coordinate point (x, y). The maximum value in the grayscale range represents a completely bright point, while a gray point equal to zero is a completely dark point. Gray points that are partially bright and partially dark will have a gray level value ranging from 0 to the maximum brightness value. It depends on the intensity of the pixels that make up the image to ensure the quality of images. That is, the high quality of images depends on how many different intensities each pixel has in the color range [12], [23]. For example, a 100x100 monochrome image has 10,000 pixels. If each pixel has a range of 0-7 different gray levels, the given image is a 3-bit image (Figure 1).

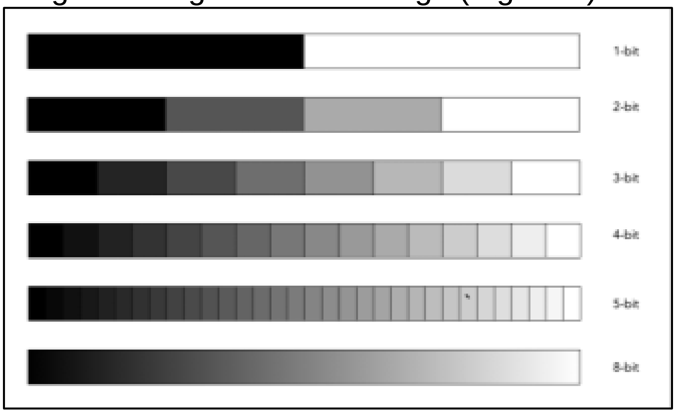

Figure 1. Ranges of gray level

Considering the above, when processing the cell image, because the illumination of the room and the light settings of the microscopes can be different, the gray level distribution of the objects will be different due to the different lighting settings. For this problem, we develop the following algorithm to equalize the gray level distributions of the image.

We assume that the image is quantized to one of the possible intensity levels "L". Also, if "B" bits are used to store the pixel value, we have L = 2^B [7],[8].

The most popular grayscale ranges used in normal images are 0–255, 0–511, 0–1023, etc. Gray levels are almost always set as non-negative integers. This saves a lot of digital storage space and significantly speeds up image processing. It can be seen that the wider the range of gray levels, the better the resolution.

Since we want to equalize the histogram of the transformed image, let us assume that the gray level of all the pixels in the transformed image has the same number of pixels with intensity level (0,1,2,…, L-1) and is equal to N/L [15]-[17], [19]. Here "N" is the total number of pixels in the image and "L" is the total number of possible intensity levels. We use the notation R represents the features of the original (given) image, and S represents the histogram features of the equalized image. Also, let r_k $(r_k = k;\ k = 0,1,2,\dots,L-1)$ be the original intensity “k”, and let s_k be the intensity corresponding to this “k” (ie, r_k) intensity. As mentioned above, the number of pixels at any image intensity $s_k(\mathrm{k} = 0,1,2,\dots,\mathrm{L}-1)$ is the same and equal to “N/L” for histogram equalization. Thus, we can write the following expression (in terms of the number of image pixels at each intensity level).

$$\sum_{i=0}^{r_k} n_R(i) = \left(\frac{N}{L}\right)(s_k + 1)\ \ :\ \ k = 0,1,2,\dots,L-1;\ r_k = k, \qquad (1)$$

Above, "N" is the total number of pixels in the given image, "L" is the total number of possible intensity (gray) levels, *n(i)* is the number of pixels in the image of intensity "i", r_k is the original intensity "k" and s_k is the original intensity The transformed intensity corresponding to "k" (ie, corresponding to r_k). Here, "r" is used to denote the given image and "s" is used to denote the superimposed image.

It should be noted that intensity levels are discrete in digital images (they are integers between 0 and "L-1"). Also, to preserve the "informational integrity" of the image, all image pixels with the same intensity in the original image cannot be assigned different intensities, but can be collectively mapped to the same new value. Therefore, we use the intensity level histogram of the original image pixels $(r_k = k;\ k = 0,1,2,\dots,L-1)$ and we minimize the error (Δ_k) between the equalized histogram $(s_k = k;\ \mathrm{k} = 0,1,2,\dots,\mathrm{L}-1)$ [10],[11]. Of course, in an ideal case, Δ_k is zero. Therefore, we can say that we replace the pixel intensity $(r_k = k;\ k = 0,1,2,\dots,L-1)$ in the given image with the intensity s_k. Thus, Δ_k is minimized using the following equation [9],[10]:

$$\Delta_k = \left|\left(\frac{N}{L}\right)(s_k + 1) - \sum_{i=0}^{r_k} h_R(i)\right|\ \ :\ \ r_k = k;\ k = 0,1,2,\dots,L-1, \qquad (2)$$

where, h_R – the pixel value of the image in its initial state.

Taking into account the N/L factor in the above equation, the above minimization can be modified as:

$$\Delta'_k = \left|s_k - \left(\left(\frac{L}{N}\right)\sum_{i=0}^{r_k} h_R(i) - 1\right)\right|\ \ :\ \ r_k = k;\ k = 0,1,2,\dots,L-1, \qquad (3)$$

For a given r_k, s_k can be defined as Taking into account that the above minimization is equal to zero, after turning Δ'_k to zero, solving s_k can be done with the following equation (4):

$$s_k = \left(\frac{L}{N}\right)\sum_{i=0}^{r_k} h_R(i) - 1 \quad : \quad r_k = k;\ k = 0,1,2,\ldots,L-1, \qquad (4)$$

However, as mentioned above, the value of s_k may consist of real values. Thus, it is appropriate to use equation (5) to ensure that the values of the above expression are integers.

$$s_k = round\left(\left(\frac{L}{N}\right)\sum_{i=0}^{r_k} h_R(i) - 1\right) : \ r_k = k;\ k = 0,1,2,\ldots,L-1, \qquad (5)$$

In equation (5), it is observed that the value of s_k is negative when the total number of pixels to be changed is less than "N/2L". Initially, given the intensity level (0,1,2,…, L-1) and the integer number of pixels, we use the following equation (6) to equate $r_k \rightarrow s_k$:

$$\left.\begin{array}{l} s'_k = \left(\frac{L}{N}\right)\sum_{i=0}^{r_k} h_R(i) - 1 \ : \ r_k = k;\ k = 0,1,2,\ldots,L-1 \\ s_k = \begin{cases} 0 & : \ s'_k < 0 \\ round(s'_k) & : \ s'_k{}^3 0 \end{cases} \quad : \ k = 0,1,2,\ldots,L-1 \end{array}\right\} \ (6)$$

In the case where equations (1)-(6) are used, an algorithm was developed to remove noise from colorless images in order to improve the clarity of images using a histogram while keeping the pixel value of the image. Contamination refers to the combination of natural and man-made factors at the time of image capture that can damage the quality of the image. For example, foggy, rainy, cloudy conditions were taken into account. So, by using the histogram, it is possible to clarify the image by looking at the pixel values as color intensities and changing their initial intensity to another intensity.

We develop an algorithm for digital processing of images, and the block diagram of the algorithm is shown in Fig. 2 below.

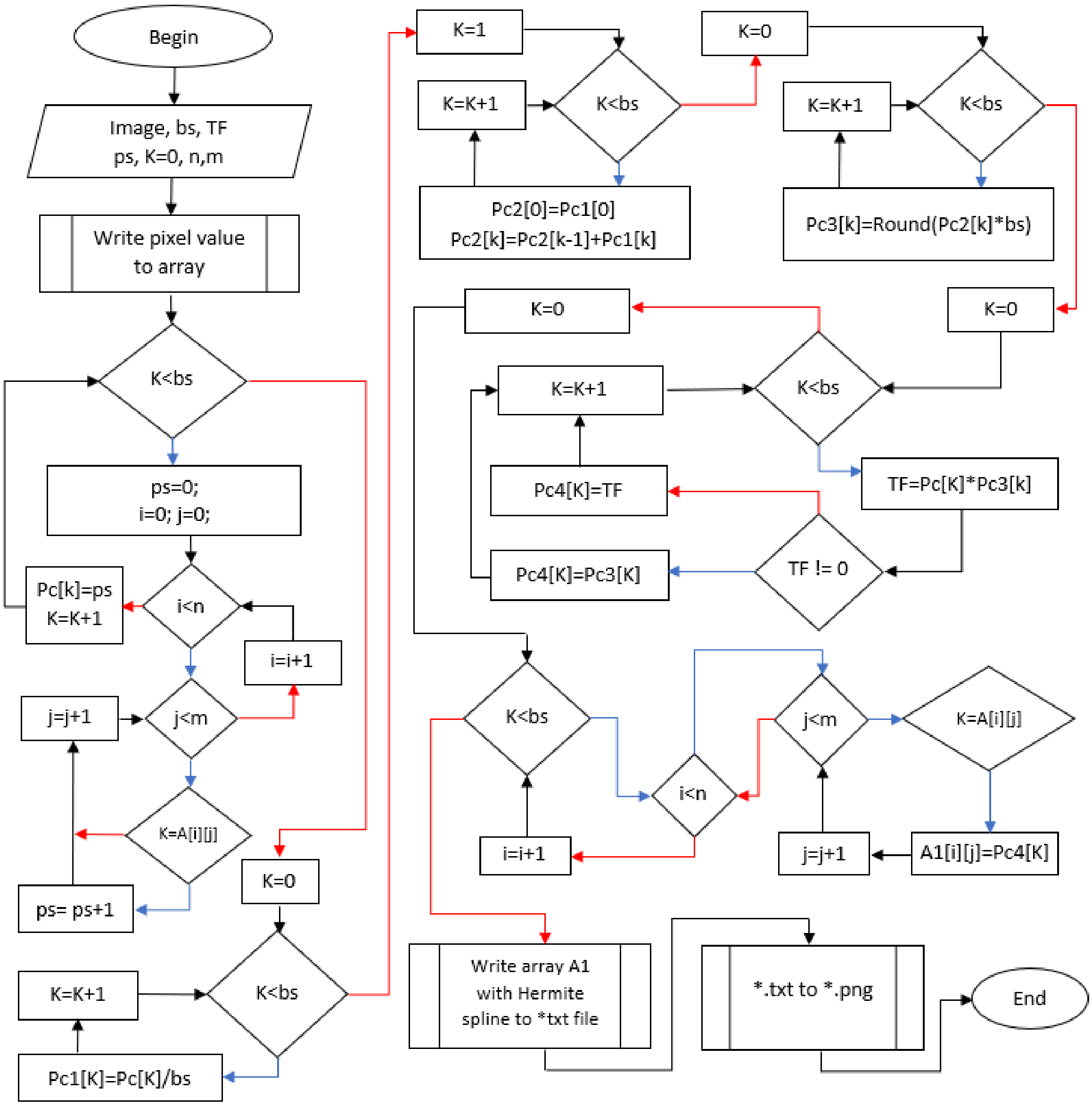

Figure 2. Algorithm for removing noise from images using a histogram methods.

In the algorithm developed above, it was cleared of errors. In order to increase the accuracy of the image. In order to determine the efficiency of the developed algorithm, we take the following

image in JPEG format, which consists of 1600x900 pixels, taken on a cloudy and foggy day, and consider digital processing using the algorithm presented in Figure 2 (Figure 3).
Figure 3. Initial view of the image.

First, we can digitize figure 3 by dividing it into pixels for digital processing. As a result, we have a table equal to 1600x900 (Table 1).

Table 1

The initial digital representation of the image

№	x_1	x_2	x_3	x_4	x_5	x_5	x_6	x_7	…	x_{1600}
y_1	77	78	79	79	78	78	78	77	…	90
y_2	76	77	78	78	78	78	79	76	…	88
y_3	75	76	78	78	78	78	79	75	…	88
y_4	75	77	78	79	79	79	80	75	…	88
y_5	75	76	78	78	78	78	79	75	…	90
y_6	75	77	78	78	78	78	79	75	…	93
y_7	76	77	78	79	78	78	79	76	…	99
y_8	75	75	74	74	75	76	76	75	…	101
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
y_{900}	77	78	77	77	78	77	77	78	…	76

Using the considered algorithm, we first change the pixel intensity of the image presented in Table 1. (Fig. 4).

Figure 4. The result of numerical processing using the developed algorithm.

We put the digital representation of the image in Table 2 to clarify the numerical performance results using the algorithm presented in Figure 2.

Table 2.

№	x_1	x_2	x_3	x_4	x_5	x_5	x_6	x_7	…	x_{1600}
y_1	12	16	20	20	16	16	16	20	…	57
y_2	7	12	16	16	16	16	20	20	…	52
y_3	5	7	16	16	16	16	20	24	…	52
y_4	5	12	16	20	20	20	24	27	…	52
y_5	5	7	16	16	16	16	20	24	…	57
y_6	7	12	16	20	16	16	20	20	…	65
y_7	5	5	4	4	5	7	7	12	…	81
y_8	5	5	5	4	5	7	7	12	…	86
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
y_{900}	12	16	12	12	16	12	12	16	…	7

From Figure 4, we can see that by changing the intensity of the gray level using the histogram, the number of pixels from the original state of the image and we have achieved an improvement in the quality of the image. We analyze the changes in the initial and final images. The initial color intensity value of the image is RV, and the intensity value obtained by the proposed algorithm is DV (Table 3).

Table 3

Analysis of image color intensities

№	0	1	2	3	4	5	6	7	8	9	10	…
RV	77	76	75	78	90	80	101	88	79	74	99	…
DV	12	7	5	16	57	24	86	52	20	4	81	…

Looking at the table, it can be seen that the original pixel value has changed significantly. Color intensity is close to black when the pixel value is high, and close to white when it is close to 0. The results show that our proposed algorithm is effective in improving image resolution.

Conclution.

The colorless images in the JPEG format were cleaned of image distortions using our proposed algorithm. First, the intensity of the gray level was changed using a histogram. In order to increase the accuracy of the image, the number of pixels has been increased. As a result, the resolution of the image was equal to 1600x900. The initial size of the image was 472 Kbytes, and as a result of digital processing it was equal to 1,15 Mbytes. Increasing the resolution of the image caused it to take up more than 2 times the size of the hard disk. In the process of diagnosing diseases with colorless images in medicine, when medical images contain various noises and distortions due to technical malfunctions, experts make it difficult to make a correct diagnosis of the disease. In such cases, the use of the proposed algorithm developed during the research shows that it is effective.

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