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On the Image Enhancement histogram Processing

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Abstract*—With the using of Image processing widely .Image enhancement technology has become a hot research field of image processing recently, it can improve the quality of images . This article mainly introduces two aspects, namely, histogram equalization processing and provision of enhanced methods . Meanwhile, compared the pre-processing with post- processing,the relative formulas and standard digital images have been shown in this paper. The experimental results have shown that the histogram equalization and specifications can improve the contrasted effect. According to the algorithm of histogram equalization and specifications, intensive gray distribution of the original image has become more sparse, so the image processing visual effects and its contrast can be improved.

***Keywords*—digital image processing; image enhancement; histogram; equalization; specification**

I. INTRODUCTION

In order to improve the visual effect, facilitate human, machine analysis and image processing, image processing is a method which improving the characteristics of the image or taking measures to strengthen the feature. Image acquisition, transfer or process of transformation, some objective factors that the optical system distortion, and other system noise, underexposed or excess, are prone to degradation of the image, reducing the visual effect of the image, or improve the error rate in the machine vision, therefore, to improve the situation, we must take certain means.Image enhancement technology is raised in this case. The primary goal is to enhance the image process for image processing, improve the visual effect of the entire image or to enhance the image of certain information in accordance with specific needs and in order to be better than the original image or a more useful image. That is to highlight interesting information, while suppressing the image information is not interest method. In other words, image enhancement purpose is to improve the image quality. Image enhancement processing has two main purposes, firstly, meeting the human visual needs, in this case, the person is a judgmental measure of image enhancing effects, there is a certain subjectivity; secondly, meeting the needs of machine vision, in this case is not required to meet the human visual effects, and the machine characters for the perception of the image to determine the effect of image enhancement. Image enhancement methods are mainly divided into two categories: spatial domain and frequency domain enhancement methods. Frequency domain is the Fourier transform processing technology as a basis for modifying images; spatial domain enhancement method is based on direct processing image pixels to change the image, it belongs to directly enhance the method. Spatial domain comprises basic gray transform, histogram processing, eliminate noise smoothing and enhanced edge sharpening method. Histogram enhancement which belongs to the spatial domain enhancement method is discussed in this article .

II. HISTOGRAM PROCESSING

A. Histogram Fundamentals

Histograms are used to represent a digital image of the statistical relationship between the each of number of gray levels and its occurrence frequency (the number of gray pixels) .In the Cartesian coordinate system with the abscissa represents gray level, the ordinate represents the gray level frequency. It assumed that the digital image gray level is $[0,\ l-1]$,the histogram of a digital image is available discrete function

$$p(r_k) = n_k / n \tag{1}$$

In the formula, r_k is a gray-scale level k ; n_k is the number of pixel gray level k ; $p(r_k)$ for the φρεθυενχψ of gray level k ; n is the total number of image pixels.

To sum up, $p(r_k)$ gives the probability of gray level r_k occurred estimates, so histograms of the original image gray value distribution, a description of all the gray values of the overall image is given. Histogram of the gray value range of the original image, distribution of gray levels, the entire image of the average brightness and so on, will be roughly described.as shown in Figure (1).

Figure (1) a pixel gray values are concentrated in a small area, so the corresponding dynamic range of the image is small, low contrast; Figure (1) b of the pixel gray value gray value concentrated in a smaller area, the corresponding image will

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dim on the whole; Figure(1) c of the pixel gray scale value distribution is more uniform, large dynamic range, corresponding to the image contrast, and high image quality; Figure (1) d of the pixel gray value gray value concentrated in the larger region, corresponding to the entire image on the bright side. So you can change the pixel gray value to change the shape of the histogram of the image to enhance the contrast of the image, commonly used methods are histogram equalization and histogram specification.

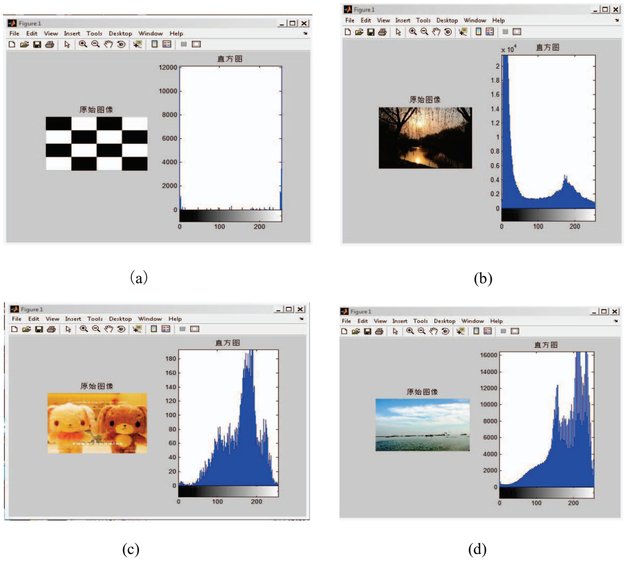

Fig. 1. Different types of histograms

(a) Contrast histogram of the smaller picture

(b) Dim the brightness of the image histogram

(c) A clear image histogram

(d) Dim the brightness of the image histogram

Histogram of the digital image has the following characteristics:

(1)A histogram is a gray value of each pixel in the image appears in the frequency statistics, so the frequency of the histogram reflects only the pixels in the image of a certain gray value occurs, but does not reflect the position of each pixel where the gray value information.

(2)An arbitrary image can uniquely calculate a histogram and its corresponding, but the same histogram may correspond to different images.

(3)Histogram of an image do not overlap each sub-section of an image and the image histogram equal.

B. Histogram Equalization

Histogram equalization The basic idea is to change the original image pixel gray value of the number of pixels in the image more gray value to widen, while the number of pixels in a small gray-level reduction, the image is converted into the form of a histogram corresponding to a uniform distribution, thereby enhancing the overall contrast of the image, to achieve the purpose of image enhancement, image information included in the maximum case. Histogram equalization is a distribution function transformation method based on histogram modification method.

Explain what is evenly distributed,its main feature is the opportunity to appear in the measured values throughout a range of the same,that uniform, it is also known rectangular distribution or the like of probability distribution.

r is set to be enhanced original image normalized gray value, s is the normalized gray value enhanced new image,and $0 \le r$, $s \le 1$;when the $r=s=0$, showing black,when $r=s=1$,showing white; n_k is a total number of pixels in the original image gradation value is k ,the probability distribution density of $p_r(r_k)$ .Histogram equalization is to find a transformation,So the probability of any of the histogram shown in FIG.2(a) with probability density distribution is converted into an image as shown in FIG.2(b) is close to the density histogram of the image.

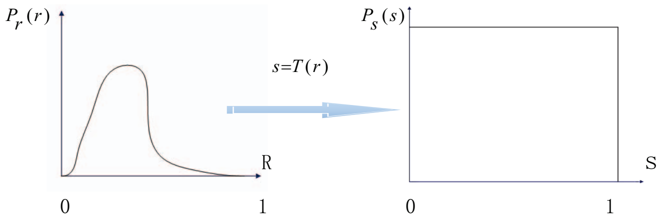

Fig. 2. Probability density distribution histogram

(a)Arbitrary probability density distribution histogram

(b)Uniform probability density distribution histogram

Obviously, histogram equalization transform function to meet the above idea:

$$s=T(r)\,,\quad 0 \le r \le 1 \qquad (2)$$

Formulas, $T(r)$ shall meet the following conditions:

(1)In $0 \le r \le 1$ is a monotonically increasing function;

(2)In $0 \le r \le 1$ parentheses, there is $0 \le T(r) \le 1$.

Wherein the condition(1)to ensure the gray level from black to white in the same order, the condition(2)to ensure pixel grayscale mapped within the allowed range. Inverse transform relationship

$$r=T^{-1}(s) \qquad (3)$$

$T^{-1}(s)$ for s also satisfies the above two conditions.

By the probability theory shows that if the random variable r is known probability density is $P_r(r)$,the random variable s is a function of r ,the s 's probability density f can be determined from $P_r(r)$ .Assumed distribution function of the random variable s is denoted by $F_s(s)$, as defined by the distribution function has

$$F_s(s) = \int_{-\infty}^{s} p_s(s)\,ds = \int_{-\infty}^{r} p_r(r)\,dr \tag{4}$$

According to the distribution of the probability density function is a function of the relationship between the derivative of the formula (4) on both sides of the derivation s available

$$p_s(s) = \frac{d}{ds}\left[\int_{-\infty}^{r} p_r(r)\,dr\right] = p_r(r)\frac{dr}{ds} = p_r(r)\frac{d}{ds}[T^{-1}(s)] \tag{5}$$

From equation (5) it can be seen, the transformation function $T(r)$ may control the image gray level of the probability density function, thereby improving the gradation image, which is the basis of the histogram equalization.

From the human visual system to consider, if the histogram of an image is uniformly distributed,when $p_s(s)=k$ (after normalization （$k=1$),This image feel more harmonious. Thus requiring the original image histogram equalization, in order to meet the requirements of human vision.

Because normalization assumed

$$p_s(s)=1 \tag{6}$$

By the formula (5) obtained $ds=p_r(r)dr$ .Points on both sides have

$$s=T(r)=\int_{-\infty}^{r} p_r(r)dr \tag{7}$$

Equation (7) is obtained by the transform function.It indicates when the transform function $T(r)$ is a cumulative distribution function of the original image histogram, histogram equalization to achieve the purpose.For discrete digital grayscale images, instead of the probability of the frequency, the discrete form transfer function $T(r_k)$ can be expressed as

$$s_k = T(r_k) = \sum_{i=0}^{k} p_r(r_i) = \sum_{i=0}^{k} \frac{n_i}{n} \tag{8}$$

Formulas $0 \le r_k \le 1$, $k=0,1,2......l-1$ .Visible, after balancing the gray value of each pixel can s_k original image histogram is calculated directly.

C. c.Histogram Specification

Histogram equalization to automatically enhance the overall contrast of the image, but it's not easy to control specific enhancement, the result of the processing is always to get a global uniform histogram. However, in some cases, it is desirable to enhance the image after the histogram which is non-uniform, but has a predetermined shape of the histogram, which highlights some of the grayscale range of interest,therefore, by a gray-scale image function, the original image histogram can be transformed into a desired histogram, this method is called or histogram specification histogram matching. In this process, the histogram is corrected grayscale image function key. In general, the correct choice of the predetermined function, it is possible to get more than histogram equalization better results.

Command $P_r(r)$ and respectively represent the original image and the desired probability density function, while they histogram equalization, then:

$$s=T(r)=\int_0^r p_r(r)dr \tag{9}$$

$$v=G(z)=\int_0^z p_z(z)dz \tag{10}$$

$$z=G^{-1}(v) \tag{11}$$

Equalization processing to produce the final result $p_s(s)=1$ the probability density has nothing to do with the inner integral.Thus, the probability of the original image and the desired image density of the processed $P_s(s)$ and $P_v(v)$ have the same uniform density. Thus, instead of the reverse process of a uniform gray v obtained from the original image, the result grayscale

$$z=G^{-1}(s) \tag{12}$$

Is the desired probability density function. The above process is:

(1) the original image gradation equalization.

(2) the probability of the target image a predetermined function of the desired density, and to obtain the transfer function $G(z)$ by the formula (10).

(3) calculation of the target image inverse transformation function $z=G^{-1}(s)$, it has been desired gray level.

Can be obtained from the above discussion:

$$z=G^{-1}[T(r)] \tag{13}$$

Discrete image, the corresponding provisions of the expression:

$$p_z(z_k)=\frac{n_k}{N} \tag{14}$$

$$v_k=G(z_k)=\sum_{i=0}^{k} p_z(z_i) \tag{15}$$

$$z_k = G^{-1}(s_k) = G^{-1}[T(r_k)] \qquad (16)$$

The above formulas show, An image determines the $T(r)$ and the inverse transform function $z = G^{-1}(v)$ can be histogram specification,but to give $T(r)$ and G^{-1} in practice it is unlikely.Fortunately, in the discrete case, this problem to a large extent, is simplified.Overall, the histogram does not require provision for any given task must be reinforced by means of the actual analysis.

III. CONCLUSION

This article describes the theoretical histogram processing and equalization provisions commonly used histogram method. The processing of proving is described briefly. Verification showed that the histogram processing techniques for image enhancement processing has a better effect, it can be applied to various fields, such as medicine, electronics and aerospace. It should be noted, the general theory of image enhancement does not exist, the final result of a particular method which is determined by an observer.

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