The improved contrast control method for LCD monitor

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Abstract : In this paper, we propose an improved contrast control method for image improvement of multi-gray scale image. The proposed contrast control method can improve contrast of image by changing gradient of weight as the type of input image. In addition, the proposed method does not require field and frame memory for large amount of computed data. And, the proposed method can be easily applied to the FPD for real-time processing because of its less hardware complexity than that of the conventional methods. Also it can flexibly control the contrast of input gray level by varying the weight values that control the contrast range. The operation and performance of the proposed controller have been verified using computer simulation.

1. Introduction

Today, an industrial development of information and telecommunication replaces a conventional CRT(Cathod Ray Tube) with FPD(Flat Panel Display) since CRT is much more bulky and consumes high power than the FPD. The main advantages of FPD include lightweight, thinness, high resolution, and low-power consumption.

Generally, the means of image quality enhancement are utilized contrast control, edge enhancement, and noise reduction. The contrast control method among these methods do not increase the inherent information contents image data[1]. A contrast indicates the range of luminance from highlight to shadow of an image. In order to enhance an image quality using contrast control, histogram that indicates distribution of luminous intensity on the image should be properly expanded.

In this paper, we describe the conventional method of contrast control in section 2 and the proposed contrast control method for enhanced image quality on a FPD and show how the proposed method expands histogram efficiently in section 3. Finally, we discuss the feature and performance of the proposed method in section 3 and 4.

2. The conventional methods

The conventional digital contrast control methods are implemented by using lookup table, histogram sliding, and histogram stretching.

The lookup table method is that a present pixel value is used as address of lookup table and data of address, weight value becomes a new pixel value. Since this method requires extra memory to save calculated weight values, its circuit becomes more complex[2,3]. The lookup table method expresses by Eqn. (1).

$$New Pixel = DATA[Address(Input Pixel)] \quad (1)$$

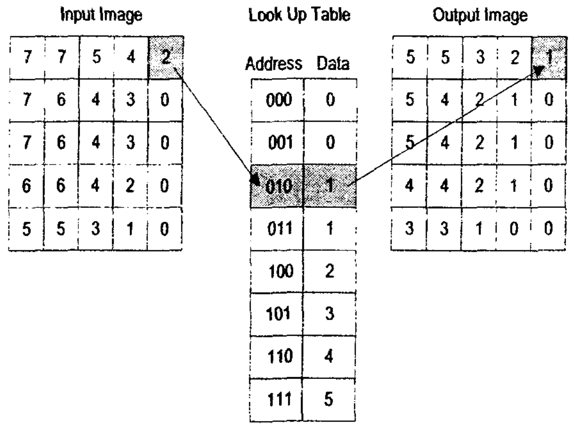


Figure 1. The 3-bit lookup table method

The histogram sliding method uses the relationship of function between an input pixel and an output pixel as shown in Fig 2. It does not require extra memory comparison with the lookup table method, but needs a circuit to prevent underflow and overflow since the weight is always constant[4,5].

$$New Pixel = Input Pixel \times Weight \quad (2)$$

The histogram stretching method shifts histogram of an image to left using low pixel value and expands histogram to the overall range as followed in Eqn. (3). This method has disadvantage for real-time processing since it require complex multiplier and divider.

$$New Pixel = \frac{Input Pixel - Low Pixel}{High Pixel - Low Pixel} \times 255 \quad (3)$$

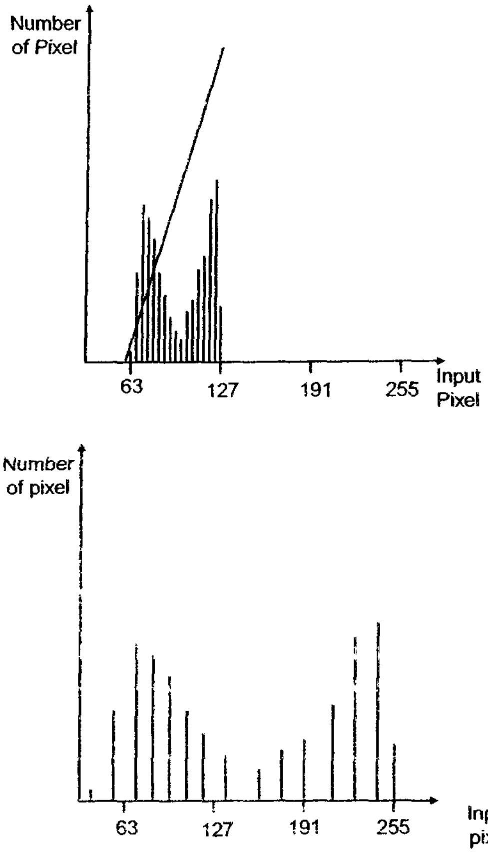


Figure 2. The histogram sliding method

3. The proposed method

The proposed method is given by the following Eqn. (4).

$$\begin{aligned} &New\,Pixel = (Input\,Pixel - Low\,Pixel) \times (M + US) \\ &If\,(16 \le DR \le 127)\,then \\ &\quad \{-2,-1,0,1,2\} \in US \qquad (4) \\ &else \\ &\quad \{0, 0.125, 0.25, 0.375, 0.5, 0.625, 0.75\} \in US \end{aligned}$$

In Eqn. (4), if we subtract an input pixel from its lowest pixel value in an image, the histogram is shifted to the left. In order to prevent overflow and expand the range of histogram including the overall histogram, the proposed method calculates weight value M+US. A user can control the contrast of an image using the US(User Select). The US(User Select), which acts as an optional function, can control the range of contrast. If the DR(Difference Range) is from 16 to 127, the US is defined from -2 to 2 and if the DR is more than 128, the US is set such as 0, 0.125, 0.25, 0.375, 0.5, 0.625 and 0.75.

The value of M(Multiple) is an integer in the difference of maximum and minimum pixel value as followed in Eqn. (5). If histogram of an image is not continuous but discrete distribution, the value of M doesn't become desired value which is the characteristic of histogram on the image. Therefore, the proposed method calculates the maximum and minimum pixel values whether histogram of an image is continuous distribution or not using reference number of pixel as shown in Fig. 3 and 4.

$$M = INT\left(\frac{255}{High\,Pixel - Low\,Pixel}\right) \qquad (5)$$

If we apply the conventional histogram stretching method to an image, then the maximum and minimum pixel values will become 255 and 0, respectively as shown in Fig. 3. Although the range of histogram is between 0 and 255, we will blurry see the image of Fig.3 since most histogram is concentrated on center of grey level.

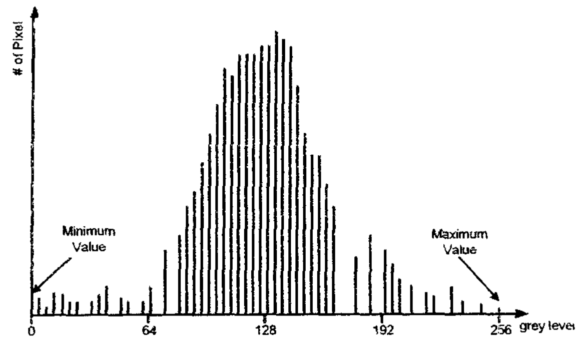


Figure 3. The example for discrete histogram

In order to prevent the above case, we propose histogram filtering method that selects the range of grey level which indicates main luminous intensity of the image using reference number of pixel as shown in Fig. 4. In Fig. 4, the maximum and minimum pixel values become 160 and 80, respectively by histogram filtering and we can see more sharp the image by expanding the range of histogram.

Fig. 5 shows a flow chart for calculation of the effective maximum and minimum pixel values in order to set the value of M using histogram filtering. In Fig. 5, the RV(Reference Value) is a reference number of pixel for histogram filtering, and HP(High Pixel) and LP(Low Pixel) are effective maximum and minimum pixel values respectively.

The proposed method can provide image improvement regardless of input grey level. In addition, we propose that a contrast control can be easily applied to the FPD for real-time processing because of its lower hardware complexity than of the conventional methods.

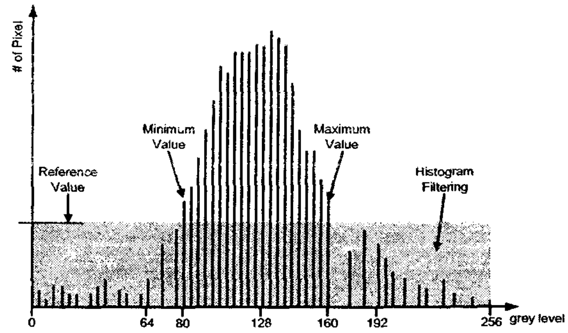


Figure 4. The concept of histogram filtering

In Fig.5 the type of input image is divided into three modes(Dark mode, Middle mode, Bright mode) by mode detection. After detecting mode, back light voltage is selected. If detected mode is bright mode, output back light voltage is high voltage. Dark image chooses the low voltage and middle image chooses the normal voltage. Therefore, back light voltage can be adaptively selected as decided mode and it can bring the rising effect of contrast. While, histogram expansion is performed by improved histogram stretching algorithm that can adjust weight by US(User Select).

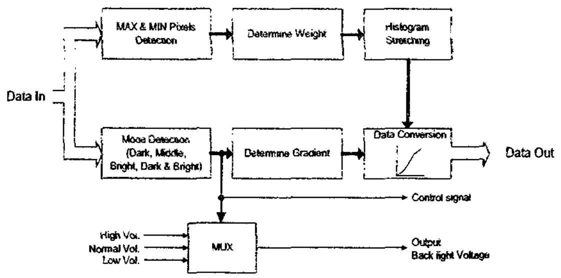


Figure 5. The principle of the proposed contrast control method

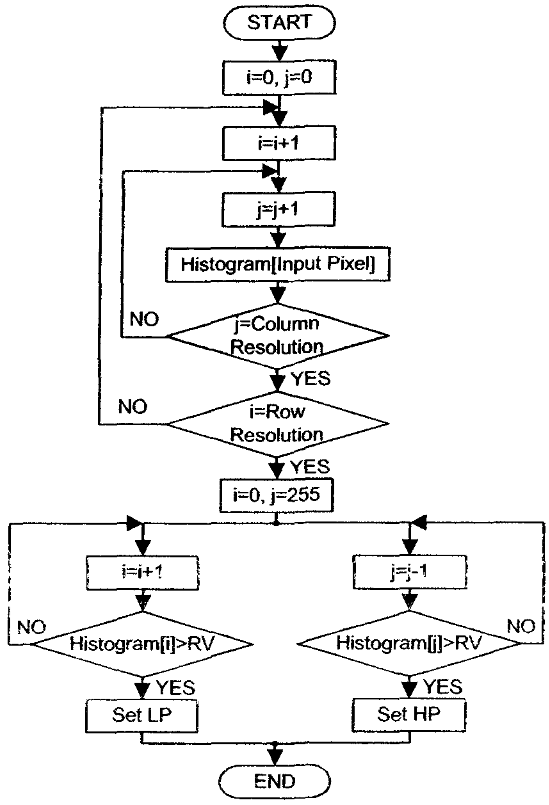


Figure 6. The flow chart for histogram filtering

4. Simulation and results

We have compared the histogram of image processed by the proposed method using computer simulation. Sample images are salesman with 512×480 resolution.

Fig. 7 represents the original image and the image processed by the proposed contrast control method. Fig. 6(b), (c), and (d) are processed according to the reference value by histogram filtering. It is clear that the images processed by the proposed method improve the image quality.

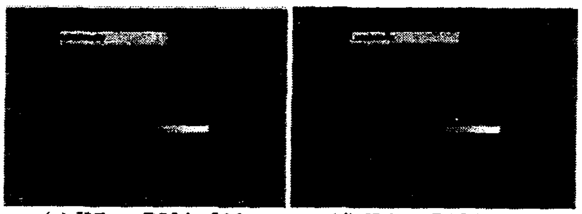
(a) Original image (b) When RV is 100

(c) When RV is 500 (d) When RV is 1000

Figure 7. The salesman images : (a) original image, (b), (c), and (d) images processed by the proposed contrast control method

Fig. 7 shows the histogram for the above images. Fig. 7(a) represents the histogram of the original image and its histogram concentrates on one side. In Fig. 7(b), (c), and (d), we know that the histogram spreads over the wide range. Quantitatively, we also know that the histogram of the image processed by the proposed control method is wide through its standard deviation that indicates a measure of the dispersion or variation in a distribution as followed in Table 1.

(a) Original image (b) When RV is 100



(c) When RV is 500 (d) When RV is 1000

Figure 8. The histogram of the above images

Table 1. The standard deviation of the Fig. 7

(a) Original image	(b) When RV is 100	(c) When RV is 500	(d) When RV is 1000
19.81	54.04	64.00	82.62

5. Conclusion

In this paper, we propose a contrast control method for enhanced image quality. The proposed method can spread out the histogram of an image widely using histogram filtering method. The histogram filtering method can decide the effective maximum and minimum pixel values which are required to stretch out the histogram. Also, the proposed method can be easily applied to FPD for real-time processing because of its lower hardware complexity than of the conventional method.

The proposed method has been verified by histogram and its standard deviation using computer simulation. And its results show that the proposed method improves image quality visually and quantitatively.

6. References

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