Fire Extinguisher Recognition using Robust Color Detection and Gamma Correction

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Abstract: In this paper, we propose an algorithm to detect the fire extinguisher in real time through the camera lens using the robust color detection for reducing optical noise with color detection method and gamma correction to 2-channel operation.

The proposed algorithm has been decreased the calculation time about 64% (conventional method : 4.182ms, proposed method : 1.505ms) than conventional method using prominent object color to change the YCbCr model. Also, the error rate by the noise decreases about 43% because proposed method uses a gamma correction.

As a result, it shows the processing speed of 10.8ms per frame and the detection rate of 96% per frame, it can quickly and accurately detect the color information for object tracking.

Keywords--**Color Detection, Gamma Correction, Object Tracking, Fire Extinguisher Recognition.**

1. Introduction

The study of the recognition technology about image processing for Internet of Things (IoT) has been actively conducted. The image processing technology using shape detection, pattern analysis, color and line detection has been applied a variety of fields. Also, it is used in intelligent vehicle and parking management systems, etc.

In recent years, the fire extinguisher installed around the building frequently has often the case that is lost. Moreover, the case to use a fire extinguisher for other purposes has been increasing. In this case, they all correspond to a violation of fire defense regulation and if the fire occurs it delays action of extinguishing. In this paper, we propose an algorithm for detecting the fire extinguisher using camera lens with monitoring device.

Existing method of color detection using the HSV, HSI, YUV(YCbCr)[1,7,8] has a characteristic for performing an operation of the 3-channel. This method spend a lot of time in the conversion process, and it is required also solution for additional noise reduction.

The proposed method highlight color in image with the RGB color model[1,7,8]. it is possible to reduce the other noise. Furthermore, using the proposed method can be detected the extinguisher accurately and quickly, it will be means to solve problem of stolen.

2. A proposed Method

As shown in Figure 1, a proposed fire extinguisher recognition algorithm is consists of six steps.

This algorithm highlights the red, green or blue in color using subtraction of Gray scale and the R, G, B channels. In this case, fire extinguisher emphasizes the red color, and through the gamma correction is to remove the noise other than the object. Using Labeling and Binarization displays the presence or absence of object.

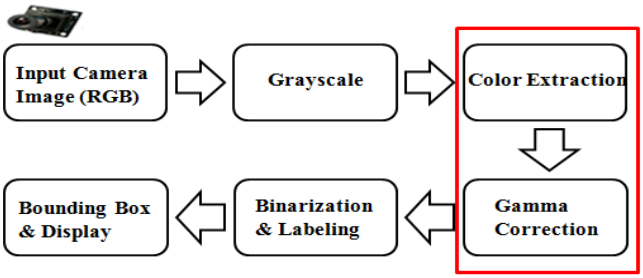
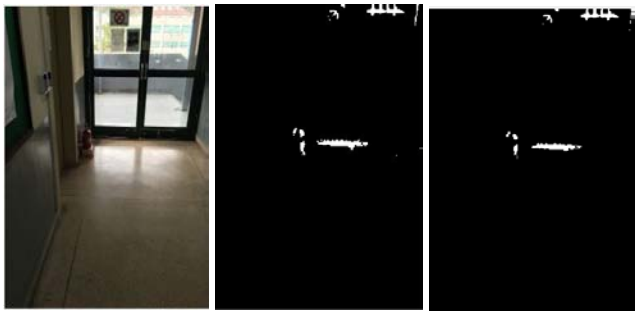


Figure 1. Block diagram of a proposed algorithm.

The aim of this paper is fast color detection in RGB image and to reduce as much as possible all noise other than the object. Finally, it is mean to increase detection rate of object in fire extinguisher detection system.

2. 1 Color Detection

The color detection used the difference between the red channel and gray-scale[3,6] channel such as Equation 1. It emphasizes red channel, and shows as Figure 2. Because it is possible to detect the subtraction of channels without converting into another color model, the computing speed and accessibility has greatly improved.



(a) original (b) traditional method(Cr) (c) proposed method

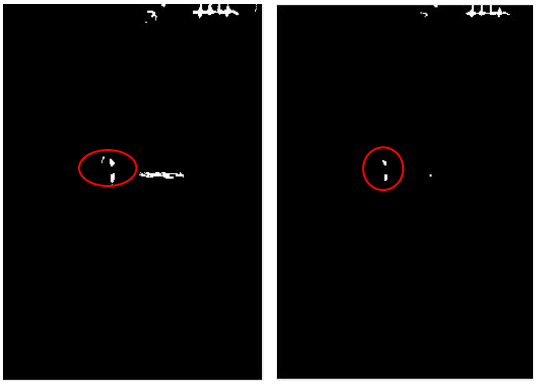
Figure 2. The results of binary. [Thresholds : (b) 0.54, (c) 0.07]

$$red = R - (R/3 + G/3 + B/3) \quad (1)$$

As shown in Figure 2, The proposed method similarly displays as the conventional method for extracting Cr in YCbCr model[1,7,8]. But, when input data is RGB color, processing time for Cr extraction in color change has more time. Also, The present detection method can highlight blue and green as well as red.

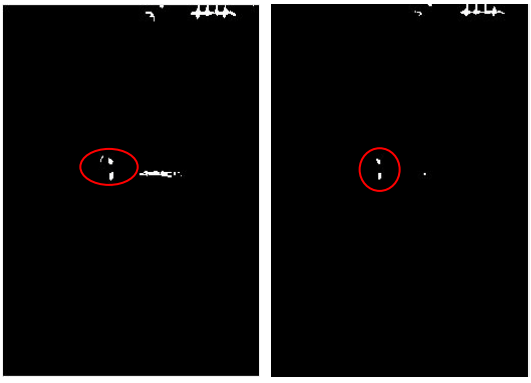
The proposed detection method may also highlight each Green, Blue, Red color in the same way as well as improvement of processing time. In addition, it has low error rate and high color detection rate than 3-channel threshold approach method. [4]

Figures 3 and 4 are the results obtained by using the threshold for binarization of traditional and proposed method.



(a) Thresholds 0.55 (b) Thresholds 0.56

Figure 3. The thresholds of traditional method.



(a) Thresholds 0.08 (b) Thresholds 0.09

Figure 4. The thresholds of proposed method.

It occur a change in the object in proportion to the noise In Figures 3 and 4. Therefore, It is requires irrelevant algorithm to noise for the binary of only object**.** It can be solved through the gamma correction.

2. 2 Gamma Correction

In this paper, using gamma correction in Equation 2 and color highlights in Equation 1 can make an improved red extraction as in Equation 3.

$$gamma(\mathrm{x}, \gamma) = 255(x/255)^{\gamma(x)} \quad (2)$$

$$red = gamma(R, \gamma) - (R/3 + G/3 + B/3) \quad (3)$$

It assumed as data of 8-bit integer in the Equation 2, which was normalized to 255. But, if it is 16-bit integer data type, can be normalized to 65535.

Figure 5 shows the non-linear characteristic[5] of the gamma values. The brightness values of the image are mapping to the new value. The value between the high_in and low_in are mapping to the value between low_out and high_out.

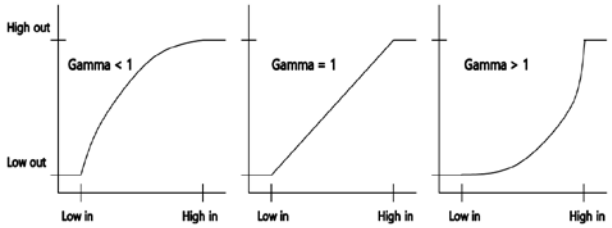


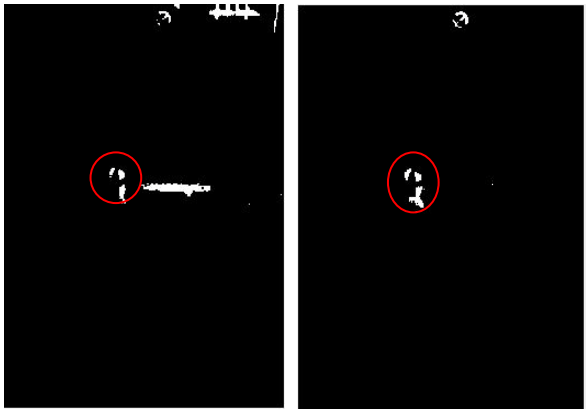
Figure 5. Non-linear characteristic of gamma value.

Using a non-linear characteristics of gamma correction remove noise outside the object, and by applying a gamma value in all the data you can eliminate the noise. But, it is more efficient to apply only R channel in the processing speed or performance. Figure 6 shows the gamma correction for Red channel using the original image.

(a) Original image (b) Gamma correction

Figure 6. Gamma correction of R channel.

Figure 7 shows result the binary threshold value of 0.3 by applying the gamma value of 0.5 in Equation (3). The result as shown in Figure 7 highlight the target object, it can be confirmed that the other noise are removed.



(a) Before (b) After

Figure 7. Binary results of Gamma application.

3. Experiment Results

In this paper, the proposed method was verified using MATLAB, we implement this system at environment of IAMD FX(tm)-8350 Eight-core 4GHz, 8GB Memory, Windows 10 Ultimate 64bit, MATLAB R2015a.

The image used for the result is recorded at a fixed position with a resolution of 720x400. The color model of the image is highlighted the R channel in proposed method using the RGB. The binarization image of the removed noise is obtained through gamma correction for this emphasis image. Finally, display bounding box for the object the proposed binary information.

In Table 1, we compared various parameters of between proposed algorithm and the conventional algorithm.

Table 1. Results of R value extraction.

	existing method	proposed method
Resolution	720x404	720x404
Whole Pixel	872640	872640
Performance	-	-
Process Speed (ms)	4.182	1.505

Table 2 shows Resolution, Whole Pixel, Binary Pixel, Object Pixel, Detection Rate (%), Error Rate (%), Processing Speed (ms) until the binary.

The detection rate was calculated as a object pixel per binary pixel, the error rate was calculated as a noise pixel per binary pixel**.**

The standard pixel of noise is defined all binary pixel excluding the object. The threshold value used in the binarization operation was applied to all of the optimum conditions (existing method : 0.55, proposed method : 0.3).

Table 2. Results of Binarization.

	existing method	proposed method
Resolution	720x404	720x404
Whole Pixel	872640	872640
Binary Pixel	920	452
Object Pixel	490	435
Noise Pixel	430	17
Detection Rate (%)	53.26	96.24
Error Rate (%)	46.74	3.76
Process Speed (ms)	11.3	10.8

As shown in Fig 8, left figure is the result when fire extinguishers are present on the existing area, and right figure is the result when one of the extinguishers is not present.

Figure 8. Detection results. (Yellow : on / Red : off)

4. Conclusion

In this paper, we proposed an algorithm to detect the fire extinguisher in real time through the camera lens using the robust color detection for reducing optical noise with color detection method and gamma correction to 2-channel operation.

If the output of the camera is assumed to be RGB, the calculation time than conventional methods to convert YCbCr model was decreased to be about 64% (existing method : 4.182ms, proposed method : 1.505ms), through the gamma correction decreases the error rate according to noise by about 43%. As a result, proposed algorithm has about 10.8ms processed per frame, it was verified to make a system for detecting the fire extinguisher in real time.

In the future, we will develop the robust detection method to remove the noise caused due to the wind in nighttime situation difficult to identify the object. Furthermore, in order to inform this situation that is continued for a long time, we plan to study the integrated warning system including alarm.

5. Acknowledgement

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