International Journal of Scientific & Engineering Research, Volume 7, Issue 11, November-2016 1001
ISSN 2229-5518

Simple Genetic Algorithm to Adjust White Balance in Color Images

RaghdaSattarJabar and Assist. Prof.Dr.Abdul-WahabS.Ibrahim

Abstract

Automatic White Balance (AWB) is one of the important functions for digital cameras.it plays a rather important role in the digital camera, its purpose is to remove the color case as the camera imaging, and keep the color constancy in the different illumination. Imageswith color cast always lose the color contrast and variations, especially those with heavy color cast. For traditional white balance algorithms, the lost color contrast and variations would probably resultin the incorrect color temperature predictions and the lack of contrast in the output images. In thispaper, a new automatic white balance algorithm through the Genetic Algorithm is proposed. The proposed approach keeps the assumption of the gray world method (GW)and the wide color range of color.

Introduction

In digital camera devices, Auto White Balance (AWB) is one of the most important functions [1].Under different illuminants, because of the difference of the spectrum distribution, the color performance of the same object will not be the same. When a white object is illuminatedunder a low color temperature, it will appear reddish in the recorded image. Similarly, it will appearbluish under a high color temperature [2]. Human eyes have the "color constancy" ability to cope withdifferent lighting conditions by adjusting their spectral response, while video cameras do not [3]. Thegoal of white balance is to process the image such that it looks as if it is taken under the canonical light [2].

One of the famous method that used to adjust white balance is "The gray world assumption" [4] which states that, the average value of the RED, GREEN, and BLUE colors of the image should average to a gray-value by finding the value of K.

K= (Racc+Gacc+Bacc)/3

Where Racc, Gacc, Bacc are accumulative values.

Then correct colors by using the value of K and equation:-

$$\begin{bmatrix} R` \\ G` \\ B` \end{bmatrix} = \begin{bmatrix} \frac{K}{Racc} & 0 & 0 \\ 0 & \frac{K}{Gacc} & 0 \\ 0 & 0 & \frac{K}{Bacc} \end{bmatrix} * \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

The advantage of the GW method is its low computation. It has good performance if the image isequally balanced and with high color variation. However, the suitability is limited. For the image witha large range of uniform color, and for the image with heavy color cast, the performance is bad. The lackof color information and color variation would probably cause low contrast and variation of the result.

In the other famous method of " white patches in YCbCr color space":- the image converted into YCbCr color space, and then correction factors are found through equations:-

$$corrR = \text{Ymax/Ravr}$$
$$corrG = \text{Ymax/Gavr}$$
$$corrB = \text{Ymax/Bavr}$$

Where:-

Ymax:-is the largest value of intensity Y in YCbCr color space.

Finally the correction coefficient for the red one is then calculated by first plugging the newly adjusted values of the blue channel, and etc.[5,6,7]

Genetic Algorithm

The term Genetic Algorithm was used by John Holland at very first Genetic Algorithms (GAs) are basically the natural selection process invented by Charles Darwin where it takes input and computes an output where multiple solutions might be taken. The GAs is designed to simulate processes in natural system necessary for evolution. GA performs efficient search in global spaces to get an optimal solution. GA is more effective in the contrast enhancement and produce image with natural contrast. A Genetic Algorithm provides the systematic random search. Genetic Algorithms provide a simple and almost generic method to solve complex optimization problems. A genetic algorithm is a derivative-free and stochastic optimization method. Based on individual fitness value, genetic algorithm uses the operators such as reproduction, crossoverand mutation to get the next generation that may contain chromosomes providing better fitness. Basically in Genetic Algorithm the new child or chromosome obtained is made up of combination of features of their parents. So genetic algorithm is applied on any image to get the new enhanced image which is much better than the original one

- RaghdaSattarJabarcurrently pursuing masters degree program in Collage of Education in computer Science ,AL-Mustansiriya University ,Iraq, PH-+964770923077 E-mail: raghad862009@gmail.com
- Assist. Prof.Dr.Abdul-WahabS.IbrahimCollage of Education in computer Science ,AL-Mustansiriya University ,Iraq, PH-+9647730752500 E-mail: alfaqeerme@gmail.com

ISSN 2229-5518

that contains features of parents. The two parameters of genetic algorithm are crossover and mutation.
Following is the Simple Genetic Algorithm which includes GA operators.[8]:-

Genetic Algorithm ()
{Initialize population;
Calculate fitness function;
While (fitness value<> termination criteria)
{Selection;
Crossover;
Mutation;
Calculate fitness function ;}}

1. Proposed Algorithm

The structure of the current work:-

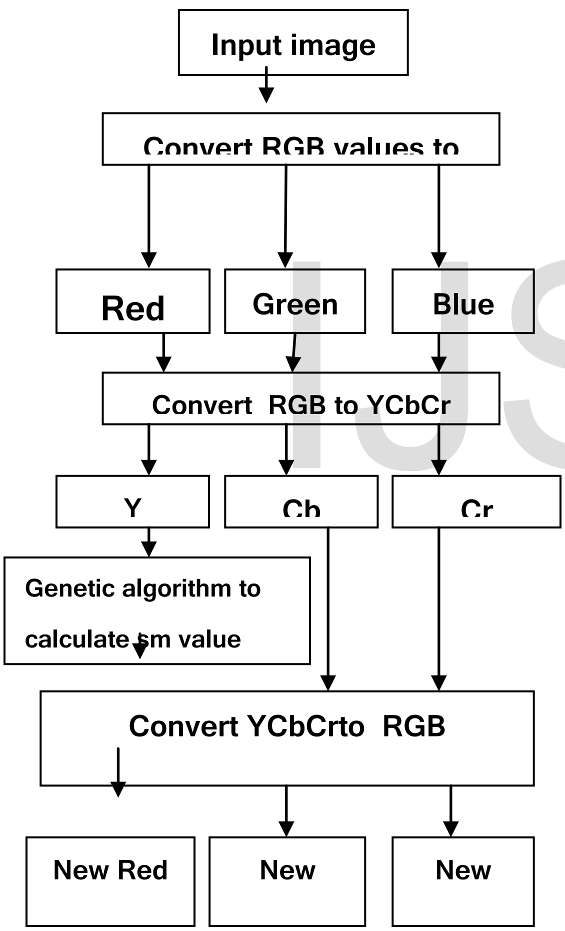


Fig (1) diagram of the main procedure of the project

I-choose an image:-

When receiving the image and reading its contents, we calculate the histogram of the image. Then the program will split the colors of image into three bands (Red, green, blue) after wards it converts the RGB to (YCbCr) by using the equations:-

$$Y = 0.183 * red + 0.614 * green + 0.062 * blue$$

$$Cb = -0.103 * red - 0.345 * green + 0.438 * blue$$

$$Cr = 0.43 * red - 0.393 * green - 0.037 * blue$$

III-Convert the value of (e) that used to correct colors value by using genetic algorithm

IV-correct value of Y, Cb and Cr in both colors (red and blue) but the green color won't change.

V-Calculate the value of (R, G, B) (inverse) by using the equations:-

$$R = 1.164 * Y + 1.793 * Cr$$

$$G = 1.164 * Y - 0.534 Cr - 0.213 * Cb$$

$$B = 1.164 * Y + 2.115 * Cb$$

VI-show the image

Genetic algorithm to adjust white balance:-

1- Initialization the first population

The population will choose (60) values from the values of y in the original image in a random way then put them in an array.

2- Evaluation the fitness of first population

In this step, we evaluate the individuals of first population by applying the fitness function to compute the fitness of individual's population, and then find the fitness by this relation

$$F = (a+b)/2$$

Where:-
a,b: are random values from population.
F: The fitness function(which must be larger or equal to mean value)

3-Selection two parents for crossover

For the selection mechanism, the user has to provide means to determine the relative fitness of the individuals. This can be done by comparing two individuals and deciding which one is better then select the individual with higher fitness to propagate into the next generation.

4-The encoding of children: In this step, we convert the value of parents to array of binary number which contain 8 bits each bits contain (1or 0) value depending because it is easy -

5-Crossover two parents and product two child:-The crossover is one of basic operators, where the two strings cut and crosswise re-combined to perform two new strings, which contain features of both parents. In this method, we will use one type of crossover (one point of crossover). The new offspring will have some properties from one parent and some properties from other parent. Example, suppose parent1 is 11001011 and parent2 is 11011111 and after performing the crossover we will get the output which contains some part of parent1 and other from parent2 i.e. 11011111.

11001011 + 11011111 = 11011111

6-Adding mutation to the new child

The mutation is one of the basic operators in GA, where one or more digits of the chromosome string change with probability pm. we used probability value 0.08.
Original offspring 1- 1101111010011110 Mutated offspring 1- 1100111010011110 Original offspring 2- 1101100100110110 Mutated offspring 2- 1101101100110110

3- Convert number to dismal value:-Convert the values to dismalnumber to compute value of y to use it to find the correction factor.

4- Replacement the new child with individual of old population:-replacement the new child with individual of old population

Adjust the white balance:-We adjust the white balance by using the value of fitness function in a range (0,1)to correct the y value in a whole image ,then compute (R,B,G) values to use them in show of image .

4. TheResult

In the experiment, the "color checker" image captured at different color temperatures is used as shown in Fig.(2-a) i ~ vii. Fig(2-b) (i ~ vii) Fig.(2-c) (i ~ vii) and Fig. (2-d)(i ~ vii) are the result images respectively adjusted by the GW method, the white patch algorithm and the proposed SGA algorithm.

The colorcontrast of the result images adjusted by the GW method decreases while that adjusted by the white patch method appears with red color. The proposed SGA can maintain both the color contrast and the details properly and can achieve better visual qualities and the details properly but it depend on the initial population because it is random ,

The distance metric, delta E, defined by the International Commission on Illumination, is applied to measure the difference or distance between two colors. Here YCbCr is used in our experiments and the formula is described as:

$$\Delta E = \sqrt{(Cr2 - Cr1)^2 + (Cb2 - Cb1)^2}$$

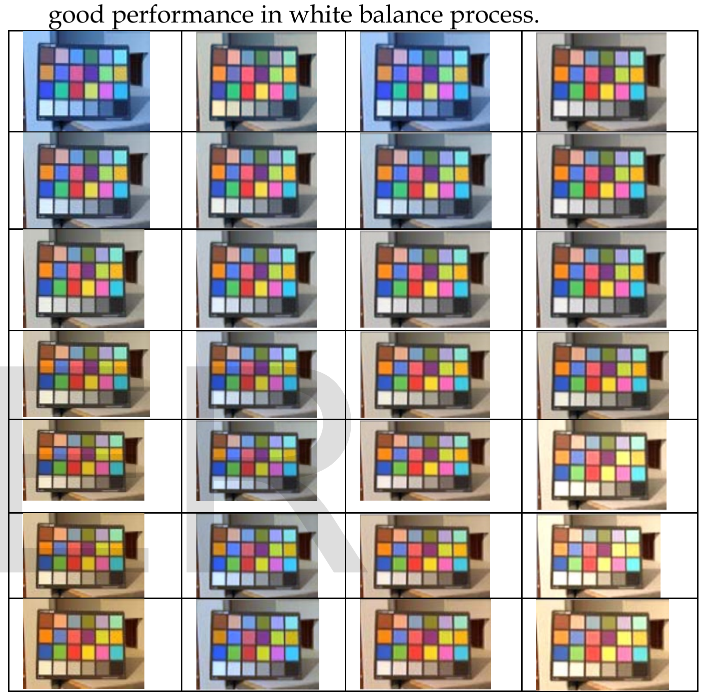
Where

ΔE: are calculated to describe the distance between the color performance of the processed images and that of the standard image.

Cr2, Cb2: is the coordinate of the adjusted images in YCbCr color space.

Cr1, Cb1: is the coordinate of the source images in YCbCr color space.

If ΔE has a small value, the corresponding image has good performance in white balance process.



(a) (b) (c) (d)

Fig 2. The result images from Fig. 2(a) i~vii by the gray world method (b), the white patch method(c) and the proposed SGA

The following table shows the different between the results:-

Table (1) average of cr,cb values

Image NO.	Gray Method		White Patch		SGA	
	Cr	cb	cr	Cb	cr	cb
I	-1	-2	-148	4	-81	3
Ii	5	-6	5	-6	-1	-6
Iii	5	-6	5	-6	15	-4
Iv	-1	-2	16	-12	41	-9
V	-1	-2	62	-16	31	-13
Vi	-1	-2	36	-19	38	-15
Vii	-1	-2	42	-21	148	-18

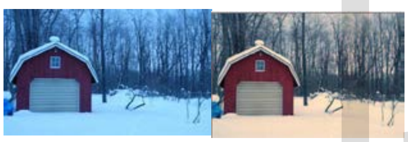
ISSN 2229-5518

The differences between the average values of Cb and Cr are smallest in grey method but the colors aren't real in it. The differences in SGA are large, but the colors are real.

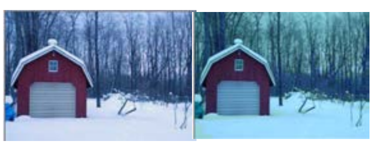
Table (2) ΔE values

Image NO.	Gray Method	White Patch	SGA
I	0.115	0.119	0.114
Ii	0.118	0.121	0.104
Iii	0.118	0.121	0.1
Iv	0.118	0.13	0.115
V	0.118	0.14	0.127
Vi	0.118	0.15	0.133
Vii	0.118	0.158	0.145

The ΔE Values in SGA are smaller than values in white patch because it correct color and Y values at same times. Besides the test images of color checker, the proposed algorithm also applied on the natural images.
Fig. 4 and 5 are the two samples of the results of the GW method, the white patch method and the proposed algorithm. Furthermore, the relative information values are listed in Table (3) and Table (4).
As shown in Fig. 3(a), the original image is bluish.



(a) Original image (b)GW



(C) white patch (d) SGA

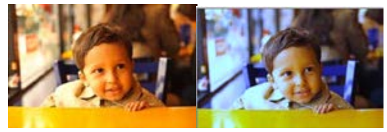
Figure 3. The bluish image and the results of the white balance algorithms.

For comparing, we used the Gray-World, White-Patch to correct the same original image with certain color cast, and then presented the results in the Fig. (3)as comparison. Apparently, the original image shot bluish, the Grey-World corrected it too much and made it look a little bit reddish; the Grey method and White-Patch only reduced the color deviation a little bit but not much; the proposed method obviously improved the performance of the color balance. The image appeared the vivid color that was similar to the human perception.

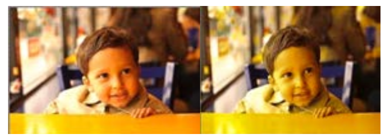
Table (3) information of figure 3

Value	Gray Method	White Patch	SGA
Cr	3	-143	-46
Cb	-2	23	15
E	0.067	0.154	0.132

As shown in Fig. 4 (a), the original image is reddish.



(a) Original image (b) GW



(C) white patch (d) SGA

Figure 4. The reddish image and the results of the white balance algorithms.

The original image show reddish, the Grey-World corrected it too much the White-Patch only reduced the color deviation a little bit but not much; the proposed method obviously improved the performance of the color balance. The image appeared the vivid color that was similar to the human perception.

Table (4) information of figure 4

Value	Gray Method	White Patch	SGA	SSGA
Cr	49	44	61	22
Cb	-8	-32	-46	-41
E	0.167	0.219	0.303	0

5. Conclusion

For the images with heavy color cast, the color variation would be low, which would cause the difficulties of color temperature prediction and the appearance of the resultswith low color variation.

The gray world method is the most simple and common white balance algorithm. It has lowcomputation and achieves good performance in most cases. However, with the level of color castbecoming heavier, the correction ability of gray world would be decreasing, because of the lost colorinformation. The white patch method corrects the color but the white color don't adjust in natural images.A new white balance algorithm is proposed in this paper, combining the advantages of the grayworld method and the white patch method.

Genetic algorithm are used to find value which correct Y,Cb and Cr values .

In the simulation results, it can be seen that the proposed GA has better performance thanthe gray world method and the white patch method in most cases.

References:-

[1] Hanma, Kentaro, Masuda, Michio, Nabeyama, Hiroaki, and Saito, Yohei, "Novel Technologies for Automatic Focusing and White Balancing of Solid State Color Video Camera," ConsumerElectronics, IEEE Transactions on , vol.CE-29, no.3, pp.376-382, Aug. 1983

[2]. R. C. Gonzalez and R. E. Woods, Digital Image Processing, Addison Wesley, MA,1992.

[3] D. A. Forsyth, "A novel algorithm for color constancy," International Journal of Computer Vision, Vol. 5, 1990, pp. 5-36.

[4] 5. Y. C. Liu, W. H. Chan, and Y. Q. Chen, "Automatic white balance for digital stillcamera," IEEE Transactions on Consumer Electronics, Vol. 41, 1995, pp. 460-466.

[5] D. A. Forsyth, "A novel algorithm for color constancy," International Journal of Computer Vision, Vol. 5, 1990, pp. 5-36.

[6]. V. Cardei, B. V. Funt, and K. Barnard, "Learning color constancy," in Proceedings of Imaging Science and Technology/Society for Information Display 4th Color Imaging Conference, 1996, pp. 58-60.

[7]. G. D. Finlayson, B. V. Funt, and K. Barnard, "Color constancy under a varying illuminates"

[8]Maričić B, 1991, 'Current Trends in Neural Network Design Tools Research, EC-News letter, Vol. 3, No. 1, PP 37-45.