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Constancy of Color using Histogram and Gradient Based Smoothening

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ABSTRACT

Color constancy is a procedure that measures the influence of the different light sources on a digital image. Lots of different techniques were used to achieve the color constancy. Earlier learning based and statistics methods used. Gray world, Max RGB method and Gray edge methods, Grey edge 1st order derivative and Grey edge 2nd order derivative are applied to digital image for color correction. In this paper, improved saturation weighting algorithm using histogram stretching and smoothening has been proposed which overcomes the drawbacks of previous techniques.

Keywords : Arduino, Wi-Fi (ESP 8266), Load cell, Database System

I. INTRODUCTION

Saturation weighting scheme:

The capability based on the intensity values and saturation values were observed [5], there was a similar method using this type of characteristic. The gray method gives high weights to the high values of each RGB channel according to the Minkowski norm *p*. Even if the method does not use the intensity channel but uses each RGB channel, since the values of each RGB channel can be thought as the independent intensity values of each channel, similar effects are expected. Therefore, the shades of gray method gives much better results than the gray world method. This method is based on the strong tendency of the performance changes according to the saturation values. Differently weighted pixels based on their saturation values will surely improve the performance of the color constancy. So a saturation weighting function added into the gray world method, which is called the gray world with saturation weighting (GWSW) given by

$$\int w^s(f(x))f_i(x)dx = ke_i,$$

Where s denotes the saturation strength factor, w(.) is the saturation weighting function,

where $w(f(x)) = (1 - S(f(x)))$, S(.) is the saturation value of the pixel.

The saturation weighting function is designed according to the observations. Since the pixels which have low saturation values tend to contain more information related to the light source than the pixels which have high saturation values. The value of the saturation weighting function decrease as the saturation value of a pixel increases. The saturation strength factor S added to the weighting function so as to adjust the strength of the weights.

For $s = 0$, method becomes the gray world method because all values of the saturation weighting function have equal weights.

For $s = \infty$, our method becomes the "do nothing" approach. Only when the saturation value is equal to zero, the weight becomes one but otherwise the weight becomes zero. Since the pixels whose saturation values are equal to zero are achromatic, they do not have color information, which results in estimating the light source as the canonical light source, i.e., the "do nothing" approach.

Finally this method was improved as general gray world with saturation weighting (GGWSW) presented as

$$\left(\int w^{s}(f(x))\left(f_{i,\sigma}(x)\right)^{p}dx\right)^{1/p} = ke_{i}.$$

The scale of smoothing operation σ handles local correlation between pixels. The smoothing operation reduces the influence of noise in an image and it was proven to be beneficial for improving the color constancy. In this way, we get better results than gray world method.

II. PROPOSED ALGORITHM

This section contains the various steps to achieve the objectives of this research work: Figure has shown various steps required to get the final image using the proposed algorithm. Subsequent are the various steps with brief detail:-

Step 1: First of all given image will be acquire and converted into a digital image to apply vision processing operations.
Step 2: Apply gray edge 1st order derivative to the digital image.
Step 3: Apply gray edge 2nd order derivative to the digital image.
Step 4: Apply saturation weighting scheme after edge applying.
Step 5: Apply histogram to the improved saturation weighting.
Step 6: Apply gradient based smoothing to preserve edges.
Step 7: Evaluate performance parameters.

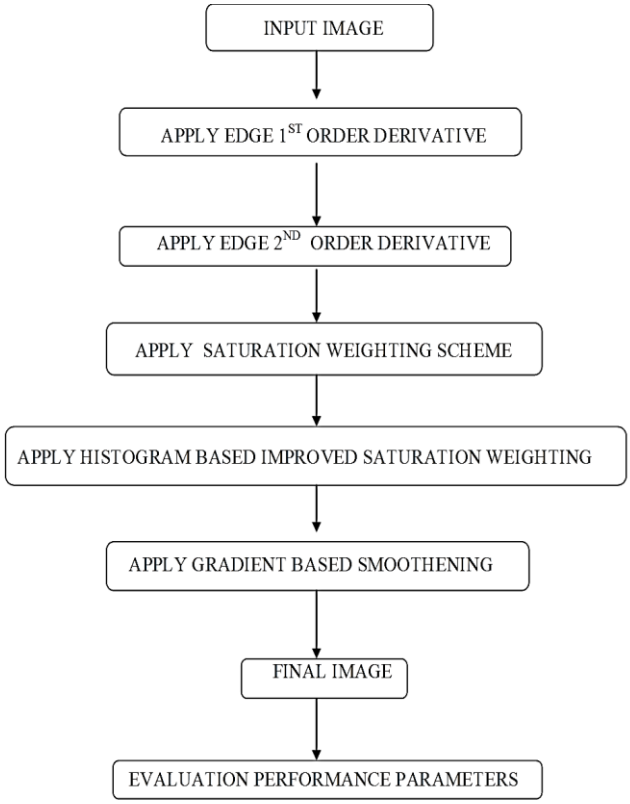

Fig. 1 Flow chart of proposed algorithm

III. EXPERIMENTAL SETUP

In this research work, we have taken 15 different images .Proposed algorithm can be implemented in MATLAB software using Image processing toolbox.

TABLE 1 EXPERIMENTAL IMAGE

Sr no.	Name	Format
1	Image 1	JPEG
2	Image 2	JPEG
3	Image 3	JPEG
4	Image 4	JPEG
5	Image 5	JPEG
6	Image 6	JPEG
7	Image 7	JPEG
8	Image 8	JPEG
9	Image 9	JPEG
10	Image 10	JPEG
11	Image 11	JPEG
12	Image 12	JPEG

Sr no.	Name	Format
13	Image 13	JPEG
14	Image 14	JPEG
15	Image 15	JPEG

IV. EXPERIMENTAL RESULTS

There are 15 different images are under observations. And then applied first order derivative, 2nd order derivative, saturation weighting algorithm and then to histogram based proposed algorithm to the digital image .After then applied smoothening to reduce the noise. This section contains result one of the 15 images which shows the improvisation of the proposed algorithm over the other technique.

Fig. 2 shows the input image. This image has less brightness, low intensity and effect of red color is much. Our goal is to improve the brightness of the image and produce the actual color of the source.

Input Image

Fig. 2

Fig. 3 is the output image produced by 1st order derivative which has more brightness as compare to the input image but effect of red color is more.

Gray edge 1 result

Fig. 3

Fig. 4 is the output image produced by 2nd order derivative. It produced the image with more brightness as compare to 1st order but there is no effect of green channel.

Gray edge result

Fig. 4

Fig. 5 shows the result produced by saturation weighting algorithm .It produced the better image than previous technique but it darks the image slightly.

Saturation weighting result

Fig. 5

Fig. 6 shows the output given by histogram based proposed algorithm. This output image with much intensity and it also decreases the effect of red channel.

Histogram based improved saturation weighting

Fig. 6

Fig. 7 after applying histogram, smoothening is done. Fig. 7 is the output image produced after the smoothening has been done. So the effect of noise has been reduced.

Result of edge preserved image

Fig. 7

V. PERFORMANCE ANALYSIS

This section contains the calculation of different parameter of the images under different algorithms. These parameters show the comparison between these different algorithms and also show the better results of proposed algorithm than previous algorithm.

A. *RMSE:*

Fig 8 has shown the analysis of Root Means Square Error. RMSE requires being less for the proposed algorithm for obtaining better results than previous techniques. As shown in the table 1 the results for proposed algorithm are less in every case. RMSE decreases shows that the color constancy is achieved by applying the proposed algorithm. This shown the efficiency of proposed algorithm.

TABLE 1: ROOT MEANS SQUARE ERROR

Image Name	Edge 1st order	Edge 2nd order	Saturation Weighting	Improved Saturation Weighting
Image 1	0.1425	0.0969	0.8343	0.0807
Image 2	0.1859	0.1245	0.1508	0.0707
Image 3	0.2274	0.1526	0.1311	0.1244
Image 4	0.1838	0.1254	0.1008	0.0465
Image 5	0.1668	0.1167	0.0897	0.0317
Image 6	0.2125	0.1442	0.1184	0.1150
Image 7	0.1986	0.1336	0.1117	0.0900
Image 8	0.2399	0.1687	0.1302	0.1221
Image 9	0.2103	0.1432	0.1182	0.0818
Image 10	0.2789	0.1944	0.1514	0.0867
Image 11	0.2640	0.1759	0.1511	0.0797
Image 12	0.1931	0.1333	0.1055	0.0721
Image 13	0.1145	0.1679	0.0887	0.0621
Image 14	0.1626	0.1074	0.0933	0.0812
Image 15	0.2238	0.1529	0.1238	0.0867

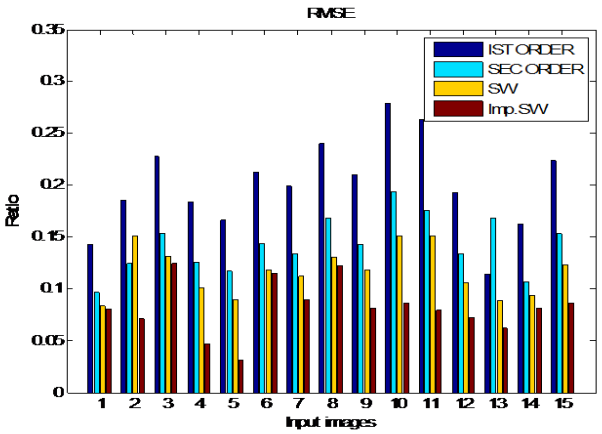

Fig. 8

B. *MAE:*

Fig. 9 has shown the analysis of Median Angular Error (MAE). MAE requires being less for the proposed algorithm for obtaining better results than previous techniques. As shown in the table 2 the results for proposed algorithm are less in every case. MAE decreases shows that the color constancy is achieved by applying the proposed algorithm. This shown the efficiency of proposed algorithm.

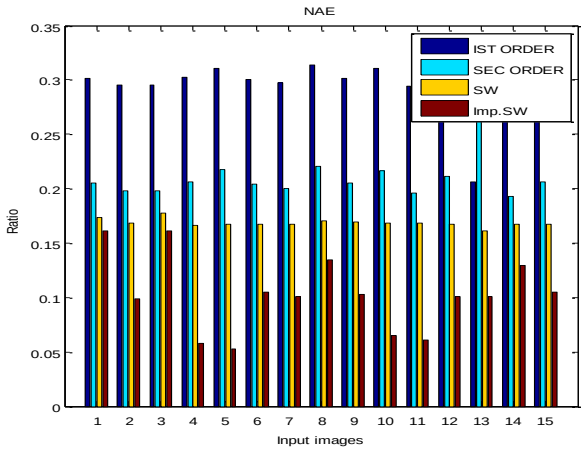

Fig. 9

TABLE 2: MEDIAN ANGULAR ERROR

Image Name	Edge 1st order	Edge 2nd order	Saturation Weighting	Improved Saturation Weighting
Image 1	6.3090	4.2909	3.7164	1.1816
Image 2	8.1394	5.4492	4.6343	0.0661
Image 3	10.4324	6.9966	6.0120	3.6271
Image 4	8.2362	5.6186	4.5250	-1.1333
Image 5	7.3188	5.1206	3.9376	-0.3265
Image 6	9.6427	6.5537	3.7164	1.1816
Image 7	9.3880	6.3154	5.286	3.2536
Image 8	11.3908	8.0128	6.1964	2.7068
Image 9	9.4952	6.4657	5.3408	2.5567
Image 10	13.3226	9.2865	7.2280	2.5750
Image 11	12.8990	8.5962	7.3820	2.4893
Image 12	8.3915	5.7923	4.5899	-2.7415
Image 13	5.1287	7.5144	4.0069	-2.4180
Image 14	7.6105	5.0272	4.3685	-0.0280
Image 15	10.4665	7.1482	5.7909	2.1954

VI. CONCLUSION

Lots of different techniques are used to improve the color constancy. The problem seems that the edge based color constancy reduce the impact of the light but it also reduces the brightness and also lost its edges. So to achieve better results, the performance of the proposed algorithm has been designed. The

comparison analysis between previous and proposed techniques has shown the significant improvement of the proposed technique. This research work has proposed improved saturation weighting color constancy based algorithms by using histogram stretching and smoothening. As known in prior that color constancy reduce the illuminate from the given image. Therefore lead to the darker image. So the use of histogram stretching has removed the problem of darker output of saturation weighting based color constancy.

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