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Enhanced Color Correction Using Histogram Stretching Based On Modified Gray World and White Patch Algorithms

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Abstract—Color constancy is the capability to determine colors of objects independent of the color of the light source. This paper deals with the different color constancy algorithms to evaluate the performance of existing color constancy algorithms. The combined effect of two color constancy algorithms i.e. White Patch Retinex (WPR) and Gray World (GW) and gamma correction used for dynamic range correction for image enhancement. The main limitation of the color constancy integrated with gamma correction proves to be efficient for dark regions but produce poor results for brighter regions. To reduce this problem in this paper we have proposed a new algorithm which will integrate the color constancy with histogram stretching and average filter to provide accurate results in dark, medium and brighter regions. The proposed algorithm is designed and implemented in MATLAB using image processing toolbox. The proposed algorithm provides significant as it has shown significantly better results in poor, high and medium intensity images as well as it reduce noise which may be introduced during color correction time.

Index terms: Color constancy, Gamma correction, Histogram Stretching, Average Filter, illumination.

1. INTRODUCTION

Image processing is a technique to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. It is a type of signal dispensation in which input is image, like video frame or photograph and output may be image or characteristics associated with that image.

Color [1-12] is an significant cue for computer vision and image processing related topics, like feature extraction, human computer interaction, and color appearance models. Color vision is a process by which organisms and machines are able to distinguish objects based on the different wavelengths of light reflected, transmitted, or emitted by that object. Colors observed in images are determined by the fundamental assets of objects and surfaces, as well as the color of the illuminant. For a robust color-based system, the effects of the illumination should be filtered out. Color Constancy is the ability to identify the correct colors, independently of the illuminant present in the scene. Human vision has a natural capability to correct the color effects of the light source. On the other hand, the mechanism that is involved in this capability is not yet fully understood. The same process is not trivial to machine vision systems in an unconstrained scene.

1.1. Color Constancy:

Color constancy[1] is a mechanism of detection of color independent of light source. It is a characteristic of the individual color perception system which ensures that the perceived color of objects remains relatively constant under altering illumination conditions.

Figure.1.1 Illustration of the influence of differently colored light sources on the measured image values.

The color of objects is primarily effected [11] by the color of the light source. The analogous object, taken by the same camera but under different light, may vary in its measured color appearance. This color variation may negatively affect the result of image and video processing methods for different applications such as image segmentation, object recognition and video retrieval. The principle of color constancy is to eliminate the effect of the color of the light source. a significant number of color constancy algorithms has been proposed. color constancy is intrinsically an ill-posed problem, different assumptions have been proposed, such as the White-Patch assumption and the Grey-World assumption. Consider the images in Fig. 1. These images show the same scene, provided under four different light sources.

1.2 Gamma Correction:

Gamma correction[16] controls the overall brightness of an image, which is not properly corrected can look either bleached out, or too dark. Varying the amount of gamma correction changes not only the brightness, but also the ratios of red to green to blue.

To explain the gamma correction we consider computer monitor example, whose intensity to voltage response curve which is roughly a 2.5 power function, it means range of voltages sent to the monitor is between 0 and 1, then it will actually display a pixel which has intensity equal to x ^ 2.5. This means that the intensity value displayed will be less than what you wanted it to be. (e.g. 0.5 ^ 2.5 = 0.177) here, are said to have gamma of 2.5 .

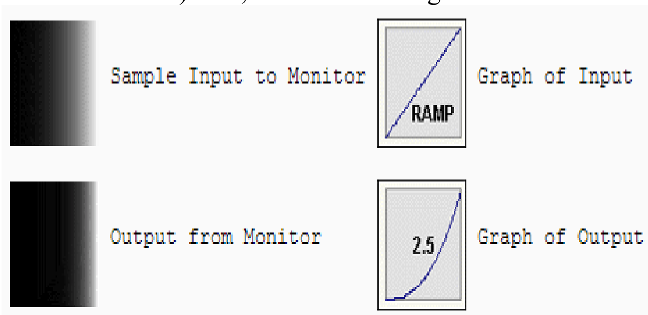

Figure 1.2.Here, output from monitor $f = v^{2.5}$, where f is pixel intensity and v is voltage.

The task of gamma correction is accomplished by raising the input value to the 1/2.5 power.

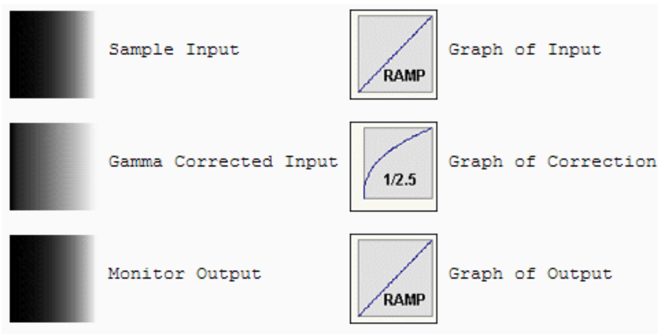

Figure 1.3.Here, gamma corrected output $f = v^{(1/2.5)}$

The luminance nonlinearity introduced by many imaging devices is described with an operation of the form

$$g[f_i(x,y)] = f_i(x,y)^{\gamma} \qquad Eq(5)$$

where $f_i(x, y) \in [0, 1]$ denotes the image pixel intensity in the component i. If the value of γ is known, then the inverse process is trivial

$$g^{-1}[f_i(x,y)] = f_i(x,y)^{\frac{1}{\gamma}} \qquad Eq(6)$$

The value of γ is determined experimentally with the aid of a calibration target taking a full range of known luminance values through the imaging system.

1.3 Color Constancy Algorithms:

We discuss about the two basics algorithms[1] of color constancy i. e. White Patch Retinex (WPR) and Gray World (GW).

1.3.1 White Patch Retinex:

White Patch Retinex[15] Algorithm is based on retinex theory by Edwin H. Land in 1971.This algorithm[8] assumes that the highest value of each color channel as white representation of image. White patch found searching for the maximum intensity in each channel, is given by

$$I_{i_{max}} = \max\{f_i(x,y)\} \qquad Eq(1)$$

where $f_i(x, y)$ is pixel intensity at position (x,y) in an image and I_i is the illuminant in the scene.

All pixel intensities are scaled according to the illuminant computed:

$$o_i(x,y) = \frac{f_i(x,y)}{I_{i_{max}}} \qquad Eq(2)$$

1.3.2 Gray World:

The Gray World assumption[8] is a white balance method that assumes that your scene is neutral gray. It produce an estimate of illuminant by computing the mean of each channel of the image.

This algorithm suggests that the average value of R, G and B components to the common gray value. To normalize the image channel i, the pixel value is scaled by

$$Si = \frac{avg}{avg_i} \qquad Eq(3)$$

where avg_i is the channel mean and avg is the illumination estimate.

Another method of normalization is normalizing to the maximum channel by scaling by s_i

$$r_i = \frac{\max(avg_R, avg_G, avg_B)}{avg_i} \qquad Eq(4)$$

1.4 Average Filter:

An moving average filter[14] is utilized to reduce the noises. Mean filtering is a simple, intuitive and easy to implement method of smoothing images, i.e. reducing the amount of intensity variation between one pixel and the next. It is often used to reduce noise in images.

The scheme of mean filtering is simply to replace each pixel value in an image with the mean value of its neighbors, including itself. Generally, a 3×3 square kernel is used.

As shown in Figure 1, although larger kernels (e.g. 5×5 squares) can be used for more severe smoothing.

1	**1**	**1**
1	**1**	**1**
1	**1**	**1**

In above Figure.1.4 used the 3*3 moving average filter.

Each pixel has been replaced by the average of pixel values in a 3*3 square .The result is to reduce noise in the image.

1.5 Histogram Stretching:

Histogram stretching[13] balances the range of pixel intensity values and distribute over the entire histogram. Histogram stretching intends to distribute the pixel exterior frequencies over the entire width of the histogram. It can modify the histogram in such a way to distribute the intensities on the scale of values available as well as possible and extend the histogram so that the value of the lowest intensity is zero and that of the highest is the maximum value. The stretching provides a better distribution in order to make light pixels even lighter and dark pixels closer to black.

Color histograms are three separate histograms i.e. R, G and B channels and are representation of distribution of each color in an RGB image. For a digital image, the color histogram is simply acquired rich source of information, the majority of the high-end cameras use color histogram as a reference of exposure and white balance set to see whether an unique color channel clips. A peak in the red, green and blue histograms when we shoot a scene, if the peaks in all the three channels are in the same place, then the image is impartial and the color temperature is set correctly. If not, then it is necessary to change the color temperature set of the camera. For example, if the blue channel is greatly towards highlights, then the scene is too greatly bluish and we should adjust the color temperature or white balance consequently.

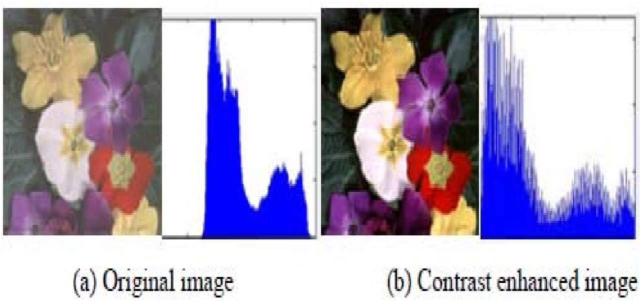

Figure.1.5. Histogram Stretching Example.(adapted from [13])

2. Performance Metrics

The quality of an image is examined by objective assessment as well as subjective assessment. For subjective assessment, the image has to be observed by a human expert. The human visual system is so intricate that it is not yet modeled correctly. As a result, besides objective assessment, the image must be observed by a human expert to judge its quality. There are various metrics[17] used for objective assessment of an image. Some of them are mean squared error (MSE), mean absolute error (MAE) and peak signal to noise ratio (PSNR).

2.1 Mean Squared Error (MSE):

Mean square error is a measure of image quality index. The large value of mean square means that image is a poor quality. Mean square error between the reference image and the fused image is

$$MSE = \frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}(A_{ij} - B_{ij})^2 \qquad Eq(5)$$

Where Ai, j and Bi, j are the image pixel value of reference image.

2.2. Root Mean Square Error:

It is the square root of the MSE.

$$RMSE = \sqrt{MSE} \qquad Eq(6)$$

2.3.Normalized Absolute Error (AE):

The large value of normalized absolute error means that image is poor quality. NAE is defined as follows

$$NAE = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}(|A_{ij} - B_{ij}|)}{\sum_{i=1}^{m}\sum_{j=1}^{n}(A_{ij})} \qquad Eq(7)$$

2.4 Peak Signal to Noise Ratio (PSNR):

PSNR computes the peak signal-to-noise ratio, in decibels, between two images. This ratio is used as a quality measurement between the original and a reconstructed image. The higher the PSNR, the better is the quality of the reconstructed image. To compute the PSNR, first we have to compute the mean squared error (MSE) using the following equation.

$$MSE = \frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}(A_{ij} - B_{ij})^2 \qquad Eq(8)$$

$$PSNR = 10 * \log_{10}(\frac{peak^2}{MSE}) \qquad Eq(9)$$

PSNR value should be as high as possible.

2.5 Normalized Cross Correlation (NCC):

Normalized cross correlation is used to find out similarities between fused image and registered image is given by the following equation:

$$NCC = \sum_{i=1}^{m}\sum_{j=1}^{n}(A_{ij} * B_{ij}) \qquad Eq(10)$$

3. Experimental Set-Up

In order to implement the proposed algorithm, design and implementation has been done in MATLAB using image processing toolbox. In order to do cross validation we have implemented the edge based color constancy with bilateral filter. Table 1 is showing the various images which are used in this research work. Images are given along with their formats. All the images has different kind of the light i.e. more or less in some images.

Table 1. Experimental Images

S.No	NAME	FORMAT
1	image1	TIF
2	image2	JPEG
3	image3	JPEG
4	image4	JPEG
5	image5	JPEG
6	image6	JPEG
7	image7	JPEG
8	image8	JPEG
9	image9	JPEG
10	image10	JPEG

3.1 Experimental results:

Figure 3.1 has shown a temple image which is infected by sun light. It has been clearly shown that the image demands constancy.

Figure 3.1 Input images

Figure 3.2 has shown the result of Gamma corrected image. It has been clearly shown the effect of the light has been removed.

Figure 3.2 Gamma corrected image

Figure 3.3 has demonstrated the result of White Patch algorithm. It has shown the better results than the result of the gamma correction.

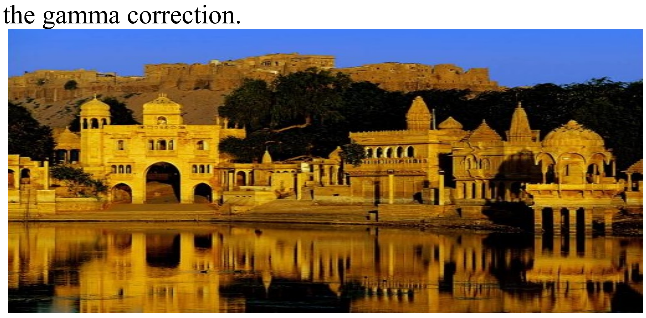

Figure 3.3 White Patch Image

3.4 has shown the result of Gamma Correction with White Patch Image based color constancy. It has been clearly shown the effect of the light has been removed at a great extent than images shown in figures 3.2 and 3.3.

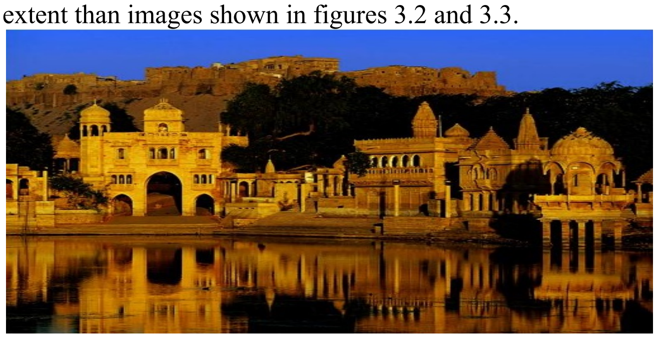

Figure 3.4 Gamma Correction With White Patch Image

3.5 has shown the result of White Patch with Gamma Correction Image based color constancy. It has been clearly shown the effect of the light has been removed very efficiently than images shown in figures 3.2,3.3 and 3.4.

Figure 3.5 White Patch With Gamma Correction

Figure 3.6 has shown the result of the proposed algorithm. It has been clearly demonstrated that the proposed algorithm has better visibility than the images given in figures 3.1, 3.2, 3.3, 3.4 and 3.5. Thus proposed algorithm provides better results.

Figure 3.6 Final Filtered Image with White Patch

Figure 3.7 has demonstrated the result of Gray world algorithm. It has shown the better results than the result of the gamma correction.

Figure 3.7 Gray World Image

Figure 3.8 has been clearly shown the effect of the light has been removed at a great extent than images shown in figures 3.2 and 3.7.

Figure 3.8 Gamma Correction with Gray World Image

Figure 3.9 has clearly shown the effect of the light has been removed very efficiently than images shown in figures 3.2,3.7 and 3.8

3.9 Gray World with Gamma Correction Image

Figure 3.10 has shown that the proposed algorithm has better visibility than the images given in figures 3.1, 3.2,3.7,3.8 and 3.9.

3.10 Final Filtered Image with Gray World

4. PERFORMANCE EVALUATION

This section contains the cross validation between existing and proposed techniques. Some well-known image performance parameters for digital images have been selected to prove that the performance of the proposed algorithm is quite better than the available methods.

4.1 Performance Evaluation With White Patch Algorithm:

Table 2 has shown the quantized analysis of the Mean Square Error. As mean square error need to be reduced therefore the proposed algorithm is showing the better results than the available methods as mean square error is less in every case.

Table 2. Mean Square Error

Image Name	Gamma Correction	White Patch	Gamma Correction with White Patch	White Patch with Gamma Correction	Proposed
Img1	607	454	114	117	3
Img2	868	773	185	190	135
Img3	661	19	242	232	1
Img4	372	271	104	102	1
Img5	446	10	306	294	13
Img6	346	89	200	188	3
Img7	314	87	87	81	17
Img8	552	18	327	310	1
Img9	758	2	360	343	17
Img10	856	1	247	237	3

Table 3 is showing the comparative analysis of the Root Mean Square Error. It has clearly demonstrated that the root mean square error is quite less in the case of the proposed algorithm; therefore proposed algorithm is providing better results.

Table 3. Root Mean Square Error

Image Name	Gamma Correction	White Patch	Gamma Correction with White Patch	White Patch with Gamma Correction	Proposed
Img1	51.0588	21.3073	10.6771	10.8167	1.7321
Img2	96.2705	27.8029	13.6015	13.7840	11.6190
Img3	79.7559	4.3589	15.5563	15.2315	1
Img4	127.5617	16.4621	10.1980	10.0995	1
Img5	127.0669	3.1623	17.4929	17.1464	3.6056
Img6	96.6747	9.4340	14.1421	13.7113	1.7321
Img7	130.4377	9.3274	9.3274	9	4.1231
Img8	120.6317	4.2426	18.0831	17.6068	1
Img9	150.8575	1.4142	18.9737	18.5203	4.1231
Img10	88.6341	1	15.7162	15.3948	1.7321

Table 4 is showing the comparative analysis of the Normalized Absolute Error. It contains the average difference between input and output image. Table 4 has clearly demonstrated that the Mean Absolute Error is quite less in the case of the proposed algorithm; therefore proposed algorithm is providing better results.

Table 4. Normalized Absolute Error

Image Name	Gamma Correction	White Patch	Gamma Correction with White Patch	White Patch with Gamma Correction	Proposed
Img1	0.5715	0.4034	0.1772	0.1778	0.0351
Img2	0.5888	0.2871	0.1153	0.1160	0.1250
Img3	0.4851	0.0539	0.2207	0.2162	0.0121
Img4	0.5913	0.1257	0.0782	0.0772	0.0076
Img5	0.4916	0.0229	0.1442	0.1413	0.0281
Img6	0.6894	0.0965	0.1478	0.1429	0.0188
Img7	0.6922	0.0691	0.0663	0.0636	0.0313
Img8	0.4913	0.0353	0.1531	0.1489	0.0096
Img9	0.5929	0.0106	0.1242	0.1212	0.0251
Img10	0.6846	0.0099	0.2166	0.2128	0.0252

Table 5 is showing the comparative analysis of the Peak Signal to Noise Ratio (PSNR). As PSNR need to be maximized; so the main goal is to increase the PSNR as much as possible. Table 5 has clearly shown that the PSNR is maximum in the case of the proposed algorithm therefore proposed algorithm is providing better results than the available methods.

Table 5. Peak Signal to Noise Ratio

Image Name	Gamma Correction	White Patch	Gamma Correction with White Patch	White Patch with Gamma Correction	Proposed
Img1	13.9694	21.5597	27.5520	27.4368	42.4822
Img2	8.4605	19.2437	25.4396	25.3295	26.8192
Img3	10.0954	35.1505	24.2841	24.4663	47.4439
Img4	6.0164	23.7921	27.9534	28.0433	47.3441
Img5	6.0500	38.1278	23.2619	23.4405	36.8116
Img6	8.4244	28.6345	25.0991	25.3862	42.6337
Img7	5.8227	28.7048	28.7136	29.0410	35.6071
Img8	6.5014	35.5759	22.9734	23.2116	45.7293
Img9	4.5594	43.6373	22.5629	22.7728	35.7962
Img10	9.1786	48.0111	24.1955	24.3723	43.2304

Table 6 shows the comparative analysis of the Normalized Cross-Correlation (NCC). As NCC needs to be close to 1, therefore proposed algorithm is showing better results than the available methods as NCC is close to 1 in every case.

Table 6. Normalized Cross-Correlation

Image Name	Gamma Correction	White Patch	Gamma Correction with White Patch	White Patch with Gamma Correction	Proposed
Img1	0.0123	1.4112	1.1622	1.1671	1.0366
Img2	0.0094	1.2862	1.1025	1.1063	0.9088
Img3	0.0103	1.0549	0.8401	0.8440	1.0047
Img4	0.0068	1.1280	1.0175	1.0200	1.0080
Img5	0.0072	1.0227	0.8806	0.8831	0.9803
Img6	0.0098	1.0965	0.8655	0.8702	1.0188
Img7	0.0074	1.0699	0.9438	0.9465	0.9721
Img8	0.0078	1.0338	0.8715	0.8752	0.9943
Img9	0.0061	1.0108	0.9082	0.9105	0.9835
Img10	0.0081	1.0109	0.8626	0.8658	0.9910

4.2 Performance Evaluation With Gray World Algorithm:

Table 7 has demonstrated the comparative analysis of the Mean Square Error. Therefore the proposed algorithm is showing the better results than the available methods as mean square error is less in every case.

Table 7. Mean Square Error

Image Name	Gamma Correction	Gray World	Gamma Correction with Gray World	Gray World with Gamma Correction	Proposed
Img1	607	463	286	126	20
Img2	268	230	88	132	186
Img3	361	263	124	100	1
Img4	372	348	232	105	12
Img5	846	765	503	240	24
Img6	346	174	44	109	3
Img7	514	431	346	295	84
Img8	452	369	180	114	1
Img9	758	656	462	320	23
Img10	856	177	82	104	2

Table 8 is viewing the comparative analysis of the Root Mean Square Error. It has visibly demonstrated that the root mean square error is quite less in the case of the proposed algorithm; therefore proposed algorithm is providing better results.

Table 8. Root Mean Square Error

Image Name	Gamma Correction	Gray World	Gamma Correction with Gray World	Gray World with Gamma Correction	Proposed
Img1	51.0588	21.5174	16.9115	11.2250	4.4721
Img2	96.2705	15.1658	9.3808	11.4891	13.6382
Img3	79.7559	16.2173	11.1355	10	1
Img4	127.5617	36.7151	32.1248	28.3725	3.4641
Img5	127.0669	27.6586	22.4277	15.4919	4.8990
Img6	96.6747	13.1909	6.6332	10.4403	1.7321
Img7	130.4377	70.9295	67.4240	62.4099	9.1652
Img8	120.6317	19.2094	13.4164	10.6771	1
Img9	150.8575	25.6125	21.4942	17.8885	4.7958
Img10	88.6341	13.3041	9.0554	10.1980	1.4142

Table 9 is showing the comparative analysis of the Normalized Absolute Error. It contains the average difference between input and output image. It has clearly demonstrated that the Mean Absolute Error is relatively less in the case of the proposed algorithm; therefore proposed algorithm is providing improved results.

Table 9. Normalized Absolute Error

Image Name	Gamma Correction	Gray World	Gamma Correction with Gray World	Gray World with Gamma Correction	Proposed
Img1	0.7715	0.4042	0.2829	0.1869	0.0874
Img2	0.4888	0.1480	0.0682	0.1214	0.1247
Img3	0.3851	0.2009	0.1094	0.1271	0.0160
Img4	0.5913	0.2784	0.2314	0.1943	0.0281
Img5	0.6916	0.2190	0.1650	0.1079	0.0389
Img6	0.4894	0.1352	0.0605	0.1056	0.0183
Img7	0.6922	0.5372	0.5057	0.4578	0.0698
Img8	0.3913	0.1586	0.0974	0.0767	0.0059
Img9	0.2929	0.1714	0.1314	0.0960	0.0304
Img10	0.4846	0.1474	0.0836	0.1395	0.0240

Table 10 is showing the comparative analysis of the Peak Signal to Noise Ratio (PSNR).It has clearly shown that the PSNR is maximum in the case of the proposed algorithm therefore proposed algorithm is providing better results than the available methods.

Table 10. Peak Signal to Noise Ratio

Image Name	Gamma Correction	Gray World	Gamma Correction with Gray World	Gray World with Gamma Correction	Proposed
Img1	13.9694	21.4716	23.5573	27.1149	35.0841
Img2	8.4605	24.5033	28.6639	26.9126	25.4269
Img3	10.0954	23.9176	27.1749	28.1184	46.3167
Img4	6.0164	16.8333	17.9910	19.0710	37.2799
Img5	6.0500	19.2936	21.1136	24.3234	34.2741
Img6	8.4244	25.7224	31.6640	27.7426	42.6307
Img7	5.8227	11.1136	11.5543	12.2252	28.8878
Img8	6.5014	22.4534	25.5684	27.5592	47.3922
Img9	4.5594	19.9584	21.4804	23.0677	34.3809
Img10	9.1786	25.6455	28.9619	27.9426	43.5629

Table 11 shows the comparative analysis of the Normalized Cross-Correlation (NCC). Therefore proposed algorithm is showing better results than the available methods as NCC is close to 1 in every case.

Table 11. Normalized Cross-Correlation

Image Name	Gamma Correction	Gray World	Gamma Correction with Gray World	Gray World with Gamma Correction	Proposed
Img1	0.0123	1.4137	1.3188	1.1698	1.0854
Img2	0.0094	1.1524	1.0768	0.9541	1.1161
Img3	0.0103	1.2012	1.1294	0.9978	0.9946
Img4	0.0068	1.2806	1.2432	1.1987	1.0263
Img5	0.0072	1.2154	1.1732	1.0959	0.9715
Img6	0.0098	1.1350	1.0643	0.9089	1.0184
Img7	0.0074	1.5284	1.5017	1.4611	0.9360
Img8	0.0078	1.1569	1.1053	1.0085	1.0034
Img9	0.0061	1.1623	1.1354	1.0855	0.9790
Img10	0.0081	1.140	1.0865	1.0098	0.9930

4.3. Comparative Analysis With White Patch Algorithm Using Graphs:

Graph 4.1 has revealed the comparative analysis of the Mean Square Error. The proposed algorithm is showing the better results than the available methods as mean square error is less in every case.

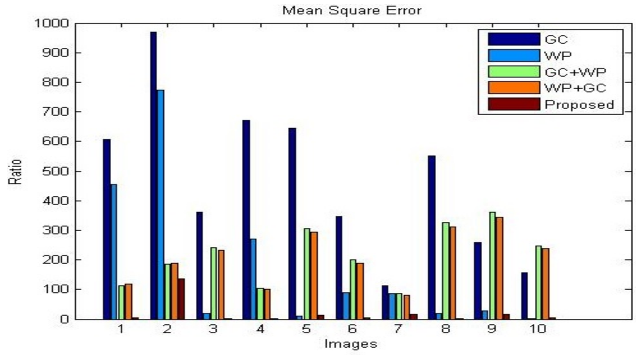

Figure 4.1 Comparative Analysis of MSE

Graph 4.2 is viewing the comparative analysis of the Root Mean Square Error. It has clearly demonstrated that the root mean square error is quite less in the case of the proposed algorithm; therefore proposed algorithm is providing better results.

Graph 4.3 has clearly demonstrated that the Normalized Absolute Error is quite less in the case of the proposed algorithm; therefore proposed algorithm is providing better results.

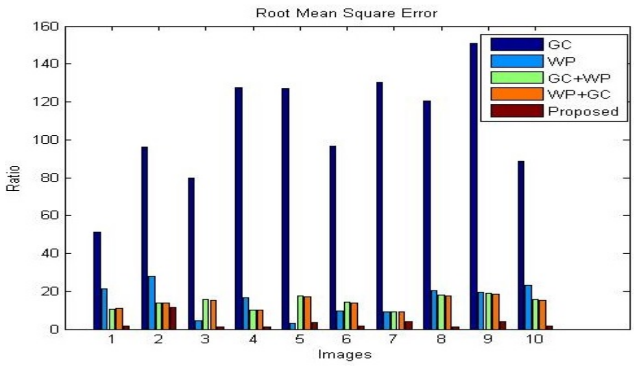

Figure 4.2 Comparative Analysis of RMSE

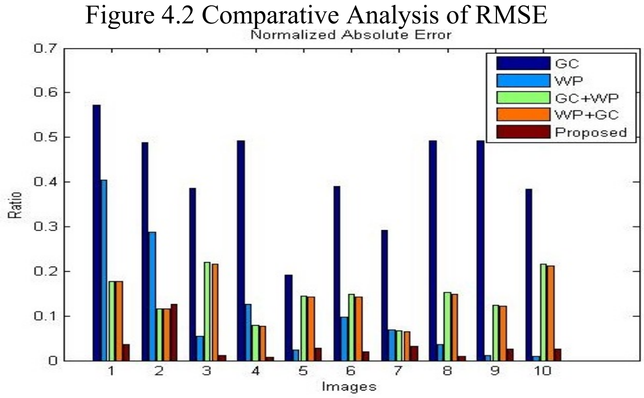

Figure 4.3 Comparative Analysis of NAE

Graph 4.4 has clearly shown that the PSNR is maximum in the case of the proposed algorithm therefore proposed algorithm is providing better results than the available methods

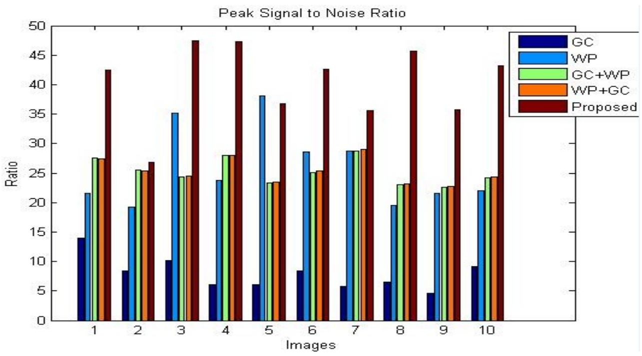

Figure 4.4 Comparative Analysis of PSNR

Graph 4.5 demonstrated the comparative analysis of the Normalized Cross-Correlation (NCC).Therefore proposed algorithm is showing better results than the available methods as NCC is close to 1 in every case.

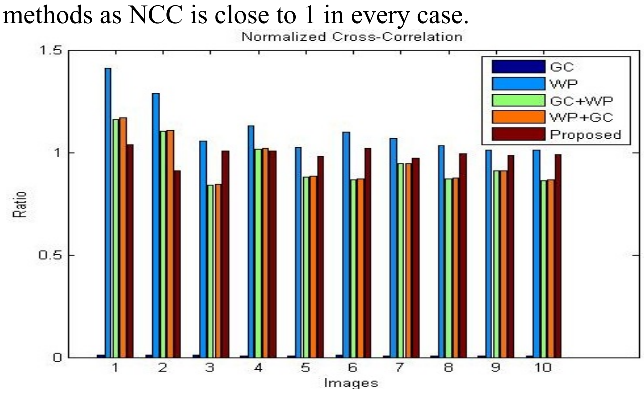

Figure 4.5 Comparative Analysis of NCC

4.4. Comparative Analysis With Gray World Algorithm Using Graphs:

Graph 4.6 has shown the quantized analysis of the Mean Square Error. As mean square error need to be reduced therefore the proposed algorithm is showing the better results than the available methods as mean square error is less in every case.

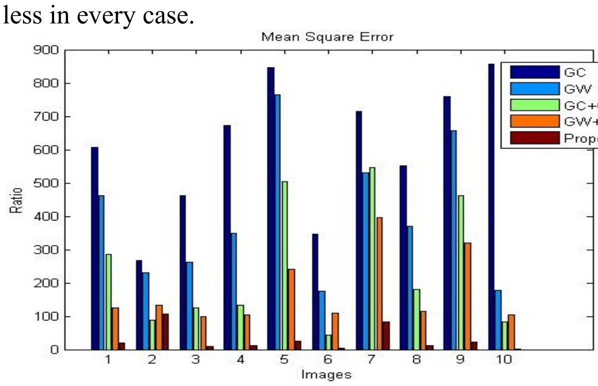

Figure 4.6 Comparative Analysis of MSE

Graph 4.7 is demonstrated the comparative analysis of the Root Mean Square Error. It has visibly demonstrated that the root mean square error is quite less in the case of the proposed algorithm; therefore proposed algorithm is providing better results.

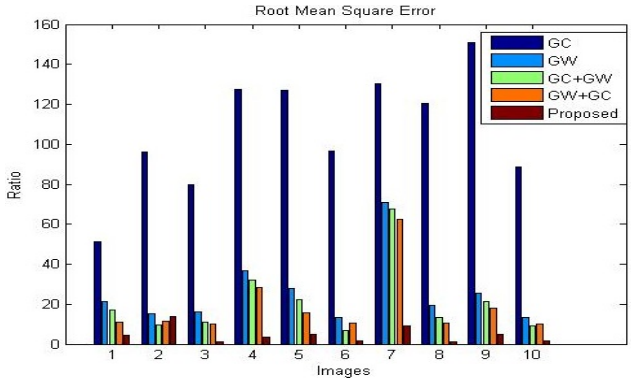

Figure 4.7 Comparative Analysis of RMSE

Graph 4.8 is showing the comparative analysis of the Normalized Absolute Error. It contains the average difference between input and output image. It has clearly demonstrated that the Mean Absolute Error is quite less in the case of the proposed algorithm; therefore proposed algorithm is providing better results.

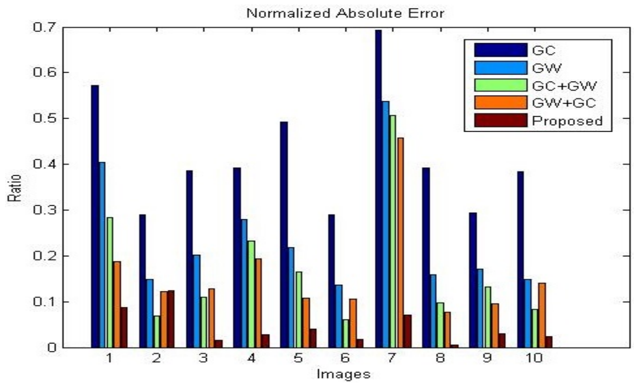

Figure 4.8 Comparative Analysis of NAE

Graph 4.9 is viewing the comparative analysis of the Peak Signal to Noise Ratio (PSNR). As PSNR need to be maximized; so the main goal is to increase the PSNR as much as possible. It has clearly shown that the PSNR is maximum in the case of the proposed algorithm therefore proposed algorithm is providing better results than the available methods.

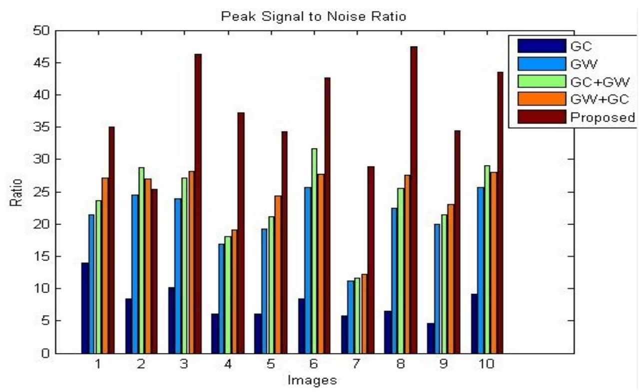

Figure 4.9 Comparative Analysis of PSNR

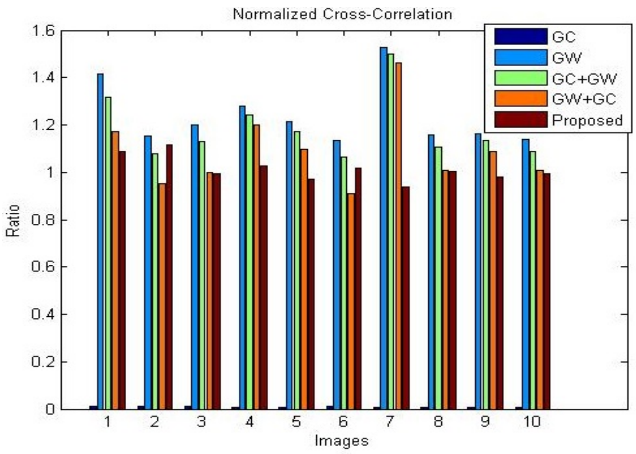

Figure 4.10 Comparative Analysis of NCC

Graph 4.10 shows the comparative analysis of the Normalized Cross-Correlation (NCC). As NCC needs to be close to 1, therefore proposed algorithm is showing better results than the available methods as NCC is close to 1 in every case.

5.CONCLUSION

This paper has proposed a new modified color constancy algorithm by integrating thegray world and white patch based color constancy algorithm withthe average filter, histogram stretching and the gamma correction. The review has shown that the existing methods may introduce some Gaussian noise and also degrade the effect of the brightness in the image. So average filter is used in this paper to remove the Gaussian noise and the histogram stretching is also used to improve the brightness of the image. The comparison of the proposed algorithm with other color constancy algorithms has shown the significant improvement over the available techniques.

In near future we will modify the gray world hypothesis by using the fuzzy if then rules to constant the colors in more efficient way.

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