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# Optimal CC Method: Improved Results

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### *Abstract*

*Color constancy allows visitors to recognize color in the diversity of conditions, and to see some regularity in the color. Generally, color constancy is a method of which calculates the particular impact involving discrete light sources using a digital image. The particular image documented with a camera is resolute by several components: the actual physical information with the picture, the particular illumination occurrence within the scene, as well as the features with the digital camera.*

*Color based images have several applications. Retrieval based on object colors must take into an explanation the features that manipulate the pattern of color images: illumination conditions, sensor spectral sensibilities and surface reflectance. Tracking objects in environments under non-uniform lighting condition is mainly challenging as the practical appearance may alter in space and time [1]. We create an integrated effort of fuzzy membership with edge preserving filtering. As fuzzy membership exploits two classes because we make use of dual membership functions in the research work. In this paper, improved results have extracted for color constancy from optimal method based on fuzzy membership with edge preservation filtering. An evaluation of the proposed technique is also drawn with existing techniques, the comparisons have obviously shown that the fuzzy based color constancy outperforms over the available techniques.*

***Keywords**: Fuzzy membership, edge preserving filtering, gray world, color constancy*

## 1. Introduction

Color has borrowed at the time of three mechanisms, such: the reflectance of the object, the acceptability of cones, as well as the illumining spectra. For such mechanisms, the illumining spectrum is the smallest amount of constant. The dissimilar aspects depend about the illumination changes, as an example, daytime (daylight) or indoor/outdoor situations. Therefore, made from of an object depends about the illumination to which we are seeing it, option mainly has focused to difficulty for computer vision.

Previously, no effort has done over fuzzy membership. This paper work has done on fuzzy membership based color image enhancement and edge preserving filtering. Fuzzy membership has used to prevent over enhancement problem. It enhanced only those objects which demand the enhancement. Also, it enhanced the object according to membership value. Basically, it decides whether to enhance the object or not.

### 1.1. Benefits of Fuzzy Membership

a) It provides good output even if the image gets blurred.
b) It manages grayness ambiguity easily.
c) It helps to identify edges in an image. This edge detection helps in various areas like face recognition, fingerprint identification, medical imaging.

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Median filtering has used as an edge preserving filter. It preserves edges while removing noise. We have made use of the two-dimensional median filter where two-dimensional represents an array. It is useful in preserving edges in an image.

The key purpose of the paper is to change saturation weighting dependent color constancy using fuzzy membership based color improvement in addition to edge preserving filtering.

## 2. Experimental Setup

### 2.1. Optimal Method

**Step 1:** First of all color response has accepted and changed into the digital image then we have located dimension of an image using the equation:

[M, N, ~]=SIZE ( I ) (1)

Where M signifies row, N signifies column, ~Represents any channel *i.e.* red, green or blue and I represents the image.

**Step 2:** Now eliminate saturation color points *i.e.* the colors which have greatly affected by the light source via following equations:

(a) Initially we compute all the three channels with the following equations:

$$T_r = \sum\sum(I_r) \quad (2)$$

$$T_g = \sum\sum(I_g) \quad (3)$$

$$T_b = \sum\sum(I_b) \quad (4)$$

**Table 1. List of Various Parameters Used in an Implementation**

| Nature | Description |
|---|---|
| $T_r$ | Total red color |
| $T_g$ | Total green color |
| $T_b$ | Total blue color |
| $I_r$ | Red image |
| $I_g$ | Green image |
| $I_b$ | Blue image |
| $G_m$ | Global mean |
| $N_i$ | New image |
| $a_r$ | Average red |
| $a_g$ | Average green |
| $a_b$ | Average blue |
| $E_W$ | effect of light |
| $w_r$ | effect of red color |
| $w_g$ | effect of green color |
| $w_b$ | effect of blue color |

 

(b) After calculating R, G, B channel, computes the mean of all the three channels with the following equation:

$$g_m = \Sigma(r_m g_m b_m)/3 \quad (5)$$

Where $g_m$ Represents global mean and $r_m g_m b_m$ represents mean of all personal channel.

(c) Now color aggregation has used elsewhere to eliminate the saturation points by means of the following equations:

$$a_r = g_m/r_m \quad (6)$$

$$a_g = g_m/r_g \quad (7)$$

$$a_b = g_m/r_b \quad (8)$$

(d) Now later than removing the saturation points we have attained new images by using these equations:

$$Ni\ (red) = a_r * I_r \quad (9)$$

$$Ni\ (green) = a_g * I_g \quad (10)$$

$$Ni\ (blue) = a_b * I_b \quad (11)$$

**Step 3:** Now we have removed the effect of light by edge based 2nd order derivation color constancy method by means of the equation as given below:

Initially we have estimated the luminance value to signify the gray edge hypothesis by using the equation:

$$Ew = \sqrt{wr * 2 + wg * 2 + wb * 2} \quad (12)$$

**Step 4:** Now after estimating the light source, color normalization have taken place in organize to balance the effect of the poor light.

(a) Firstly compute the effect of red, green and blue channel by using these equations:

$$wr = wr/ew \quad (13)$$

$$wg = wg/ew \quad (14)$$

$$wb = wb/ew \quad (15)$$

(b) Now normalize red, green and blue color separately.

$$OI_r = OI_r/wr * \sqrt{3} \quad (16)$$

$$OI_g = OI_g/wg * \sqrt{3} \quad (17)$$

$$OI_b = OI_b/wb * \sqrt{3} \quad (18)$$

**Step 5:** Now apply fuzzy membership which have enhanced only those objects which demand the enhancement, in systematize to get the final color constant image.

 

**Table 2. List of Various Parameters Used in Fuzzy Enhancement Implementation**

| Nature | Description |
|---|---|
| K | Control parameter |
| M | Control parameter |
| $C_1$ | Class one having range[0-M-1] |
| $C_2$ | Class two having range[M-255] |
| $\mu D_1$ | First membership value |
| $\mu D_2$ | second membership value |
| X | intensity value |
| $X_e$ | Enhanced intensity value |
| V | value |
| $V_e$ | Enhanced value |

The pseudo code of our implementation is presenting in five parts. Algorithm 1 shows development of histogram and Algorithm 2 shows how we update the histogram value according to membership values. Algorithm 3 looks for the same membership values and shows the progress of the histogram. Algorithm 4 calculates the difference of commutative histogram of enhancement variables. Algorithm 5 computes the fuzzy transformation map.

Algorithm 1: The development of histogram

```
[csisp_hist,grayScales] =
imhist(ip_image);

fHistogram =
zeros(numel(csisp_hist)+numel(f_mem_t
ype)-1,1);
```

Algorithm 2: Update the histogram value according to membership values

```
for counter = 1:numel(f_mem_type)
    fHistogram = fHistogram +
f_mem_type(counter)*[zeros(counter-
1,1);csisp_hist;zeros(numel(f_mem_ty
pe)-counter,1)];
end
```

 

Algorithm 3: Looking for the same membership values and shows the progress of the histogram

```
fHistogram =
fHistogram(ceil(numel(f_mem_type)/2):en
d-floor(numel(f_mem_type)/2));

del1_fHist = [0;(fHistogram(3:end)-
fHistogram(1:end-2))/2;0];
del2fHistogram = [0;(del1_fHist(3:end)-
del1_fHist(1:end-2))/2;0];

LI = (2:numel(fHistogram)-1)'+1;

MLAmbiguous = LI(((del1_fHist(1:end-
2).*del1_fHist(3:end))<0) &
(del2fHistogram(2:end-1)<0));

counter = 1;

ML = 1;
while counter < numel(MLAmbiguous)
    if
(MLAmbiguous(counter)==(MLAmbiguous(cou
nter+1)-1))
        ML = [ML ;
(MLAmbiguous(counter)*(fHistogram(MLAmb
iguous(counter))>fHistogram(MLAmbiguous
(counter+1)))) +
(MLAmbiguous(counter+1)*(fHistogram(MLA
mbiguous(counter))<=fHistogram(MLAmbigu
ous(counter+1))))];
        counter = counter + 2;
    else
        ML = [ML ;
MLAmbiguous(counter)];
        counter = counter + 1;
    end
end
if(ML(end)~=numel(fHistogram))
    ML = [ML ; numel(fHistogram)];
end
```

Algorithm 4: Calculates the difference of commutative histogram of enhancement variables.

```
low = ML(1:end-1);
high = [ML(2:end-1)-1;ML(end)];
span = high-low;
CH = cumsum(fHistogram);
M = CH(high)-CH(low);
factor = span .* log10(M);
range =
max(grayScales)*factor/sum(factor);

transformationMap =
zeros(numel(grayScales),1);

fuzzy_factor=sum(range)/(max(high)-
min(low))+.01;
```

Algorithm 5: Computes the fuzzy transformation map

```
for counter = 1:length(low)
    for index =
low(counter):high(counter)
        transformationMap(index) =
round((low(counter)-1) +
(range(counter)*(sum(fHistogram(low
(counter):index)))/(sum(fHistogram(
low(counter):high(counter))))));
    end
end

fuzzy_factor_image =
stretchlim(ip_image, fuzzy_factor);
final_image = imadjust(ip_image,
fuzzy_factor_image, []);
```

**Phase1:** The first step in the proposed method is to change the given RGB image of size P × Q into HSV along with computing the histogram h(x) where x Є V. h(x) specifies the number of pixels in the figure by means of intensity value x. Proposed method uses two strengthening parameters M and K, which handles the amount at which the intensity value x has increased.

**Phase 2:** Now, extract the V constituent from HSV.

**Phase 3:** The value of K computed empirically according to what level the stretching has required. From the investigational analysis, we set the value 128 for K, which gives better results for the low distinction and low intense color images.

**Phase4:** The feature M separates the histogram h(x) into two categories or classes. The first class C1 has pixel values in the range [0, M − 1] and the second class C2 in the range [M, 255].

**Phase5:** The stretching of V component is approved out supported on two fuzzy membership values µD1and µD2, calculated for C1and C2class of pixels correspondingly. Parameter M has a major function in the working out of fuzzy membership values; µD1 and µD2. Enhancement parameter K makes the decision the stretching intensity to calculate the enhanced intensity values $x_e$ for the two classes C1 and C2.

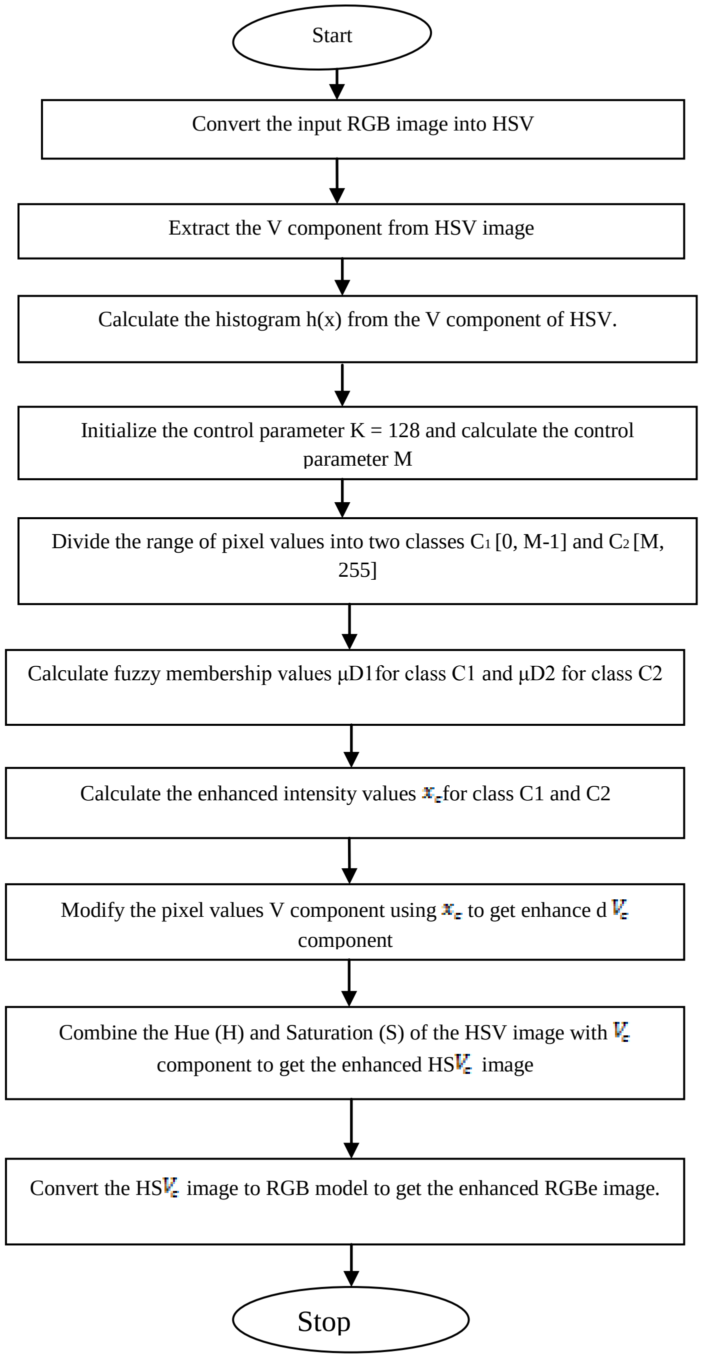


**Figure 1. Flowchart of Fuzzy Enhancement [2]**

Parameter K comes to a decision the stretching point to which the intensity value x can stretch based on the membership values $\mu_{d1}$ and $\mu_{d2}$. Once the membership value of x has calculated, the contrast enhanced value $x_e$ for class C2 can be computed.

**Phase6:** The substitute of the earlier x values of the V factor with the improved $x_e$ Values can cause the V component to be extended resulting in contrast and brightness enhanced part $V_e$.

**Phase7:** This enhanced achromatic information $V_e$ Can be joint with the preserved chromatic in sequence (Hue and Saturation components) to acquire improved image HS$V_e$ which is in conclusion converted to enhanced RG$B_e$ Image.

### 2.2. Data Set Description

In this dataset, we have taken the total number of images 25 which has taken at different positions. Few examples have shown in the Figure 2 and Figure 3 respectively. Dataset named follows - 51959-color-constancy, which is available online (https://in.mathworks.com/matlabcentral/fileexchange/51959-color-constany) [19].

**Figure 2. Examples of the Datasets (Adapted from [19])**

**Figure 3. Examples of the Datasets (Adapted from [19])**

## 3. Improved Experimental Results

In the prior paper [2], we have obtained results for MSE, RMSE and PSNR. It has observed that MSE is 0.026, RMSE is 0.149 and PSNR is 64.2104 over saturation weighting method.

### 3.1. Mean Square Error

The mean square error (MSE) computes the average of the squares of the "errors", *i.e.*, the differentiation between the estimator and what has estimated. The distinction occurs because of the estimator doesn't account for information that could create a more accurate estimate [2].

Table 3 shows the quantized analysis of the mean square error. As the mean square error needs to be reduced, therefore the proposed algorithm is showing better results than the available methods as mean square error is less in every case. For example in giving table it is clearly shown that 1, 2, 4, 9 images have less MSE values of the modified gray world with edge preserving filter. So the proposed technique works efficiently.

 

**Table 3. Mean Square Error Evaluation**

| Images | Gray Edge 1 | Gray Edge 2 | Modified gray world | Modified gray world with Edge Preserving Filter | Proposed Results |
|---|---|---|---|---|---|
| **1.** | **0.0215** | **0.0205** | **0.0171** | **0.0161** | **0.0148** |
| **2.** | **0.0339** | **0.0297** | **0.0227** | **0.0211** | **0.0169** |
| 3. | 0.0589 | 0.0549 | 0.0486 | 0.0467 | 0.0413 |
| **4.** | **0.0253** | **0.0236** | **0.0177** | **0.0172** | **0.0156** |
| 5. | 0.0558 | 0.0518 | 0.0487 | 0.0481 | 0.0343 |
| 6 | 0.0387 | 0.0361 | 0.0325 | 0.0317 | 0.0264 |
| 7 | 0.0482 | 0.0460 | 0.0403 | 0.0377 | 0.0305 |
| 8 | 0.0389 | 0.0363 | 0.0332 | 0.0324 | 0.0223 |
| **9** | **0.0210** | **0.0205** | **0.0194** | **0.0185** | **0.0183** |
| 10. | 0.0786 | 0.0701 | 0.0614 | 0.0596 | 0.0457 |

### 3.2. Root Mean Square Error

Root mean square error measures the square of the root of the error. The RMSE represents the cumulative root squared error between the output and the original image [2].

Table 4 shows the comparative analysis of the Root Mean Square Error. It has clearly demonstrated that the root mean square error is moderately less in the case of the suggested algorithm; therefore suggested algorithm is providing better results.

**Table 4. Root Mean Square Error Evaluation**

| Images | Gray Edge 1 | Gray Edge 2 | Modifie d gray world | Modified gray world with Edge Preserving Filter | Proposed Results |
|---|---|---|---|---|---|
| **1.** | **0.1467** | **0.1432** | **0.1308** | **0.0161** | **0.0148** |
| **2.** | **0.1842** | **0.1724** | **0.1506** | **0.1451** | **0.1302** |
| 3. | 0.2427 | 0.2344 | 0.2205 | 0.2162 | 0.2032 |
| **4.** | **0.1592** | **0.1537** | **0.1329** | **0.1312** | **0.1247** |
| 5. | 0.2363 | 0.2277 | 0.2206 | 0.2193 | 0.1852 |
| 6. | 0.1968 | 0.1901 | 0.1802 | 0.1781 | 0.1625 |
| 7. | 0.2195 | 0.2146 | 0.2007 | 0.1941 | 0.1747 |
| **8.** | **0.1973** | **0.1904** | **0.1821** | **0.1800** | **0.1494** |
| **9.** | **0.1448** | **0.1432** | **0.1393** | **0.1360** | **0.1353** |
| 10. | 0.2804 | 0.2647 | 0.2478 | 0.2442 | 0.2139 |

For example in giving table it is clearly shown that 1, 2, 4, 8, 9 images have less RMSE values of the modified gray world with edge preserving filter. So the suggested technique works efficiently.

### 3.3. Peak Signal to Noise Ratio

Another parameter is to maximize the quality of an image is Peak Signal to Noise Ratio (PSNR). This ratio is frequently utilized as a quality measurement sandwiched between the original and an output image. The higher the PSNR value better will be the quality of the reconstructed image [2].

Table 5 shows 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. For example in giving table it is clearly shown that 1, 2, 4, 8,9 images have more PSNR values of modified gray world with edge preserving filter. So the suggested technique works efficiently.

**Table 5. Peak Signal to Noise Ratio Evaluation**

| Images | Gray Edge 1 | Gray Edge 2 | Modified gray world | Modified gray world with eps | Proposed Results |
|---|---|---|---|---|---|
| **1.** | **64.8019** | **65.0119** | **65.7959** | **66.0637** | **66.4248** |
| **2.** | **62.8244** | **63.3984** | **64.5739** | **64.8967** | **65.8409** |
| 3. | 60.4300 | 60.7323 | 61.2629 | 61.4354 | 61.9730 |
| **4.** | **64.0918** | **64.3945** | **65.6591** | **65.7740** | **66.2108** |
| 5. | 60.6606 | 60.9838 | 61.2580 | 61.3117 | 62.7803 |
| 6. | 62.2483 | 62.5523 | 63.0167 | 63.1180 | 63.9132 |
| 7. | 61.3018 | 61.4988 | 62.0800 | 62.3682 | 63.2860 |
| **8.** | **62.2279** | **62.5371** | **62.9230** | **63.0260** | **64.6414** |
| **9.** | **64.9166** | **65.0140** | **65.2542** | **65.4587** | **65.5064** |
| 10. | 59.1784 | 59.6761 | 60.2482 | 60.3753 | 61.5273 |

In order to put into practice the algorithm, implementation has done in MATLAB R2010a version 7 using an image processing toolbox. In this paper we are trying to publish these constraints Normalized Cross-Correlation, Structural Content and Normalized Absolute Error.

### 3.4. Normalized Cross-Correlation

Normalized cross correlation has been generally used as a metric to estimate the degree of similarity between two compared images. The large value of normalized cross-correlation means that image is of good quality.

 

**Table 6. Normalized Cross-Correlation Evaluation**

| Images | Gray Edge 1 | Gray Edge 2 | Modified gray world | Modified gray world with Edge Preserving Filter | Proposed Results |
|---|---|---|---|---|---|
| **1.** | **0.8151** | **0.8188** | **0.8340** | **0.8398** | **0.8545** |
| **2.** | **0.7399** | **0.7553** | **0.7886** | **0.8014** | **0.8616** |
| 3. | 0.6098 | 0.6208 | 0.6426 | 0.6502 | 0.6718 |
| **4.** | **0.8017** | **0.8069** | **0.8329** | **0.8364** | **0.8568** |
| 5. | 0.4934 | 0.5110 | 0.5279 | 0.5333 | 0.6176 |
| 6 | 0.6028 | 0.6152 | 0.6354 | 0.6398 | 0.6854 |
| 7 | 0.6962 | 0.7021 | 0.7204 | 0.7303 | 0.7862 |
| 8 | 0.6583 | 0.6688 | 0.6830 | 0.6870 | 0.7762 |
| **9** | **0.7924** | **0.7944** | **0.8008** | **0.8113** | **0.8121** |
| 10. | 0.5439 | 0.5678 | 0.5952 | 0.6033 | 0.6676 |

### 3.5. Structural Content

The large value of structural content means that image is of good quality. In this research work our method has shown better result to improve the quality of the related digital image as compared to the previous work.

For example in giving Table 7 it is clearly shown that 1, 2, 4, 9 images have more structural content values of modified gray world with edge preserving filter. So the projected technique works efficiently.

**Table 7. Structural Content Evaluation**

| Images | Gray Edge 1 | Gray Edge 2 | Modified gray world | Modified gray world with Edge Preserving Filter | Proposed Results |
|---|---|---|---|---|---|
| **1.** | **0.7070** | **0.7117** | **0.7312** | **0.7386** | **0.7566** |
| **2.** | **0.6201** | **0.6368** | **0.6736** | **0.6875** | **0.7559** |
| 3. | 0.5113 | 0.5203 | 0.5378 | 0.5439 | 0.5620 |
| **4.** | **0.6909** | **0.6976** | **0.7302** | **0.7345** | **0.7590** |
| 5. | 0.4390 | 0.4497 | 0.4598 | 0.4627 | 0.5189 |
| 6 | 0.5083 | 0.5179 | 0.5336 | 0.5371 | 0.5724 |
| 7 | 0.5836 | 0.5893 | 0.6069 | 0.6164 | 0.6690 |
| 8 | 0.5529 | 0.5621 | 0.5745 | 0.5779 | 0.6581 |
| **9** | **0.6790** | **0.6815** | **0.6889** | **0.7002** | **0.7013** |
| 10. | 0.4642 | 0.4807 | 0.5003 | 0.5058 | 0.5538 |

 

### 3.6. Normalized Absolute Error

The large the value of normalized absolute error means that image is poor quality. In this research paper our method has been shown the least error using normalized method as compared to the previous work.

**Table 8. Normalized Absolute Error Evaluation**

| Images | Gray Edge 1 | Gray Edge 2 | Modified gray world | Modified gray world with Edge Preserving Filter | Proposed Results |
|---|---|---|---|---|---|
| **1.** | **0.2035** | **0.1990** | **0.1737** | **0.1682** | **0.1618** |
| **2.** | **0.2968** | **0.2775** | **0.2259** | **0.2165** | **0.1908** |
| 3. | 0.4277 | 0.4130 | 0.3809 | 0.3748 | 0.3420 |
| **4.** | **0.2210** | **0.2138** | **0.1742** | **0.1715** | **0.1612** |
| 5. | 0.5246 | 0.5045 | 0.4807 | 0.4769 | 0.3789 |
| 6 | 0.4263 | 0.4111 | 0.3711 | 0.3677 | 0.3141 |
| 7 | 0.3225 | 0.3155 | 0.2887 | 0.2785 | 0.2432 |
| 8 | 0.3592 | 0.3467 | 0.3278 | 0.3240 | 0.2478 |
| **9** | **0.2320** | **0.2295** | **0.2282** | **0.2245** | **0.2218** |
| 10. | 0.4909 | 0.4631 | 0.4262 | 0.4197 | 0.3508 |

For example in giving Table 8 it is clearly shown that 1, 2, 4, 9 images have less normalized absolute error values of modified gray world with edge preserving filter. So the proposed technique works efficiently.

## 4. Comparative Analysis

Figure 4 has revealed the comparative analysis of the Mean Square Error. The proposed algorithm is showing better results than the available methods as mean square error is less in every case.

 

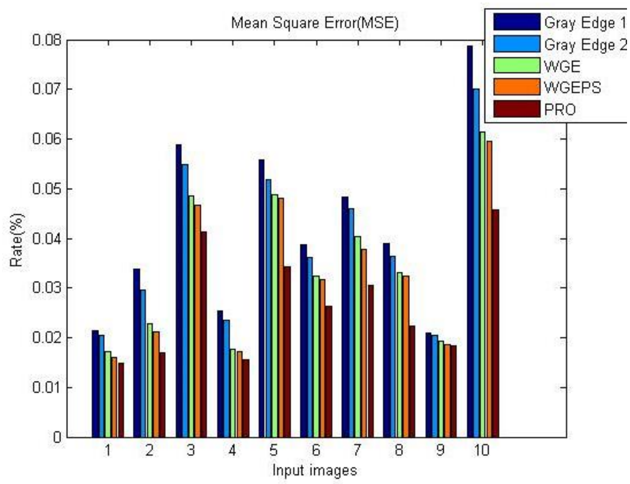


**Figure 4. Mean Square Error**

Figure 5 is viewing the comparative analysis of the Root Mean Square Error. It has clearly demonstrated that the root mean square error is moderately less in the case of the proposed algorithm; therefore suggested algorithm is providing better results.

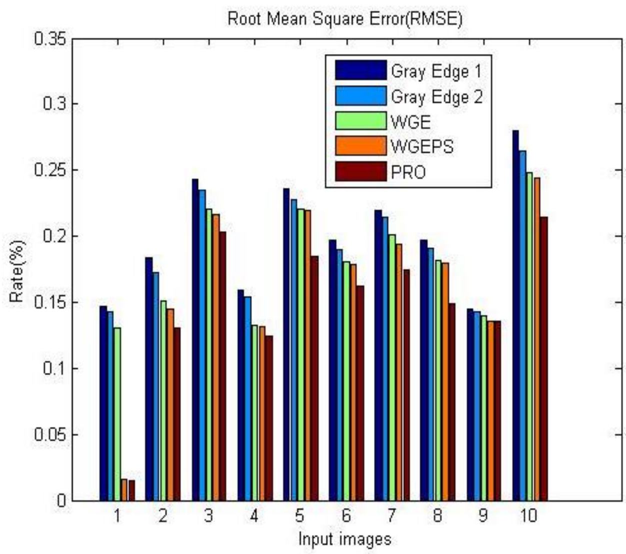


**Figure 5. Root Mean Square Error**

Figure 6 has clearly shown that the PSNR is maximum in the case of the proposed algorithm therefore suggested algorithm is providing better results than the available methods.

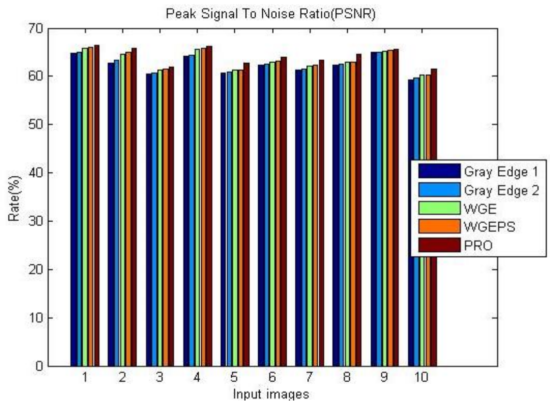


**Figure 6. Peak Signal to Noise Ratio**

Figure 7 demonstrated the comparative analysis of the Normalized Cross-Correlation (NCC). Normalized cross correlation has used to find out similarities between fused images. It has clearly shown that the normalized cross correlation is maximum in the case of the proposed algorithm. Therefore; suggested algorithm is showing better results than the available methods.

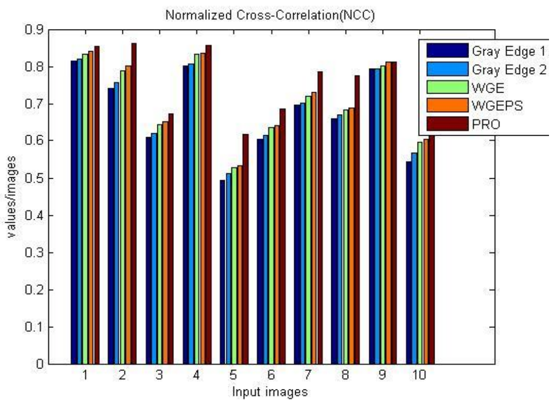


**Figure 7. Normalized Cross Correlation**

Figure 8 shows the comparative analysis of the Structural Correlation (SC). As SC needs to close to 1. It has clearly shown that the structural content is maximum in the case of the proposed algorithm. Therefore, suggested algorithm is showing better results than the available methods.

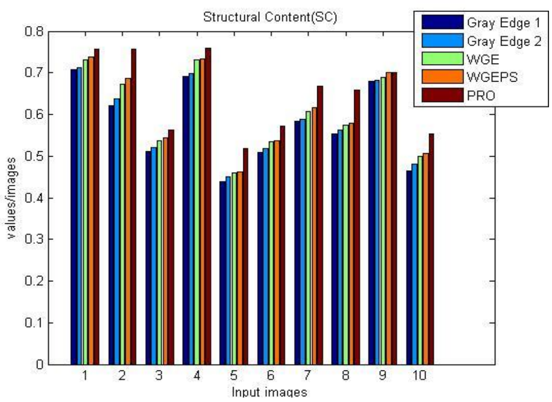


**Figure 8. Structural Content**

Figure 9 shows the comparative analysis of the normalized absolute error. It has clearly shown that the normalized absolute error seems to least in the case of the suggested algorithm.

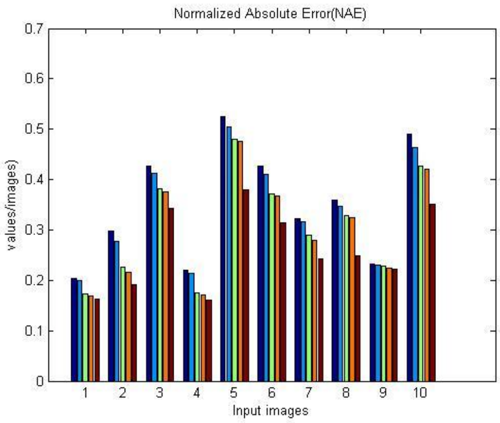


**Figure 9. Normalized Absolute Error**

## 5. Conclusion

As fuzzy membership makes use of two classes and give better results under that scenario. The same method can experimented with more results.

This work has not considered any soft computing technique to check the optimistic value of a light source. Also the effect of the noise is also ignored, therefore in the near future we will use some well-known image filters.

## References

[1] G. Kaur and Pooja, "Color Constancy Algorithms: Significant Study", in International Conference on Communication, Information and Computing Technology (ICCICT-15), **(2015)**.

[2] G. Kaur and Pooja, "Improving Saturation Weighting Color Constancy with Fuzzy Membership and Edge Preservation", in an International Journal of Engineering Sciences, **(2015)**.

[3] B. Li, W. Xiong, W. Hu and O. Wu, "Evaluating combinational color constancy methods on real-world images", IEEE Conference on In Computer Vision and Pattern Recognition (CVPR), **(2011)**.

[4] A. Gijsenij and T. Gevers, "Color Constancy Using Natural Image Statistics and Scene Semantics", IEEE Conference on Pattern Analysis and Machine Intelligence, vol. 33, no. 4, **(2011)**.

[5] A. Chakrabarti, K. Hirakawa and T. Zickler, "Color constancy with spatio-spectral statistics", IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 34, no.8, **(2012)**.

[6] H. R. V. Joze and M. S. Drew, "Exemplar-Based Colour Constancy and Multiple Illumination", IEEE Transactions on Pattern Analysis and Machine Intelligence, **(2013)**.

[7] M. Rezagholizadeh and J. J. Clark, "Edge-based and Efficient Chromaticity Spatio-Spectral Models for Color Constancy"", IEEE International Conference on Computer and Robot Vision (CRV), **(2013)**.

[8] M. Bleier, "Color constancy and non-uniform illumination: Can existing algorithms work?", Computer Vision Workshops (ICCV Workshops), IEEE International Conference, **(2011)**.

[9] A. Gijsenij, R.Lu and T. Gevers, "Color constancy for multiple light sources", IEEE Transactions on Image Processing, vol. 21, no.2, **(2012)**.

[10] J. V, Corral, "Color constancy by category correlation", IEEE Transactions on Image Processing, vol. 21, no. 4, **(2012)**.

[11] A. Gijsenij, T. Gevers and J. V. De Weijer, "Improving color constancy by photometric edge weighting", IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 34, no.5, **(2012)**.

[12] S. Bianco and R. Schettini, "Color constancy using faces", IEEE Conference on Computer Vision and Pattern Recognition (CVPR), **(2012)**.

[13] E.Monari, "Color Constancy Using Shadow-Based Illumination Maps for Appearance-Based Person Re-identification", IEEE Ninth International Conference on Advanced Video and Signal-Based Surveillance (AVSS), **(2012)**.

[14] M. Ebner, G.Tischler and J. Albert, "Integrating color constancy into JPEG 2000", IEEE Transactions on Image Processing, vol.16, no. 11, **(2007)**.

 

[15] S. J. J. Teng, "Robust Algorithm for Computational Color Constancy", IEEE International Conference on Technologies and Applications of Artificial Intelligence (TAAI), **(2010)**.
[16] A. Gijsenij and W. Gevers, "Computational Color Constancy: Survey and Experiments" IEEE Conference on image processing, Vol. X, No. X, **(2010)**.
[17] T. Akhavan, "A new combining learning method for color constancy" IEEE International Conference on Image Processing Theory Tools and Applications (IPTA), **(2010)**.
[18] K. Barnard, A. Coath and B. Funt, "A Comparison of Computational Color Constancy Algorithms—Part II: Experiments with Image Data", IEEE Confertence on image processing, vol. 11, no. 9, **(2002)**.
[19] https://in.mathworks.com/matlabcentral/fileexchange/51959-color-constany accessed on Jul. 4,2015.
[20] A. Gehler, "Bayesian Color Constancy Revisited", Max Planck Institute Tubingen, Germany, Microsoft Research Cambridge, UK.
[21] L. Brown, A. Datta and S. Pankanti, "Exploiting Color Strength to Improve Color Correction", Multimedia (ISM), 2012 IEEE International Symposium on IEEE, **(2012)**.
[22] S. Bianco and R. Schettini, "Computational color constancy", Visual Information Processing (EUVIP), 2011 3rd European Workshop on IEEE, **(2011)**.
[23] J. C.-Negrete and R. E. S.-Yanez, "Combining color constancy and gamma correction for image enhancement", Electronics, Robotics and Automotive Mechanics Conference (CERMA), 2012 IEEE Ninth. IEEE, **(2012)**.
[24] F.-J. Chang and S.-C. Pei, "Color constancy via chromaticity neutralization:From single to multiple illuminants", In Circuits and Systems (ISCAS), 2013 IEEE International Symposium on, IEEE, **(2013),** pp. 2808-2811.
[25] H. Ahn, S. Lee and H. Soo Lee, "Improving color constancy by saturation weighting", IEEE International Conference on Speech and Signal Processing (ICASSP), **(2013)**.
[26] A. Madi, "Color correction problem of image displayed on non-white projection screen", in International Conference on Image Analysis and Recognition, **(2013)**.
[27] C. Barata, M. E. Celebi and J. S. Marques, "Improving Dermoscopy Image Classification Using Color Constancy" in IEEE xplore, **(2014)**.
[28] A. Madi and D. Ziou, "Color constancy for visual compensation of projector displayed image", **(2014)**.
[29] K.-F.Yang, S.-B. Gao and Y.-J. Li, "Efficient Illuminant Estimation for Color Constancy Using Grey Pixels", in IEEE xplore, **(2015)**.
[30] N. Banic and S. Loncaric, "Color Cat: Remembering Colors for Illumination Estimation", in Signal Processing Letters, IEEE, **(2015)**.

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