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An Improved Dominant Brightness Level Analysis (DBLA) Approach for Image Contrast Enhancement

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Abstract: Image enhancement has originated to be one of the most significant visualization applications for the reason that it has capability to improve the visibility of images. It improves the quality of low contrast images. Distinctive procedures have been estimated so far for getting better the feature of the digital images. To improve picture superiority image enhancement can explicitly recover and bound some data accessible in the input image. In this paper, the performance of dominant brightness level based image enhancement technique has been evaluated. By using image processing toolbox, the design and implementation has been done in MATLAB. The comparison among the dominant brightness level, histogram equalization and the adaptive histogram equalization has shown that the dominant brightness level outperforms over the histogram based image enhancement.

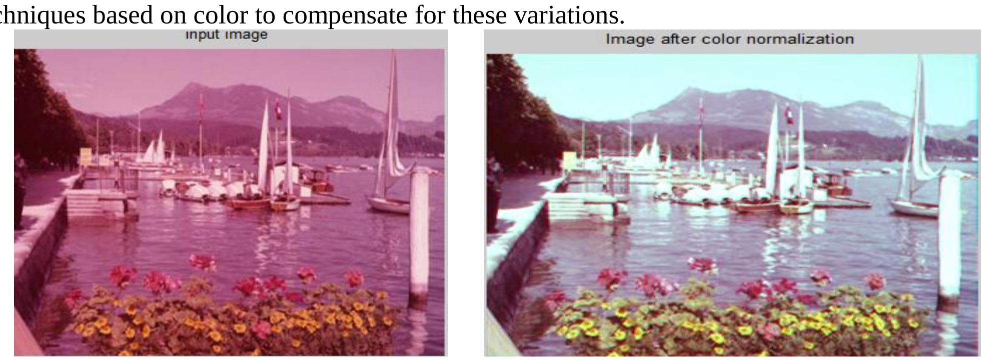
Keywords: Enhancement, Histogram equalization, Adaptive Histogram Equalization, Dominant Brightness level Analysis, Color Normalization

I. INTRODUCTION

Image enhancement plays a very essential role in different types of image processing applications. Image enhancement consists of number of methods that are used to get better the visual facade of an image or to convert the image to a better form. Enhancement is also used as a pre-processing step in applications, where human viewing of an image is required. The most important purpose of image enhancement is to alter attributes of an image. During this procedure, one or more attributes of the image are enhanced. A digital Image enhancement method gives a number of choices for getting better the visual superiority of images. Digital image enhancement can be divided into different categories:

a) Spatial Domain method
b) Frequency Domain Method

Contrast enhancement has enormous impact in digital image processing. Histogram Equalization (HE) is one of the most well known, fast and straightforward method to implement techniques for contrast enhancement of digital images. It is a graphical illustration of distribution of data. It is similar to bar chart. It shows that how many times a particular grey level appears in an image. The first employ as it has also been discussed above is the analysis of the image. We can expect about an image by just looking at its histogram. It's looking as an x- ray of a bone of a body. Adaptive histogram equalization [AHE] is a computer image processing method used to get better contrast of the images. Adaptive histogram equalization [AHE] is a brilliant contrast enhancement for both natural images and medical images and other initially non visual images. Dominant Brightness means that is effective or impressible technique for the images. Contrast enhanced images may contain intensity distortion and lose image information in various regions. To overcoming the problems of contrast enhanced images, to decompose the input image into several layers of single dominant brightness levels [3]. Color normalization is a topic in computer vision concerned with artificial color vision and object recognition. Color image normalization will also be done to reduce the color artefacts. Distribution of color values in an image depends on the illumination, which may vary that is depending on different lighting conditions or different cameras. It allows object recognition techniques based on color to compensate for these variations.



a) Original image (b) Output of color normalization

Fig 1: The results of color normalization

II. LITERATURE REVIEW

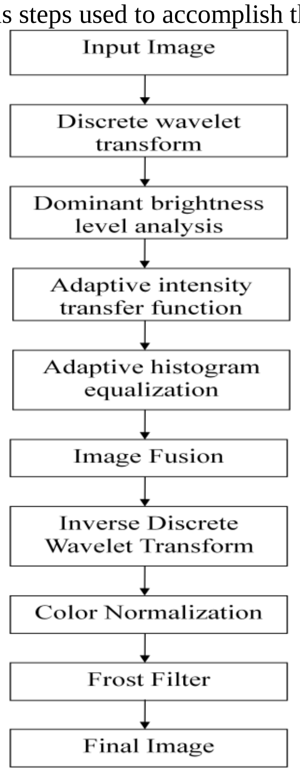
Veena et al. (2013) [1] has discussed that the improved visual observation and color imitation. By using Discrete Wavelet transform and singular value Decomposition, Discrete Cosine Transform the Histogram equalization, Contrast Enhancement, Bi-histogram equalization discussed the basic enhancement methods and projected method contrast enhancement based on dominant Brightness and Adaptive transformation. The concert of each technique has evaluated with parameters like Mean Square Error, Measure of Enhancement Peak Signal to Noise ratio and Mean absolute error. Without changing original image quality it has an appropriate for enhancement of low contrast satellite image. Srivastava et al. (2013) [2] has presented histogram equalization has one of the best method that is very effective method to process the digital contrast enhancement but has not been suitable for every image. Sometimes it shows not good outcomes. To overcome this problem it provides a new method to improve the image result. In this interact with histogram that reflects improved outcomes as compare to conservative one. On the basis of Absolute mean brightness error and peak Signal to Noise Ratio values. It has an appropriate for real time applications. Lee et al. (2013) [3] The work has based on the satellite images the low contrast images used as an input after applying all the methods the result has the better quality image. For remote sensing images on the basis of adaptive intensity transfer function and dominant brightness level analysis proved a new contrast enhancement technique. It divide the input image into four wavelet subbands and split the LL subband into low-, middle-, and high-intensity layers by analyzing the log-average luminance of the resultant layer. After that apply adaptive intensity transfer function and then implement contrast enhancement technique then combine the decomposed image by using image fusion method after that at last use inverse discrete wavelet transform method. Then the contrast enhanced image has ready as a result. Amina saleem et al. (2012) [20] has planned a scheme that balances the situation of local and global contrast enhancements and a reasonable illustration of the original image and defeat the limitations of altered contrast enhancement that is fusion-based contrast enhancement algorithms. By using laplacian pyramid decomposition techniques has used for fusion. The results show that enhancing the local and global contrasts. Chauhan and Bhadoria (2011) [10] has shown that histogram equalization has predictable technique for contrast enhancement. Histogram equalization has some limitations. Histogram equalization recovers the disparity of an image by altering the intensity level of the pixel based on the intensity of the original image. To overcome these problems apply brightness preserving weight clustering histogram equalization that protect image brightness and enhance visual effects of an image efficiently as compare to histogram equalization technique. Garg et al. (2011) [11] has provide that the different enhancement methods like gray scale manipulation, filtering and HE are used to enhancing an image. Histogram Equalization is very important and known image enhancement method. It is a famous method for contrast enhancement just because it is easier and efficient. In Histogram Equalization it is not compulsory that the contrast of an image will always be raised. Sometimes it shows that it can be not as good as than the contrast of an image reduced. In this paper compare different enhancement methods on the basis of the performance analysis methods like PSNR, MSE, NAE, CPSNR and normalized correlation. Demirel et al. (2010) [12] has provided a novel satellite image contrast enhancement method based on the discrete wavelet transform and singular value decomposition has been projected. In this method by using discrete wavelet transform divide the input image into the four frequencies subbands and estimates the singular value matrix of low-low subband image and then restructure improved by applying inverse discrete wavelet transform. The illustration results on the finishing image quality show the advantage of the projected technique over the predictable and the state-of-the-art method. The different techniques used for example discrete wavelet transform, Image equalization and satellite image contrast enhancement. Compare the techniques with general histogram equalization and local histogram equalization. Ke et al.(2010) [13] has discussed that there are so many types of image enhancement techniques that makes the image results better that associate to the person visual system. It includes the two techniques bilateral tone Adjustment and Saliency Weighted Contrast Enhancement both combined in image enhancement framework. The main scenes that are contained in mid-tone regions enhanced by bilateral tone adjustment in most of the curve-based global contrast enhancement techniques. The saliency-weighted Contrast enhancement integrates the notion of image saliency into an easy filter-based contrast enhancement technique. It performs extra enhancement in regions that persons give larger concentration to. By using the luminance component in this saliency weighted contrast enhancement achieves extra performance. It proved that to achieve higher contrast enhancement with slight sound and huge image quality. Murahira et al. (2010) [14] has proved for improving images histogram equalization is one of the general technique. On the other hand, it will cause a consequence on the brightness saturation or shadow in several identical areas. To overcome these things mean preserving bi-histogram equalization technique has been developed. New histogram equalization with variable enhancement degree and bi-histogram equalization with variable degree has developed. By only one parameter the degree of every of these techniques has controlled. Every type of images is enhanced effectively. The outcomes show that especially, bi-histogram equalization with variable degree can recognize the normal enhancement. Zhao et al. (2010) [15] has explained a new technique has been used in this paper to attain real-time subject-independent automatic facial facet enhancement and detection, with combination of Contrast-limited Adaptive Histogram Equalization and multi-step integral projection. First of all, sigma filter has been used to eliminate the noise in images after the detection of real time face images. Sigma filtering has been chosen in this work for the reason that of its soundness in noise deduction. This method has the compensation to proving the best noise deduction; the image has not been blurred and rapid presentation. Sun et al. (2009) [17] has proved that to automatically produce bas-reliefs based on adaptive histogram equalization, starting from an input height field. A network model may on the other hand be provided, in which case a height field was first created via orthogonal or perspective projection. The height field has been regularly gridded and treated as an image, enabling a modified adaptive histogram equalization technique to be used to produce a bas-relief with a user-chosen height range.

III. PROBLEM DEFINITION

To overcome this problem we have introduced an integrated approach. The new integrated approach will have the capability to enhance the contrast in remote sensing images using dominant brightness level analysis (DBLA), Frost Filter and adaptive histogram specification (AHS). The selection of the histogram specification seems to be justifiable as it has the ability to overcome the problem of poor brightness in enhancement of the existing methods. The benefit of frost filter has that being linear it retains the mean level of homogenous image regions irrespectively to the p.d.f of multiplicative noise. Therefore the algorithm is applicable for different types of images. However to handle the short coming of transform domain method color image normalization will also be done to reduce the color artefacts.

IV. PROPOSED METHODOLOGY

To attain the objective, step-by-step methodology is used in this paper. Sub sequent are different steps which are used to accomplish this work. Following are the various steps used to accomplish the objectives of the dissertation.



BEGIN: IDBLA(Image)
Step 1: Input images: select an input image. This image may be satellite image, underwater image, natural image etc. Step 2: Discrete wavelet transform: Now perform the DWT is a wavelet transform for which the wavelets are discretely sampled. Discrete wavelet transform captures both frequency and location information. Wavelet used for feature extraction, denoising, compression, face recognition, image super resolution. Step3: Dominant brightness level analysis: This analysis is done to remove the problem of intensity distortion and lose image details due to contrast enhancement and divide image based on dominant brightness level analysis is into three intensity (low, middle, high). Step4: Adaptive intensity transfer function: then apply adaptive intensity transfer function on each layer and do boundary smoothing after smoothing weighting map estimation method applied on it. Step5: Adaptive histogram equalization: then this technique is apply to prevent the limiting amplification and this also applicable for limiting the amplification of noise. Step7: Image Fusion: Then image can be fused means to combine the decomposed image into a single one. Step 8: Inverse discrete wavelet transform: this technique is applied to reform the data. Step 9: Color Normalization: For the purpose of the object recognition Step10: Frost Filter: Used the removal of speckle noise
RETURN ENHANCED IMAGE

V. RESULTS AND DISCUSSIONS

In order to implement the proposed algorithm, design and implementation has been done in MATLAB using image processing toolbox. Result shows that our proposed approach gives better results than existing techniques.

1. Experimental Set-up

Table 1 is showing the various images which are used in this research work. Images are given along with their formats. All the images are of most probably same kind and passed to proposed algorithm.

Table 1. Various images used in research

Image	Extension	Size in K.Bs
1	.jpg	29.5KB
2	.jpg	57.3KB
3	.jpg	41.0KB
4	.jpg	63.0KB
5	.jpg	505KB
6	.jpg	8.24KB
7	.jpg	33.7KB
8	.jpg	140MB
9	.jpg	129KB
10	.jpeg	10.7KB

Fig 2 has shown the input images for experimental analysis. The overall objective is to combine relevant information from multiple images that is more informative and suitable for both visual perception and further computer processing.

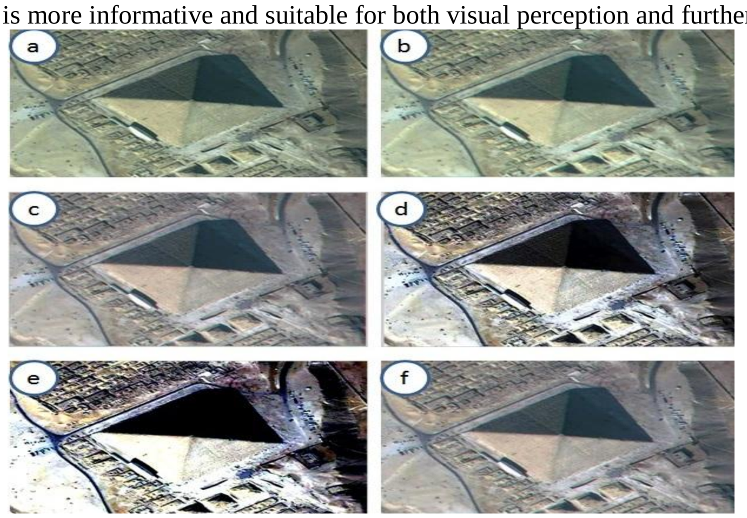


Fig 2: (a) Input image (b) Dominant brightness level analysis image (c) Color Normalization image (d) Histogram Equalization Image (e) Adaptive Histogram Equalization image (f) Final Proposed image

2. Performance Analysis

This section shows the performance analysis between existing and proposed techniques. These parameters are very important part of the digital image processing. In this different parameters are used to show the performance of proposed method is better than the existing algorithm.

a) Mean Square Error

In image processing mean square error is the most general measure for performance measurement of the existing method and the coded images. It is straightforward method to design system that decrease the MSE but cannot capture the impurities like blur artifacts. It is computed by using equation

$$\mathrm{MSE} = \frac{1}{\mathrm{MN}} \sum_{i=1}^{M} \sum_{j=1}^{N} (f(i,j) - f'(i,j))^2 \qquad (1)$$

Table 2. Mean square error evaluation

Image	Dominant Results	HE Results	AHE Results	Proposed Results
1	438	1059	3264	209
2	409	1528	3211	99
3	507	2378	3320	175
4	667	1112	3292	180
5	572	5106	2225	244

6	315	393	2260	82
7	367	323	1811	139
8	564	1727	3362	343
9	542	513	1464	190
10	358	2021	3367	130

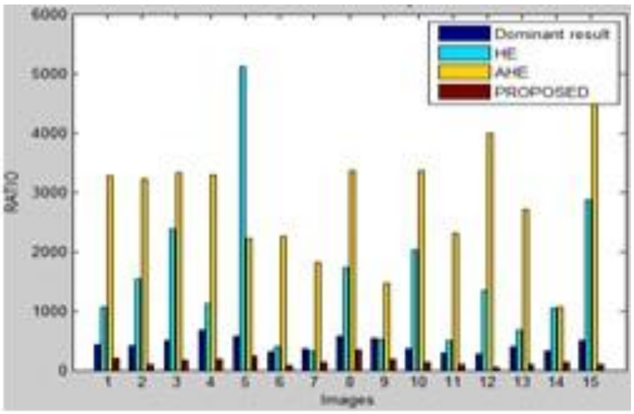


Fig 3: Analysis of mean square error

Figure 3 has shown the quantized analysis of the mean square error of different images by using AHE (Black Color), HE (Orange Color) and DBL (White Color). It is especially clear from the plot that there is decrease in MSE value of images. This decrease shows enhancement in the objective quality of the image.

b) Peak Signal to Noise Ratio

Peak signal to noise ratio measure the degree of image distortion. PSNR is used to measure the quality between the original image and compressed image. If the value of PSNR is higher, then the quality of reconstructed image is better PSNR represent the peak error. PSNR is defined as:

$$PSNR = 10.\log_{10}\left(\frac{MAX_I^2}{MSE}\right)$$
$$= 20.\log_{10}\left(\frac{MAX_I}{MSE}\right)$$
$$= 20\log_{10}(MAX_I) - 10.\log_{10}(MSE). \qquad (2)$$

TABLE 3

PEAK SIGNAL TO NOISE RATIO EVALUATION

Image	Dominant Results	HE Results	AHE Results	Proposed Results
1	21.7161	17.8818	12.9933	24.9293
2	22.0136	16.2896	13.0644	28.1745
3	21.0807	14.3687	12.9194	25.7004
4	19.8895	17.6698	12.9562	25.5781
5	20.5568	11.0500	14.6575	24.2569
6	23.1477	22.1869	14.5897	28.9927
7	22.4841	23.0388	15.5516	26.7007
8	20.6180	15.7579	12.8648	22.7779
9	20.7908	21.0296	16.4754	25.3433
10	23.4473	15.0751	12.8584	26.9914

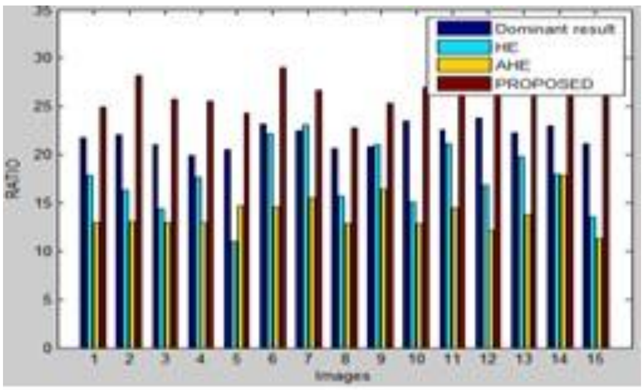


Fig 4: Analysis of peak signal to noise ratio

Fig 4 has shown the quantized analysis of the peak signal to noise ratio of different images by using AHE (Black Color), HE (Orange Color) and DBL (White Color). It is especially clear from the plot that there is increase in PSNR value of images. This maximization shows enhancement in the objective quality of the image.

c) Root Mean Square Error

The root mean square error is a generally used to compute of the difference among values predicted by a model and values actually observed from the surroundings that is being modelled. The RMSE of a model total with respect to the estimated variable X_{model} is defined as the square root of the mean squared error:

Table 4. Root mean square error

Image	Dominant Results	HE Results	AHE Results	Proposed Results
1	20.9284	32.5423	57.1314	14.4568
2	20.2237	39.0896	56.6657	9.9499
3	22.5167	48.7647	57.6194	13.2288
4	25.8263	33.3467	57.3760	13.4164
5	23.9165	71.4563	47.1699	15.6205
6	17.7482	19.8242	47.5395	9.0554
7	19.1572	17.9722	42.5558	11.7898
8	23.7487	41.5572	57.9828	18.5203
9	23.2809	22.6495	38.2623	13.7840
10	17.1464	44.9555	58.0259	11.4018

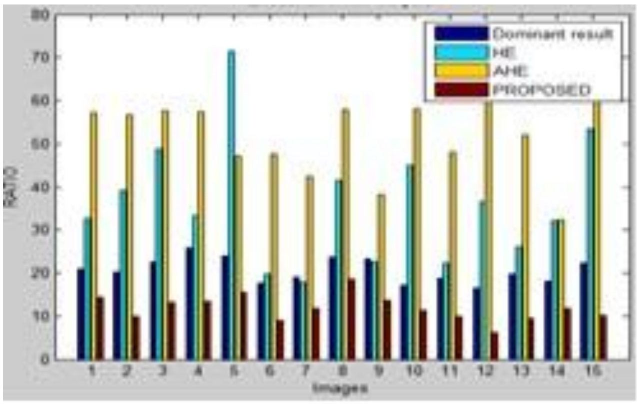


Fig 5: Analysis of root mean square error

Fig 5 is showing the relative analysis of the Root Mean Square Error (RMSE). As RMSE need to be minimized; therefore the key goal is to reduce the RMSE as much as possible. It is providing better results than the available methods.

d) Bit Error Rate: BER need to be minimized; so the main goal is to decrease the BER as much as possible. Table 5 has clearly shown that the BER is minimum in the case of the proposed algorithm therefore proposed algorithm is providing better results than the available methods.

Table 5. Bit error rate

Image	Dominant Results	HE Results	AHE Results	Proposed Results
1	12.2670	4.6406	9.5661	10.5765
2	10.3803	23.3195	13.2508	0.0570
3	8.5532	40.0667	31.9212	0.0364
4	15.3529	26.0979	28.1494	0.0246
5	4.7081	60.6672	17.1147	4.2054
60	12.0507	6.7926	0.2515	0.0088
7	13.3898	6.9936	6.7614	0.0716
8	8.4673	39.3351	41.8961	10.5257
9	10.1063	19.8605	19.7824	5.7945
10	12.1213	36.1020	29.4273	5.2023

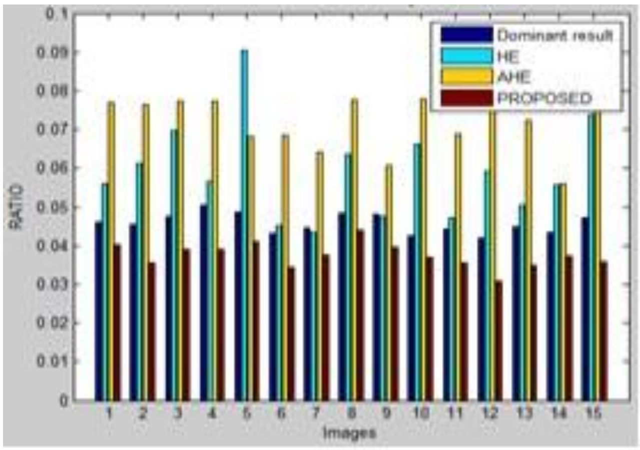


Fig 6: Analysis of Bit Error Rate

Fig 6 is showing the comparative analysis of the BIT ERROR RATE (BER).

e) Average Difference

Less the value of Average difference [AD] that gives the result more clear and appropriate and reduce the noise from image by using equation of AD

$$\frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}[f(i,j)-f'(i,j)] \qquad (3)$$

Table 6. Average difference

Image	Dominant Results	HE Results	AHE Results	Proposed Results
1	20.9284	32.5423	57.1314	14.4568
2	20.2237	39.0896	56.6657	9.9499
3	22.5167	48.7647	57.6194	13.2288
4	25.8263	33.3467	57.3760	13.4164
5	23.9165	71.4563	47.1699	15.6205
6	17.7482	19.8242	47.5395	9.0554
7	19.1572	17.9722	42.5558	11.7898
8	23.7487	41.5572	57.9828	18.5203
9	23.2809	22.6495	38.2623	13.7840
10	17.1464	44.9555	58.0259	11.4018

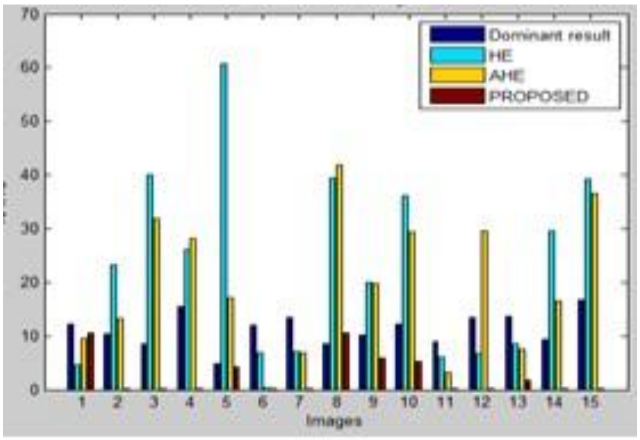


Fig 7: Analysis of Average Difference

Fig 7 is showing the comparative analysis of the Average Difference. As Average Difference needs to be minimized; so the main objective is to reduce the Average Difference as much as possible. It shows better results as compare to existing methods.

f) Normalized Cross-Correlation Evaluation

Table7 is showing 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 7. Normalized cross-correlation

Image	Dominant Results	HE Results	AHE Results	Proposed Results
1	1.0857	1.1102	1.1948	1.0787
2	1.0802	1.2809	1.2688	0.9919
3	1.0616	1.4230	1.4395	0.9795
4	1.0858	0.8881	0.9327	0.9925
5	1.0517	1.4105	1.3581	1.0349
6	1.0930	1.0955	1.1317	0.9961
7	1.0933	0.9947	1.0488	0.9933
8	1.0653	1.3530	1.4994	1.0915
9	1.0787	1.1360	1.2445	1.0415
10	1.0940	1.3834	1.4183	1.0458

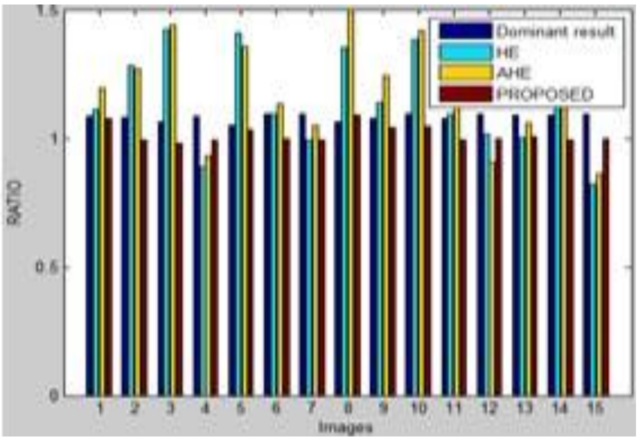


Fig 8: Analysis of Normalized Cross-Correlation

Fig 8 is showing the comparative analysis of the normalized cross-correlation (NCC). As NCC needs to be close to one; so the main goal is to maintain NCC as much as possible to close to one. It has clearly shown that the NCC is more close to one.

VI. CONCLUSION AND FUTURE SCOPE

The image enhancement methods have become significant pre-processing tool for digital vision processing applications. This paper has been shown that the image enhancement has been effectively used for enhancing the superiority of low contrast images by using the different linear and non-linear methods. The proposed method has modified the Dominant brightness level using Adaptive histogram equalization, color normalization and frost filter. The modified Dominant brightness level has the capability to overcome the disadvantages of the earlier work. The proposed method has been designed and implemented in MATLAB by using image processing toolbox. A different type of images has been selected in this research work to evaluate the efficiency of the proposed method. The comparison among the dominant brightness level, and proposed methods has shown the significant improvement of proposed method.

In near future, we may modify the dominant brightness level based image enhancement by using the adaptive histogram stretching as a post processing technique.

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