Enhancement of Medical Images using Histogram Based Hybrid Technique

Navjot Kaur[1], Er. Harpal Singh[2]

[1]Research Scholar M-Tech, Computer Science and Engineering, Guru Kashi University, India
[2]Assiatant Professor, UCCA, Guru Kashi University, India

Abstract — *Digital Image Processing is very important area of research. A number of techniques are available for image enhancement of gray scale images as well as color images. They work very efficiently for enhancement of the gray scale as well as color images. Important techniques namely Histogram Equalization, BBHE, RSWHE, RSWHE (recursion=2, gamma=No), AGCWD (Recursion=0, gamma=0) have been used quite frequently for image enhancement. But there are some shortcomings of the present techniques. The major shortcoming is that while enhancement, the brightness of the image deteriorates quite a lot. So there was need for some technique for image enhancement so that while enhancement was done, the brightness of the images does not go down.*

To remove this shortcoming, a new hybrid technique namely RESWHE+AGCWD (recursion=2, gamma=0 or 1) was proposed. The results of the proposed technique were compared with the existing techniques. In the present methodology, the brightness did not decrease during image enhancement. So the results and the technique was validated and accepted. The parameters via PSNR, MSE, AMBE etc. are taken for performance evaluation and validation of the proposed technique against the existing techniques which results in better outperform.

Keywords — *Histogram Equalization (HE), BBHE, RSWHE, AGWCD, PSNR, MSE, Enhancement.*

I. INTRODUCTION

Image resolution enhancement is a technique that helps to obtained high-resolution images from low-resolution images. It is needed to achieve a good effect of vision, in an improved effective image resolution, required for a good quality of images where it is required to adjust in a better size of image. It is mainly used in practical applications, such as robot vision, medical system, police system, remote image and image disposal software [1]. Improved investigation of high resolution image won the breakthrough progress. Algorithms [1] that are used for typical image enhancement are:-

- Interpolation nearest neighbour interpolation,
- Bilinear interpolation
- Interpolation cubic spine

The three algorithms are simple and easy to implement, while the marginal inaccuracy and keystone are fairly obvious. Process of self-adaptive interpolation uses edge direction and edge magnitude quantization that are limited to fit the edge of the image sub-pixel, which prevents the edge interpolation. It can produce strong, but the different artifacts that will be apparent due to a single edge and robust methodology [1].

One of the oldest and most popular image resolution enhancement methods is Histogram equalization (HE) which is used to enhance the contrast of the image intensity values that spreads throughout the range. In contrast control, the overall brightness of the image is changed. It turns out that the Gray level transform that we are seeking is simply a scaled version of the original image's cumulative histogram [2].

The method is useful in images with backgrounds and foregrounds that are both bright or both dark. In particular, the method can lead to better views of bone structure in x-ray images, and to better detail in photographs that are over or under-exposed. A key advantage of the method is that it is a fairly straightforward technique and an invertible operator. So in theory, if the histogram equalization function is known, then the original histogram can be recovered.

The calculation is not computationally intensive [2]. A disadvantage of the method is that it is indiscriminate. It may increase the contrast of background noise, while decreasing the usable signal. Histogram equalization determines a transformation function designed to produce an output image with a uniform histogram. Another method is to generate an image having a histogram corresponding histogram is specified [2].

II. LITERATURE SURVEY

Chao Zuo (2014) proposed spatially weighted histogram equalization. Spatially weighted histogram not only considers the times of each grey value appears in a certain

image, but also takes the local characteristics of each pixel into account. The experimental results show that the proposed method Spatially weighted histogram has better performance than the existing methods, and preserve the original brightness quite well, so that it is possible to be utilized in consumer electronic products. To reduce undesired artifacts associated with the conventional histogram, a weight function according to each pixel's spatial activity is introduced to make the contrast enhancement appropriate to the human observers. Then the grey scale transform function is calculated by accumulating this spatially weighted histogram. Finally, the transform function is modified to make sure that the mean output intensity will be almost equal to the mean input intensity. Here the proposed method had achieved visually more pleasing contrast enhancement while maintaining the input brightness. More importantly, the amount of calculation and storage involved in this algorithm is rather low which makes it more competitive in real-time processing [1]. Ravichandran and Magudeeswaran (2012) proposed mean brightness preserving Histogram Equalization based techniques for image enhancement. Generally, these methods partition the histogram of the original image into sub histograms and then independently equalize each sub-histogram with Histogram Equalization. The comparison of recent histogram based techniques is presented for contrast enhancement in low illumination environment and the experiment results are collected using low light environment images. The histogram modification algorithm is simple and computationally effective that makes it easy to implement and use in real time systems [3]. Vinod Kumar (2012), here author presents about Contrast enhancement of digital images is conveniently achieved by spreading out intensity values known as Histogram Equalization. In this paper, author evaluated the performance of different Histogram Equalization techniques for gray scale static images. In order to evaluate, the performance of these techniques, are examined on the basis of AMBE, PSNR and Entropy metrics. In this process enhancement techniques are applied on the images with different sizes and received from different application fields like real images, medical images etc. It is well illustrated that Brightness Preserving Dynamic Histogram Equalization (BPDHE) is the most suitable technique in terms of mean brightness preservation as it has least average AMBE value. In terms of PSNR, MPHEBP is the most suitable technique because it has the highest average PSNR value. In terms of Entropy, BBHE and RSIHE(r=2) are the best techniques, since these have the highest average Entropy values. The performance of BPDHE is not satisfactory in terms of Entropy. Swati Khidse (2013), here author proposes as Image enhancement is the first preprocessing step in image processing, that has the image with more clarity. In this paper the authors describes various techniques of image enhancement and compare it with image fusion techniques, with the help of various error analysis techniques. Image fusion techniques are assessed using the various metrics. A comparative study is carried out on different categories of images [4]. Shi-Chia Huang (2013), here modified histogram and enhanced contrast in digital images which improves the brightness of dimmed images via gamma correction and probability distribution of luminance pixels. In this, video enhancement with the framing difference as for producing enhanced and higher quality [14]. Mary Kim (2008), here new histogram equalization method, called RSWHE (Recursively Separated and Weighted Histogram Equalization), for brightness preservation and image contrast enhancement is worked out which provides image brightness more accurately and produces images with better contrast enhancement [10]. Zadbuke (2012) proposed modified dualistic sub image HE method which preserves the brightness of the image. Histogram equalization (HE) is one of the common methods used for improving contrast in digital images. However, this technique is not very well suited to be implemented in consumer electronics, such as television because the method tends to introduce unnecessary visual deterioration such as the saturation effect. One of the solutions to overcome this weakness is by preserving the mean brightness of the input image inside the output image [5]. Sonkar and Parsai (2013) reviewed various image enhancement schemes for enhancing an image which includes gray scale manipulation, filtering and Histogram Equalization (HE). The basic idea of HE method is to re-map the gray levels of an image. There are different images used in different time period and comparison on the basis of subjective and objective parameters. Subjective parameters are visual quality and computation time and objective parameters are Peak signal noise ratio (PSNR), Mean squared error (MSE), Normalized Absolute Error (NAE), Normalized Correlation, Error Color and Composite Peak Signal to Noise Ratio (CPSNR) [6].

III. METHDOLOGY

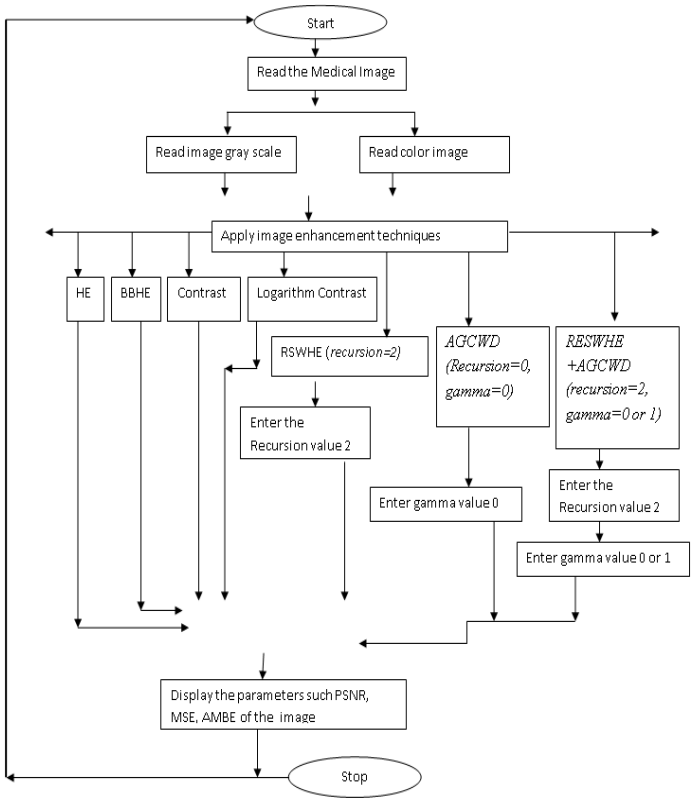


Fig.1.1: Image Enhancement Methodology Flowchart

IV. RESULTS

As the proposed technique is developed using MATLAB, its results features are explained below: Firstly, a GUI window is there in which we select the techniques of enhancement such as HE, BBHE, Contrast or Logarithm, RSWHE, AGCWD, Proposed Hybrid Technique named as (RESWHE +AGCWD) with 7 buttons. Exit button is there from existing GUI part, combining total 8 buttons.

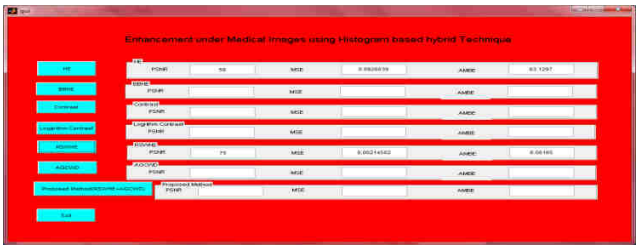


Fig.1.2: Main screens for selecting Enhancement Techniques

After selecting any technique button, input is asked for Medical Gray Scale image or Medical Color image by browsing window.

Fig.1.3: Browse window for selecting grayscale or color image

After selecting any off the Gray Scale or Color images, a browsing window as shown below in fig 1.4 is used for selecting or loading an image on which enhancement is to be done is continued in next steps.

Fig.1.4: Browsing windows for Image Selection

After selecting image, Enhanced Image with Original image and its histogram are shown below with figures for different techniques of Enhancement as their procedures follows but above three steps or figures from 1.2 to 1.4 are same:

(i) HE (Histogram Equalization) implementation for gray scale images.

Fig.1.5: Output image and original image of HE Technique on gray scale image.

(ii) HE (Histogram Equalization) implementation for Color images.

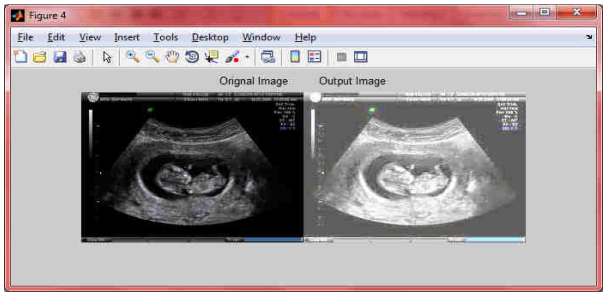


Fig.1.6: Output image and original image of HE Technique on Color image.

(iii) BBHE (Brightness Preserving Bi-histogram equalization) implementation for gray scale images.

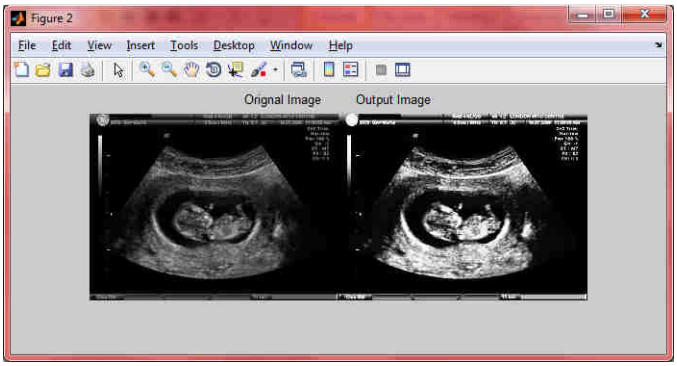


Fig.1.7: Output image and original image of BBHE Technique on gray scale image.

(iv) BBHE (Brightness Preserving Bi-histogram equalization) implementation for Color images.

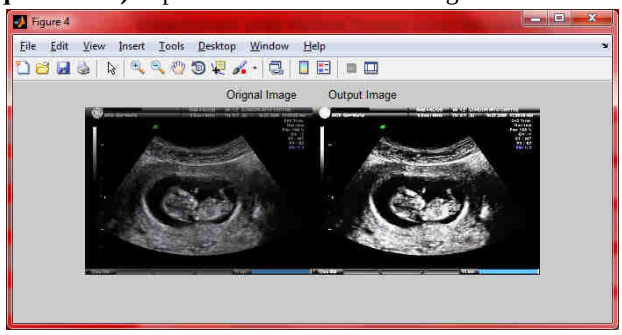


Fig.1.8: Output image and original image of BBHE Technique on color image.

v) Contrast enhancement with Mean implementation for gray scale images.

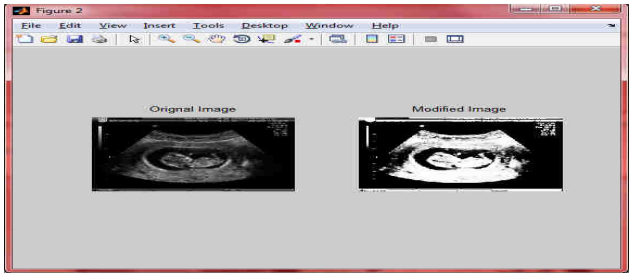


Fig.1.9: Output image and original image of Contrast enhancement with Mean Technique on gray scale image.

vi) Logarithm (Contrast stretched and threshold stretched) Enhancement implementation for gray scale images.

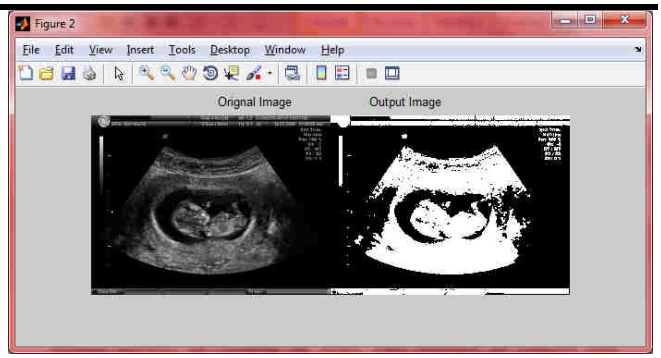


Fig.1.10: Output image and original image of Logarithm (Contrast stretched and threshold stretched) Technique on gray scale image.

vii) **RSWHE Enhancement (Recursively Separated and Weighted Histogram Equalization)** implementation for gray scale images. Before getting histogram and enhanced image in this technique recursion value is used to be asked for input which is used as formula 2^r.

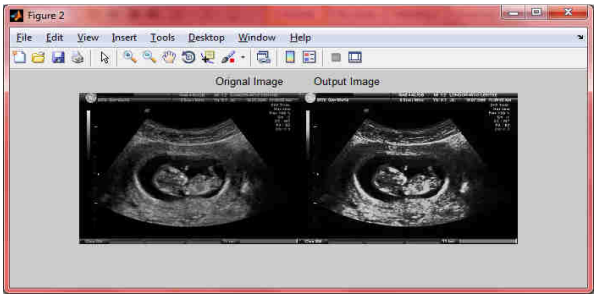


Fig.1.11: Output image and original image of RSWHE Technique on gray scale image

viii) RSWHE Enhancement (Recursively Separated and Weighted Histogram Equalization) implementation for color images.

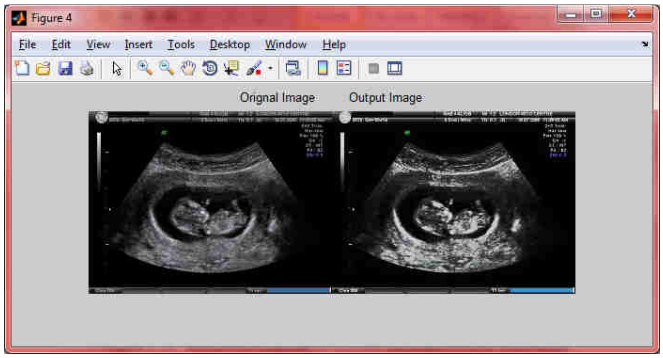


Fig.1.12: Output image and original image of RSWHE Technique on color image

ix) **AGCWD Enhancement (Adaptive Gamma Correction and Weighting Distribution)** implementation for gray scale

images. Before getting histogram and enhanced image in this technique gamma value is used to be asked for input as zero (NO) or one (YES).

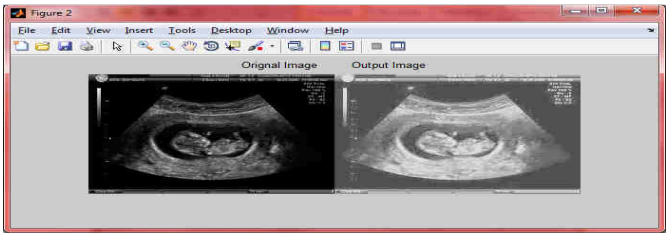


Fig.1.13: Output image and original image of AGCWD Technique on gray scale image

x) **AGCWD Enhancement (Adaptive Gamma Correction and Weighting Distribution)** implementation for Color images.

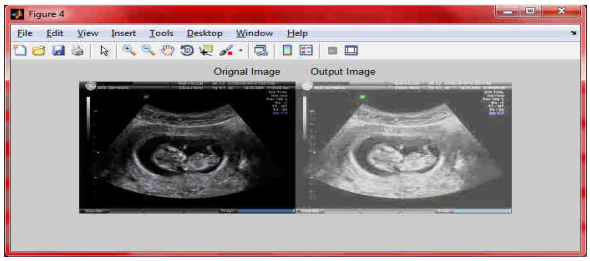


Fig.1.14: Output image and original image of AGCWD Technique on color image

xi) **RESWHE+ AGCWD Enhancement (Recursively Separated and Weighted Histogram Equalization + Adaptive Gamma Correction and Weighting Distribution)** implementation for gray scale images. Before getting histogram and enhanced image in this technique gamma value is used to be asked for input as zero (NO) or one (YES) and recursion value also asked for input which is used as formula 2^r.

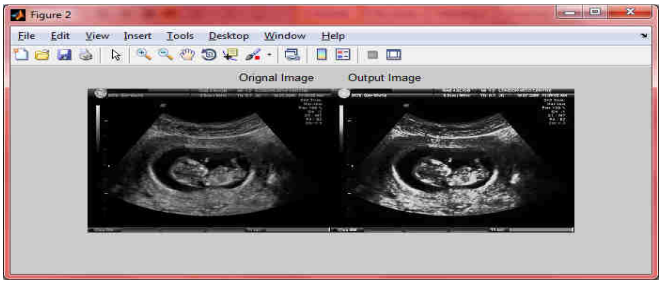


Fig.1.15: Output image and original image of Proposed (RESWHE+AGCWD) Technique on gray scale image

xi) **RESWHE+ AGCWD Enhancement (Recursively Separated and Weighted Histogram Equalization + Adaptive Gamma Correction and Weighting Distribution)** implementation for Color images.

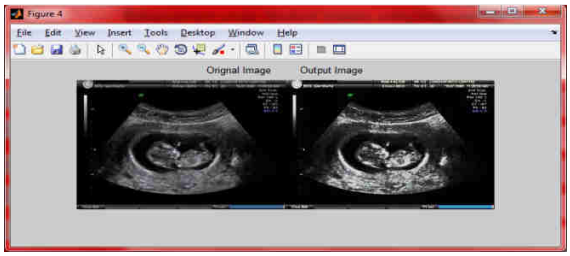
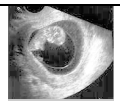
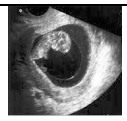


Fig.1.16: Output image and original image of Proposed (RESWHE+AGCWD) Technique on color image

The proposed algorithms has been experimentally worked out on gray scale and color images. Our performance is meseaured with various parameters such as PSNR. MSE, AMBE which are tested on images of gray sclae and color. In each testing image we have used all image enhancement techniques such as Histogram equalization (HE), Brightness preserving bi histogram equalization (BBHE), Contrast with Mean and Logarithm (Stretched contrast and threshold stretched), RSWHE, AGCWD and Proposed method (RESWHE +AGCWD) for comparing our results. These techniques are compared using parameters PSNR (Peak Signal-to-Noise Ratio), MSE (Mean Square Error) and AMBE (Absolute Mean Brightness Error).

V. DISCUSSION

Comparison of these techniques on grayscale images is shown in Figure 1.17.

Name Images	Image 1	Image 2	Image 3	Image 4
Original images				
HE				
BBHE				

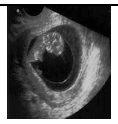
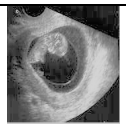
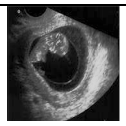
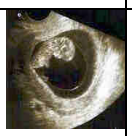
Contrast with Mean				
Logarithm (Contrast Stretched and Threshold Stretched)				
RSWHE				
AGCWD				
Proposed Method (RESWHE+ AGCWD)				

Fig.1.17: Comparison on Grayscale Medical test images

Comparison of these techniques on Color images is shown in Figure 1.18.

Name of the Images	Image 1	Image 2	Image 3	Image 4
Original images				
HE				
BBHE				

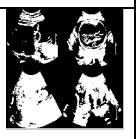
Contrast with Mean				
Logarithm (Contrast Stretched and Threshold Stretched)				
RSWHE				
AGCWD				
Proposed Method (RESWHE + AGCWD)				

Fig.1.18: Comparison on color Medical test images

The values of Parameters i.e quality metrics for the gray scale or color images had been inputed by the proposed existing techniques which is shown in figure 1.17, 1.18 from the table 1.1 and 1.2 below it is verfied that PSNR, MSE, ABME values are better of our proposed techniques as compared to the existing techniques.

Table 1.1: PSNR (Peak Signal-to-Noise Ratio), MSE (Mean Square Error) and AMBE (Absolute Mean Brightness Error) for gray scale images

Techniques/ Images Name	**1**			**2**			**3**		
	PSNR	**MSE**	**AMBE**	**PSNR**	**MSE**	**AMBE**	**PSNR**	**MSE**	**AMBE**
HE	**58**	0.115	81.4	**60**	0.067	61.3	**60**	0.061	56.8
BBHE	**64**	0.026	33.0	**67**	0.011	20.9	**67**	0.013	21.0

Contrast	**58**	0.108	46.4	**60**	0.063		**60**	0.061	70.2
Logarithm Contrast	**56**	0.172	60.7	**57**	0.133	44.6	**57**	0.129	39.8
RSWHE	**75**	0.001	1.22	**75**	0.001	7.32	**75**	0.002	9.58
AGCWD	**58**	0.097	78.10	**62**	0.043	49.5	**64**	0.027	38.1
Reswhe+ AGCWD	**73**	0.002	4.66	**79**	0.0008	3.37	**77**	0.001	5.41

Table 1.2: PSNR (Peak Signal-to-Noise Ratio), MSE (Mean Square Error)and AMBE (Absolute Mean Brightness Error) for Color images

Techniques/ Images Name	**1**			**2**			**3**		
	PSNR	**MSE**	**AMBE**	**PSNR**	**MSE**	**AMBE**	**PSNR**	**MSE**	**AMBE**
HE	**58**	0.115	81.4	**60**	0.065	60.54	**60**	0.070	59.70
BBHE	**64**	0.026	33.0	**68**	0.011	20.32	**66**	0.014	21.05
Contrast	**58**	0.108	46.4	**60**	0.063		**60**	0.061	70.25
Logarithm Contrast	**56**	0.172	60.7	**57**	0.133	44.69	**57**	0.129	39.88
RSWHE	**75**	0.001	1.22	**75**	0.001	7.73	**75**	0.001	8.68
AGCWD	**58**	0.097	78.1	**62**	0.042	48.61	**63**	0.032	40.76
Reswhe+AGCWD	**73**	0.002	4.166	**78**	0.0009	3.77	**77**	0.001	4.64

The performance of image contrasting or enhancing technique is compared through the evaluation of quantitative mesure such as MSE, PSNR and AMBE quality metrics. There is large improvement in the value of PSNR (Peak Signal to Noise Ratio) for RSWHE and Our Proposed technique (RESWHE+AGCWD) from our all existing algorithms. As MSE (Mean Square error) and AMBE (Absolute Mean Brightness Error) is less in case of again RSWHE and our Proposed technique (RESWHE+AGCWD) as shown above in table 5.1 and 5.2 of gray scale and color images.

The proposed method give better results as compared by other techniques in term of quality Proposed technique (RESWHE+AGCWD) shows better result in all parameters as well in some cases RSWHE also shows next to it results. Both are about to be nearby quality.

VI. CONCLUSION

A number of techniques are available in the literature for image enhancement of gray scale images as well as color images. They work pretty well for images enhancement of the gray scale as well as color images. Few important techniques namely Histogram Equalization, BBHE, RESWHE (recursion=2, gamma=No), AGCWD (Recursion=0, gamma=0) are used quite frequently for image enhancement. But there are some short comings of the present techniques. The major shortcoming is that while enhancement, the brightness of the image deteriorates quite a lot. So there was need for some technique for image enhancement so that while enhancement was done, the brightness of the images does not go down. To remove this shortcoming, a new hybrid technique namely RESWHE+AGCWD (recursion=2, gamma=0 or 1) was proposed. The results of the proposed technique were compared with the existing techniques. In the present methodology, the brightness did not decrease during image enhancement. So the results and the technique was validated and accepted.

VII. FUTURE SCOPE

Although there was reduced brightness problems while image enhancement for gray scale and color images, yet the brightness did reduced to some extent. It can be said that even if the proposed technique is better as compared to the existing technique yet there is further scope of improvement in the

designed methodology and further investigation of the proposed methodology is required for better results.

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