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Image Enhancement Using DWT, High Boost Filtering and IDWT

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ABSTRACT: In digital image processing, image enhancement is a technique to improve the quality of image due to which the perception of information in image for human viewer increases and for doing this a lot of work has been done. In this work, proposes an image enhancement using DWT and high boost filtering. Initially, Wavelet transform decomposes the image into sub-bands and then apply high boost filtering to again decompose the high frequency sub band on both image to augment the PSNR. The simulation analysis of proposed methodology is done using MATLAB toolbox and comparative analysis is perform on performance metrics AMBE, PSNR and EME. The results of proposes method give improved value than the existing method, it means that our approach is much efficient to enhance the image quality.

1. INTRODUCTION

Digital image processing is an area characterized by need for extensive experimental work to establish the viability of proposed solutions to a given problem. One of part of the image processing is the image enhancement. Image enhancement processes consist of a collection of techniques that seek to improve the visual appearance of an image or to convert the image to a form better suited for analysis by a human or machine. Image Enhancement is the improvement of digital image quality, without knowledge about the source of degradation. Image Enhancement is the technique to improve the interpretability or perception of information in images for human viewers [1]. It is to improve the image quality so that the resultant image is better than the original image for a specific application. When pictures are converted from one form to another by processes such as imaging, scanning, or transmitting, the quality of the output image may be inferior to that of the original input picture. Image enhancement performs a foremost role in image processing functions where People (the knowledgeable) make selections with respect to the image information. Form of image enhancement comprises noise reduction, side enhancement and distinction enhancement. Enhancement could also be the technique of bettering the prevalence of an electrically saved image. To supply picture lighter or darker or to develop or slash contrast. Image enhancement is to give a boost to the sensitivity of information in images for human viewers, or to present enhanced input for other usual image processing procedures. In this approach, more than one attributes of the image are personalized. The likelihood of attributes and the course they're personalized are specific to special assignment [2l].

Image enhancement is to enhance the interpretability or idea of data in images to outfit higher enter for other mechanized images processing steps. The image got from usual atmosphere with excessive dynamic range involves each dark and bright regions. Due to exceed in dynamic variety of human eyes sensing, these image are problematic to perceive by way of human eyes. Image enhancement is a normal strategy to make stronger the nice of those images in terms of human visual perception. Enhancement procedures will also be divided into two classes specifically:

- Spatial domain methods
- Transform domain methods

A. Spatial Domain

- It is manipulating or changing an image representing an object in space to enhance the image for a given application.
- Techniques are based on direct manipulation of pixels in an image
- Used for filtering fundamentals, smoothing filters, sharpening filters, unsharp masking and laplacian

B. Frequency Domain

-This technique are based on modifying the spectral transform of an image

-It transform the image to its frequency representation

-Carry out an image processing

-Figure out inverse transform back to the spatial domain

- High frequencies correspond to pixel values that modify hastily across the image (e.g. text, texture, leaves, etc.)
- Strong low frequency components correspond to huge scale features in the image (e.g. a single, homogenous object that dominates the image)

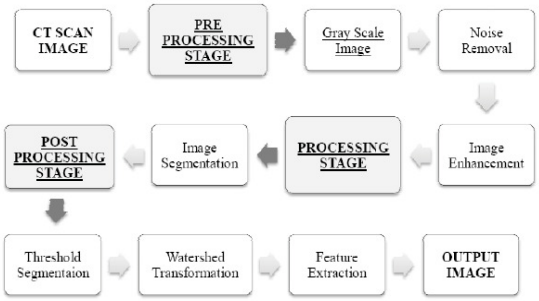

Fig. 1. Stages in Image Enhancement Process.

In this paper, we propose DWT, HBF and IDWT techniques to improve the quality of images and it generates better quality of image than existing method.

II. IMAGE ENHANCEMENT TECHNIQUE

This section of the paper we are describing the various image enhancement techniques below:

A. Adaptive Histogram Equalization

HE is not suitable for consumer electronics since it could make the vast majority of issues. Root Mean Separation is a splendor conservation strategy. The conservation going is from 0 to 100%. The Dynamic Range worth is changed at the output furthermore the output depends on the picture quality. Here various images producing distinctive results. Frequency ought to be low when the uniform histogram distribution. It offers low frequency.

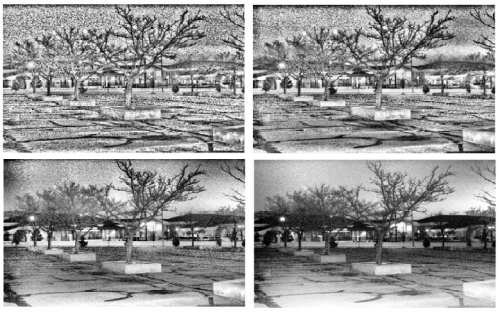

Fig. 2. An example of AHE.

Calculation many-sided quality is fundamentally lessened. At last the DRSHE could use in consumer electronics like LCD and Plasma Display Panel (PDP) TV [2].

B. Histogram Equalization

HE is extensively utilized as a part of the field of difference enhancement. Proposed algorithm essentially concentrates on the novel extension furthermore used to use HE. Extreme objective is available the brightness esteem. In this study recently created one binary safeguarded HE is proposed. Numerous applications can be comprised of the proposed algorithm. Primary point of proposed algorithm is to lessen the Complexity. HE is a one of the valuable system, proposed strategy furthermore the comparison of some HE strategies and enhances the difference, save the image as brightness. Diverse HE strategies can be utilized as a part of the images. Every picture is having their own particular ratio. Test results demonstrate that two techniques M and D are given the best results [2].

Fig. 3. An example of HE.

C. Brightness Bi-Histogram Equalization (BBHE)

This method provides mean brightness on the resultant image which lies between input mean along with the middle gray level. BBHE method is used to decompose the original image into to sub-images. Histogram vary from 0 to L-1 and BBHE technique divides the whole picture into two parts where First histogram provides the variety of 0 to and the second histogram has the selection of L-1[5].

D. Dualistic Sub Image Histogram Equalization (DSIHE)

DSIHE technique used to decompose original image into two sub- images; one is coloured, other one is bright based on its gray level probability density function and equalizes the histograms of sub- images distinctly [3] Decomposition of image in this method aim at the maximization of the Shannon's entropy of the output image. In the end, the result of the dualistic sub-image histogram equalization is achieved after the two processed sub-images are composed into one image.

E. Minimum Mean Brightness Error Bi-Histogram Equalization (MMBEBHE)

The basic principle of MMBEBHE method of decomposing an image and then applying the HE method to equalize the resulting sub-images independently. MMBEBHE technique helps to achieve the minimize the brightness between input image and output image [4]

This technique consists of given three steps:

- For each threshold level, calculate the AMBE
- Find the threshold level, XT that yields minimum MBE
- Based on the XT, separate the input histogram into two and then equalized it independently as in BBHE

F. Threshold Transformation

Thresholding transformations are mostly effective for partitioning the image elements in which we wish to segregate a desired object from the background [5]. Image threshold transformation is an approach of segmenting the information from it's own background. Therefore, thresholding is generally implemented on gray- level or scanned color document images. If f(x,y) is the input image and g(x,y) is processed or output image then we can easily locate threshold image because it acquire pixel value of '0' or '1'.

G. Logarithmic Transformations

Logarithmic transformations are widely utilized in the cases where the input values of gray level are very high [6]. These are used for spreading or compressing the grey levels in an image. The general expression for Logarithmic transformation is: S = C log (1+r) where, C ---> 1 or constant r ---> >= 0 This transformation turns the input values of low range into the output values of higher range and vice -a- versa [5].

H. Power-Law Transformation

The power Law transformation presents the relation between pixels of the input image f(x,y) and the boosted image g(x,y). General expression for this transformation is as : $s = cr^{\gamma}$ In the above expression, c and r ----> are positive constants, By having 'c' = 1 and r with varying values the transformations can be achieved where 'r' results in ascending the contrast of some regions in the original image with high value in opposition of low regions. [7] In Power Law Transformation each and every pixel value is upended to fixed power. This transformation technique is utilized for transfiguring small and dark range of input image elements (pixel) into larger and brighter range of output image elements (pixels) or vice-versa.

III. RELATED WORK

Agarwal *et al.* [8] proposed a new method named (MH-FIL) for medical images. This method uses two step processing, in first step global contrast of image is enhanced using histogram modification followed by histogram equalization and then in second step homomorphic filtering is used for image sharpening, this filtering if followed by image normalization. To evaluate the effectiveness of our method we choose two widely used metrics Absolute Mean Brightness Error (AMBE) and Entropy. Based on results of these two metrics this algorithm is proved as a flexible and effective way for medical image enhancement and can be used as a pre-processing step for medical image understanding and analysis. Bhateja, V. *et al.* [9] proposed a truncated Volterra filter combination to provide contrast enhancement as well as texture based processing of masses in digital mammograms. Noteworthy improvement in visualization of masses has been observed in the simulation results carried out on cases from DDSM database. The improved performance of the proposed filtering approach is well supported with calculated values of objective evaluation parameters. Suriya and Rangarajan [10] implemented an innovative image fusion system for the detection of brain tumours. Fusing images obtained from MRI and PET can accurately access the tumour response. In this work, the proposed image fusion technique consists of two major processes such as (I) image enhancement and (II) image fusion both depend on Discrete Wavelet Transform (DWT). Lagrange's interpolation is used for image enhancement. MRI and PET images are fused based on image enhancement and fusion technique that has been implemented and simulated in MATLAB. The fused image has complement information from both MRI and PET images and the visual quality has improved. The fusion parameters Average Gradient, Discrepancy, PSNR, MSE and Entropy are calculated and the results show the effectiveness of fusion based on DWT. This work can be extended to diagnose any type of abnormalities in all human organs. Firoz *et al.* [11] morphological transform operation is carried out on medical images to enhance the contrast and quality. A disk shaped mask is used in Top-Hat and Bottom-Hat transform and this mask plays a vital role in the operation. Different types and sizes of medical images need different masks so that they can be successfully enhanced. The method shown in this study takes a mask of an arbitrary size and keeps changing its size until an optimum enhanced image is obtained from the transformation operation.

The enhancement is achieved via an iterative exfoliation process. The results indicate that this method improves the contrast of medical images and can help with better diagnosis. Hong-Seng Gan *et al.* [12] proposed to implement cubic spline to reduce the difference in pixel intensity prior to histogram equalization while retaining the partition of histogram to prevent dramatic mean brightness shift in resultant image. Qualitative results indicate that our proposed contrast enhancement method is capable of avoiding extreme brightness elevation and excessive tissue contrast improvement to provide holistic views of the knee MR images. In future, we would like to recommend the development of adaptive data interval to substitute the uniform data point intervals.

IV. PROPOSED WORK

In digital image processing multiple techniques have been listed to improve the perfection of image including HE, MHE, IDBPHE, DBAIT etc. In consideration of, we proposed a contrast enhancement of various images using DWT with High Boost Filter that confer a preferable result for contrast enhancement with brilliancy or clearness observed.

The proposed algorithm mainly classifies in six part DWT, Image Decomposition, Contrast Enhancement, Kernel Adaptive Filter, High Boost Filter, Image Fusion, IDWT.

A. DWT

Wavelet transform interfuse a signal into a definite base function. These base functions are called wavelet. DWT is a method which mold a discrete time signal to a discrete wavelet illustration. The distinctive many resolution images, Wavelet-coding tactics for applications where endurable and satisfactory downgrade are prominent or important. DWT was based on time scale model which produce effectual multi-resolution. In this technique, input low appearance image is decayed into our sub-band images such as Low-Low (LL), Low-High (LH), High-Low (HL), High-High (HH). In which LL (Low-Low) focus the brighten information. Therefore the LL sub-band preserves the high frequency part (i.e. edges) because it goes through the introduced process And rest of the sub-bands (LH, HL, HH) consist the edge details of image and another undesirable information.

B. DWT Based Image Decomposition

Now, In this paragraph LL sub-band Image is interfuse into three intensity layers i.e. Low, Middle, High. Intensity of high values is pre-eminent in radiant field and vice versa. And we will fix a accurate range for Low, Middle, High and then decompose the LL sub-band image on the base of these value. The intensity layer and illumination of particular image differ in the range between 0 to 1.

C. Contrast Enhancement

In this paragraph, On the basis of each decomposed layer, intensity transfer function is generated. As we have to generate efficient transfer function which effectually work on three brightness area for appropriate contrast enhancement. The intensity transfer function is generated by adjoining the Knee transfer function and modified Gamma adjustment function.

The knee transfer function is used first and it stretches the low intensity range by calculating knee point on the basis of brightness level of each layer.

Knee point for low intensity layer is Pl, Bl is low bound, Wl is tuning parameter & Ml is mean brightness of low intensity layer then,

Pl = Bl + Wl (Bl -Ml) (1)

Knee point for high intensity layer is Ph, Bh is low bound, Wh is tuning parameter & Mh is mean brightness of low intensity layer then,

Ph=Bh + Wh (Bh - Mh) (2)

For middle intensity layer two knee points will be,

Pml=Bl-Wm (Bml-Mm) + (Pl-Ph) (3)

Pmh=Bh-Wm (Bmh-Mm) + (Pl-Ph) (4)

Knee transfer function work well for in middle intensity layer and distort image details in lower and higher intensity layers, therefore gamma adjustment function is used for these regions .The gamma adjustment function is modified from its original form to incorporate the knee transfer function.

Here k=l, m, h and M stand for each section intensity range, Ml=Bl, Mm=Bh-Bl, Mh=1-Bh& L is the intensity value.

By this gamma adjustment function distortion in low & high intensity range created by knee operator is corrected.

After generating intensity transfer function the intensity of three layers are modified by applying generated intensity transfer function to enhance the contrast of three layers.

D. Kernel Adaptive Filter

Kernel Adaptive Filters is a non-linear adaptive filter type. An Adaptive filter is a filter that alter its transform function to change the properties of signal over time by reducing an error that represent how ulterior the filter alienate from ideal behaviors. By Using Kernel methods, Kernel Adaptive filter implement a non-linear transfer. It is a natural generalization of linear adaptive filtering in reproducing kernel Hilbert spaces. Kernel adaptive filters are online kernel methods, closely related to some artificial neural networks such as radial basis function networks and regularization networks.

Some distinguishing features include: The learning process is online, the learning process is convex with no local minima, and the learning process requires moderate complexity.

E. High Boost Filter

In digital image processing, it is generally emphasize high frequency components describing the image details without dissipating low frequency components such as sharpen.

The High boost Filter can be used to improved or enhance high frequency component and it is inscribed by all pass filter and a edge detection filter. Hence it emphasizes edges in image. Gaussian filter is also used with high boost filter to perform noise reduction and used as a smoother operator. It is mainly used in graphic software generally to reduce noise of image.

F. Image Fusion

Image fusion is a broadly topic for reforming the content of image. The principle objective of Image Fusion algorithm is to integrate details from varied images of a particular scene. The outcome of new image in a image fusion which is more appropriate for machine and human perception. The processing operation of image fusion including as Object recognition, Segmentation, Feature extraction. So the concept of image fusion is used to combine different part of images received by various methods of image enhancement to get highly enhanced image.

G. IDWT

Now in the next step Image Fusion, it is obtained by sub bands such as LL, LH, HL, HH of original image are integrated by using IDWT to get ultimately improved contrast of image.

Steps of Proposed methods-

1) Take a low contrast image as the Input.
2) Apply DWT transform operation on the selected image.
3) Now, this image for analysis brightness level based image decomposition of LL band in low, middle, high intensity layers.
4) The sample image is an unsigned 8-bit integer type (the most common situation), number of colors value will be 256.
5) Applying the decompositions on the basis of dominant brightness level then proceed it.
   - Approximation coefficient storage.
   - Horizontal detail coefficient storage.
   - Vertical detail coefficient storage.
   - Diagonal detail coefficient storage.
   - Convert to unsigned 8-bit integer.
6) Apply Adaptive intensity transfer function on different intensity levels of the decomposed image and then smoothened out.
7) The smoothen image is passed to the Kernel Adaptive Filter which is then integrated with the Contrast enhancement techniques.
8) Now apply kernel function to filter an image after weighted map and smoothening edge process.
9) The inverse DWT is then applied on the fusion image and HH, HL, LH bands to get the contrasted image.
10) Then apply IDWT for inverse the fused image.
11) Then at last we will measure the AMBE, PSNR, EME of the images.

Apply the histogram equalization of that image with the original image to get the enhanced image.

V. EXPERIMENTAL RESULTS AND ANALYSIS

In this part we are going to explain the software used in proposed research work. By searching we have observed that for our proposed work the MATLAB R2012a is better software. It is platform independent language and program written in other language including C, C++, C#, Java, Fortran, Python.

A. Image Dataset

The datasets are used for intelligent retrieval research. Datasets are the elemental component of the domain of learning. The record contain high quality data set that have been introduced to be of value to the knowledge engineering research community from numerous distinct data depository to provide huge coverage of the topic than is otherwise available like image dataset, text dataset, sound dataset, financial dataset, weather dataset etc. In this project, we have used many dataset images such as: cameraman, lena test2, Barbara, Baboon, Boat. In the following section, we discussed about the GUI comparison and AMBE, PSNR, EME values proportion.

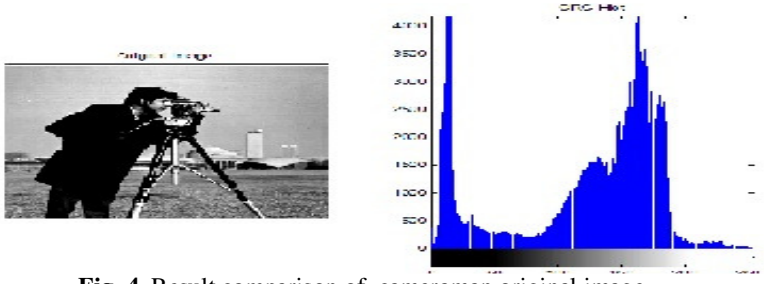

Fig. 4. Result comparison of cameraman original image.

In the figure 4 is showing that the experimental layout for the cameraman image. In the below, GUI window the five methods are compared, and their PSNR, EME are shown below of the associated methods, where in the axes1 shows the original image, axes2 shows its histogram.

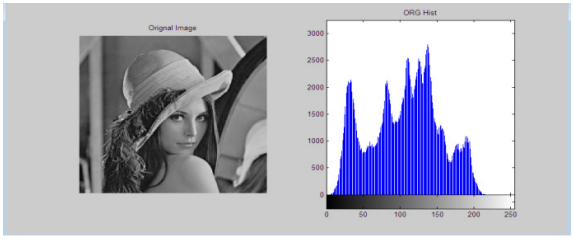

Fig. 5. Result comparison of Lena original image

In the figure 5.3.6 is showing that the experimental layout for the lena image. In the below, GUI window the five methods are compared, and their PSNR, EME are shown below of the associated methods, where in the axes1 shows the original image, axes2 shows its histogram.

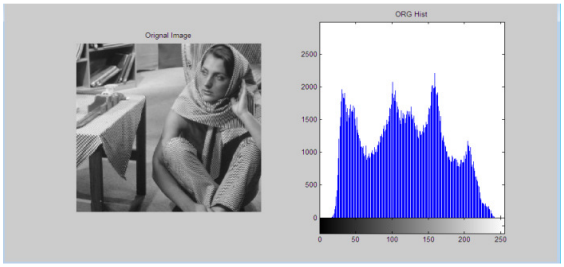

Fig. 6. Result comparison of original Barbara image.

In the figure 6 is showing that the experimental layout for the Barbara image. In the below, GUI window the five methods are compared, and their PSNR, EME are shown below of the associated methods, where in the axes1 shows the original image, axes2 shows its histogram.

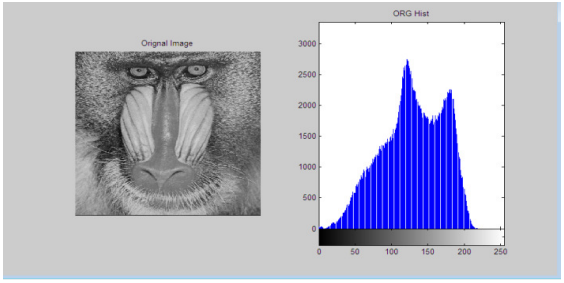

Fig. 7. Result comparison of original Baboon image.

In the figure 7 is showing that the experimental layout for the Baboon image. In the below, GUI window the five methods are compared, and their PSNR, EME are shown below of the associated methods, where in the axes1 shows the original image, axes2 shows its histogram.

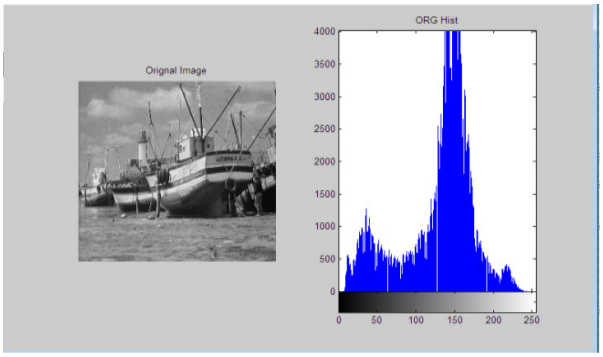

Fig. 8. Result comparison of original Boat image.

In the figure 8 is showing that the experimental layout for the Boat image. In the below, GUI window the five methods are compared, and their PSNR, EME are shown below of the associated methods, where in the axes1 shows the original image, axes2 shows its histogram.

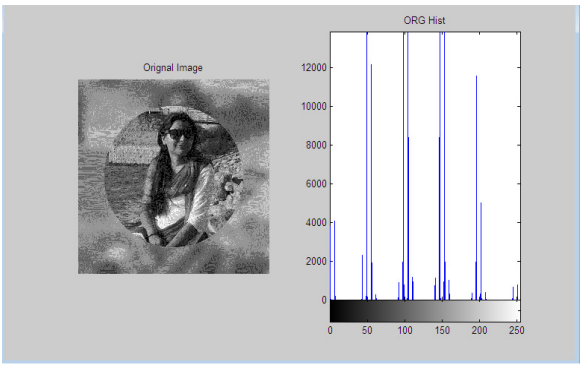

Fig. 9. Result comparison of original Swati image.

B. Results Analysis

Subsequently, the detailed comparison of all methods with various different images, the overall performance of proposed DWT-HBF method is best in the comparison of resultant parameters AMBE, PSNR and EME. Now in the next part they are showing the summarized comparative result analysis of the all five methods.

Here table 1 shows that the overall performance of AMBE of all Five methods for the appropriated images. And the figure 10 shows the graph comparison analysis of the AMBE summary table.

Table 1: Comparison of AMBE.

ABSOLUTE MEAN BRIGHTNESS ERROR (AMBE)					
METHOD/IMAGE	HE	MHE	IDBPHE	DBAIT	DWT-HBF
Cameraman	54.3578	52.4957	31.8267	8.3887	6.56
lena Test2	85.3029	82.3807	49.9451	13.1643	10.2945
Barbara	41.6821	40.2542	24.405	5.0302	6.4325
Baboon	25.9232	25.0351	15.1781	4.006	3.1284
Boat	40.2709	38.8913	23.5787	6.2148	4.8599
Swati	37.6228	36.338	22.0283	5.8061	4.5404

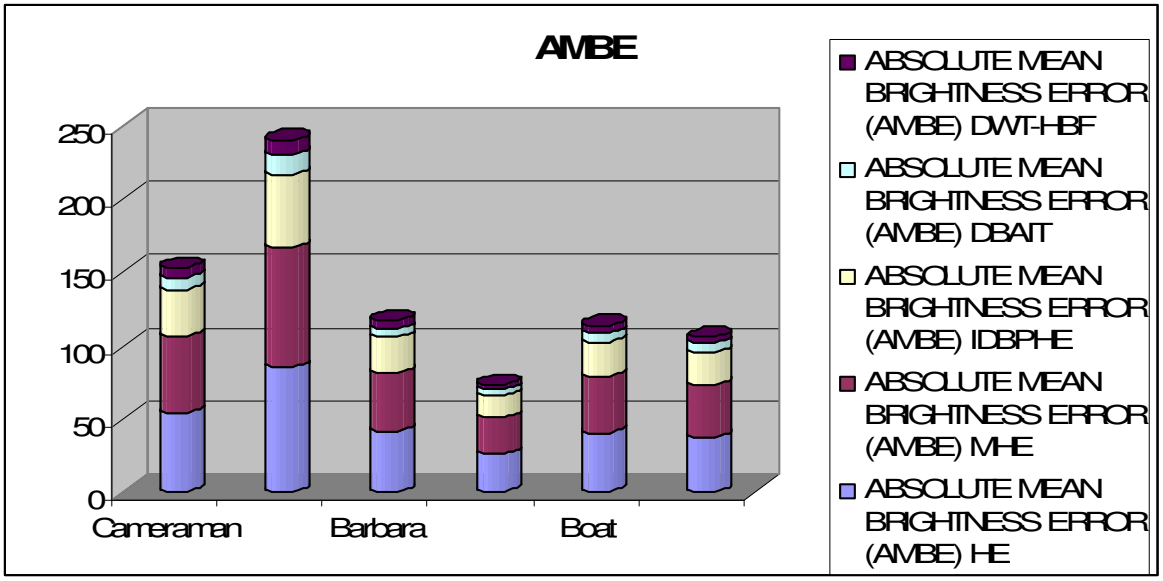

Fig. 10. Graph analysis of AMBE.

Table 2: Comparison of PSNR.

PEAK SIGNAL TO NOISE RATIO (PSNR)					
METHOD/IMAGE	HE	MHE	IDBPHE	DBAIT	DWT-HBF
Cameraman	15.602	17.4501	21.492	36.9003	37.9338
lena Test2	24.848	27.3842	33.7271	57.9071	59.5289
Barbara	11.9638	13.3809	16.4803	29.088	28.2955
Baboon	7.4406	8.3219	10.2495	17.5977	18.0906
Boat	11.5587	12.9279	15.9223	27.3375	28.1032
Swati	10.7986	12.0778	14.8753	25.5399	26.2552

Here in the table 2 showing, overall PSNR Performance of all five methods and figure 11 showing graph representation of PSNR summary table.

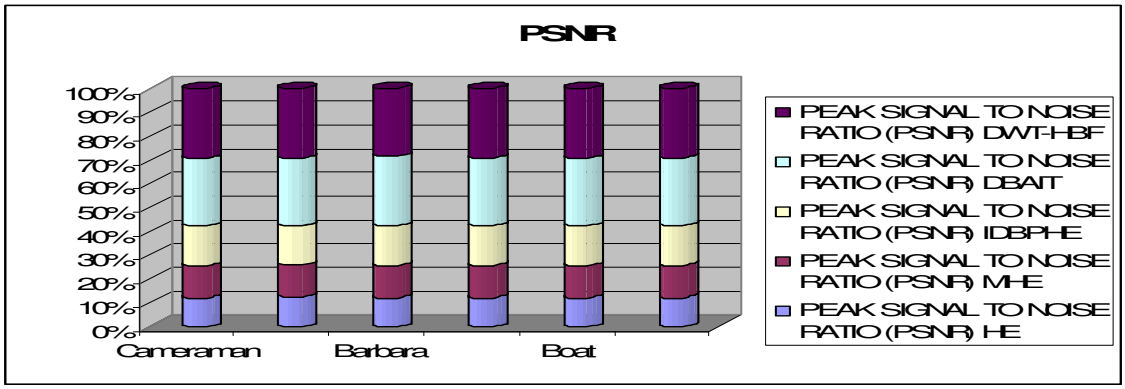

Fig. 12. Comparative graph analysis of PSNR.

Table 3: Comparison of EME.

ENHANCEMENT MEASUREMENT ERROR (EME)					
METHOD/IMAGE	HE	MHE	IDBPHE	DBAIT	DWT-HBF
Cameraman	1.8801	1.8862	1.9047	1.9173	1.9332
lena Test2	2.9504	2.96	2.9891	3.0088	3.0338
Barbara	1.4417	1.4464	1.4606	1.4824	1.4702
Baboon	0.89663	0.89953	0.90837	0.91436	0.92196
Boat	1.3929	1.3974	1.4111	1.4204	1.4322
Swati	1.3013	1.3055	1.3183	1.327	1.3381

Here in the table 3 showing, overall EME Performance of all five methods and figure 12 representing graph analysis of the taken images.

C. Discussion

After comparing the performance of all five methods on various different images downloaded from the website. The performance of proposed method measured with existing popular algorithm consist of HE,MHE,IDBPHE,DBAIT,DWT-HBF and proposed method(DWT-HBF) showing better result compare than other four methods in any state.

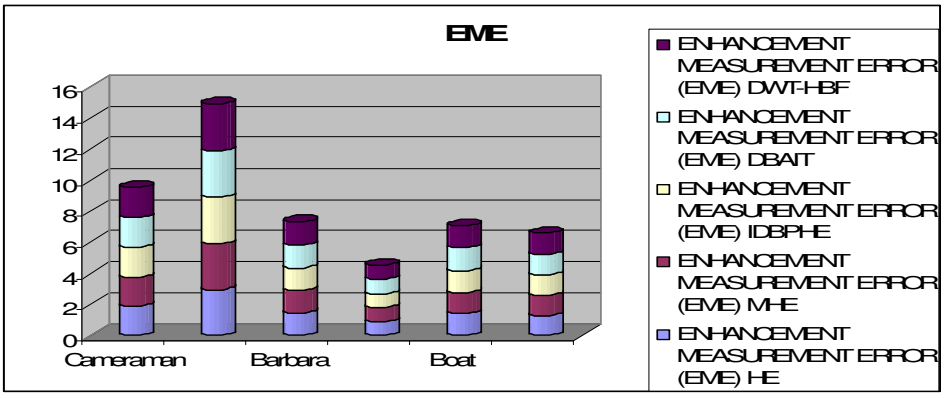

Fig. 12. Graph of overall performance of EME.

VI. CONCLUSION

In digital image processing, contrast enhancement plays a crucial role in analyzing of several peculiar images data through different methods particularly in medical applications and digital image. To enhance the image contrast, many enhancement technique have been introduced in literature including Histogram equalization(HE), Multi histogram equalization(MHE), Image dependent brightness preservation histogram equalization(IDBPHE), Contrast enhancement using dominant brightness level analysis and adaptive intensity transformation(DBAIT) for remote sensing images, homomorphic etc.

In this tract, introduce an efficient technique to improve image contrast exploiting the idea of DWT (Discrete wavelet transforms) with High boost filter. In DWT-HBF technique confer less error rate and have utmost Peak signal to noise ratio (PSNR).Here in this proposed method, provides more enhancement over contrast and brightness too as compared to the other method, this proposed method not only reform the contrast enhancement but it justify or maintain sharpness as well. But when these idea used for the emissive display image than the power consumption is more therefore for the future work we can provides a proficient model for power display, so contrast of the image can be improved and intensity gets preserved.

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