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Contrast Enhancement of Remote Sensing Images using DWT with kernel filter and DTCWT

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ABSTRACT: Image enhancement is the indispensable features in image processing to increase the contrast of the remote sensing data and to provide better transform representation of the remote image data. This paper presents a new method to improve the contrast and intensity of the image data. The method employs that the discrete wavelet transform with Kernel adaptive filtering. The performance of this algorithm is analysed and compared between AMBE and PSNR using simulator MATLAB 2009A.

Keywords: Brightness Preservation, Histogram Equalization, Discrete Wavelet Transform, Dual Tree Complex Wavelet Transform, Kernel filter

I. INTRODUCTION

Digital image processing is a widely used area under discussion now a days and it is typically used in the area of computer science and mathematics employ procedures which can be mathematically difficult, but fundamental idea behind digital image processing is quite easy. The critical mean of image processing is to use data enclosed in the image to enable the system to comprehend, identify and interpret the developed information obtainable from the image pattern [1].Image Enhancement is one of the most significant and complicated techniques in image research. The aim of image enhancement is to get better the visual appearance of an image, or to provide a "better transform illustration for upcoming automated image processing. Several images like satellite images, medical images, aerial images and still real life photographs undergo from poor contrast and noise. It is essential to enhance the contrast and remove the noise to increase image quality. One of the most important stages in medical images detection and analysis is Image Enhancement techniques which improve the quality (clarity) of images for human viewing, abolish blurring and noise, increasing contrast, and revealing facts are examples of enhancement operations. The improvement technique differs from one field to another according to its objective [2]. By unscrambling smooth and detail areas of an image, the algorithm is applied to each of them to avoid excessive enhancement of noises. In some cases, quality of images is influenced by environment medium and water medium, consequently image enhancement is mandatory. Image enhancement (IE) has contributed to research advancement in a variety of fields. Some of the areas in which IE has wide applications such as: in forensic, atmospheric science and medical imaging etc. There are various image enhancement methods that have been proposed and developed, the most accepted method being Histogram Equalization. It usually increases the global contrast of the images mostly in cases where the important and useful data of the image is shown by low contrast values. Histogram equalization is a simple and effective contrast enhancement technique which distributes pixel values uniformly such that enhanced image have linear cumulative histogram. The HE technique is a global operation therefore; it does not defend the image brightness. In this paper, it uses DWT with kernel adaptive filtering which greatly increase the contrast and overcome the problem of HE.

There are many image enhancement techniques that have been proposed and developed, the most popular method being Histogram Equalization. This technique is one of the most popular methods for image enhancement due to its simplicity and efficiency. It usually increases the global contrast of the images mostly in cases where the important and useful data of the image is shown by low contrast values. The image enhancement methods can mostly divided in to the following two categories:

- Spatial Domain Methods
- Frequency Domain Methods

A. Spatial domain methods

The spatial domain method [3] method directly manipulates the image data array, either by point processing or area processing. Basically it deals with spatial frequency, i.e. difference between the highest and the lowest values of a contiguous set of pixels.

The approaches regarding image enhancement using spatial domain methods can be divided into two categories – global image enhancement and local image enhancement. Global methods are mainly histogram modifications that aim to exploit the full dynamic range of a rendering device by modifying the histogram of an image. The attractiveness is their simplicity and minor computational effort. However it is often necessary to enhance detail over a smaller area. So, the local image enhancement method plays a major role in those applications. This method can be characterized by equation 1.

$G(x, y) = T[F(x, y)]$ ……………………………....... (1)

Where F(x, y) is input image, G(x, y) is output image and T is an operator on f, defined over some locality of f(x, y).

The idea of blurring an image by reducing its high frequency components or sharpening an image by increasing the magnitude of its high frequency components is intuitively easy to comprehend. Conversely, computationally, it is recurrently more efficient to implement these operations as convolutions by small spatial filters in the spatial domain.

B. Frequency domain methods

In the frequency domain [4] [5] relation the discrete convolution is often more efficiently the using fast Fourier transform algorithm. In a typical image enhancement problem f (x, y) is given and the goal after computation of F (u, v) is to select H (u, v) so that the desired image given by:

$G(x, y) = F^{-1}\{H(u, v) * F(u, v))\}$.................................. (2)

It also exhibits some highlighted attribute of f (x, y) for example ends in f (x, y) can be emphasize by using a function H (u, v) which emphasizes the high frequency components of F (u, v).

The goal of image enhancement techniques is to develop a quality or contrast of an image such that enhanced image is better than the real image. Several image enhancement techniques have been proposed in both spatial and frequency domains. The rest part of research paper is organized in this way; the section 2 describes the previous work done. Section 3 gives detailed description of enhancement technique. Section 4 describes the proposed methodology. Section 5 shows the results produced by the analysis of proposed work and last section concluded about the research paper and its future scope.

II. RELATED WORK

This section describes some previous works done in contrast enhancement of the remote sensing image data in the literature:

G. Veena, V. Uma, Ch. Ganapathy Reddy [6] proposed an algorithm in which it first performs the DWT to decompose the input image into a set of band-limited components, called HH, HL, LH, and LL sub bands. Since the LL sub band has the illumination information, the log-average luminance is calculated in the LL sub band for computing the dominant brightness level of the input image The LL sub band is divided into three low, middle, and high concentration layers according to the principal intensity level. The adaptive intensity transfer function is deliberated in three partitioned layers by the foremost intensity level, the knee transfer function, and the gamma alteration function. Subsequently, the adaptive transfer function is concerned for colour preserving high quality contrast enhancement. The resultant enhanced image is obtained by the inverse DWT (IDWT).

Chi-Farn Chen, Hung-Yu Chang, Li-Yu Chang [7] developed a fuzzy based approach to contrast enhancement of the remote sensing image data to partition the image pixel values into dissimilar degrees of associates in order to reimburse the local brightness lost in the dark and bright areas. The algorithm includes three steps: primarily, the satellite image is distorted from gray-level space to membership space by Fuzzy c- Means clustering. Secondly, suitable stretch model of each cluster is constructed based on corresponding memberships. Third, the image is changed back to the gray-level space by merging stretched gray values of each cluster

Deepak Kumar Pandey, Rajesh Nema [8] proposed a method to improve the quality of image using Kernel Padding and DWT with Image Fusion that enhances the contrast of Images that has varying intensity distribution particularly satellite images, maintain the brightness of images, sharpens the edges and abolish the blurriness of images. Fundamentally this is a pixel based edge guided image fusion technique. In this technique LL sub band of Image DWT is processed by contrast enhancement section where based on image brightness level image is decomposed in different layers and then every layers intensity is stressed or compressed by generating intensity transformation function. The partitioned intensity layers are also processed by canny edge detection method as all the satellite images includes the noise due to atmospheric turbulence and this is Gaussian by nature. The Canny edge detector is the best method for detecting edges of image in the existence of Gaussian noise. At last the contrast enhanced images are fused according to the weight map determined byedge map of image

Demirel [9] proposed a new method for enhancement of satellite images contrast. Their method was based on Discrete Wavelet Transform (DWT) and singular-value decomposition. They first applied DWT to input image to divide it into four frequency sub-bands, then used singular value decomposition and then again applied inverse DWT to reconstruct the image. This technique showed enhanced results than conventional Brightness preserving Dynamic Histogram Equalization (BPDHE) method and other methods.

Eunsung Lee [10] proposed the method which uses dominant brightness level of Image for decomposing the Image in different three layers and then these layers are used for appraisal of adaptive intensity transfer function.

This predictable adaptive intensity transfer function is used for image contrast enhancement subsequently these layers are fused to get enhanced image.

Shujun Fu , Qiuqi Ruan, Wenqia Wang [11] presented a robust inverse diffusion equation method which sharpens image details by a robust Laplacian after demonstrating the equivalence of the sharpening by the Laplacian to inverse heat equation processing. Image gradient magnitude is used to avoid the noise magnification. At the same time, the min-mod function is used to manage diffusion flux adaptively, which reduces effectively overshoots inherent in the Laplacian. The Experimental results demonstrate that this algorithm can enhance important details of image data effectively exclusive of overshoots, giving the opportunity for a good interpretation and subsequent processing.

III. IMAGE ENHANCEMENT TECHNIQUE

The quality of images can be improved by using various enhancement technique and several techniques has been developed so far. This dissertation illustrates the several methods of image enhancement or to improve the quality of image.

A. Discrete Wavelet Transform

These days, wavelets have been used quite frequently in image processing. It is used for feature extraction, de-noising, compression, face detection, image super resolution. The decomposition of images into dissimilar frequency ranges permits the isolation of the frequency components introduced by "intrinsic deformations" or "extrinsic factors" into definite sub bands. This procedure results in isolating small changes in an image mainly in high frequency sub band images. Therefore, discrete wavelet transform (DWT) [6] is an appropriate tool to be used for designing a classification system. The 2-D wavelet decomposition of an image is performed by applying 1-D DWT beside the rows of the image first, and, after that, the results are decomposed beside the columns. Such operation results in four decomposed sub band images referred to as low–low (LL), low–high (LH), high–low (HL), and high–high (HH). Where, the signal is denoted by the sequence CAj, where Aj is an integer. The low pass filter is denoted by Lo_D while the high pass filter is denoted by Hi_D. At each level, the high pass filter build detail information, whereas the low pass filter associated with scaling function generates coarse approximations. On every decomposition level, the half band filters produce signals spanning only half the frequency band. It doubles the frequency resolution as the vagueness in frequency is decreased by half. The frequency components of those sub-band images cover the frequency components of the novel image as shown in Fig. 1 (a).

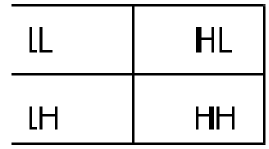

Fig. 1. (a) Result of 2-D DWT.

Comprehensible decomposition steps of Discrete Wavelet Transform as shown here in Fig. 1 (b).

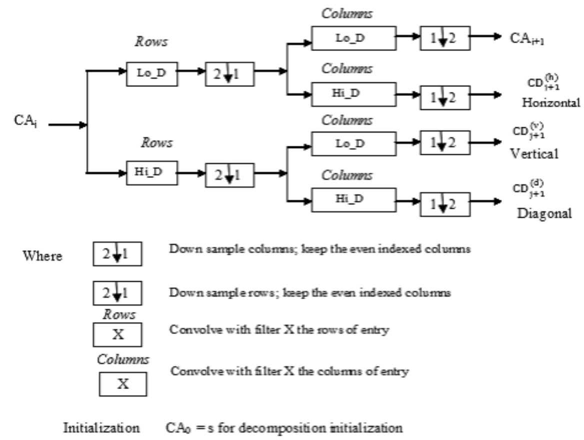

Fig. 1. (b) 2D-DWT Functional Process.

B. Local Enhancement

Previous methods of histogram equalizations and histogram matching are global. Hence, local enhancement [14] is used. Illustrating the square or rectangular neighbourhood (mask) and move the centre from pixel to pixel. For every neighbour, determine histogram of the points in the neighbourhood. Find the histogram equalization/specification function. Map gray level of pixel centred in neighbourhood. It can utilize new pixel values and preceding histogram to calculate next histogram.

C. Contrast Stretching

To expand the range of brightness values in an image the contrast enhancement techniques are used, so that the image can be efficiently displayed in a manner desired by the analyst. The level of contrast in an image may vary due to poor illumination or inappropriate setting in the acquisition sensor device. Consequently, there is a need to manipulate the contrast of an image in order to reimburse for difficulties in image achievement. The idea behind contrast stretching is to increase the dynamic range of the gray levels in the image being processed. The idea is to modify the dynamic range of the grey-levels in the image. Linear Contrast Stretch is the simplest contrast stretch algorithm that stretches the pixel values of a low-contrast image or high-contrast image by extending the dynamic range across the whole image spectrum from 0 – (L-1).

D. Histogram Processing

Histogram processing is used in image enhancement the information inherent in histogram can also used in other image processing application such as image segmentation and image compression. A histogram simply plots the frequency at which each grey-level occurs from 0 to 255 or (black -white). Histogram processing should be the initial step in pre-processing. To produce a much better image histogram equalization and histogram specification (matching) are two methods widely used to modify the histogram of an image.

The histogram is a discrete function that is shown in figure 2 Histogram correspond to the frequency of happening of all gray level in the image, which means it notified us how the values of individual pixel in an image are dispersed. Histogram is given as:

h (rk) = nk/N ……………………………………………(3)

Where r_k and n_k are intensity level and number of pixels in image with intensity r_k respectively.

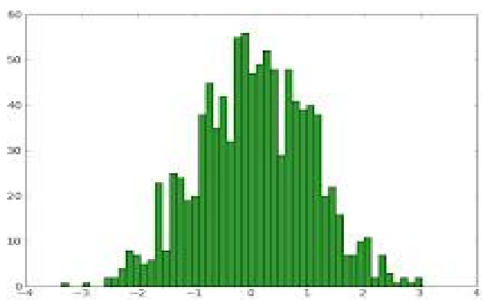

Fig. 2. Histogram.

Histogram equalization [15] is a frequent used technique for enhancing the quality of images. Assume we have an image which is primarily dark. Then its histogram would be skewed in the direction of the lower end of the grey scale and all the image detail is compressed into the dark end of the histogram. If we could `stretch out' the grey levels at the dark end to produce a more uniformly distributed histogram then the image would become much clearer. Histogram equalization stretches the histogram across the entire spectrum of pixels (0–255). It increases the contrast of images for the finality of human inspection and can be applied to normalize illumination variations in image understanding problems. Histogram equalization is one of the operations that can be applied to obtain new images based on histogram specification or modification. Histogram equalization is considered a global technique.

IV. PROPOSED METHODOLY

For improving the quality or contrast of image there are several techniques has been developed but in this paper we proposes a novel method to increase the contrast of the remote sensing image data. This technique includes DWT with kernel adaptive filtering technique.

A. Discrete Wavelet Transform

The Discrete Wavelet Transform (DWT) is discrete in time and scale, meaning that the DWT coefficients may have real (floating-point) values, but the time and scale values used to address these coefficients are numeral. The signal is **partitioned** by DWT into one or more levels of resolution (also called octaves), A 1-dimensional, one octave DWT. It comprises the analysis (wavelet transform) on the left side and the synthesis (inverse wavelet transform) on the right side. The low-pass filter produces the average signal, while the high pass filter produces the detail signal. In multi-resolution analysis, the average signal at one level is sent to an additional set of filters, which turns out the average and detail signals at the next octave [18].

B. Kernel Adaptive Filter

This filter is basically a non-linear adaptive filter type. An Adaptive filter is that alter its transform function to multicity the qualities of signal over period by reducing an error that represent how ulterior the filter alienate from ideal behaviors.

By Using Kernel methods, it executes a Non-Linear transfer function. It is a typical Popularization of linear adaptive filtering in replicating the kernel Hilbert spaces. It is approximately related to certain artificial neurological network likewise radial basis function. This schema has the avail of having with no local minima, convex loss and the learning process requires moderate complexity .

C. High Boost Filter

In image transformation process, it is predominantly emphasis high frequency constituents describing the image descriptions without dissipating low frequency constituents such as sharpening.

The High boost Filter is been exercised to improved high frequency constituents and this also inscribed by all filters and edge detection filter. Hence, this will going to emphasis on the edges of an image. Gaussian filter is also incorporated with high boost filter to perform noise reduction and availed as a smoother operator. It is mainly used in graphic software generally to minimize the effect of noise in an image.

D. Image Fusion

This topic has been broadly availed for reforming the content of image. The foremost assumption of this algorithm is to concatenate details from varied snapshots of a particular scene. The outcome of new image in an image fusion that is vastly appropriate for machine and human perception. The processing in the operation of this included the fact recognition, Segmentation, Feature extraction. So the conception of figure fusion is employed to integrate varied segment of images received by multiple Procedure of image intensification to get highly enhanced image.

E. Algorithm for Proposed Method

Now in the upcoming step, Image Fusion will be obtained by sub bands such as LL, HH, HL and LH of the real image are that integrated by using IDWT to get ultimately improved contrast of image.

Steps of Proposed methods-

1) Consider a low variant image as the Input.
2) Execute DWT reform action on the selected image.
3) Now, this image for analyzing brightness level formed on image decomposition of LL band in low, middle, high intensity layers.
4) The replica image is an 8-bit integer type, number of colors value will be 256.
5) Applying the decompositions depend on Emphatic effulgence stage then proceed it.
   - Approximation coefficient storage.
   - Lateral detail coefficient storage.
   - Vertical detail coefficient storage.
   - Diagonal detail coefficient storage.
   - Conversion of it into an unsigned 8-bit integer.
6) Apply intensity transfer function on multiple intensity stage of the disintegrated image and then smoothened out.
7) Then smoothen snapshot is proceeded to the Kernel Adaptive Filter which is then consolidated with the Contrast intensification method.
8) Now apply kernel function to filter an image after weighted map and smoothening edge process.
9) The inverted DWT is then applicable on the fused image and HH, HL, LH bands to obtain the contrast image.
10) Then apply IDWT for inverse the fused image.
11) Then at last we will measure the AMBE, PSNR and AMBE of the images. Apply the HE of that taken snapshot with the actual image to receive the amplified image.

V. RESULT ANALYSIS

Here MATLAB2009A is used for the evolution of experimental result with 4GB RAM, I3 processor system configuration.

A. Image Dataset

The datasets are used for intelligent retrieval research. Datasets are the elemental module of the domain of learning. The record contain eminent tract data set which will eventually presented to be of utility to the knowledge engineering exploration commonality from numerous distinct data depository to provide huge indemnity of the keynote which is variously applicable like image dataset, text dataset, sound dataset, financial dataset, weather dataset etc. In this tactics, we used many dataset images such as: 7.10.7.png, 7.1.09.png, 7.1.05.png, 7.1.03.png, 4.1.02.png. In the Under-mentioned section, we discussed about the GUI comparison and AMBE, PSNR values proportion. In the sketch 3 is showing that the experimental outline for the 4.1.02.pgm image. In the graphic 3 GUI window contains the experimental framework of the HE, BPCLBHE (existing) with proposed DWT-KHFF method and the result also compared on standard parameters like AMBE and PSNR.

Fig. 3. Result paralleling of two approaches with proposed method for 4.1.02.pgm.

After final completion of all iterations they observed that the AMBE results as follows for HE = 46.1387, BPCLBHE = 7.2448, proposed DWT-KHFF = 6.9584 etc. similarly we have also found that PSNR of HE = 32.5459, BPCLBHE = 58.5027, proposed DWT-KHFF = 65.791. So in finally observation we deduce that the propound tack gives the higher PSNR with minimum AMBE.

Fig. 4. Result paralleling of two approaches with proposed method for 7.1.01.pgm.

In the sketch 4 is showing that the experimental outline for the 7.1.01.pgm image. In the graphic 4 GUI window contains the experimental framework of the HE, BPCLBHE (existing) with proposed DWT-KHFF method and the result also compared on standard parameters like AMBE and PSNR. After final completion of all iterations they observed that the AMBE results as follows for HE = 26.6122, BPCLBHE = 4.1847, proposed DWT-KHFF = 4.0235 etc. similarly we have also found that PSNR of HE = 18.4837, BPCLBHE = 33.7975, proposed DWT-KHFF = 38.0412. So in finally observation we deduce that the propound tack gives the higher PSNR with minimum AMBE.

In the sketch 5 is showing that the experimental outline for the 7.1.03.pgm image. In the graphic 5 GUI window contains the experimental framework of the HE, BPCLBHE (existing) with proposed DWT-KHFF method and the result also compared on standard parameters like AMBE and PSNR.

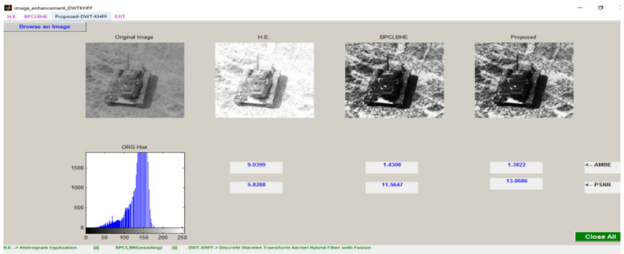

Fig. 5. Result paralleling of two approaches with proposed method for 7.1.03.pgm.

After final completion of all iterations they observed that the AMBE results as follows for HE = 9.0399, BPCLBHE = 1.4308, proposed DWT-KHFF = 1.3822 etc. similarly we have also found that PSNR of HE = 5.8288, BPCLBHE = 11.5647, proposed DWT-KHFF = 13.0686. So in finally observation we deduce that the propound tack gives the higher PSNR with minimum AMBE.

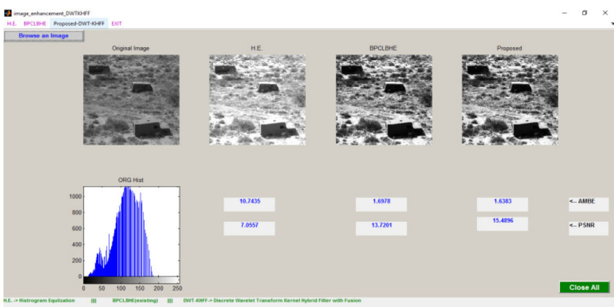

Fig. 6. Result paralleling of two approaches with proposed method for 7.1.05.pgm.

In the sketch 6 is showing that the experimental outline for the 7.1.05.pgm image. In the graphic 6 GUI window contains the experimental framework of the HE, BPCLBHE (existing) with proposed DWT-KHFF method and the result also compared on standard parameters like AMBE and PSNR. After final completion of all iterations they observed that the AMBE results as follows for HE = 10.7435, BPCLBHE = 1.6978, proposed DWT-KHFF = 1.6383 etc. similarly we have also found that PSNR of HE = 7.0557, BPCLBHE = 13.7201, proposed DWT-KHFF = 15.4896. So in finally observation we deduce that the propound tack gives the higher PSNR with minimum AMBE.

In the sketch 7 is showing that the experimental outline for the 7.1.07.pgm image. In the graphic 5.5 GUI window contains the experimental framework of the HE, BPCLBHE (existing) with proposed DWT-KHFF method and the result also compared on standard parameters like AMBE and PSNR. In the sketch 8 is showing that the experimental outline for the 7.1.09.pgm image.

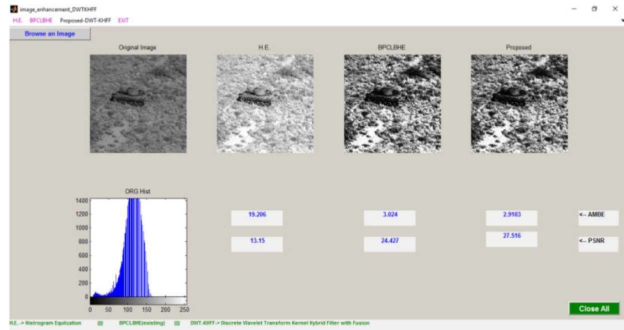

Fig. 7. Result paralleling of two approaches with proposed method for 7.1.07.pgm.

After final completion of all iterations they observed that the AMBE results as follows for HE = 19.206, BPCLBHE = 3.024, proposed DWT-KHFF = 2.9103 etc. similarly we have also found that PSNR of HE = 13.15, BPCLBHE = 24.427, proposed DWT-KHFF = 27.516. So in finally observation we deduce that the propound tack gives the higher PSNR with minimum AMBE.

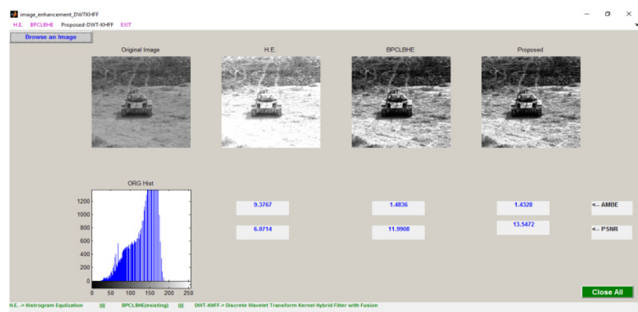

Fig. 8. Result paralleling of two approaches with proposed method for 7.1.09.pgm

In the pattern 5.6 GUI window contains the experimental framework of the HE, BPCLBHE (existing) with proposed DWT-KHFF method and the result also compared on standard parameters like AMBE and PSNR. After final completion of all iterations they observed that the AMBE results as follows for HE = 9.3767, BPCLBHE = 1.4836, proposed DWT-KHFF = 1.4328 etc. similarly we have also found that PSNR of HE = 6.0714, BPCLBHE = 11.9908, proposed DWT-KHFF = 13.5472. So in finally observation we deduce that the propound tack gives the higher PSNR with minimum AMBE.

Here table 1 shows the overall performance of AMBE of all three methods (HE, BPCLBHE and proposed method DWTKHFF) for the appropriated images. And the figure 9 shows the graph comparison of AMBE summary table.

Table 1: AMBE Comparison.

Image/Method	HE	BPCLBHE	DWTKHFF
4.1.02.pgm	46.1387	7.2448	6.9584
7.1.01.pgm	26.6122	4.1847	4.0235
7.1.03.pgm	9.0399	1.4308	1.3822
7.1.05.pgm	10.7435	1.6978	1.6383
7.1.07.pgm	19.206	3.024	2.9103
7.1.08.pgm	16.2407	2.5593	2.4646
7.1.09.pgm	9.3767	1.4836	1.4328

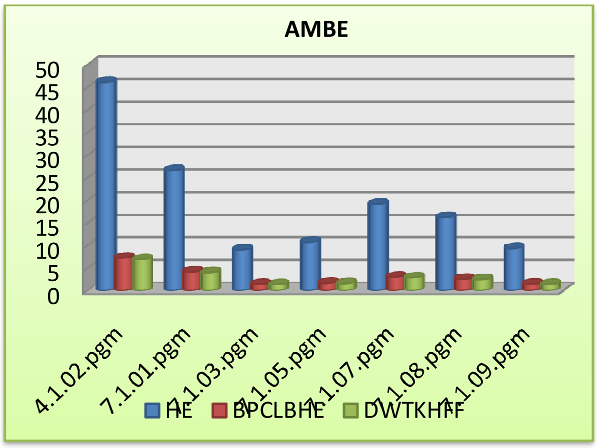

Fig. 9. AMBE comparison of HE, BPCLBHE and proposed method (DWTKHFF).

Table 2: PSNR Comparison.

Image/Method	HE	BPCLBHE	DWTKHFF
4.1.02.pgm	32.5459	58.5027	65.791
7.1.01.pgm	18.4837	33.7975	38.0412
7.1.03.pgm	5.8288	11.5647	13.0686
7.1.05.pgm	7.0557	13.7201	15.4896
7.1.07.pgm	13.15	24.427	27.516
7.1.08.pgm	11.0146	20.6753	23.302
7.1.09.pgm	6.0714	11.9908	13.5472

Here table 2 shows the overall performance of PSNR of all three methods (HE, BPCLBHE and proposed method DWTKHFF)for the appropriated images. And the figure 10 shows the graph comparison of PSNR summary table.

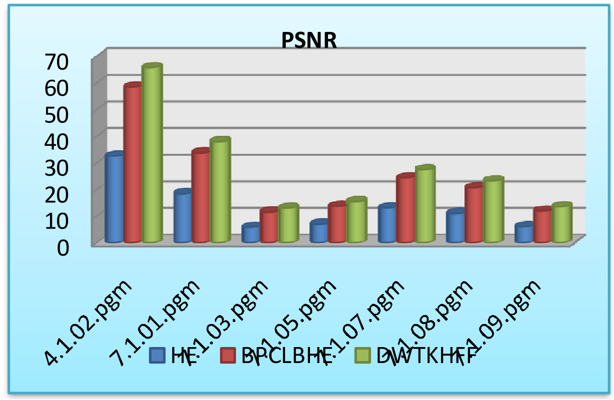

Fig. 10. PSNR comparison of HE, BPCLBHE and proposed method (DWTKHFF).

VI. CONCLUSION AND FUTURE SCOPE

In digital or binary image intensifying, contrast enhancement enacts an imperatival procedure in analyzing of several peculiar images data through different methods particularly in medicinal applications and digital image. To intensify the image contrast, many reformation tactics have been popularized in literature including Histogram Equalization (HE).

In this tract, introduce an efficient technique or performance to magnify facsimile for contrast exploiting the conceptualization of DWT (Discrete wavelet transforms) with High boost filter. In DWT-KHFF technique confer less error rate and have utmost PSNR. Here in this proposed method provides more enhancements over illumination and luminosity too as observed to the other method, this proposed method not only reform the contrast intensification 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 snapshot may be refined and intensity gets preserved.

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