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Satellite Image Enhancement Using DWT and Gaussian Filter

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Abstract- These days the image taken by the satellite generally utilized for differing applications however the element of these image degraded because of climate change, atmosphere and different elements are responsible. In image processing, an assortment of image enhancement methods have been produced for the satellite image restoration and improvement. This paper proposes an approach which utilizes DWT, Hybrid filter and Gaussian filter. The simulation of our anticipated technique is done utilizing the MATLAB2012a simulator which involves various functions for image enhancement and the similar examination of our strategy utilizes the execution measurements, for example, PSNR, EME and RMSE. The experimental consequences of our methodology give enhanced quality of image than the existing methods.

Keywords- Image processing; Satellite image; DWT; MATLAB; PSNR; MSE, RMSE

1. INTRODUCTION

In image processing images are the most advantageous and powerful methods for passing on data. Image processing where the info is a image, for example, a photo or video outline and the yield of might be either a image or an arrangement of parameters identified with the image. In image processing it builds up the application that could play out the operation identified with the visual elements of all images like enhancement the image to enhance image quality, perform pressure to lessen storage room and expel the commotion and so forth. In this day and age image processing is a quickest developing field in numerous zones of science and building. There are a few vital viewpoints in it, from which image enhancement is most engaging and easiest zone among all. [1].

Image enhancement in which processing a image such that the improved image is more helpful than the first for the specific application. The fundamental thought identified with the image enhancement is to bring out detail that isn't unmistakable plainly or feature certain vital highlights of a image. Likewise it is important to enhance the perceivability of the image by expelling undesirable clamor, to discover more points of interest and enhance differentiate and so on. There are two fundamental methodologies of image improvement: Spatial space and Frequency area strategy.

Spatial space techniques [2] straightforwardly control the image information cluster, either by point preparing or region processing. Essentially it manages spatial frequency, i.e. distinction between the most astounding and the least estimations of a bordering set of pixels. The methodologies with respect to image improvement utilizing spatial space techniques can be partitioned into two classes – worldwide image enhancement and nearby image enhancement. Worldwide techniques are for the most part histogram alterations that expect to misuse the full powerful scope of a rendering gadget by adjusting the histogram of a image. The appeal is their straightforwardness and minor computational exertion. Be that as it may it is regularly important to enhancement detail over a littler territory. In this way, the nearby image improvement strategy assumes a noteworthy part in those applications. It can be spoken to by condition 1.1

$G(x,y)=T[f(x,y)]$ … . (1.1)

Image improvement in the frequency area is direct. We just figure the Fourier change of the image to be improved, increase the outcome by a filter (instead of convolve in the spatial space), and take the converse change to deliver the enhanced image.

Blurring an image by lessening its high frequency segments or honing a image by expanding the greatness of its high frequency segments is naturally straightforward. Be that as it may, computationally, it is regularly more effective to execute these operations as convolutions by little spatial filters in the spatial area. Understanding frequency area ideas is essential, and prompts enhancement strategies that won't not have been thought of by limiting thoughtfulness regarding the spatial space. [2]

Satellite images are utilized as a part of many image preparing applications, for example, cartography, geosciences thinks about, agribusiness, climate anticipating, space science, scene and geological data frameworks and so forth. In our work the principle exertion nervous enhancement has been centered primarily to improve the visual impression of images which is hazy. In existing techniques the well known edge improvement sifting is perform by utilizing conventional filters yet it contains a few downsides [3, 4]. In this work, propose an approach which utilizes DWT, half and half filter and Gaussian filter for image improvement. The recreation aftereffects of this technique beats than the current strategy, for example, HE, MHE and so forth.

The association of residual area of research paper is as per the following: Section II gives the diagram about the writing work, Section III gives detailed overview of the proposed system and in segment IV the experimental outcomes and examination of the proposed methodology is existed. At last in last section overall conclusion of the examination work is talked about

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2. RELATED WORK

The area of image improvement is the noteworthy normal for satellite image processing, as of their mammoth applications in a few zones, for example, cartography, geosciences examines, horticulture, climate estimating, cosmology, scene and topographical data frameworks and so forth. Loads of articles and writing assessment are distributed around there and we will illuminate some of these works.

P. Suganya, N. Mohanapriya et al. [5] proposed strategy for satellite image improvement which incorporates Haar filter for pre-handling, Multi Wavelet Transform, Interpolation Process, Inverse Process of Multi Wavelet Transform for the low determination image. The Multi Wavelet Transform and Interpolation system used to deliver less relics. Constraint of this technique isn't successful strategy to lessen contortion and for losing of high frequency content. Additionally in this work depicts about Inter-Sub band Correlation Technique utilizing Sub Bands-It utilized when a image is in low determination, the image will be uncertain that it is indicated as obscure image. With the goal that the frequency will likewise be low and broken, property is move variation due to frequency isn't constant, the property continues evolving. On the off chance that the determination is high, the image will be clear a direct result of the frequency will be as much as persistent. Utilizing Inter-Sub band relationship is we can get ceaseless frequency in this manner the moving property keeps invariant. Favorable position of it the low determination image will get clear and improved. **Arya P Unni et al. [6]** creator proposed technique for improvement of satellite shading images. Utilizing the idea of 2D Discrete wavelet change, limit deterioration and morphological separating. It can separate superfluous commotion substance of the image and high frequency segments. Additionally Haar filter is utilized to filter the frequency segments that are superfluous. Likewise in this paper portray about Histogram Equalization method is utilized to enhancement images by normalizing image powers. This technique can't keep up normal shine level in light of the fact that there might be an expansive distinction in power estimations of pixels along these lines the normal esteem isn't ideal in such circumstances. Splendor level is either under or over immersion in the handled image. Impediment of this system can't be utilized for substantial images. Satellite images are vast images by and large so not helpful all things considered. **Yong Yang, Shuying Huang et al. [7]** in this work creator proposed strategy for multi-center image combination and the physical importance of wavelet coefficients, combination method of a discrete wavelet change based with another coefficients determination calculation. Source images are disintegrated by DWT technique, two distinctive window-based combination rules are independently apply to join the both low frequency and high frequency coefficients. Daubechies db8 as the wavelet reason for DWT based technique is utilized. This proposed strategy can accomplish better visual quality and target assessment files. Restriction of this strategy is that it doesn't actualized this technique on multi-sensor images, for example, remote detecting images, medicinal images and so on. **S. Bhargavi et al. [8]** creator proposed a strategy for melding two dimensional multi-determination 2-D images utilizing wavelet change by utilizing the consolidate slope and smoothness measure. Essentially it deteriorate each enrolled image into sub-images by utilizing forward wavelet change which have same determination at that same level and diverse determination at various levels. Image combination is performed in view of the high frequency sub-images and last image is acquired utilizing reverse wavelet change. Utilizing the reverse wavelet change it can recreate the image. This remade image has data accumulate from all the distinctive images sources so this is more useful. Critical point is the proposed calculation is area autonomous. It can be utilized as a part of various types of multi-modular images and furthermore it protects the edge data. Restriction of this it needs more space for execution and computationally more costly. **Wenkao Yang, Jing Wang et al. [9]** creator proposed strategy in light of foremost parts investigation (PCA) is a factual method that can change over multivariate information with related factors into with uncorrelated factors. The new factors are gotten as direct mixes of the current factors. PCA strategy has utilized for some, reasons like in image encoding, image combination, image information pressure and image enhancement. In the combination procedure, PCA technique produces uncorrelated images. The main vital part is supplanted with the panchromatic band, with one which has higher spatial determination. At long last the opposite PCA change is connected to acquire the image in the RGB shading image. Restriction of it is PCA image combination strategy predominant spatial data and powerless shading data is frequently a Problem. **K. Raveendra et al. [10]** creator proposed a technique for enhancing nature of satellite images. Creator introduce a strategy, DWT to break down the info image into various sub groups and apply limit technique on it. Distinguish the regions of the edges by utilizing edge deterioration strategy. After that the edges are honed by utilizing morphological filters. This technique works for honing and decrease the bending of a image. Constraint of this work might be stretched out for different issues identified with satellite images, for example, ancient rarities. **Revathy et al. [11]** proposed work has been refined in two stages to be specific preprocessing and pressure. Pre-preparing is important to dispense with the clamors and to enhance the nature of the image. In this stage, Wiener Filter is proposed to improve the image quality. The sifted image is packed utilizing Huffman coding. At last, the compacted image is measured by PSNR and MSE esteems. The proposed work is explored different avenues regarding the satellite images which are gathered from the NASA and ISRO space station however sites. The aftereffects of pressure with and without preprocessing are contrasted and the pressure and preprocessing yields better outcomes. **Sundaram et al. [12]** have built up a preprocessing of mammogram image utilizing a versatile middle filter, which is a preprocessing method for upgrading the substance of restorative image in view of expulsion of unique markings and commotion. Evacuation of extraordinary markings and commotion existing in medicinal images will expand the nature of image division. Here three sorts of sifting strategies for pre-handling of mammography images are considered. The yield parameters, for example, image quality, mean square mistake, top flag to clamor proportion are compacted of three sorts of filters are tried on mammogram images. **Deepa et al. [13]** have built up a proficient denoising and enhancement method for medicinal image, the filter which gave the productive denoising. Exhibit approach has actualized a complexity Enhancement and de-noising system, and the medicinal image is given as the info, if the information image is shading image, at that point it is changed over into grayscale with a specific end goal to diminish the handling time the differentiation of the information image is enhancement and the image is denoised utilizing different filter and the quality and exactness is measured by PSNR and MSE esteem and we assessed the best denoised image as indicated by these esteem. **Sahnoun, K., et al. [14]** exhibited another coding plan for satellite image. The Fast Fourier change and the scalar quantization for standard LENA image and image satellite image, the (SQ) stage is encoded utilizing entropy, after decompression. In this paper, we can examine the accomplish higher pressure proportions, over 78%. **Yashavanth, E., et al. [15]** displayed half and half fractal image pressure technique for satellite images. It can disintegrate images into low frequency sub-band and high frequency sub-band. Relative change and iterative capacity framework strategies have been connected to the pressure, decompression the satellite images. It will demonstrate the huge change in the pressure proportion, PSNR esteems and encoding time.

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3. PROPOSED WORK

In this section, we briefly discuss about our proposed methodology to enhance the brightness, contrast and sharpening the satellite images.

The proposed technique implemented here consists of two phase's one DWT transformation of high band and the image fusion of low band. The contrast enhancement techniques provided here starts with the DWT transformation of images which removes blurriness and provides restoration of image. Here the Low pass band of the images is used for the restoration purpose where we apply adaptive intensity concept and the pixel intensity gets smoothened out e=which is then fused with the other sub bands of the image pixels and then inverse DWT is applied on the fused and the smoothened image to get the restored image consisting of enhanced contrast and brightness preserved.

The outline of the proposed technique for contrast enhancement is shown in below figure 1

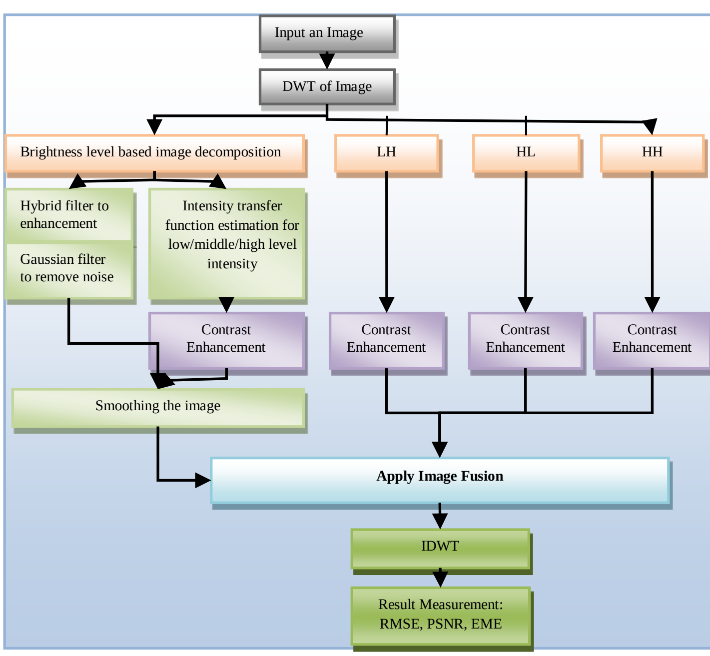


Figure 1: Outline of the Proposed Method

3.1 DISCRETE WAVELET TRANSFORMATION

The Discrete Wavelet Transform (DWT) is discrete in time and scale, implying that the DWT coefficients may have genuine (floating point) values, yet the time and scale esteems used to file these coefficients are whole numbers. A signal is disintegrated by DWT into at least one levels of determination (additionally called octaves), a one-dimensional, one octave DWT. It incorporates the examination (wavelet transform) on the left side and the combination (opposite wavelet transform) on the correct side. The low-pass filter delivers the normal signal, while the high pass filter creates the detail signal. In multi-determination examination, the normal signal at one level is sent to another arrangement of filter, which creates the normal and detail signals at the following octave [16]. The detail signals are kept, however the higher octave midpoints can be disposed of, since they can be re-processed amid the reverse transform. Each filter's yields have just a large portion of the information's measure of information (in addition to a couple of coefficients because of the filter). Subsequently, the wavelet portrayal is around an indistinguishable size from the first. The DWT can be 1-Dimensional, 2-D, 3-D, and so forth relying upon the signal's measurements [17].

The 2-D transform is just a use of the 1-D DWT in the flat and vertical headings [18], at any rate for the distinct case. The non-distinguishable 2-D transform works uniquely in contrast to the one appeared, since it processes the transform in light of a 2-D test of the information convolved with a grid, however the outcomes are the same. The distinguishable thought can be stretched out to the 3-D DWT.

1-D Wavelet Architecture

One-dimensional models can be ordered into many sorts, the fundamental ones are: space multiplexed, systolic cluster, time multiplexed, collapsed, and digit-serial. There are procedures for enhancing these outlines, which incorporate grid, pipelining/enlist organizing, consolidated DWT and IDWT, and approximating comes about. Nonetheless, every transform includes a specific tradeoff: for instance, cross section utilizes less space to the detriment of a slower speed. Cases of every classification will be talked about beneath. Structures are frequently outlined on account of uses. For 1-D transforms, applications may incorporate denoising an atomic attractive reverberation (NMR) signal, compacting seismic data [19], and recognizing loud FM signals [20].

Algorithm for DWT

1. Load the image I and take the dynamic histogram of the original image.
2. The quantity of qualities each color segment has. Since the example image is an unsigned 8-bit whole number sort (the most widely recognized circumstance), number of hues will be 256.
3. Applying the disintegrations is the same than in the listed image case. The coefficient matrices will just be M-by-N-by-3 lattices rather than M-by-N networks.
a. nLevel=3 is the Number of disintegrations.
b. Estimation coefficient storage.
c. Even detail coefficient storage.
d. Vertical detail coefficient storage.
e. Inclining point of interest coefficient storage.
4. Change over to unsigned 8-bit number to show

5. Image demonstrating the first RGB image (upper left), the completely reproduced image utilizing the whole put away detail coefficient networks (upper right), and the halfway recreated image utilizing none of the put away detail coefficient lattices (base left).
Apply the histogram equalization of this image with the original image to get the improve image.

3.2 HYBRID FILTER

This hybrid filter is the mix of Median and wiener filter. When we organize these filter in arrangement we get the coveted yield. To start with we expel the drive commotion and after that pass the outcome to the wiener filter. The wiener filter evacuates the blurredness and the added substance background noise the image. The outcome isn't the same as the first image, yet it is practically same.

Algorithm

The accompanying advances are taken after when we separated the image:

- If the image is hued change over it in the dim scale image.
- Convert the image to twofold for better accuracy.
- Find the middle by arranging every one of the estimations of the 3*3 veil in expanding request.
- Replace the inside pixel esteem with the middle esteem.
- Estimate the Signal to Noise proportion.
- Deconvolution function is connected to sifted the image.

3.3 GAUSSIAN FILTER

Gaussian filter is a filter whose motivation reaction is a Gaussian capacity (or a guess to it). Gaussian filters have the properties of having no overshoot to a stage work input while limiting the ascent and fall time. This conduct is firmly associated with the way that the Gaussian filter has the base conceivable gathering delay. It is viewed as the perfect time space filter, similarly as the sinc is the perfect recurrence area filter. These properties are critical in territories, for example, oscilloscopes and digital telecommunication system. The exchange capacity of a Gaussian lowpass filter is characterized as:

$$H(u,v) = e^{-D^2(u,v)/2D_0^2}$$

3.4 PROPOSED STEPS

1. Load an image I and take the dynamic histogram of the original image.
2. Since the input image is 8 bit unsigned, so the values vary between 0 to 255.
3. Apply DWT based decomposition (LL, LH, HL, HH) bands
4. Applying the decompositions is no different than in the indexed image case. The coefficient matrices will simply be M-by-N-by-3 matrices instead of M-by-N matrices.
   a. nLevel=3 is the Number of decompositions.
   b. Approximation coefficient storage.
   c. Horizontal detail coefficient storage.
   d. Vertical detail coefficient storage.
   e. Diagonal detail coefficient storage.
5. Convert to unsigned 8-bit integer to display
6. Image showing the original RGB image (top left), the fully-reconstructed image using the entire stored detail coefficient matrices (top right), and the partially-reconstructed image using none of the stored detail coefficient matrices (bottom left).
7. Apply hybrid filter to reduce noise and enhanced image quality
8. Apply Gaussian filter with step 6
9. Smoothing image after step 7
10. Apply the histogram equalization of this image with the original image to get the enhance image.
11. Apply fusion rule to combine all decomposed layers into one image.
12. Apply IDWT
13. Result measurement: RMSE, PSNR, EME

4. EXPERIMENTAL RESULTS & ANALYSIS

In this section we demonstrate the effectiveness of our proposed methodology DWT, hybrid and Gaussian filter in comparison with some existing approach HE, MHE in satellite image enhancement. The experimental analysis of the proposed methodology is done using a widely used MATLAB2012A toolbox and the machine configuration is Intel I3 core 2.20Ghz processor, with 4GB RAM, windows 7 home basis & analysis of our method is performs using performance metrics such as RMSE, EME and PSNR.

4.1 EXPERIMENTAL RESULT

The proposed method for image enhancement has applied on several images and we have compared the result of our method with other image enhancement methods such as histogram equalization and multi-histogram equalization and. To evaluate the effectiveness of our proposed method, we have used the RMSE and PSNR. By comparing the RMSE, EME and PSNR of proposed method with HE and MHE, mathematically we have proved that proposed method is better than HE and MHE.

4.1.1 Result Analysis for Bora Image

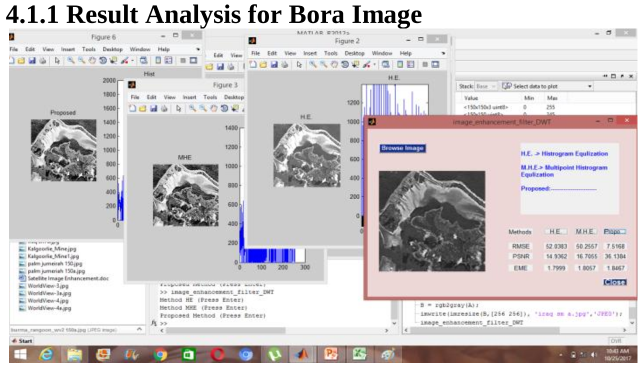


Figure 2 Enhanced Image of Bora Image dataset using HE, MHE and Proposed

Figure 2 shows the enhanced image of Bora image dataset with corresponding histogram that we have inserted to enhance the visualization of Bora Image. In original image of Bora image dataset, the contrast is low.
In this also shows the performance of Histogram Equalization with corresponding histogram on Bora image. The overall brightness of image has been improved in certain degree. The RMSE, PSNR and EME that is calculated by proposed method for Bora image dataset is as follows :
RMSE : 7.5168

PSNR : 36.1384
EME : 1.8467

4.1.2 Result Analysis for Burma_Rangoon Image

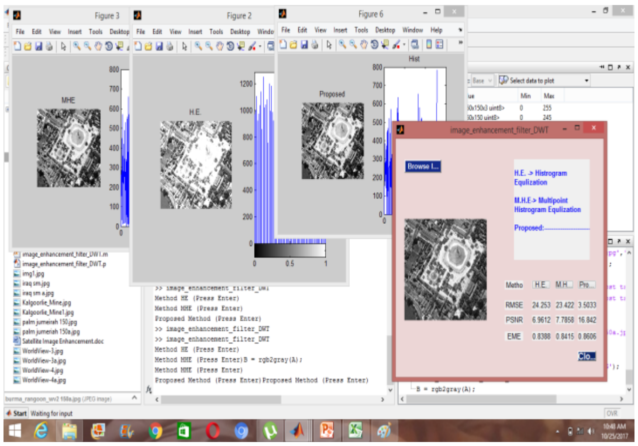


Figure 3 Enhanced Image of Burma_Rangoon dataset using HE, MHE and Proposed

Figure 3 shows the enhanced image of Burma_Rangoon image dataset with corresponding histogram that we have inserted to enhance the visualization of Burma_Rangoon. In original image of Burma_Rangoon dataset, the contrast is low.
In this also shows the performance of Histogram Equalization with corresponding histogram on Burma_Rangoon image. The overall brightness of image has been improved in certain degree. The RMSE, PSNR and EME that is calculated by proposed method for Burma_Rangoon image dataset is as follows:
RMSE : 3.5033
PSNR : 16.842
EME : 0.8606
AS comparison to HE and MHE with proposed method our method provide a better visualization.

4.1.3 Result Analysis for Doha_Qatar Image

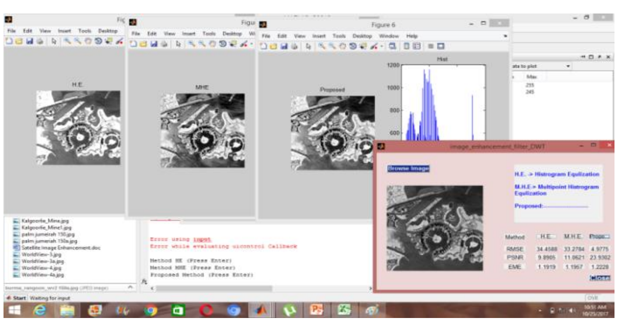


Figure 4 Enhanced Image of Doha_Qatar dataset using HE, MHE and Proposed

The figure 4 shows that the enhanced image of Doha_Qatar image dataset with corresponding histogram that we have inserted to enhance the visualization of Doha_Qatar. In original image of Doha_Qatar dataset, the contrast is low.
In this also shows the performance of Histogram Equalization with corresponding histogram on Doha_Qatar image. The overall brightness of image has been improved in certain degree. The RMSE, PSNR and EME that is calculated by proposed method for Doha_Qatar image dataset is as follows:
RMSE : 4.9775
PSNR : 23.9302
EME : 1.2228
The proposed method provides a better visualization as comparison to other image enhancement methods because it improves the contrast with brightness preservation.

4.1.4 Result Analysis for fukushima_daiichi Image

In figure 5 shows it that the enhanced image of fukushima_daiichi image dataset with corresponding histogram that we have inserted to enhance the visualization of I fukushima_daiichi. In original image of fukushima_daiichi dataset, the contrast is low.
In this also shows the performance of Histogram Equalization with corresponding histogram on fukushima_daiichi image. The overall brightness of image has been improved in certain degree. The RMSE, PSNR and EME that is calculated by proposed method for fukushima_daiichi image dataset is as follows:
RMSE : 4.0659
PSNR : 19.5474
EME : 0.99886

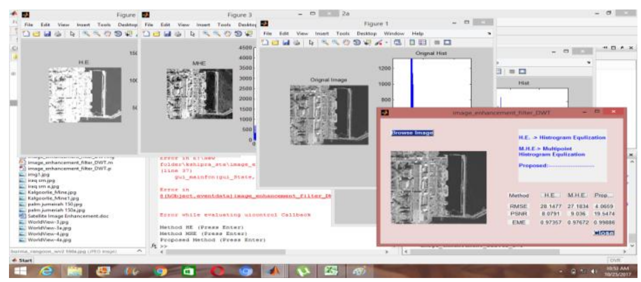


Figure 5 Enhanced Image of fukushima_daiichi dataset using HE, MHE and Proposed

4.1.5 Result Analysis for Iraq_sm Image

Here figure 6 shows it that the enhanced image of Iraq_sm image dataset with corresponding histogram that we have inserted to enhance the visualization of Iraq_sm. In original image of Iraq_sm dataset, the contrast is low.
In this also shows the performance of Histogram Equalization with corresponding histogram on Iraq_sm image. The overall brightness of image has been improved in certain degree. The RMSE, PSNR and EME that is calculated by proposed method for Iraq_sm image dataset is as follows:
RMSE : 3.9535
PSNR : 19.0072
EME : 0.97126

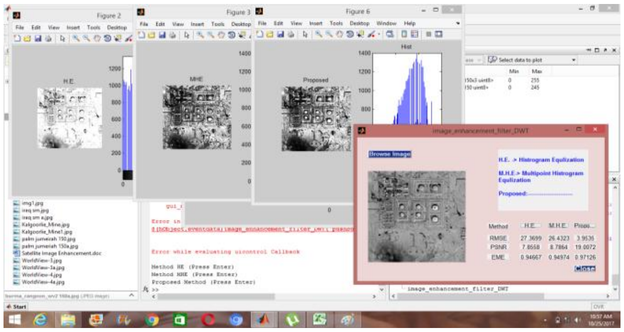


Figure 6 Enhanced Image of Iraq_sm dataset using HE, MHE and Proposed

4.1.6 Result Analysis for Kalgoorlie_mine Image

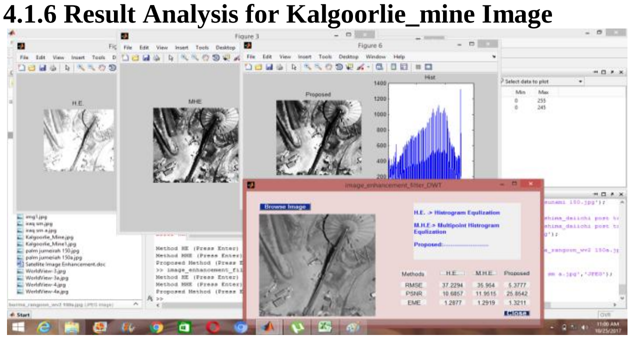


Figure 7 Enhanced Image of Kalgoorlie_mine dataset using HE, MHE and Proposed

Here figure 7 shows it that the enhanced image of Kalgoorlie_mine image dataset with corresponding histogram that we have inserted to enhance the visualization of Kalgoorlie_mine. In original image of Kalgoorlie_mine dataset, the contrast is low.

In this also shows the performance of Histogram Equalization with corresponding histogram on Kalgoorlie_mine image. The overall brightness of image has been improved in certain degree. The RMSE, PSNR and EME that is calculated by proposed method for Kalgoorlie_mine image dataset is as follows:

RMSE : 5.3777
PSNR : 25.8542
EME : 1.3211

4.1.7 Result Analysis for palm_jumeirah Image

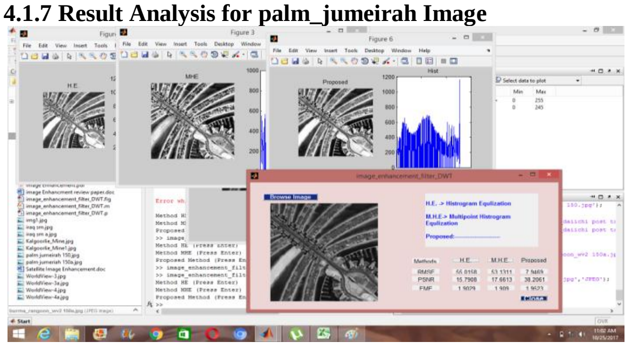


Figure 8 Enhanced Image of palm_jumeirah dataset using HE, MHE and Proposed

Here figure 8 shows it that the enhanced image of palm_jumeirah image dataset with corresponding histogram that we have inserted to enhance the visualization of palm_jumeirah. In original image of palm_jumeirah dataset, the contrast is low.

In this also shows the performance of Histogram Equalization with corresponding histogram on palm_jumeirah image. The overall brightness of image has been improved in certain degree. The RMSE, PSNR and EME that is calculated by proposed method for palm_jumeirah image dataset is as follows:

RMSE : 7.9469
PSNR : 38.2061
EME : 1.9523

4.1.8 Result Analysis for Worldview 3 Image

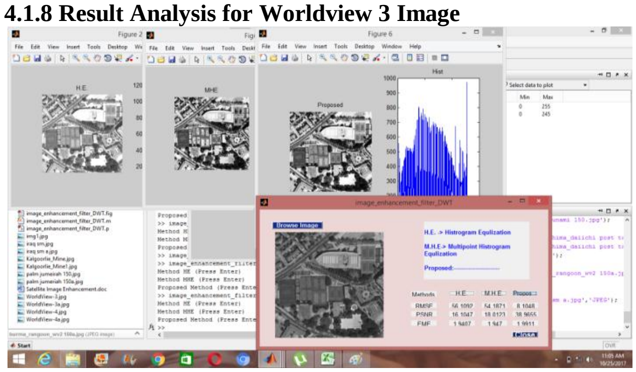


Figure 9 Enhanced Image of Worldview 3 dataset using HE, MHE and Proposed

Here figure 9 shows it that the enhanced image of Worldview 3 image dataset with corresponding histogram that we have inserted to enhance the visualization of Worldview 3. In original image of Worldview 3dataset, the contrast is low.

In this also shows the performance of Histogram Equalization with corresponding histogram on Worldview 3image. The overall brightness of image has been improved in certain degree. The RMSE, PSNR and EME that is calculated by proposed method for Worldview 3image dataset is as follows:

RMSE : 8.1048
PSNR : 38.9655
EME : 1.9911

4.1.9 Result Analysis for Worldview 4 Image

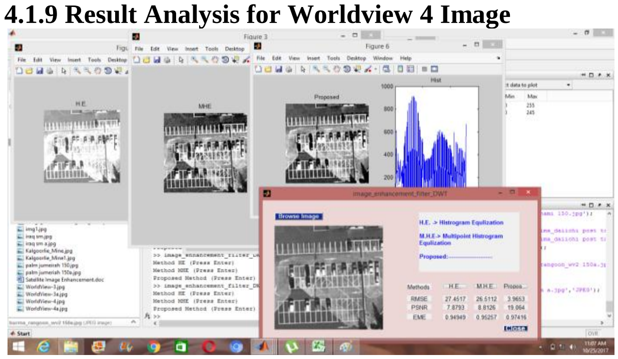


Figure 10 Enhanced Image of Worldview 4 dataset using HE, MHE and Proposed

Here figure 10 shows it that the enhanced image of Worldview 4 image dataset with corresponding histogram that we have inserted to enhance the visualization of Worldview 4. In original image of Worldview 4 dataset, the contrast is low.

In this also shows the performance of Histogram Equalization with corresponding histogram on Worldview 4 image. The overall brightness of image has been improved in certain degree. The

RMSE, PSNR and EME that is calculated by proposed method for Worldview 4 image dataset is as follows:

RMSE : 3.9653
PSNR : 19.064
EME : 0.97416

After analysis it is found that our proposed method provides a better visualization as comparison to other image enhancement methods because it improves the contrast with brightness preservation.

4.2 PERFORMANCE EVALUATION

The proposed method for image enhancement has applied on several images; here we are displaying the result of nine image dataset and we are comparing the result of proposed method with other image enhancement methods HE, MHE using performance metrics PSNR, RMSE and EME. The result is shown through table and graph.

4.2.1 RMSE Performance

Root Mean Square Error (RMSE) and is defined as the absolute difference between the input and the output image's mean:

RMSE = E(X) − E(Y).

After simulation of the proposed work, HE and MHE, it is found that the result for RMSE metrics of our work is about 85% more effective to enhance the brightness of images.

Table 1 RMSE Performance

Root Mean Square Error			
Methods/Images	H.E	M.H.E	Proposed Method
Aerial.png	19.9308	19.248	2.8789
WorldView-3.jpg	56.1092	54.1871	8.1048
bora.jpg	52.0383	50.2557	7.5168
doha_qatar1.jpg	34.4588	33.2784	4.9775
burma_rangoon_wv2 150a.jpg	24.253	23.4222	3.5033
fukushima_daiichi post tsunami 150.jpg	28.1477	27.1834	4.0659
iraq sm.jpg	27.3699	26.4323	3.9535
Kalgoorlie_Mine1.jpg	37.2294	35.954	3.9535
palm jumeriah 150a.jpg	55.0158	53.1311	7.9469
WorldView-4.jpg	27.4517	26.5112	3.9653

4.2.2 PSNR Performance

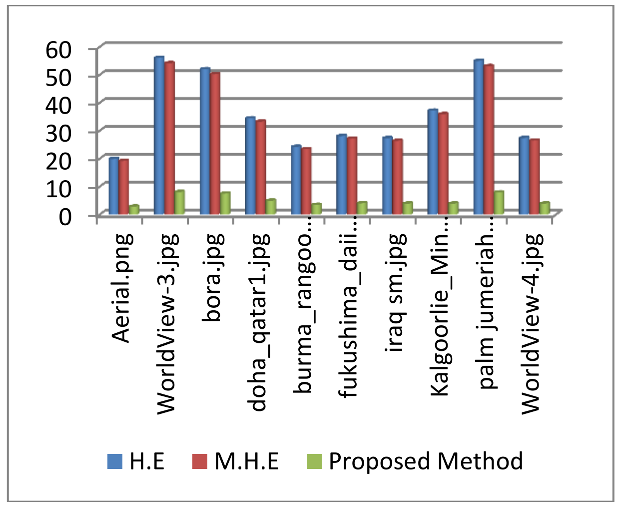
Peak signal to noise ratio (PSNR) is used to assess the degree of contrast enhancement, greater PSNR is better. PSNR is calculated by:

$$\mathrm{PSNR} = 20 \log \left(\frac{I_{max}}{\sqrt{\mathrm{MSE}}} \right)$$

After simulation of the proposed work, HE and MHE, it is found that the result for PSNR metrics of our work is about 80% more effective to enhance the brightness of images.

4.2.3 EME Performance

After simulation of the proposed work, HE and MHE, it is found that the result for EME metrics of our work is about (2 to 5 %) more effective to enhance the brightness of images.



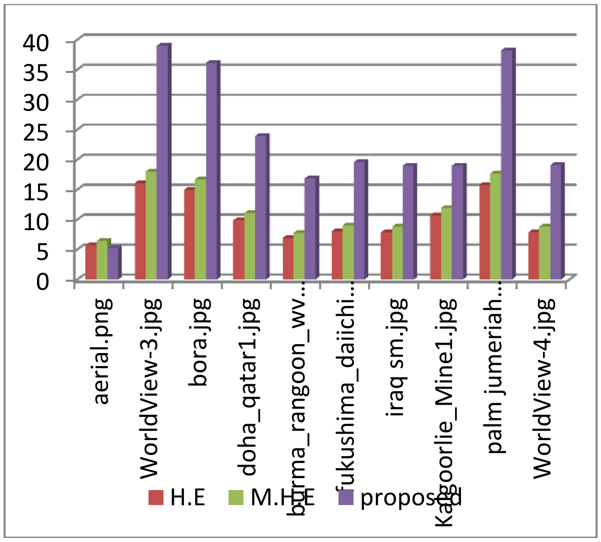
Graph 1 RMSE Performance

Table 2 PSNR Performance

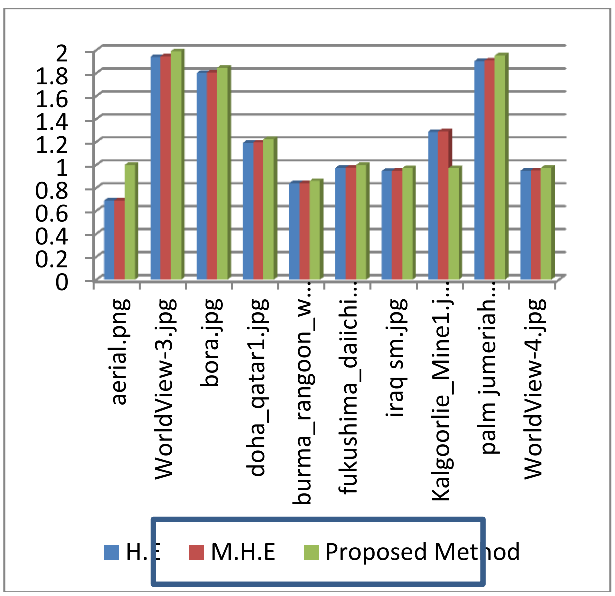
PSNR comparison			
method/images	H.E	M.H.E	proposed
aerial.png	5.7206	6.3982	5.236
WorldView-3.jpg	16.1047	18.0123	38.9655
bora.jpg	14.9362	16.7055	36.1384
doha_qatar1.jpg	9.8905	11.0621	23.9302
burma_rangoon_wv2 150a.jpg	6.9216	7.7858	16.8427
fukushima_daiichi post tsunami 150.jpg	8.0791	9.036	19.5474
iraq sm.jpg	7.8558	8.7864	19.0072
Kalgoorlie_Mine1.jpg	10.6857	11.9515	19.0072
palm jumeriah 150a.jpg	15.7908	17.6613	38.2061
WorldView-4.jpg	7.8793	8.8126	19.064

Table 3 EME Performance

EME Comparison			
Method/Images	H.E	M.H.E	Proposed Method
aerial.png	0.68936	0.6916	1
WorldView-3.jpg	1.9407	1.947	1.9911
bora.jpg	1.7999	1.8057	1.8467
doha_qatar1.jpg	1.1919	1.1957	1.2228
burma_rangoon_wv2 150a.jpg	0.83886	0.84158	0.86065
fukushima_daiichi post tsunami 150.jpg	0.97357	0.97672	0.99886
iraq sm.jpg	0.94667	0.94974	0.97126
Kalgoorlie_Mine1.jpg	1.2877	1.2919	0.97126
palm jumeriah 150a.jpg	1.9029	1.909	1.9523
WorldView-4.jpg	0.94949	0.95257	0.97416



Graph 2 PSNR Performance



Graph 3 EME Performance

5. CONCLUSION

In image enhancement field various techniques have proposed to enhance the quality of image such as histogram equalization, multi-histogram equalization and pixel dependent contrast preserving. Here in this work we proposed an efficient technique of contrast enhancement using the concept of Gaussian filter and Hybrid filter. The proposed technique implemented here provides less error rate and have more Peak Signal to Noise Ration. The simulation result of proposed methodology for RMSE, PSNR and EME parameter is about 85%, 80% and 2-5% is more than the existing techniques.

The proposed method is efficient as compared to the other existing techniques which doesn't provides more enhancement over contrast and also the brightness can't be preserved, but the technique implemented here not only improves the contrast enhancement but also the brightness can be preserved.

Although the technique implemented here provides more contrast enhancement but when these concept can be used for the emissive display models then the power consumption is more, hence for the future work we provides an effective model for power displays such that the contrast of the image can be improved, brightness gets preserved and more importantly power dissipation should be less.

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