# Dynamic Histogram Equalization and Transform domain fusion for Medical Image Enhancement

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## ABSTRACT

This study uses a triple clipped histogram model-based fusion technique in an innovative way to improve medical images. Medical imaging involves the creation of internal body structures for the purpose of medical research, scientific investigation, and treatment. Medical images are typically more difficult to analyze because of the low-light setting in which they are captured. Consequently, medical images frequently exhibit low contrast. The approach starts by equalizing a medical image with poor contrast using a dynamic histogram equalization technique. The histogram of the incoming medical image is partitioned into three segments depending on standard deviation , ensuring a uniform distribution of pixels. A sub-histogram equalization method is then carried out on the approximation and detail-coefficients produced from the discrete wavelet transform(DWT). In order to enhance image quality, a fusion procedure takes place to change these coefficients. The approximation coefficients are modified using singular value decomposition (SVD). The effectiveness of these improvements is comprehensively evaluated through both qualitative and quantitative analysis. The methodology utilizes a fusion technique that merges the characteristics of both the equalized and input images, resulting in a promising enhancement compared to current methods.

**Keywords :** Image Enhancement , Triple Clipped Histogram Model , Dynamic Histogram Equalization , Fusion Techniques.

## INTRODUCTION

Image Enhancement plays a crucial role in all image processing applications such as medical images, satellite images and photography which includes improving the visual appeal of a photograph or highlighting the features in a medical image more visible. Enhancing an image involves changing its attributes to make it better suited for improving its quality and relatively to make better representation for further image analysis .

In general, some acquired images suffer from low light conditions, which result in poor vision, blurriness, graininess, and overall lack of clarity. As a result, not all the details are clearly visible in the image. This lack of clarity makes it hard to use the image for important tasks like reading text, detecting defects in an image. Therefore, resolving these problems through image enhancement is essential for making the images to be utilized in real-world applications. It is like giving those unclear images a makeover to make them brighter, sharper, and understandable. The algorithmic view of image enhancement technique involves designing an effective filtering strategy by directly modifying pixel values and intensity adjustments to improve the quality of the image as perceived by humans. Researchers have commonly used image fusion, histogram equalization for image enhancement. Therefore, transform domain fusion, which combines the data from transformed representations of an image to create an improved version, is utilized here to overcome the shortcomings. Wavelet transform

(DWT) is one of the methods that could be used to accomplish the transformation. This allows for more effective extraction and manipulation of these features. In this paper, we have implemented DWT and the results are compared with evaluation metrics such as PSNR, AMBE, GMSD and ENTROPY. These parameters indicate which algorithm is superior in providing better image.

## LITERATURE SURVEY

[1] In Contrast Enhancement Using Bi-histogram Equalization with Brightness preservation is used to address a limitation of traditional histogram equalization. The primary objective of BBHE is to maintain the mean brightness of the image while enhancing its contrast. In essence, BBHE provides a way to enhance contrast in an image while preserving its original brightness, making it suitable for applications where maintaining the original appearance of the image is important. This proposed method suggests exploring methods to reduce this complexity, such as utilizing quantized probability density functions to facilitate the practical implementation of BBHE in real-world applications.

[2] In Image Enhancement Based on Equal Area Dualistic Sub-Image and Non-Parametric Modified Histogram Equalization. This method involves three main steps: segmenting the original images into two sub-images based on its median value, modifying the histogram of these sub-images to maximize entropy and control over-enhancement, and then equalizing the histogram independently before merging them into a final enhanced image. It addresses the limitation of existing methods by effectively preserving brightness, reducing noise, and enhancing contrast. It outperforms other methods in both subjective and objective evaluation, such as AMBE, PSNR, ENTROPY and SSIM. The proposed method offers a balanced approach to contrast enhancement, making it suitable for various applications in image processing.

[3] In Contrast Enhancement using Novel White Balancing Parameter Optimization for Perceptually Invisible Images. This algorithm aims to address the issue of imbalanced color channels by enhancing each channel individually Quantitative evaluation of the enhanced images is conducted using key performance metrics such as visual Similarity Index (VSI), Gradient Magnitude Similarity Index (GMSD), Patch-Based Contrast Quality Index (PCQI), and Peak Signal to Noise Ratio (PSNR). Experimental results demonstrate the effectiveness of this proposed method across various image databases. This proposed algorithm achieves superior results in terms both perceptual quality and quantitative metrics indicating its potential for practical applications in image enhancement.

[4] In Image Contrast Enhancement using Triple Clipped Dynamic Histogram Equalization Based on Standard Deviation, it is used to design and to improve the contrast of image by employing a sophisticated histogram equalization technique is a method to improve the image contrast by redistributing pixel intensities, And the next step is TCDHE enhances this by introducing three clipping points to control contrast enhancement and maintain naturalness. On continuation of its standard deviation measures the spread of pixel intensities, and “Dynamic Clipped Point Adjustment” adapts the clipping points based on SD, optimizing contrast enhancement for each image. Overall, TCDHE with dynamic adjustment offers improved contrast while preserving image features. This result in images with improved contrast while avoiding over-enhancement and preserving the natural appearance of it. Overall, this method presents a better technique for enhancing image quality in various applications.

[5] In A Novel Fuzzy Clustering-Based Histogram Model for Image Contrast Enhancement, it enhances the contrast of images. Fuzzy clustering tells which data point belongs to a particular cluster. Following this we perform histogram analysis by understanding the distribution of pixel intensities is crucial for identifying areas of the image that require enhancement. Once the image is segmented into clusters using fuzzy clustering, the algorithm applies contrast enhancement techniques to each cluster individually. This technique results an image with improved contrast, when details in both dark and bright areas are enhanced, leading to a more visually pleasing image overall.

[6] In Color Retinal Image Enhancement Based on Luminosity and Contrast Adjustment, it uses Histogram Equalization to adjust the distribution of pixel intensities in an image, which enhances the overall contrast of an image. And the technique which improves the appearance of the image part particularly in regions of different brightness levels is Tone Mapping. After that to balance the color and saturation of an image color correction is used based on the resulted image a dynamic range compression method is applied to improve visibility in both bright and dark areas. This enhancement can aid healthcare professionals in diagnosing and monitoring various retinal conditions, ultimately leading to improved patient care and outcomes

## EXISTING METHOD

The existing methods for contrast enhancement in image processing include Global Histogram Equalization (GHE), Brightness Preserving Bi-Histogram Equalization (BBHE), Dualistic Sub-Image Histogram Equalization (DSIHE), and Contrast Limited Adaptive Histogram Equalization (CLAHE). Here's a concise theory of each method.

1. Global Histogram Equalization (GHE):

GHE is simple and widely used technique for image enhancement. It redistributes pixel intensity values to achieve a more uniform histogram, enhancing contrast. It's simple and computationally efficient but can lead to over-enhancement and loss of detail in certain images. The advantages include in this are enhanced visibility, simplicity, and non-linear enhancement.

2. Brightness Preserving Bi-Histogram Equalization (BBHE):

BBHE divides the histogram into two sub-histograms based on the image's mean intensity and applies histogram equalization independently. It retains mean brightness while reducing saturation effects, providing more localized and adaptive contrast enhancement. BBHE offers adaptive contrast enhancement, preservation of local contrast, and improved image quality.

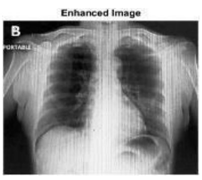
3. Dualistic Sub-Image Histogram Equalization (DSIHE):

DSIHE divides the image into smaller sub-images, computes histograms locally, and applies histogram equalization independently to each sub-image. It maintains local details and textures while enhancing overall contrast, providing an adaptive approach to contrast enhancement. DSIHE offers contrast enhancement, preservation of global and local features, and adaptability.

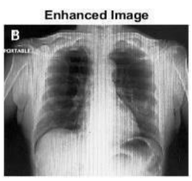
4. Contrast Limited Adaptive Histogram Equalization (CLAHE):

CLAHE divides the image into tiles, compute local histograms, and applies contrast enhancement with histogram equalization while limiting the contrast. It adapts to local features, prevents over-amplification of contrast, and enhances overall image quality. CLAHE provides enhanced contrast, local adaption, and simple implementation.


1. GHE




2. BBHE




3. DSIHE


4. CLAHE

Each existing method has its strengths and weakness. GHE is simple but may cause over-enhancement. BBHE is effective in preserving mean brightness but may not be suitable for every type of image. DSIHE maintains local details but may amplify noise. CLAHE provides adaptive contrast enhancementbut requires careful parameter tuning.

## PROPOSED METHOD

Wavelet transform can be efficiently implemented using fast algorithms such as the discrete wavelet transform (DWT), making it suitable for real-time image enhancement applications such as X-ray images. The above-mentioned method is compared and analyzed with evaluation parameters such as Peak Signal to Noise Ratio (PSNR), Absolute Mean Brightness Error (AMBE), Gradient Magnitude Similarity Deviation (GMSD), Difference Entropy (DE).

An algorithm is a step-by-step procedure or a set of rules for accomplishing a task. It is a finite sequence of well-defined instructions that describes the computation or problem-solving process. These are often evaluated based on their efficiency including factors such as time complexity and space complexity. Based on this here we use TCDHE-SD algorithm which is designed to be robust to noise and other artifacts present in the image. It offers adaptive contrast enhancement that preserves important image details without introducing unnatural enhancements. On integrating TCDHE-SD with DWT offers improved image enhancement making it suitable for real-time applications.

## BLOCK DIAGRAM

Fig: Block Diagram of Proposed Method

**Proposed algorithm:**

1. Original Image (I).
2. To find I', use the TCDHE-SD algorithm.
3. Used the DWT algorithm to decompose the sub-bands of both I and I'.
4. Use the SVD technique on the LL and LL' sub-bands.

5. Compute the improvement factor(ξ))

$$\xi = \frac{\max(U^F_{LL}) + \max(V^F_{LL})}{\max(U_{LL}) + \max(V_{LL})}$$

6. Compute the enhanced new SVM.

$$\Sigma_N = (\beta\xi\Sigma_{LL} 1) + ((1-\beta) \quad 1 \quad \Sigma'_{LL} 1)$$

7. To reconstruct the enhanced new LL sub-band.

$$LL_N = U'_{LL} \Sigma_{LL} V'^{T}_{LL}$$

8. Apply the SF approach to the additional sub-bands of both I and I' to calculate the spatial frequencies SL H, SH L, SH H and S L H, S H L, S H H.

9. Determine the normalized detailed coefficients of spatial frequencies.

$$S_N(LH) = \frac{S_{LH}}{S_{LH} + S'_{LH}}$$

$$S'_N(LH) = \frac{S'_{LH}}{S_{LH} + S'_{LH}}$$

10. Use the fusion procedure to compute the new sub-bands LH, HL, and HH.

11. Use IDWT to reconstruct the improved image from the improved new sub-bands.

12. Finally, Obtained enhanced image.

**RESULTS**

This project presents a novel method to improve medical images by utilizing a triple clipped histogram model-based fusion technique. The proposed method of enhancement i.e., dynamic histogram equalization techniques and the wavelet-based image enhancement techniques provide better results than the conventional methods This shows the preservation of low contrast Images. High frequency sub band images are generated by using DWT and TCDHE with DWT. Some evaluation parameters have been compared such as PSNR, GMSD, AMBE, ENTROPY. It is concluded that the proposed method produces the better enhancement of medical images comparatively. Performance parameters show the supremacy of the technique by comparing the values from the existing methods.

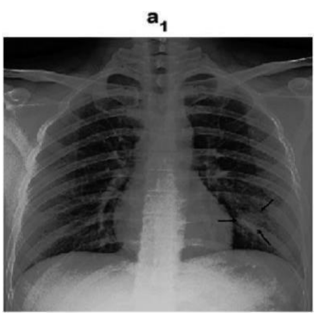



**Fig a: Input Image**


**Fig b: Enhanced Image**

## RESULT ANALYSIS

| INPUT IMAGES | GHE METHOD | BBHE METHOD | DSIHE METHOD | CLAHE METHOD | PROPOSED METHOD |
|---|---|---|---|---|---|
| 1.  |  |   |   |  |  |
| 2.  |  |   |   |  |   |
| 3.  |  |   |   |  |   |

## QUANTITATIVE ANALYSIS

**PSNR calculation for existing and proposed method :**

| SNO | IMAGES | GHE METHOD | BBHE METHOD | DSIHE METHOD | CLAHE METHOD | PROPOSED METHOD |
|---|---|---|---|---|---|---|
| 1 | Image1 | 10.61 | 9.53 | 10.03 | 11.05 | 11.60 |
| 2 | Image2 | 8.05 | 7.89 | 6.07 | 10.54 | 13.32 |
| 3 | Image3 | 12.08 | 10.35 | 11.01 | 10.89 | 13.01 |

**AMBE calculation for existing and proposed method :**

| SNO | IMAGES | GHE METHOD | BBHE METHOD | DSIHE METHOD | CLAHE METHOD | PROPOSED METHOD |
|---|---|---|---|---|---|---|
| 1. | Image 1 | 30.28 | 43.65 | 45.97 | 33.77 | 49.27 |
| 2. | Image 2 | 41.16 | 58.01 | 42.28 | 63.09 | 65.62 |
| 3. | Image 3 | 30.39 | 33.65 | 41.14 | 29.89 | 37.39 |

**ENTROPY calculation for existing and proposed method :**

| SNO | IMAGES | GHE METHOD | BBHE METHOD | DSIHE METHOD | CLAHE METHOD | PROPOSED METHOD |
|---|---|---|---|---|---|---|
| 1. | Image 1 | 6.475 | 6.535 | 5.607 | 6.312 | 7.654 |
| 2 | Image 2 | 5.908 | 5.098 | 6.034 | 6.234 | 6.767 |
| 3. | Image 3 | 6.342 | 3.653 | 5.898 | 5.786 | 6.543 |

**GMSD calculation for existing and proposed method :**

| SNO | IMAGES | GHE METHOD | BBHE METHOD | DSIHE METHOD | CLAHE METHOD | PROPOSED METHOD |
|---|---|---|---|---|---|---|
| 1. | Image 1 | 154.65 | 134.76 | 189.06 | 176.98 | 183.34 |
| 2. | Image 2 | 187.90 | 123.65 | 167.98 | 165.65 | 195.46 |
| 3. | Image 3 | 93.445 | 112.43 | 145.32 | 156.47 | 172.17 |

## CONCLUSION

This project presents a novel method to improve medical images by utilizing a triple clipped histogram model-based fusion technique. The proposed method of enhancement i.e., dynamic histogram equalization techniques and the wavelet-based image enhancement techniques provide better results than the conventional methods.

When we work on Low contrast Images, our proposed system gives better results as compared withother techniques results.

This shows the preservation of low contrast Images. High frequency sub band images are generated by using DWT and TCDHE with DWT. Some evaluation parameters have been compared such as PSNR, GMSD, AMBE, ENTROPY. It is concluded that the proposed method produces the better enhancement of medical images comparatively. Performance parameters show the supremacy of the technique by comparing the values from the existing methods.

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