International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 04 | Apr 2021 www.irjet.net p-ISSN: 2395-0072

# X-Ray Image Enhancement Using CLAHE Method

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**Abstract -** *Contrast Enhancement is one of the foremost Method for improving Standard of Medical Image as it provides better visualization that make diagnostic more accurate. Its key objective is to eliminate the utilization of contrast dye during the method of MRI scan and to seek out the parameters MSE, PSNR, AMBE and contrast and compare the result. The histogram equalization (HE) is an approved method which is ineffective when the contrast nature differs across the image. Adaptive Histogram Equalization (AHE) overcomes this limitation by considering and developing the mapping for every pixel from the histogram during a neighboring window. Another acceptable technique is CLAHE. It reduces enhancement in very uniform areas of the image, which prevents over enhancement of noise and reduces the sting shadowing effect of unlimited AHE. It is after enhancing that the image using AHE and CLAHE the contrast of their parameters is executed. The goal is to produce tissue contrast optimized for every treatment site so as to support accurate patient daily treatment setup and therefore the subsequent offline review. The advance method processes the 2D x-ray images with an optimized image processing filter chain, which consists of a noise reduction filter and a high pass filter followed by CLAHE filter.*

***Key Words***: **Normalization, Histogram Equalization, Contrast Limited Adaptive Histogram Equalization (CLAHE), Cumulative Distribution Function (CDF).**

## 1. INTRODUCTION

X-rays are beneficial in the detection of pathology of bony structures and detecting some disease processes in soft tissue The image quality of a raw X-ray image collected directly from a digital flat detector is normally poor, rendering it unsuitable for diagnosis and treatment preparation.

Light or dark spots, patterns, fogging, specks, and other "artefacts" may appear on a diagnostic X-ray image. This can be caused by motion, poor contact between the film and the cassette which hold that film. Here the quantum noise is dominant and usually comes from the quantization of energy into photons. It is Poisson distributed and usually independent of measurement noise.

The measurement noise is Gaussian noise and usually negligible to the quantum noise. It comes from the movement of the patient. In the high frequency sub-bands, random noise would be expressed primarily by small coefficients.

So, by setting coefficients to zero, will definitely eliminate much of the noise in the image. This work presents an approach for increasing contrast of the X-ray image or of its selected regions of interest (ROI), which is based on contrast limited adaptive histogram equalization (CLAHE).

Local structures may be removed or the geometry of the examined object by properly choosing opening, closing, top & bottom hat filtration, and a suitable type of structuring feature. So, a pre-processing technique is usually required to enhance image quality to get better image.

So, to obtain this result an improved image enhancement technique i.e. CLAHE method is used which is based on global and local enhancement techniques. Basically, this technique consists of two main steps. First, intensity correction of the raw image is encountered by making use of the log-normalization function which is used to adjust the intensity level of the image. Second, is the method which is used to enhance small details, textures and local contrast of the images is called Contrast Limited Adaptive Histogram Equalization (CLAHE).

This approach was tested by making use of a radiographic survey phantom and a radiographic chest phantom and finally was compared with conventional enhancement methods, i.e. histogram equalization, unsharp masking, CLAHE.

## 2. Background and Related Work

Techniques focused on histogram equalization, noise reduction using the Wiener filter, linear contrast correction, the CLAHE method, and other existing methods for low image enhancement.

Image contrast, colour enhancement using adaptive gamma correction, and histogram equalization were suggested by the author Veluchamy et al. Histogram equalization is used to improve optical images, but it usually leads to over-illumination and distortion. The work is based on performing adaptive histogram distribution method for contrast improvement. This method can be performed adaptively to adjust and enhance the contrast.

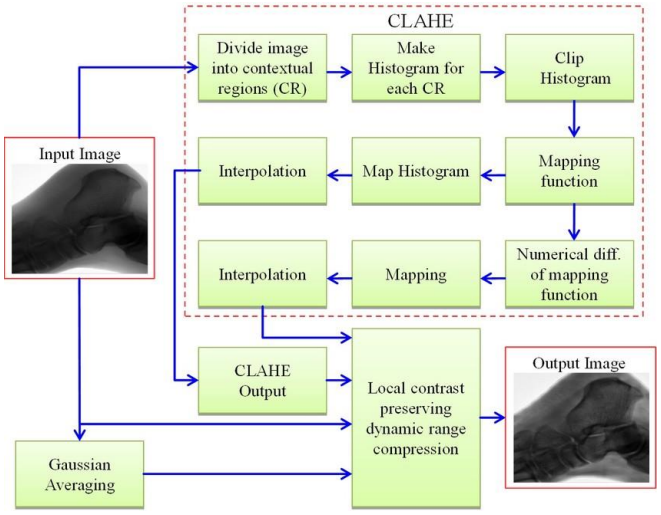
The work's weighted histogram distribution retains colour while still revealing fine data. Yuen Peng Loh et al. address

the use of the Gaussian function in a CNN-based work on dark and weakly illuminated image enhancement.

The authors have proposed a new model based on Gaussian smoothing for enhancing less illuminated images as a localized function. The Convolution Neural Network learns the luminance distribution of dark images to understand the relation between the pixels. The key disadvantage of this technique is that it produces excessive results due to noise problems with camera sensors when taking low-light photographs.

Xiankun Sun et.al discussed a works on low light enhancement based on the Guidance of Image Filtering in Gradient Domain. It is used to achieve the illumination component of the image using guided image filter. This method obtains impressive edge preservation and details results utilizing edge aware constraints in the gradient domain. CLAHE and structural restoration with Top-hat transformation was suggested as an enhanced approach for boosting or strengthening highly dark pictures dependent on histogram equalisation.

### 3. The System Architecture:




1) **CLAHE:-** To avoid saturation, the CLAHE algorithm restricts the slope associated with the grey level assignment scheme. This is achieved by limiting the amount of pixels allowed in each of the bins associated with the local histograms to a certain number. After "clipping" the histogram, the clipped pixels are evenly redistributed around the entire histogram in order to maintain the same overall histogram count. Contrast limited adaptive histogram Equalization is a technique utilized for improving the local contrast of images. It's a hybrid of adaptive histogram equalization and ordinary histogram equalization. CLAHE, unlike ordinary Histogram Equalization (HE), does not work on the entire image; instead, it works on small areas of images called tiles. The contrast of each tile is increased such that the output area's histogram closely matches the histogram defined by the 'Distribution' parameter. Depending on the type of input image, this parameter may be modified. To remove artificially induced boundaries, neighboring tiles are combined using bilinear interpolation. To avoid amplifying any unwanted information in images, such as noise, the contrast can be reduced, especially in homogeneous regions.

2) **Normalization** :- It is a technique which changes the range of pixel intensity values. Applications which also include photos with poor contrast quality due to glare. The each pixel intensity is multiplied by 255/130, making the range 0 to 255.

3) **Gray Scaling** :- Gray-scaling is a technique of converting continuous-tone image to an image that a computer can manipulate. While Gray scale is an improvement over monochrome, it requires larger amounts of memory allocation because each dot is represented by from 4 to 8 bits.

4) **Unsharp Masking:-** Unsharp masking (USM) is an image sharpening process usually available in digital image processing software. The name is derives from the fact that this process uses a blurred, or "unsharp", negative image to create a mask of the original image.

5) **Clip histogram:-** Clipping is nothing but where a region of your photo is too dark or too light i.e:- under-exposed or over-exposed, for the sensor to capture any detail in that particular region. Clipping usually occurs when the highlights disappear off the right side of the histogram and are blown out or, referred as the shadows extend beyond the left side of the histogram and usually loss in details.

6) **Interpolation :-** Image interpolation is process which usually occurs when you resize or distort your image from one-pixel grid to another pixel grid. Image resizing is very necessary basically when you need to increase or decrease the total number of pixels of an image, whereas remapping can occur when you are correcting for lens distortion or rotating an image.

7) **Mapping Function :-** Mapping function is that function that maps one set to another set, after performing some operations. In digital image processing, here an input is an image whose output is also an image.

8) **Mapping :-** Mapping is process of converting analog image into digital format of image with pixel values arranged in 2D or 3D array etc.

**4. Analysis and Workflow**

1) Taking image as an input, if the image is colored then converting the image from RGB to hsv and segregating the following image into its contextual regions (which means identifying the relationship of the nearby pixels and classify the pattern). Then making the histogram for each contextual region.

2) After that the histograms are made for each contextual region the mapping function is used to map the all characteristics of the histogram for one-to-one mapping of the input image to output image and then the intensity values are mapped to form a new histogram (that is it clearly limits the amplification by clipping the histogram at predefined values also called as clip limit).

3) Performing adaptive histogram equalization requires that we convert the input image to grayscale/extract a single channel from it.

4) The adaptive approach differs from traditional histogram equalization in that it computes multiple histograms, each corresponding to a different part of the image, and uses them to redistribute the image's lightness values.

5)It is thus fitting for enhancing the meanings of edges in each area of an image, referring to a normalized image, and improving local contrast. Normalization is a process which changes the range of pixel intensity values. Applications include images with poor contrast due to glare or with more brighter range of pixels.

6) Hence for reducing the noise and enhancing the image to visible grid, and as well removing the non uniforms pixels in the neighborhood we apply high-pass filter. To adapt to nearby pixels, image entropy measures the randomness that can be used to characterize the texture of the input image. This will be the iterative process unless the certain tiles of the image are enhanced.

7) And as a result, we get our enhanced image using CLAHE method which also includes normalization, unmasking, adaptive histogram equalization and high pass filter.

**5. Proposed methodology**

On the given input image, we used high boost filtering and then applied histogram equalization as a contrast constrained adaptive histogram equalization, i.e. (CLAHE).

The proposed approach uses an optimized image processing filter chain that includes a noise reduction filter and a high pass filter, followed by a contrast limited adaptive histogram equalization (CLAHE) filter to process the 2D x-ray images. An interior point constrained optimization algorithm was used to evaluate three main parameters influencing the image processing chain: the Gaussian smoothing weighting factor for the high pass filter, the block size, and the clip limiting parameter.

The method performs automatic and user-independent contrast enhancement on 2D x-ray images. The aim is to provide tissue contrast that is tailored for each treatment site in order to facilitate correct regular treatment setup and eventual offline analysis for each patient.

**6. Advantages**

- The ambiguity that arise between different regions in an image is removed by image enhancement.
- CLAHE divides the input image into many non-overlapping regions of equal size and applies histogram equalization to each of them.
- As a result, the local contrast and edge definitions in each region of an image are improved.
- CLAHE was created to avoid adaptive histogram equalization from producing unnecessary noise amplification. It is used to increase contrast more than other techniques.
- CLAHE is an AHE refinement that modifies the enhancement measurement by imposing a user-specified amount on the height of the local histogram.
- It results in enhancement of the image in very uniform areas, preventing noise over enhancement and the edge shadowing effect of unlimited AHE.

**7. Drawbacks**

- As CLAHE computes histogram to each pixel, its complexity is high and takes a lot of time to complete the task.
- Its software is expensive as CLAHE operates on small data regions(tiles).
- Time-consuming, as recursions are performed sequentially.
- To over-amplify noise in relatively homogeneous regions of an image the method is AHE .
- It is quite complex (in hardware).It is very complex to implement recursion in hardware.

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## 10. BIOGRAPHIES

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