X-Ray Image Enhancement using CLAHE Method

SARTHAK HAILAKAR[1], SANKET GODASE[2], ABHISHEK LAYGUDE[3], PROF. P.A.BHOR[4]

[1]*Sarthak Hailkar, JCOE Kuran*
[2]*Sanket Godase, JCOE Kuran*
[3]*Abhishek Laygude, JCOE Kuran*
[4]*Prof.P.A.Bhor, Department of Computer Engineering, JCOE Kuran, Maharashtra, India*

Abstract *Contrast Enhancement is one of the most significant techniques for increasing the standard of medical images since it allows for better visualisation and thus more accurate diagnosis. Its main goal is to eliminate the use of contrast material during the MRI scan method and compare the results of the metrics MSE, PSNR, AMBE, and contrast. When the contrasted nature of the image vary across the image, the histogram equalization (HE) approach is unsuccessful. Automatic Histogram Equalization (AHE) circumvents this issue by taking into account and increasing the mapping for each pixel in the histogram during a subsequent frame. CLAHE is another viable option. It prevents over-enhancing of noise and lowers the sting shadowing effect of limitless AHE by limiting enhancement to relatively uniform parts of the image. The contrast of their parameters is executed after the image has been enhanced using AHE and CLAHE. The goal is to provide tissue contrast that is optimised for each treatment location, allowing for precise patient daily treatment setup and, as a result, offline review. The advanced technique uses an image processing filter chain that includes a noise reduction filter, a high pass filter, and a CLAHE filter to handle 2D x-ray pictures.*

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

1.INTRODUCTION

X-rays are useful for detecting abnormalities in skeletal structures, as well as some related disorders in soft tissue. A raw X-ray image acquired object from a digital flat detector typically has low image quality, reducing the availability for diagnosis and management.

On a diagnostic X-ray image, light or dark patches, patterns, fogging, specks, and other "artefacts" may emerge. Motion, as well as inadequate contact between both the film as well as the cassette that holds it, can cause this. The quantum noise dominates here, which is often caused by the conversion of energy into photons. It has a Poisson distribution and is typically unaffected by measurement noise.

The measuring noise is Gaussian, and it is usually insignificant in comparison to the quantum noise. It is caused by the patient's mobility. In the sub-bands of high frequency,

Small coefficients would be used to express random noise.

As a result, setting coefficients to 0 will virtually remove much of the image's noise. Based on contrast limited adaptive histogram equalization, this work presents a method for enhancing contrast of the X-ray image or of its chosen regions of interest (ROI) (CLAHE).

By carefully selecting opening, closing, top & bottom hat filtration, and an appropriate sort of structuring feature, local structures can be deleted or the geometry of the investigated item can be changed. As a result, to improve image quality, a pre-processing approach is frequently required.

So, a better image enhancement methodology, the CLAHE method, is employed to achieve this outcome, which is dependent on global and local improvement strategies. Essentially, there are two primary components to this approach. First, the intensity of the raw image is corrected using the log-normalization function, which is used to alter the image's intensity level. Second, Limited Adaptive Histogram Equalization is a technique for enhancing fine details, textures, and local contrast in photographs (CLAHE).

A radiographic survey phantom as well as a radiographic chest phantom were used to test this method, which was then compared to traditional enhancement approaches such as histogram equalization, unsharp masking, and CLAHE.

2. LITERATURE SURVEY

Histogram equalization, noise reduction with the Wiener filter, linear contrast correction, the CLAHE approach, and other modest image improvement techniques were studied.

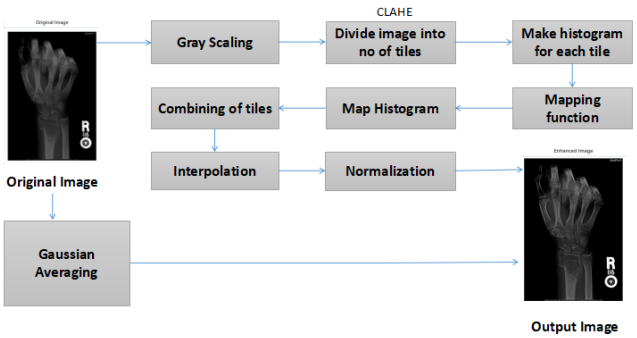
The authors Veluchamy et al. suggested image contrast, colour enhancement utilising adaptive gamma correction, and histogram equalization. Although histogram equalization is used to improve optical images, it often results in over-illumination and distortion. The study is based on the use of an adaptive histogram distributions method to improve contrast. This method can be used to alter and increase the contrast in real time.

The application of the Structuring element in a CNN-based work on image improvement for dark and poorly light areas

The authors have developed a new model for improving less lit images as a localised function based on Gaussian smoothing. To grasp the relationship between the pixels, the Convolution Neural Network learns the brightness distribution of dark images. The main disadvantage of this method is that it gives excessive results while capturing low-light images due to noise issues with camera sensors.

Xiankun Sun et.al discussed a studies on low light enhancement based on the Guidance of Image Filtering in Gradient Domain. It is used to create the image's lighting component using a guided image filter. Using edge aware restrictions in the gradient domain, this approach achieves outstanding edge conservation and details results. CLAHE as well as structural restorations with Top-hat transformation have been proposed as an improved method for boosting or strengthening excessively dark images that are dependent on histogram equalization.

1. The System Architecture:



1. **CLAHE:**- The CLAHE algorithm limits the slope related with the grey level assignment technique to avoid saturation. This is often accomplished by setting a limit on the amount of pixels allowed in each of the bins related to the local histograms. The clipped pixels are uniformly redis tributed over the full histogram after "clipping" the histogram to retain the identical total histogram count. Contrast limited adaptive histogram Equalization could be a technique utilized for improving the local contrast of images. It is a hybrid of adaptive histogram equalization and ordinary histogram equalization. CLAHE, unlike ordinary Histogram Equalization, doesn't work on the whole image; instead, it works on small areas of images called tiles.
The contrast of every tile is increased specified the output area's histogram closely matches the histogram defined by the 'Distribution' parameter.

1.**Normalization** :-It's a way for altering the range of pixel intensities. Photos having poor contrast quality due to glare are among the applications. The in tensity of every pixel is multiplied by 255/130, resulting in a spread of 0 to 255.

2.**Gray Scaling** :- Gray-scaling could be a method of remodeling a continuous-tone image into computer-readable image. It necessitates more memory allocation because every dot is represented by 4 to eight bits.

3.**Unsharp Masking**:- Unsharp masking may be a kind of image sharpening that's commonly found in digital image editing software.

4.**Histogram clipped:**- Clipping occurs when a part of your photograph is either too dark or too light, i.e. under-exposed or over-exposed, for the sensor to catch any detail in this area. Clipping happens when the highlights are blown out and disappear off the proper side of the histogram, or when the shadows extend beyond the left side of the histogram, leading to a loss of detail.

5.**Using interpolation**: Image interpolation could be a process that happens after you resize or distort a picture from one pixel grid to a different. . once you must increase or decrease the overall number of pixels in a picture, image resizing is employed.

6.**Function of Mapping**: A mapping function could be a function that, after executing some operations, maps one set to a different. a picture is employed as an input in digital image processing, and also the output is likewise a picture.

7.**Mapping** :- A mapping function maps one set to a different after performing various operations. In digital image processing, a picture is used as an input, and therefore the result's also a picture.

2. Analysis and Workflow

1. Using an image as an input, transforming the image from RGB to hsv and separating the next image into its contextual sections if the image is coloured (which means identifying the relationship of the nearby pixels and classify the pattern). Then, for each contextual zone, create a histogram.

2. After that, histograms are created for each contextual region, and the mapping function is used to map all of the histogram's attributes for one-to-one mapping of the input image to the output image, followed by the intensity values being mapped to create a new histogram (that is it clearly limits the amplification by clipping the histogram at predefined values also called as clip limit.

3. Converting the input image to grayscale/extracting a single channel from it is required for adaptive histogram equalization.

4. Unlike classic histogram equalization, the adaptive technique computes numerous histograms, each related to a distinct part of the image, and uses them to disperse the image's brightness values.

5. It is thus appropriate for strengthening local contrast, enhancing the meanings of edges in each area of a picture, and refers to a normalised image. The term "normalisation" refers to a technique that alters the range of pixel intensity values. Images with poor contrast due to glare or a brighter range of pixels are examples of applications.

6. As a result, we use a high-pass filter to reduce noise and enhance the image to a viewable grid, as well as to remove non-uniform pixels in the surrounding area. Image entropy estimates the unpredictability that can be utilised to characterise the texture of the input image in order to adapt to surrounding pixels. Unless the image's specific tiles are upgraded, this will be an iterative process.

7. As a result of the CLAHE approach, which also involves normalisation, unmasking, adaptive histogram equalization, and a high pass filter, we receive our enhanced image.

3. Proposed methodology

We used high boost filtering to the supplied input image and then histogram equalization as a contrast constrained adaptive histogram equalization, i.e. (CLAHE).

To process the 2D x-ray pictures, the suggested method employs an efficient 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. Three important parameters influencing the image processing chain were evaluated using an interior point restricted optimization algorithm: the weighting of Gaussian smoothing The high pass filter, block size, and clip limiting parameter all have a factor.

On 2D xray images, the approach achieves automatic and user-independent contrast augmentation. The goal is to give tissue contrast that is customised for each treatment location, allowing for proper routine therapy setup as well as eventual offline analysis for each patient.

4. Advantages

- Image enhancement removes the uncertainty that can emerge between distinct sections of an image.
- CLAHE separates the input image into a number of non-overlapping, equal-sized sections and applies histogram equalization to each of them.
- As a result, each region of an image's local contrast as well as edge definitions are improved.
- CLAHE was intended to prevent noise amplification caused by adaptive histogram equalization. It is more commonly employed to boost contrast than other procedures.
- CLAHE is an AHE refinement that adjusts the enhancement measurement by increasing the height of the local histogram by a user-specified amount.
- It prevents noise over enhancement and also the edge shadowing effect of unrestricted AHE by enhancing the image in highly uniform places.

5. Drawbacks

- CLAHE's complexity is considerable, and it takes a long time to accomplish the work because it computes histograms for each pixel.
- Because CLAHE works with limited data regions, its software is costly (tiles).
- Recursions are executed in a sequential order, hence it takes a long time.
- The AHE approach is used to overamplify noise in reasonably homogeneous portions of a picture.

- It's a complicated situation (in hardware).
- Recursion in hardware is extremely difficult to accomplish.

6. CONCLUSION

We'll show you how to optimise your digital X-ray image with CLAHE, which uses CLAHE algorithms to retain both structures and information in the image. This is a technique for automatically enhancing contrast in x-ray pictures used in radiation therapy patient treatments. When used as an automatic image processing filter in clinical systems, this method could be effective in a variety of clinical applications, such as patient treatment setup and afterwards offline assessment of patient daily setup.

7. REFERENCES

[1]Senthilkumaran N, "Histogram equalization on image enhancement using MRI images", IEEE World Congress on Computing and communication technologies 2014.

[2]Raja Babu A.K, "Contrast enhancement of MRI image: a review", international journal of engineering technology and advanced engineering, vol.5, issue 6, June 2015.

[3]JianfengQiu H. Harold Li Tiezhi Zhang Fangfang Ma Deshan Yang "Automatic x-ray image contrast enhancement based on parameter auto- optimization" September 2017

[4]C. Rubini, N. Pavithra "Contrast Enhancement Of MRI Images using AHE and CLAHE Techniques"ISSN: 2278-3075, Volume-9 Issue-2, December 2019.

[5]Image Enhancement using Contrast Limited Adaptive Histogram Equalization and Wiener filter. Authors :- Mithilesh Kumar , Ashima Rana