

# Medical Image Enhancement based on Statistical and Image Processing Techniques

Sidhavi Naidu  
Computer Engineering SRIEIT,  
Goa University

Ayesha Quadros  
Computer Engineering SRIEIT,  
Goa University

Arsha Natekar  
Computer Engineering SRIEIT,  
Goa University

Prajakta Parvatkar  
Computer Engineering SRIEIT,  
Goa University

K.M Chaman Kumar  
Computer Engineering SRIEIT,  
Goa University

Shailendra Aswale  
Computer Engineering SRIEIT,  
Goa University

**Abstract:-** X-rays are the most used clinical pictures to study the inner structures of the human body. X-rays images consists of issues of low contrast, noise and low intensity. Therefore, the medical image quality enhancement is required. In this paper, a new enhancement procedure is proposed for X-ray images based on statistical and image processing concepts. It is the combination of Gaussian filter, Contrast-stretching transformation, Standard logic, Logarithmic image processing and statistical range. The proposed method will help the doctors and also the patients to identify particular diseases accurately. The proposed method will result in images having improved contrast, reduced noise, etc. In short, the proposed method provides better image quality in less processing time.

**Keywords—** X-Ray, Medical imaging, Image processing, Edge detection, Histogram Equalization, Wavelet Transform, Statistical Range.

## I. INTRODUCTION

Medical images play a very important role in treatment of patients. It depicts various parts and tissues of human body. An enhanced medical image is necessary for doctors to make accurate diagnosis and treatment [13].

Medical imaging means viewing a human body to treat medical conditions or diagnose by using different techniques. Because of progression in clinical procedures, identification of the diseases has become easier. Medical imaging includes techniques like X-Ray, MRI, ultrasound, endoscopy etc. Medical imaging is very important in healthcare world-wide for physicians to diagnose, treat and prevention purpose. Regardless of whether you have encountered a physical issue, are suffering from chronic pain, or are facing another medical condition, medical imaging permits specialists to figure out what is going on inside your body and suggest the appropriate treatment. Without medical imaging both diagnosis and treatment in digital

health can be very hard to accomplish with any degree of precision.

An X-ray is a quick, painless test that produces images of structures inside human body-particularly bones. X-ray beams pass through the body, and they are absorbed in different amounts depending on the density of the material they pass through. The X-ray has been widely used in the biomedical and medical fields since it was born. At present, X-rays has become important basis in the process of medical diagnosis. Medical X-ray image contains a large amount of information, but the details are fuzzy and contrast is low, which makes adverse effects on the doctor's judgment. Thus, improving the image contrast and enhancing the details sharpness while suppressing the noises are the key points of this kind of image enhancement [4].

Medical image enhancement intense to improve the perceivability of the image. Image enhancement methods provide benefits like denoising, sharpening edges, increasing brightness, increasing contrast, etc. which helps the doctors and the physicians to observe fine details of the image more carefully. Enhancement methods include contrast adjustment, histogram equalization, edge preserving filters, wavelet-based approaches, deblurring, denoising etc. Medical images are often obtained with low-contrast, low-intensity, noise, blurred, etc. due to limitations in the medical devices. Such images have poor quality and cannot be used for diagnostic purpose. Thus, it is necessary to process the images accurately to produce better-quality images with improved details for better analysis. In the last few years, different methods have been introduced by various researchers to deal with the low-quality images. Numerous search methods are discussed below.

This paper is organized as follows: In Section II, we review relevant work on various medical image

enhancement techniques. Section III contains our proposed method and Section IV has conclusion of the paper.

## II. LITERATUREREVIEW

The main aim of medical image enhancement techniques is to make internal structures and conditions visible within the patient to the doctors and physicians for proper diagnosis and treatment.

### A. HISTOGRAM EQUALISATION

[3] Here, equalization of the contrast distribution at the boundaries of objects and background of the image is proposed. This provides the increase of contrast enhancement of low-contrast images.

[9] This paper presents N-CLAHE algorithm which consists of the log-normalization and CLAHE. The result shows that it provided the best image quality when compared with HE, USM and CLAHE.

[15] This paper presents modified local histogram equalization method. This approach results in a

clearly visible edge of fixture and screw area in the image.

[19] This paper introduces a new form of histogram called gray-level information histogram. This results in increasing contrast of low-contrast images.

[20] In this paper, the proposed algorithm enhanced the X-ray image. The results proved that the proposed algorithm is effective and efficient to enhance the X-ray images.

[23] In this study, we improved the performance of original anisotropic diffusion by combining with the histogram equalization and weighted K-means clustering. This reduces the noise and also increases the image contrast.

[31] in this paper, Global enhancement algorithm for medical X-ray image is proposed. The noise in medical X-ray image is removed by using multi- wavelet transform.

Table 1: HISTOGRAM EQUILAZATION

REFERENCE	DATASET	METHODOLOGY & TOOLS	MERITS	DEMERITS	ACCURACY	RESULT
[3]	<a href="http://vatechrussia.ru/wp-content/uploads/2016/05/CEPH_Pax-3D_006">http://vatechrussia.ru/wp-content/uploads/2016/05/CEPH_Pax-3D_006</a>	Histogram Java programming language	In automatic mode, it preprocesses low contrast images	NA	Medium	Enhances contrast of low- contrast images
[9]	NA	N-CLAHE Java programming language	NA	NA	85	Provides good image quality
[15]	NA	Modified local histogram equalization Microsoft Visual Studio, C#, EmguCV,	NA	After enhancement there is decrease in quality of an image	Low	Provides clearly visible edges of fixture and screw
[19]	NA	Gray Level Histogram	Different gray levels of an image are assessed accurately	Increases contrast of background noise	Low	Increases the overall contrast
[20]	NA	CLAHE, Fuzzy Set Theory MATLAB	Can be used in different fields	NA	High	Enhance and sharp the image detailing
[23]	NA	Anisotropic diffusion, Histogram Equalization-means clustering	NA	Causes Gaussian blurring	85	Enhances image contrast, reduces noise
[31]	NA	Histogram Equalization, multi- wavelet transform MATLAB	High degree of noise reduction	NA	Low	Denoising and enhancement

## B. FILTERS

[4] In this paper, a new method based on homomorphic filtering was proposed which used TV model as a transfer function. The method resulted in an enhanced image.

[7] In this paper, experiments on low-quality images were dealt with by the proposed method and other existing methods. The results showed that the edges are preserved and the noise is removed.

[11] This paper aims to present an iterative algorithm based on Guided Image Filtering for contrast enhancement. This suppresses artifacts and also enhances the contrast.

[13] In this paper an Iterative 2D Kalman filter is used enhancing the medical images. It provides clearer edges, better and clear result of any image those are in this filtering process.

[14] In this paper, a method was proposed that detects edges from X-Ray image based on Gaussian filter and statistical range. The proposed algorithm detects edges, robust to noise, provides better quality image.

[18] This proposed method is based on histogram equalization and homomorphic filtering. It enhances the low contrast images more efficiently as compared to other methods.

Table 2: FILTERS

REFERENCE	DATASET	METHODOLOGY & TOOLS	MERITS	DEMERITS	ACCURACY	RESULT
[11]	NA	Guided filter	Suppresses artifacts	NA	Medium	Reduces noise, preserves edges
[13]	NA	Kalman filter MATLAB	It is direct and time reliant	NA	High	Clears out the edges and provides better and clear result
[14]	imageprocessingplace.com	Statistical range method, Gaussian filter Scilab 5.5.2	Removes noise and requires less time	NA	High	Removes noise and provides clear edges
[18]	National brain research centre (NBRC), Manesar, public image database	Homomorphic Filtering, Histogram Equalization, Gamma Correction MATLAB	Can be used in video processing	NA	Medium	Enhances the low contrast images
[4]	NA	Tv homomorphic filter	TV model provides better detail enhancement	Using the TV model may be difficult	High	Reduces the uneven brightness in the image
[7]	Images were collected from DDR system without processing	Fuzzy noise removal method, Homomorphic filtering MATLAB	NA	NA	High	Reduces noise, preserves fine texture and edges

## C. WAVELET TRANSFORM

[5] In this paper a model is proposed to enhance image with Haar wavelet transform. Visibility of the enhanced image is better compared to the original image.

[6] The proposed algorithm is based on wavelet homomorphic filtering and CLAHE, can enhance the image brightness, contrast and details and suppress the noise amplification, avoids over- enhancement.

[17] In this paper, the proposed method for increasing contrast of the X-ray image which is based on CLAHE, morphological processing and is proposed which is based on stationary wavelet

wavelet transformations results in noise suppression and detail preservation.

[22] In this paper, a method was proposed using wavelet transform and multiresolution analysis. This provides good quality images and also detects edges with less computation time.

[28] The proposed method to reduce speckle noise which is based on stationary wavelet transform and fuzzy logic, reduces noise, enhances contrast and preserves edges.

[30] In this paper, a new medical image illumination enhancement and sharpening technique

is proposed which is based on stationary wavelet transform. Compared to conventional techniques, this method was superior.

Table 3: WAVELET TRANSFORM

REFERENCE	DATASET	METHODOLOGY & TOOLS	MERITS	DEMERITS	ACCURACY	RESULT
[22]	NA	Wavelet transform, Multiresolution analysis MATLAB	Requires less processing time	NA	Medium	Detects edges
[5]	Images were collected from Reliance Medical Center, TB gate, Mohakhali, Dhaka, Bangladesh	Haar wavelet transform, Histogram matching technique MATLAB	Increase in high frequency components of an image	NA	Medium	Visibility of the image is improved
[6]	NA	Wavelet transform, Improved homomorphic filtering, CLAHE MATLAB	Avoids over-enhancement	NA	90	Improves brightness, contrast and denoising
[17]	Real grayscale X- ray images	CLAHE, Morphological Processing, Wavelet Packet Decomposition MATLAB	Enhanced images can be used for 3D reconstruction	NA	85	Enhances image and reduces noise
[28]	NA	Stationary Wavelet Transform, Fuzzy logic MATLAB	NA	Can lead to loss of some information due to decomposition	Low	denoising, sharpens edges, increases the contrast
[30]	Randomly chosen from a variety of databases	Stationary Wavelet Transform MATLAB	Provides better results than conventional methods	NA	Medium	Sharpens the image

#### D. MISCELLANEOUS

[1] The proposed method is based on Laplacian, Sobel, Power law transformation. This results in sharpened image and edges were also detected.

[2] The proposed method is the combination of CSL, LIP, SL. This provides pleasant appearance, natural contrast, acceptable brightness, and no visible flaws.

[10] This paper a method was proposed based on dark channel prior for enhancing the image. This results in increase of contrast and also highlights the details.

[12] The proposed paper presents a prototype of a new generation of medical image fil digitizer. This improves the quality of overexposed images, improves the readability of images that have lost its quality.

[21] In this paper, modified Harris corner detector is introduced. This removes Poisson noise from the images.

[25] In this paper, the proposed method use morphological operators for enhancing contrast of images. This method results in improved and clear output result.

[26] The method is based on Stacked Random Forests Feature Fusion. This method helps to detect edges.

[27] Here, a method was proposed using contrast adjustment, image fusion and component attenuation. The proposed method enhances edges and fine details.

[29] In this paper, we propose an adaptive fractional differential calculus-based technique. This results in clearer edges and richer textures.

Table 4: MISCELLANEOUS

REFERENCE	DATASET	METHODOLOGY & TOOLS	MERITS	DEMERITS	ACCURACY	RESULT
[1]	NA	Laplacian, Sobel gradient, power law transformation Object oriented language	Works very well in different fields	Any color image activity is not tested	Medium	Sharpens the edges
[10]	<a href="https://www.kaggle.com/paultimothymooney/chest-xray-pneumonia">https://www.kaggle.com/paultimothymooney/chest-xray-pneumonia</a>	Dark Channel Prior	NA	Noise amplification	Low	Increases contrast, highlights features
[12]	NA	Guided filter Canon optical module with a 20 megapixels CMOS sensor	Quality images are obtained without misrepresentation of structures	NA	Medium	Over-bright images are improved
[2]	<a href="https://www.ctisus.com/">https://www.ctisus.com/</a>	LIP, CST, SL MATLAB	Can be used with simple hardware devices	NA	High	Enhances contrast, brightness and denoising
[21]	NA	Improved Harris operator, Median filtering MATLAB	NA	NA	Medium	Removes noise
[25]	ChestX-ray8, NLM (Open-i)	Top-hat, bottom-hat transform, SE MATLAB	NA	Time consuming	Medium	Enhances contrast
[26]	Images retrieved through a web image search engine	Stacked Random Forests Machine Learning Tools	Capable of combining different image features	Difficulty in capturing fractures	Low	Edge detection
[27]	Dataset provided by Japanese Society of Radiological Technology	Component attenuation, Contrast adjustment, and Image fusion MATLAB	NA	Tiny features cannot be recognized	Low	Enhances edges and fine details
[29]	<a href="https://radiopaedia.org/cases/emphysema-on-chestx-ray">https://radiopaedia.org/cases/emphysema-on-chestx-ray</a>	Adaptive Fractional Differential Approach JAVA programming language	Without changing gray level textures can be enhanced	Smooth areas are neglected	Low	Enhances Contrast and edges

### III. PROPOSED METHOD

The proposed method is the combination of some basic statistical and image processing concepts.

#### STEPS:

- Step1- An X-Ray image is taken as an input.
- Step2- Applying Gaussian filter for image smoothing.
- Step3- An Input image is partitioned into 3 x 3 matrix.
- Step4- We use statistical range. In this step we calculate range of 3x3 matrix.
- Statistical Range= lowest pixel value - highest pixel value.
- Step5- We will replace the center pixel value of 3 x 3 matrix with pixel value achieved in step-4.
- Step6-Repeat step-3, step-4 and step-5 until we find the statistical range of last 3 x 3 partition of an input image.
- Step7- The edges of the input X-Ray image are detected.

Next, we aim to enhance the overall contrast on an X-Ray image.

Step8- We use Contrast-stretching Transformation (CST) method that aims to enhance the local contrast.

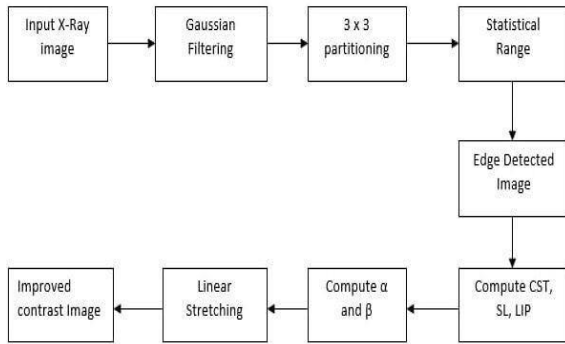
Step9- We use standard logistic (SL) function to enhance global contrast.

Step10- We combines results of step-8 and step-9 using Logarithmic Image Processing (LIP).

Step11- We will compute parameters  $\alpha$  and  $\beta$  parameters that are used to control stretching process.

Step12- We will use Linear Stretching method to reallocate image pixel values to the regular range. Step13- Finally, we will achieve an improved contrast image.





Flowchart of proposed algorithm

#### IV. CONCLUSION

A survey of many image enhancement techniques such as Histogram Equalization, Wavelet Transform, etc. is presented along with their comparison. In this paper, a new method is proposed to enhance X-Ray images. The proposed method is the combination of statistical and image processing concepts. The proposed algorithm provides enhanced contrast and edge detected image. Additionally, our algorithm also removes noise, provides better image quality and enhances features. Simple hardware devices can be used for this method.

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