

# Analysis and Comparison of Image Enhancement Technique for Improving PSNR of Lung Images by Median Filtering over Histogram Equalization Technique

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## Abstract

**Aim:** The main goal of this project is image enhancement to improve interpretability or perception of information in images for human viewers and also to provide better input for other automated image processing techniques. **Materials and Methods:** In this research different sources of lung images collected from Kaggle website were used. Samples were considered as (N=30) for median filtering and (N=30) for novel histogram equalization technique with total sample size calculated using clinical.com. As a result the total number of sample was calculated to be 60. Using SPSS Software and a standard data set, the PSNR was obtained. Both median filter and novel histogram technique image enhancement were implemented on Lung images through Matlab coding and also extracting PSNR values of each image. Then through SPSS software comparison and analysis has been made. **Results:** In an image enhancement of the image processing pathway, novel histogram equalization technique shows the best performance by removing noise to improve PSNR of lung images than median filtering. Comparison of PSNR values are done by independent sample test using IBM-SPSS software. There is a statistical difference between histogram technique and median filtering. The novel histogram equalization technique showed higher results of PSNR (69.6557dB) with ( $p=0.04$ ) in comparison with median filtering (37.6427dB). **Conclusion:** Histogram equalization image enhancement technique provides high PSNR values for different sources of lung images than median filtering Technique.

## Keywords

Image Enhancement, Filtering Technique, Median Filter, Peak Signal to Noise Ratio (PSNR), Novel Histogram Equalization Technique, Image Processing.

## Imprint

Sabarish Raja T, Ramadevi R. Analysis and Comparison of Image Enhancement Technique for Improving PSNR of Lung Images by Median Filtering over Histogram Equalization Technique. *Cardiometry*; Special issue No. 25; December 2022; p. 818-824; DOI: 10.18137/cardiometry.2022.25.818824; Available from: <http://www.cardiometry.net/issues/no25-december-2022/histogram-equalization-technique>

## Introduction

Imaging plays an essential role in evaluating the lungs, both anatomically and functionally whether it is for establishing a diagnosis, monitoring disease severity, or for screening (Gangolli, Fonseca, and Sonkusare 2019). Image processing techniques play an important role in development of medical image diagnostic methods based on enhancing the medical images. Image enhancement technique in medical images, particularly lung images, plays a vital role in medical field applications.

There are 240 research articles published on the image enhancement to compare with different algorithms and the storage location in science direct and 165 articles on Google Scholar and 34 research articles were found in IEEE xplora.

Image enhancement techniques help to improve the clarity of images for medical diagnosis. Novel histogram equalization technique is an algorithm for image enhancement where PSNR value gets improved (El-Baz and Suri 2011). Hence PSNR is considered as a performance measure in lung images. Comparison is made between median filtering and histogram technique. In this area of research, ((Sriram 2014; Ohkubo et al. 2016) concluded that histogram equalization technique has better PSNR values than median filtering technique on lung images. Hence, the major objective of this research is to improve PSNR of lung images by analyzing and comparing median filtering technique over novel histogram equalization technique.

Genetic, image processing and morphology based fully automated segmentation techniques were proposed by (Khan et al. 2019). The proposed technique would serve as a pre-processing step of CAD and greatly benefit the nodule detection process. According to (O'Riordan et al. 2019) noise filtering techniques which maintain image contrast while decreasing image noise had the potential to optimize the quality of

Computed Tomography (CT) images acquired at reduced radiation dose. The author compared various linear and non-linear filters on lung CT scan images for removing the noises and expressed the results in terms of evaluation metrics such as PSNR. Based on the acquired knowledge on this research area the best article is (Masood and Al-Jumaily 2013) Our team has extensive knowledge and research experience that has translate into high quality publications (Chellapa et al. 2020; Lavanya, Kannan, and Arivalagan 2021; Raj R, D, and S 2020; Shilpa-Jain et al. 2021; S, R, and P 2021; Ramadoss, Padmanaban, and Subramanian 2022; Wu et al. 2020; Kalidoss, Umapathy, and Rani Thirunavukarasu 2021; Kaja et al. 2020; Antink et al. 2020; Paul et al. 2020; Malaikolundhan et al. 2020)

The research gap identified from the survey is that there are many methods proposed for medical image enhancement but most of the methods which are proposed have less PSNR. The main aim of this study is to recognize image enhancement using novel histogram equalization techniques and median filtering to improve PSNR.

## Materials and Methods

The research work was carried out at the department of Biomedical Engineering, Saveetha School of Engineering. This study was implemented using Matlab software. Two groups are required for this study. The PSNR in image enhancement technique is performed by evaluating two groups. A total of 30 iterations were performed on each group to achieve better PSNR. The study uses a CT, X ray, MRI lung images dataset downloaded from kaggle website (Geraldo and Mascarenhas 2011). It is not necessary to obtain ethical approval. The sample size calculation was done using clinicalcalc.com by keeping alpha error threshold as 0.05 with 80% g power and value for enrollment ratio is 0.1 with 95% confidence Interval. As per calculation total sample size is 60.

In sample preparation, for Group1 the number of lung image samples collected from CT Scan images is 10, X-ray scan images is 10 and MRI scan images is 10. The collected image samples are used for PSNR based lung image enhancement using median filtering technique. For Group 2 sample preparation, 10 lung images were collected from X-ray, MRI and CT scan. Testing setup is done by installing the Matlab R2018a software. After preparation a Matlab code was implemented for both histogram equalization and median

filtering methods. The performance of both algorithms was measured using the PSNR parameter in lung images. This parameter was calculated and evaluated to assess the method's efficacy and comparison of results was done for both methods to find which algorithm performed significantly better results for enhancing images.

## Statistical analysis

The SPSS statistical software was used in the research for statistical analysis. Group statistics and independent sample t-tests were performed on the experimental results and the graph was built for two groups with one parameter under study (Senthil Kumar, Venkatalakshmi, and Karthikeyan 2019). The independent variable is noise which affects the quality of an image and the dependent variable is PSNR.

## Results

Table 1 shows PSNR (dB) values of 30 lung images obtained using histogram equalization and median filter. The mean value of PSNR (dB) of the histogram equalization filter is 69.6557dB and for median filter is 37.642dB.

Table 1

Comparison of histogram equalization and median filter with improved PSNR of lung images. The mean value of PSNR (dB) of the histogram equalization filter is 69.6557dB and for median filter 37.6427dB.

Images	Histogram Equalization	Median Filter
Image 1	37.59	37.42
Image 2	36.96	36.45
Image 3	36.45	36.32
Image 4	36.32	34.34
Image 5	34.60	42.26
Image 6	42.31	40.75
Image 7	41.39	39.12
Image 8	40.55	37.40
Image 9	42.97	41.60
Image 10	42.47	43.64
Image 11	42.74	43.65
Image 12	57.54	54.72
Image 13	54.86	58.69
Image 14	59.75	63.32
Image 15	64.24	65.54
Image 16	66.34	67.43
Image 17	69.67	71.24
Image 18	73.33	74.53

Images	Histogram Equalization	Median Filter
Image 19	75.34	76.65
Image 20	77.10	77.34
Image 21	77.18	76.16
Image 22	77.22	77.64
Image 23	77.27	77.65
Image 24	78.43	78.54
Image 25	78.44	78.65
Image 26	78.87	78.24
Image 27	79.38	79.65
Image 28	79.76	79.25
Image 29	79.38	79.43
Image 30	79.54	79.32

Table 2 represents group statistics that shows comparison of histogram equalization of image enhance-

Table 2

Group statistics shows comparison of histogram equalization of image enhancement algorithms with median filter based on PSNR. Mean value of PSNR is high 69.6557dB for histogram equalization and low 37.6427dB for median filter. Standard deviation of PSNR is low for median filter (2.54849) and high (19.98646) for histogram equalizer.

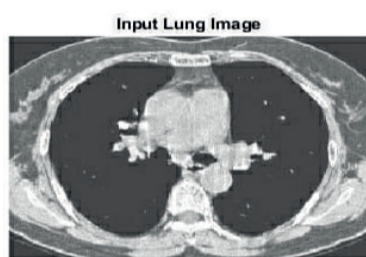
	Group	N	Mean	Standard Deviation	Standard Error Mean
PSNR	Histogram equalizer	30	69.6557	19.98646	0.46529
	Median filter	30	37.6427	2.54849	3.64901

ment algorithms with median filter based on PSNR values. Mean value of PSNR is high (69.6557dB) for histogram equalizer and low (37.6427dB) for median filter. Standard deviation of PSNR is low (2.54849)

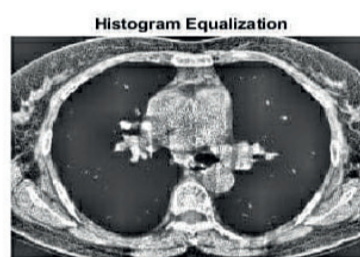
Table 3

Independent sample t-test providing mean difference, significance value (2-tailed), standard error difference and 95% confidence interval of the difference in both lower and upper level for PSNR at equal variances assumed and not assumed.

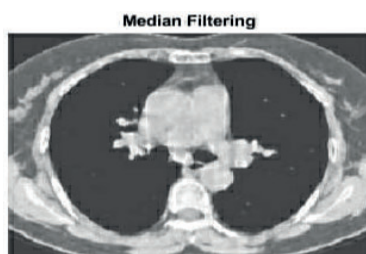
		Levene's test for Equality of variance		T-Test for equality of mean						
		F	Sig	t	df	Sig (2-tailed)	Mean difference	Std. Error Difference	95% confidence of Difference	
									Lower	Upper
PSNR	Equal variances assumed	66.37	0.02	-8.70	58	0.04	-30.35633	2.41234	-35.18516	-25.52751
	Equal Variances not assumed			-8.70	29.943	0.04	-30.35633	2.41234	-35.18516	-25.52751



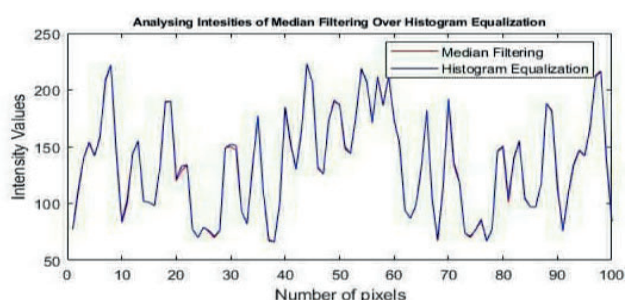
(a)



(b)



(c)



(d)

Fig. 1. Simulation results of median filter and histogram equalization algorithm. (a) Input image (X-ray chest), (b) Histogram equalization restored image, (c) Median filter on X-ray image and (d) Intensities analysis of median filter over histogram equalization (X-ray image)

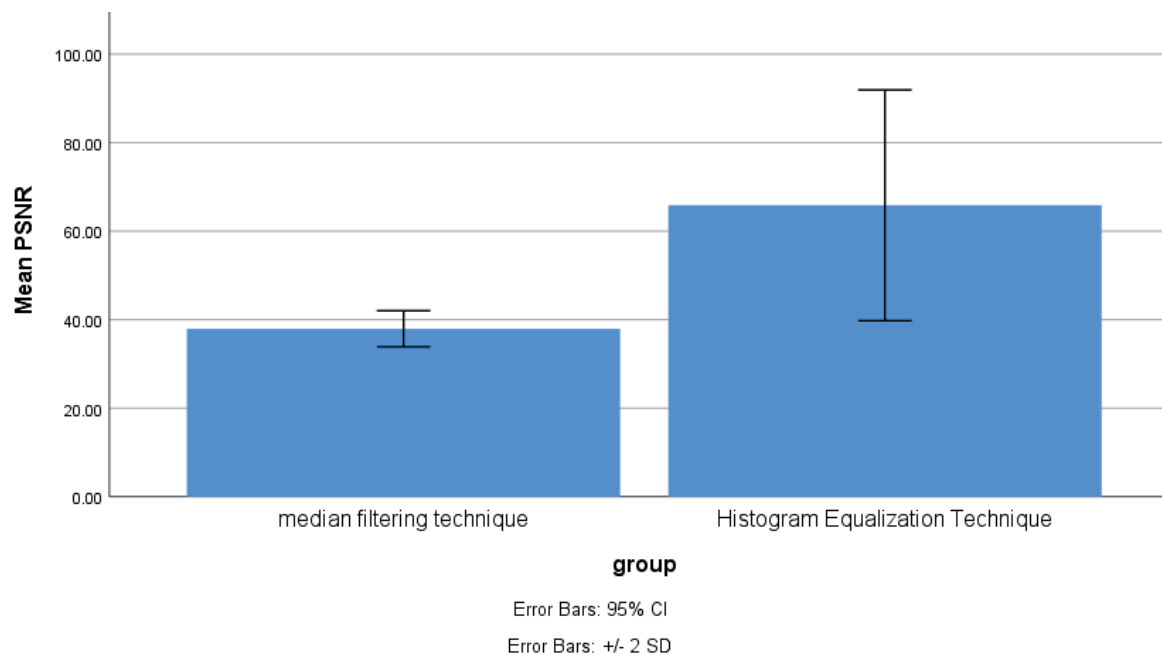


Fig. 2. Bar chart representation of the comparison between proposed histogram equalization technique and median filter method. X-Axis represents histogram equalization and median filter and Y-Axis represents mean PSNR of histogram equalization and median filter with mean accuracy of  $\pm 2$  ( $\pm$  SD) and 95% CI

for median filter and high (19.98646) for histogram equalizer.

Table 3 represents an independent sample test of PSNR based image enhancement using histogram equalizer and median filter algorithms. The two tailed significance p-value is 0.04. The significant difference in PSNR is 0.04 and standard mean difference is -30.35633 with a standard error difference of 2.41234. In the test confidence interval, the lower value is (-35.18516) and the upper value is (-25.52751). Based on independent sample T test results, histogram equalization based image enhancement method performed better than median filtering method with 95% confidence interval.

## Discussion

Figure 1 represents simulation results of median filter and histogram equalization algorithm. (a) Input image (X-ray chest), (b) X-ray lung image with histogram equalization restored image, (c) Median filter on X-ray lung image, (d) Intensities analysis of median filter over histogram equalization (X-ray lung image).

Figure 2 shows a bar chart representing the comparison of mean ( $\pm 2$  SD) of histogram equalization and median filter methods. PSNR appears to produce most variable results with its standard deviation ranging from the lower 0.82 to the upper 1.00 and median filter appears to produce consistent results with min-

imal standard deviation. X-Axis represents the histogram equalization vs median filtering, Y-Axis represents mean ( $\pm 2$  SD).

Image segmentation plays a vital role in many medical imaging applications by automatically locating the regions of interest. Image segmentation is the most crucial function in image analysis and processing. Also segmentation results affect all the subsequent processes of image analysis (Mohan, Raj Mohan, and Thirugnanam 2013), manual segmentation of medical images by the radiologist is not only a tedious but time consuming process and also not very accurate. Hence it is necessary to develop medical image segmentation algorithms that are accurate and efficient. This research proposes a sub-image histogram equalization based enhancement techniques. The proposed method has been tested and evaluated on several medical images. In this work, the medical image is lineated and extracted out so that it can be viewed individually.

The median filter is performed by taking the magnitude of all of the vectors within a mask and sorted according to the magnitudes (Jain and Jain 2013). It is based upon moving a window over an image as in a convolution and computing the output pixel as the median value of the brightness within the input window.

Histogram equalization is a technique to obtain a uniform histogram for the output image (Arif, Khan,



and Siddique, n.d.). It flattens the histogram and stretches the dynamic range of gray levels or in other words histogram equalization maps the input image's intensity values over the range 0 to 255 so that the histogram of the resulting image will have an approximately uniform distribution. This technique is used for contrast stretching and certain modifications in this technique can make it useful for preserving the brightness of the image. Due to this reason, histogram equalization has been found to be a powerful technique for image enhancement.

The medical image enhancement plays a vital role and targets the problems of low contrast and high-level noise in accurate diagnosis of particular disease and also for research documentation and analysis. In this research work, authors proposed efficient medical image enhancement using Hue transforms and adaptive histogram equalization (Bhairannawar 2018).

Lung segmentation is a process of segmenting the lungs from the chest X-ray scan image. The normal process of region growing technique for segmenting the lungs First choose a pixel from the chest X-ray scan image as default (Sundaram, Meenakshi Sundaram, and Ravichandr 2013). Then it needs to set a threshold value for comparison to find the pixel intensity for the lung area in the chest x-ray scan.

The default pixel which is chosen is compared with the adjacent pixel values. Exclude the adjacent pixel, if the difference between the default pixel and the adjacent pixel is greater than the threshold value. The standard median filter performs well as long as the spatial noise density of the salt and pepper noise is not large. The filter performance degrades when the spatial noise variance of the salt and pepper noise increases. The application of adaptive median filter provides three major purposes: to denoise images corrupted by salt and pepper (impulse) noise; to provide smoothing of non-impulsive noise, and also to reduce distortion caused by excessive thinning or thickening of object boundaries.

Nowadays multi-disciplinary actions are carried out for effective and efficient solutions for human health and survival (Strickland 2002). One of the most popular multi-disciplinary work is on image processing techniques that have been used in various medical fields. For removing the noise, erosion, median filters are applied to the system respectively. Erosion is one of the basic operators in morphological image processing. The main effect of the operator on a binary image

is to erode away the confines of sites of foreground pixels such as white pixels. Median filtering is applied to reduce the noise within x-ray images preserving the details and smooth non impulsive noise. If the aim is to simultaneously minimize noise and conserve edges, a median filter is more impressive.

Major difficulty with median filtering technique is background noise removal but novel histogram equalization technique shows the best performance by removing background noise to improve PSNR of lung images. Image processing techniques are used for providing meaningful representations of lung image patterns. Image Enhancement techniques play a vital role in medical field applications in image diagnosis of lung images in order to detect respiratory disorders like lung cancer, tuberculosis and lung tumor disorder and for COVID 19.

## Conclusions

The results show that the proposed histogram equalization technique performs better than median filtering in terms of PSNR. The Proposed histogram equalization proved with better PSNR (69.6557dB) when compared with median filtering (37.6427dB).

## Declaration

## Conflict of Interest

The authors declare no potential conflict of interest.

## Authors Contribution

Author TS was involved in data collection, data analysis, manuscript writing. Author RR was involved in conceptualization, data validation, and critical review of manuscript.

## Acknowledgement

The authors would like to thank the Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences (formerly known as Saveetha University) management for providing us all the necessary facilities to complete this project successfully.

## Funding

We thank the following organizations for providing financial support that enabled us to complete this study.

1. Healthminds Pvt. Ltd, Bangalore.
2. Saveetha University.

3. Saveetha Institute of Medical and Technical Sciences.
4. Saveetha School of Engineering.

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