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Smart Edge Detection Technique in X ray Images for Improving PSNR using Canny Edge Detection Algorithm with Gaussian Filter in Comparison with Laplacian Algorithm

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ABSTRACT

Aim: The aim of this study is to propose smart edge detection techniques in x-ray images for improving PSNR using canny edge detection algorithm and compared with laplacian algorithm. **Materials and Methods**: Using the design of edge detection technique and to improve PSNR, canny edge detection algorithm is used along with gaussian filter and it is compared with laplacian algorithm. Canny edge detection algorithm and laplacian algorithm are the two groups considered in this study. For each group the sample size is 20 and the total sample size is 40. Sample size calculation was done using clinicalc.com by keeping g-power at 80%, confidence interval at 95% and threshold at 0.05%. **Result:** When comparing the two algorithms, it is clear that the canny edge detection algorithm has a higher mean PSNR value of 28.98db than the laplacian algorithm 27.08 db. It is observed that the canny edge detection algorithm performed better than the laplacian algorithm ($p>0.05$) by performing an independent sample t-test. **Conclusion:** Canny edge detection has insignificantly greater PSNR when compared to laplacian algorithm

Keywords

Edge detection, Canny Edge Detection, laplacian Algorithm, PSNR, Image processing, Innovative edge detection.

Imprint

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INTRODUCTION

This research is done to propose a smart edge detection technique in x-ray images for improving PSNR using canny edge detection with gaussian filter algorithm in comparison with laplacian algorithm. An important feature of an image is the edge. The amount of data in an image can be reduced by using an edge detection technique. Removing unwanted data in an image can be done by using edge detection techniques. By removing the data which is not necessary the work of a physician can be reduced while examining the x-ray. One of the most significant tasks in digital image processing is image edge detection. The major goal of this work is to provide a brief overview of the canny, prewitt, Robert, and Sobel operators. This operator uses appropriate and quick solutions to process photos with high luminous density. Picture quality evaluation research is used to develop measurement methods for assessing image quality. The boundary regions of the photos may be obscure due to low image quality and other causes. The edge detection process generates erroneous edge detection points, resulting in incorrect image determination values. In this work, various edge detection methods are analysed for identifying a better way for digital image edge identification(Selvakumar and Hariganesh 2016). It is applied to reduce the noise in x-ray. The noise in the x-ray makes the physician's work more complicated by making it hard to find the minor cracks. By applying this technique physicians work can be reduced and the accuracy can be improved. Medical image segmentation has been studied for a long time as a way to differentiate object regions for subsequent image analysis. One of the most widely used methods is the segmentation of the lung region in a chest X-ray (CXR) using object edge detection. Although early edge detection methods such as Sobel, Prewitt, and Laplacian have been employed to segment the lung, none of them have been able to produce truly satisfactory segmentation results. This is due to the fact that they are high pass filters, which are susceptible to image noise. As a result, the need for a superior edge recognition technique that can handle suitable lower and upper threshold values for picture noise, such as canny edge, should be emphasised (Saad

et al. 2014). The classic canny operator lacks adaptive capabilities when it comes to gaussian filtering variance selection. Filtering necessitates human interaction, and the variance of gaussian filtering has an impact on edge preservation and denoising. This article proposes an enhanced edge detection technique. The morphological filtering replaces the gaussian filtering. Experiments demonstrate that the enhanced canny operator can successfully filter salt and pepper noise, improve edge detection, accuracy, and reach an optimum edge detection effect. The findings of the experiment reveal that the objective evaluation and visual effect are both satisfactory(Deng, Wang, and Yang 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 Thirunavukkarasu 2021; Kaja et al. 2020; Antink et al. 2020; Paul et al. 2020; Malaikolundhan et al. 2020)

Many research articles were published in canny edge detection in the last five years. In IEEE database 12 articles were published and in pubmed database 78 articles were published. The most cited article proposes a method to identify the edges which finds it useful when an remote based hospital has fewer equipment to diagnose (Basha et al. 2020). The Best article was(Johari and Singh 2018). Most important stage in medical image processing and digital image processing is edge detection. Locating sharp intensity changes and finding object boundaries in medical imaging and computer vision is done by canny edge detection. Because of the advantages canny edge detection is widely used. The Canny edge detector identifies a pixel as an edge if the gradient magnitude of the pixel is larger than those of pixels at both its sides in the direction of maximum intensity change (Ding and Goshtasby 2001) to obtain a clear and good edge from the image. For detecting the edges properly the edge detection methods have been modified. Medical images carry a huge amount of information which is used for analysis of various diseases(D.c et al. 2012). Nowadays usage of computer based techniques for diagnosis is tremendously growing. To speed up the process and increase the accuracy a system with high efficiency which incorporates modern techniques and fewer resources is needed (Johari and Singh 2018). The discontinuity in intensity from one pixel to another pixel can be identified as edge. To improve the quality of image, edge detection is one of the most useful image enhancement techniques. Identifying and classifying the discontinuities in an image is the principle objective of edge detection. Edge detection reduces the data required to represent the image by filtering the futile information while keeping the essential structural assets of an image. Since edges and noise have high frequency components it is difficult to perform edge detection in noisy images. Number of methods have been proposed in the past few decades for edge detection in colour and high intensity images (Ganesan and Sajiv 2017).

The accuracy in predicting the edges in x-ray is less in existing methods which made to study further on this research work. The main aim of this work is to improve the edge detection by increasing the PSNR.

MATERIALS AND METHODS

The study which was carried out at Saveetha School of Engineering college in a simulation lab uses image enhancement technique for improving PSNR of x-ray images using MATLAB simulation software. As the study was fully based on software it did not need any ethical permission. The sample size calculation was done using clinical.com by keeping alpha error threshold 0.05and power as 80% and value for enrollment ratio as 0.1 and 95% confidence interval. The sample size is 40. In sample preparation for group 1 the image samples were collected from kaggle.com. In group 2 sample preparation 20 samples were collected from kaggle.com. Working station in designing the image processing filter is mostly in a personal computer in software named MATLAB R2014a with all the required add-ons installed. Both the algorithms have been simulated using the software MATLAB for optimization. The resultant graph shows that canny edge detection technique along with gaussian filter produces better PSNR values.

Statistical Analysis

By using the software IBM SPSS statistics 26 the statistical analysis is done. It helps to find the significant variance between two. In our study the dependent variable is PSNR and there are input image samples identified as dependent variables (McCormick and Salcedo 2017).

RESULT

The proposed algorithm shows better results when compared to the laplacian algorithm. The proposed

algorithm shows better PSNR values when compared to PSNR values produced by the laplacian algorithm.

Table 1 shows PSNR values in decibels for the proposed algorithm and laplacian algorithm. From the table we can find that the proposed algorithm produces better PSNR values than the laplacian algorithm.

Table 1

PSNR values for canny edge detection algorithm and laplacian algorithm for different iterations. The improved canny edge detection algorithm produces higher PSNR values than laplacian algorithm

Iterations	Canny Edge Detection Algorithm PSNR(db)	Laplacian Algorithm PSNR(db)
1	27.9	25.4
2	27.9	25.6
3	28	25.8
4	28	26
5	28.1	26.2
6	28.2	26.3
7	28.3	26.4
8	28.5	26.5
9	28.6	26.6
10	28.7	26.7
11	28.8	26.7
12	28.9	27
13	29	27.2
14	29.2	27.8
15	29.5	28.2
16	30	28.4
17	30.2	28.5
18	30.4	28.6
19	30.6	28.8
20	30.8	28.9

In Table 2 Group statistics providing mean, standard deviation and standard error mean for a total of 40 samples is determined and shown. The mean PSNR value is 28.98 for canny algorithm and 27.08 for laplacian algorithm. Canny algorithm provides better PSNR than laplacian algorithm.

Table 2

SPSS analysis of two groups – Group statistics providing mean, standard deviation and standard error mean of the PSNR for the total samples of 40. The canny edge detection algorithm has better PSNR than laplacian algorithm

Group Statistics					
	Group	N	Mean	Std. deviation	Std. error mean
PSNR	Canny Edge Detection Algorithm	20	28.9800	.95675	.21394
	Laplacian Algorithm	20	27.0850	1.13753	.25436

Table 3 shows the independent sample test obtained from statistical analysis using algorithms like canny edge detector and laplacian with the IBM spss tool.

In Fig.1. The various images are depicted. Fig.1(a) shows the input original sample image.This image is given as input image to canny edge and laplacian algorithm. In Fig. 1(b) the original image is converted into a binary image. By changing the pixel values the binary image is converted into a segmented image which is depicted in Fig. 1(c). The output image using customised Canny edge detection algorithm is depicted in Fig. 1(d) and in Fig. 1(e) the output image without filter is shown.

Figure 2 shows the graphical representation of PSNR values for both algorithms simulated for different iterations. From the graph it is evident that for most of the iterations the canny algorithm provides a better PSNR.

Figure 3 gives the comparison of both algorithms. Independent t-test is used for comparing both the algorithms and a statistically insignificant difference is noted for the mean accuracy value.

Table 3

Independent Sample Test: The Mean Standard deviation and significance difference of canny edge detection algorithm has better PSNR consistent with laplacian algorithm. There is a significance difference between two groups using independent T test.

Parameters		Leven's test for Equality of Variances					T-Test for Equality of Means		95% Confidence interval of the difference	
		F	Sig	t	df	sig(2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
PSNR	Equal Variances assumed	1.226	.275	5.702	38	<.001	1.89500	.33237	1.22216	2.56784
	Equal variances not assumed			5.702	36.916	<.001	1.89500	.33237	1.22151	2.56849

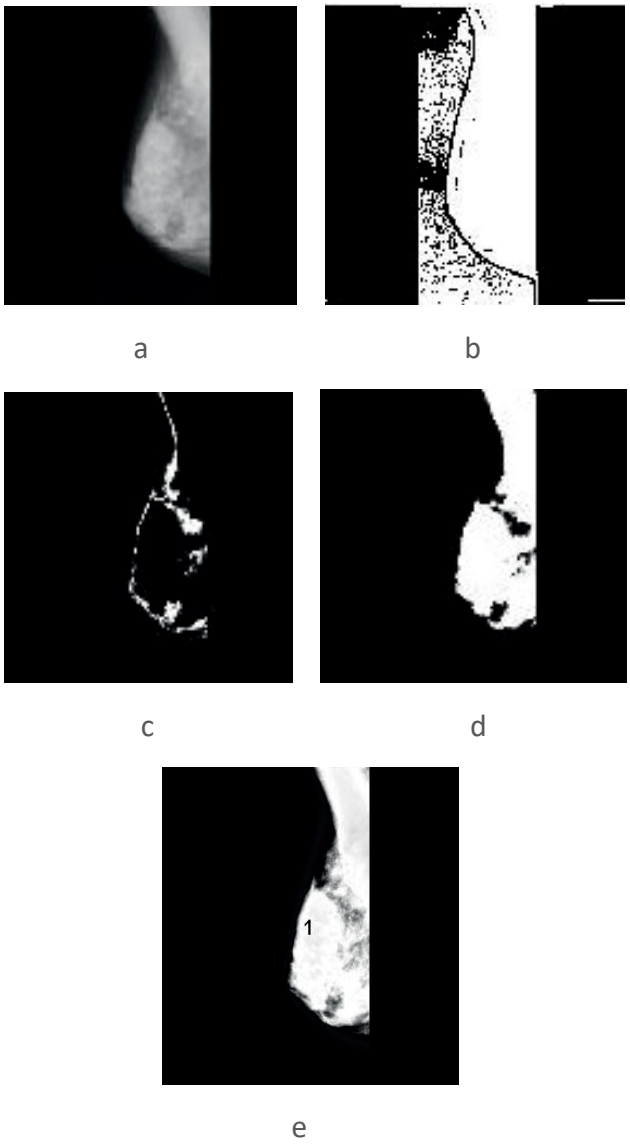

Fig. 1. Simulation result using Canny edge detection algorithm. (a).Input image (b)binary image.(c) segmented image.(d)simulated image with gaussian filter (e)Simulated image without filter.

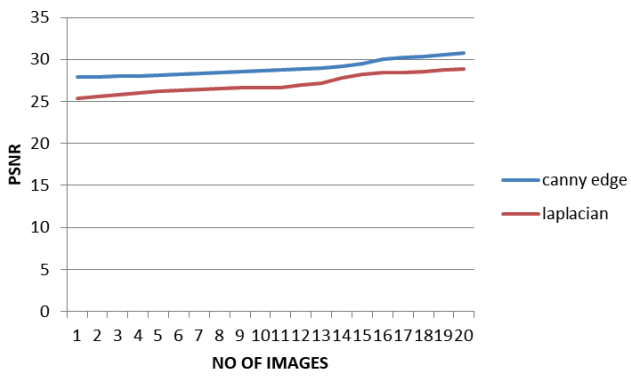

Fig. 2. The difference in PSNR values produced by canny edge detection algorithm and laplacian algorithm. 20 iterations are performed and canny edge detection algorithm produces more PSNR values than laplacian algorithm

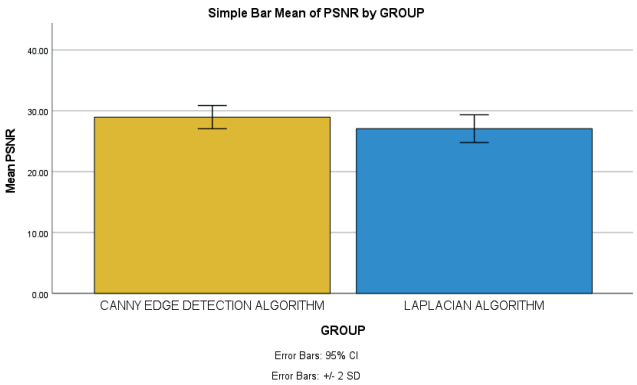

Fig. 3. Comparison of canny edge detection algorithm and laplacian algorithm using standard deviation values. The mean PSNR of the canny edge detection algorithm is better than the laplacian algorithm. X-axis: canny edge detection algorithm vs laplacian algorithm Y-axis: Mean PSNR with +/- 2 SD

DISCUSSION

The standard Canny edge detection algorithm is susceptible to noise and it is easy to miss weak edge information when filtering out the noise and its fixed parameters make it difficult to change. This work presented an improved approach based on the Canny algorithm to address these issues. This technique created the gravitational field intensity operator by replacing picture gradient with the concept of gravitational field intensity. For two types of typical images (one with less edge information and the other with rich edge information), two adaptive threshold selection methods based on the mean of image gradient magnitude and standard deviation were proposed. The revised Canny algorithm is straightforward to implement. The method can maintain more useful edge information, according to experimental data. The article using the improved algorithm shows a better PSNR values between 4.4 to 9.7 (Rong et al. 2014). Segmentation methods are often used for cancer or object detection on image computed tomography. The Segmentation method which is most commonly used is based on edge detection. A quantum based canny operator is the edge detection method proposed in this study. Gradient magnitude value is generated by observing the strength of neighbouring pixels which results in the quality improvement of edge detection. The pixel change value and the distance of the neighbour pixel to the centre pixel is used to calculate the strength of the pixel. The proposed method outputs a PSNR value of 64.23 for CT scan lung image which is higher when compared to other methods(Widiyanto et al. 2019). Very important component of the diag-

nostic process is ultrasound medical images. Since it is a non-invasive and non ionising diagnostic method it is widely used. For further segmentation or more precise measurements of elements in the picture, edge detection is used as a part of image analysis. High frequency components of an image are represented as edges. Speckle noise which is a high frequency component ultrasound images are subjected to degradation by speckle noise. In this article the authors used dynamic smoothing median filter instead of gaussian filter and canny edge operator with different threshold values ranging from 0.9 to 2.4 for ultrasound images for internal organs (Nikolic, Tuba, and Tuba 2016).In the article proposed by (Deng, Wang, and Yang 2013) the proposed algorithm have shown tremendous improvement in the average gradient, PSNR, entropy and distortion degree. The PSNR value for a image shows 13.74 and ha for tree image shows 13.18. There are opposite findings for the edge detection methods which uses mathematical morphological techniques(Huang and Wang 2006).The morphological techniques are also suited for sequential and parallel computing. Image arithmetic techniques are also proposed for the edge detection methods. The method proposed find useful in letter extraction process. And it works according to the users desiring(Swathika, Sree Sharmila, and Bhattacharya 2018)

CONCLUSION

The canny edge detection algorithm has significantly greater PSNR than the laplacian algorithm. Canny edge detection gives better PSNR of about 28.98 when compared to laplacian algorithm which gives 27.08

DECLARATIONS

Conflict of interest

No Conflict of interest in the manuscript

Author Contribution

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

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