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A New Image Processing Technique for Medical Image Analysis

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Abstract: ***In this communication, we report identification of lung cancer with the help of a new image processing technique. To start with, we compare the results obtained from our proposed method with those obtained from the original Sobel edge detection method. The comparison is done by creating a confusion matrix and considering various parameters such as True Positive, True Negative, False Positive, False Negative, Accuracy, Misclassification Rate, Precision, Recall, Specificity, F Score, Matthews Correlation Coefficient (MCC), F Measurement (FM), Z score, T Score, and P Score. Our proposed method gives better total accuracy than the normal Sobel edge detector.***

Keywords: Neural network, statistical learning, edge filters, deep learning, image processing

I. INTRODUCTION

Edge is one of the prime features used for the analysis of an image. Many researchers have been applying edge detection techniques to extract useful information from medical images. K. Lakhani et al. [1] aimed to detect discontinuities in dental radiographs using the Sobel and Prewitt edge detection techniques followed by smoothening of the image with the help of the Gaussian filter. The Sobel operator showed better results. The Laplacian filter was then used for image sharpening to identify any dental defects. B. Padmapriya et al. [2] presented a technique for estimating the thickness of the bladder wall by automatic edge-based image segmentation from a 2D ultrasound image of the urinary bladder. The Sobel operator used for edge detection was found promising and was expected to reduce human error while tracing the boundaries of the bladder. Binary particle swarm optimization technique was applied by N. S. Dagar et al. [3] for better edge detection of the images. A. Kumar et al. [4] proposed a two-level approach for detecting edges. The first step included the enhancement of edges using guided image filtering which was an advanced form of bilateral filter. The second step involved a modified ant colony optimization (ACO) method which was applied to the enhanced images for edge detection purpose. The complexity of the normal ACO method and modified ACO method was the same. The proposed method was able to detect minor variations of edge with guided filtering and heuristic clique function. The proposed method performed better when compared with other edge detection techniques in terms of the F-score. B. S. Tchinda et al. [5] proposed a method of blood vessel segmentation in retinal photographs which was based on artificial neural networks and classical edge detection. Initially, for the extraction of feature vectors, edge detection filters were applied. For the recognition of every pixel whether it belonged to blood vessels or not, the resulting features were used for training an artificial neural network. DRIVE, CHASE, and STARE datasets containing retinal images were used for the evaluation of the obtained algorithm. The parameters on the basis of which the performance of the algorithm evaluated were- detection of accuracy, specificity, sensitivity, and area under the ROC curve. MATLAB was used for the development of the algorithms. Two manual segmentation results, provided by three databases DRIVE, CHASE, and STARE, were given by two experts for each image. The result given by the first observer was chosen as ground truth. The edge detection algorithms used were Canny, Sobel, Roberts, Prewitt, Laplacian of Gaussian (LoG), and morphological filters for the generation of feature vectors. Experiments revealed that the proposed method was robust and had different widths of the vessel and diverse luminosity conditions. In comparison to the state-of-the-art methods, the proposed method showed a better performance concerning accuracy, specificity, and area under ROC curves. N. Mathur et al. [6] proposed to enhance the Sobel edge detection technique using fuzzy edge detection method and k-means clustering algorithm. The proposed method was used for the detection and finding the location of a tumour. The experimental results revealed that the modified Sobel edge detector enhanced the performance of the classical Sobel edge detector and produced better results and retained the information about brain tumour thereby providing its exact location. S. Thirumavalavan et al. [7] presented an enhanced Teaching Learning based Optimization (TLO) along with a methodology to obtain edge maps of noise-infused digital images. TLO, a population-based algorithm, consists of the teaching phase and the learning phase.

The teaching phase indicates acquiring knowledge from the teacher and the learning phase indicates communication between learners. A third phase, which is the 'Avoiding Phase' was also introduced which meant keeping the learners far away from the worst students to explore the problem space and to escape from the suboptimal solutions. The enhanced TLO provided the best global solution by exploring the solution space. The proposed method was applied on planes, Saturn, and few other real-life images. A metaheuristic robot method involving ACO, and two classical operators of Canny and Sobel was also tested on the images to get the edge maps. The experimental results concluded that the proposed method was robust and was capable to produce edge maps under a noisy environment as well. An Edge Adaptive Tool Variation Denoising technique was applied by R. B. Vallabhaneni et al. [8] which incorporated multiclass Support Vector Machine (SVM) to detect brain tumours automatically in noisy images. In all of the above communications, edge detection method has been taken into consideration along with some other techniques like optimization, machine learning, etc.

Lung cancer is one of the dreadful diseases. Hence early detection and accurate diagnosis of this disease is an important aspect to the medical practitioners. In this paper, an attempt is made to diagnose lung cancer with the help of a new technique. Detection of lung cancer is done using MATLAB software. For an initial study, the results so obtained are compared with the original Sobel edge detection method. The comparison is done by creating a confusion matrix and considering various parameters such as True Positive, True Negative, False Positive, False Negative, Accuracy, Misclassification Rate, Precision, Recall, Specificity, F1 score, MCC, FM, Z score, T score, and P score.

II. PROPOSED METHOD

We have already mentioned that we intend to propose a new technique to extract more useful information from the lung cancer affected images. The RGB image of the lung cancer dataset is converted to grayscale image by reducing the hue and saturation and preserving the luminance. In an image there are different types of noises such as salt noise, pepper noise, salt and pepper noise, Gaussian noise etc. Here we have strived to work for the removal of Gaussian noise using the Weiner filter. The sharpening of the image is done next to highlight the fine details and the edges in the image. Image smoothing is used to remove the noise and improve the quality of the images. The value of standard derivation used for image smoothing is taken to be 2. Out of the four morphological operations – dilation, erosion, open and close, we have used the dilation operation as it is responsible for adding pixels on the boundaries of the object. A composite image is created by fusing the original image with the dilated image. Lastly, the image is converted to a binary image. The algorithm of the new method may be summarized as follows:

1) STEP 1 Reading of the lung cancer images
2) STEP 2 Display of the original image
3) STEP 3 Conversion of the RGB image to grayscale
4) STEP 4 Application of Wiener filter to remove the Gaussian noise
5) STEP 5 Sharpening of the grayscale image
6) STEP 6 Application of image smoothing on the sharpened image using standard derivation 2
7) STEP 7 Using the dilation operation, one of the morphological operations, on the smoothed image
8) STEP 8 Fusion of the original image with the dilated image
9) STEP 9 Conversion of the fused image into binary image
10) STEP 10 Display of the modified image

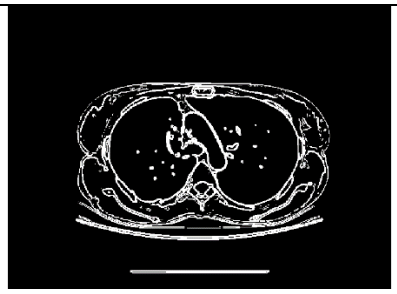
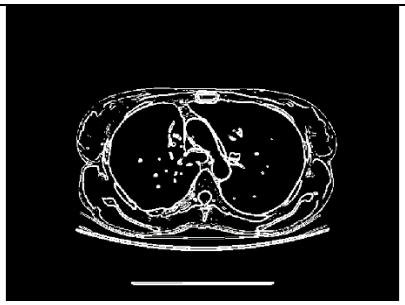
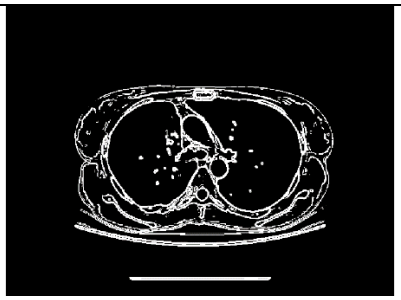
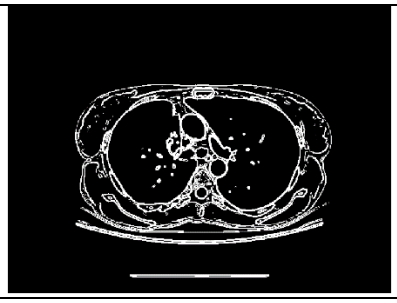
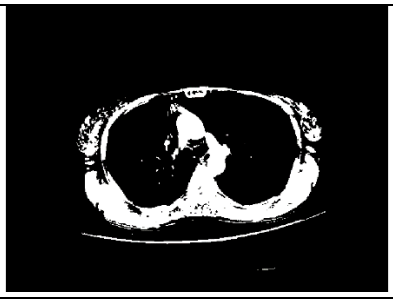
III.RESULTS AND DISCUSSIONS

The dataset is taken from github [9] which consists of 90 images of lung cancer. The entire dataset is divided into three folders- set 1, set 2 and set 3. The address of the folder is loaded into the program. Our proposed algorithm is applied on the three sets and the desired results are generated. Table 1 shows the original images, corresponding Sobel images and the images obtained from our proposed method. Table 2 and Table 3 represent the confusion matrix and the values of the performance parameters corresponding to the Sobel edge detection technique respectively. Similarly, the confusion matrix and the performance parameters for our proposed method are given in Table 4 and Table 5 respectively.

The comparison of our method and the Sobel edge detection method is based on the parameters such as True Positive, True Negative, False Positive, False Negative, Accuracy, Misclassification Rate, Recall, Specificity, F1 score, MCC, FM, Z score and P score. The True Positive value for set 2 in the new approach is more while for other sets the value remains the same in both cases. The False Negative value for set 2 in the new method is 5 while in the Sobel method is 6. The accuracy is much more for set 2 and set 3 in the new approach but for set 1, the value is 0.09 less than the Sobel method.

The precision value for the new approach is 0.33 for all the three sets but the precision value for set 1 in Sobel method is slightly more. The Z score, T score, P score is same for all the three sets in case of both the new method and the Sobel method. Overall, the accuracy of the new approach is 33.3% while the accuracy of the Sobel method is 28.6%. Hence, it can be concluded that the new method is better than the Sobel method.

TABLE I
Original Image, sobel image and Image obtained from the proposed method

Original Image	Sobel Image	Image from the Proposed Method
		
		
		
		
		

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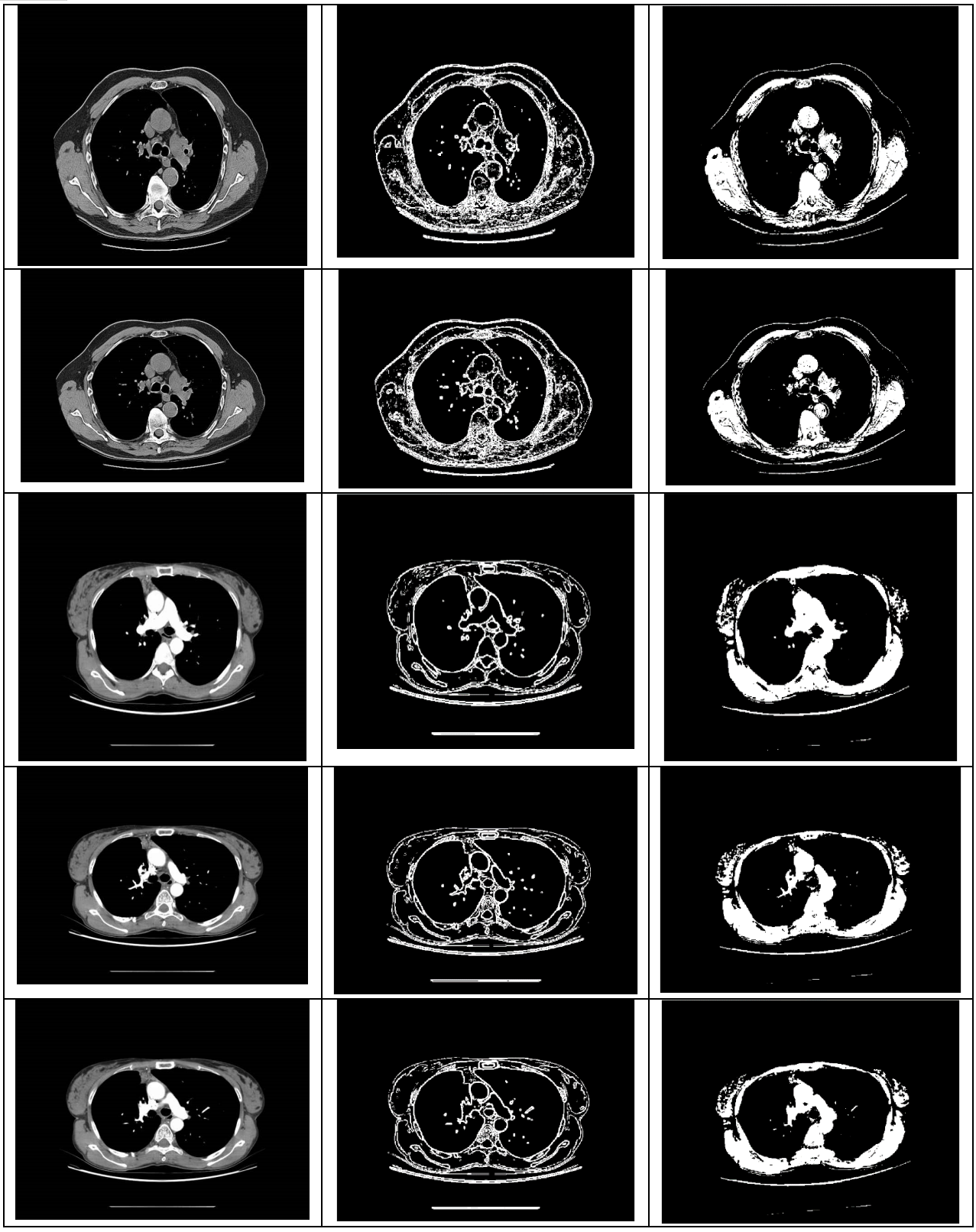

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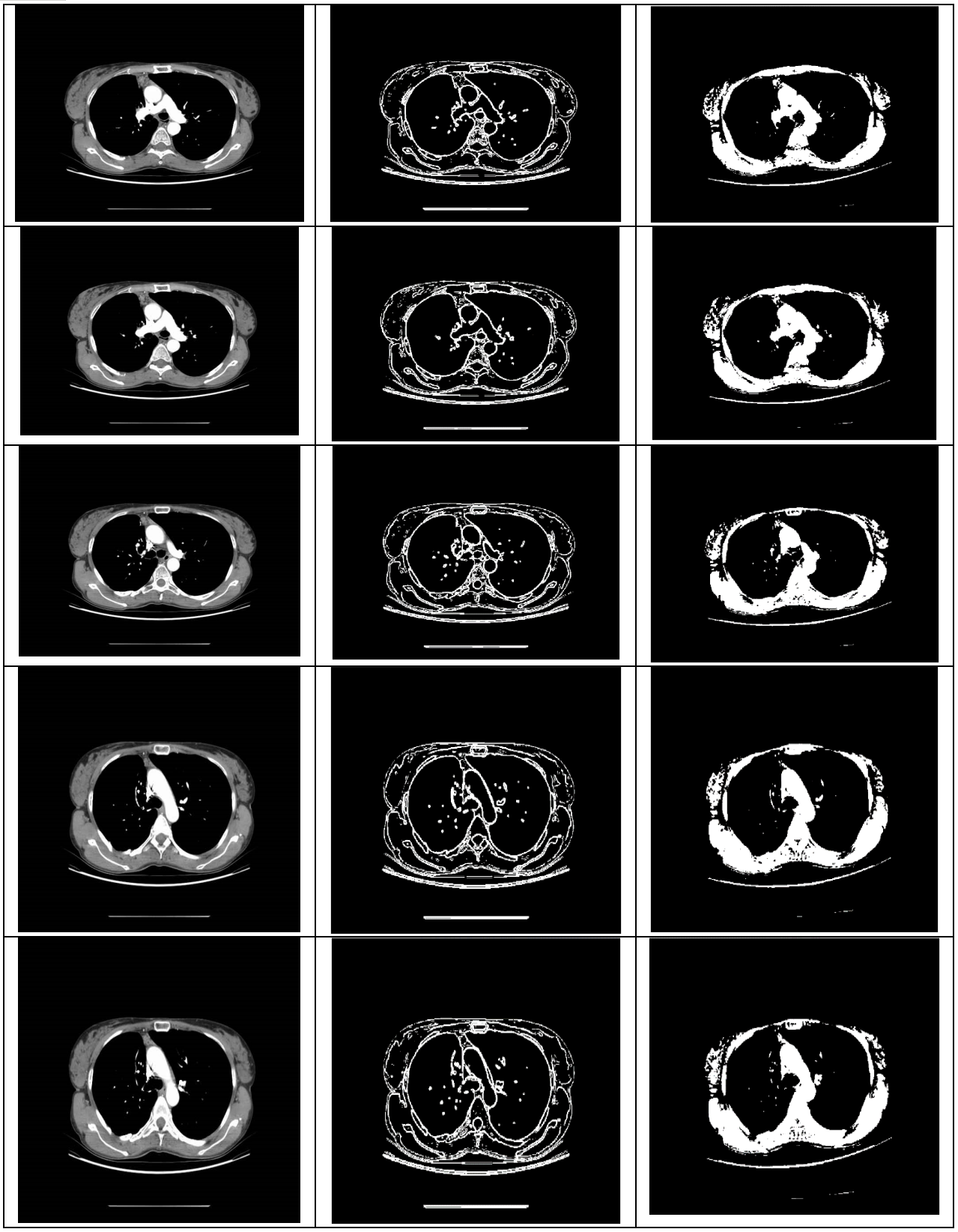

TABLE 2
confusion matrix for the sobel edge detection technique

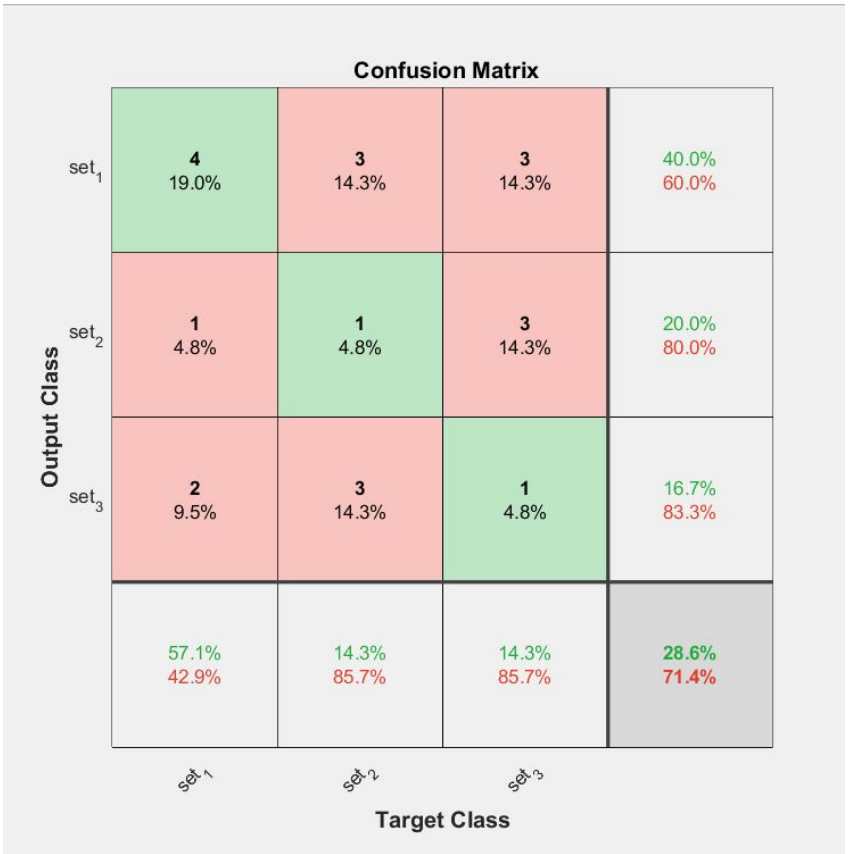

TABLE 3
performance parameters corresponding to the sobel edge detection technique

	SET_1	**SET_2**	**SET_3**
TP	4	1	1
TN	8	10	9
FP	6	4	5
FN	3	6	6
Accuracy	0.57	0.52	0.52
Misclassification Rate	0.43	0.48	0.48
Precision	0.4	0.2	0.16
Recall	0.57	0.14	0.14
Specificity	0.57	0.71	0.64
F1 score	0.47	0.167	0.15
MCC	0.135	-0.158	-0.22
FM	0.48	0.17	0.15
T score	58.4	58.4	58.4
Z score	0.84	0.84	0.84
P score	0.4009	0.4009	0.4009

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TABLE 4
Confusion Matrix for the Proposed Method

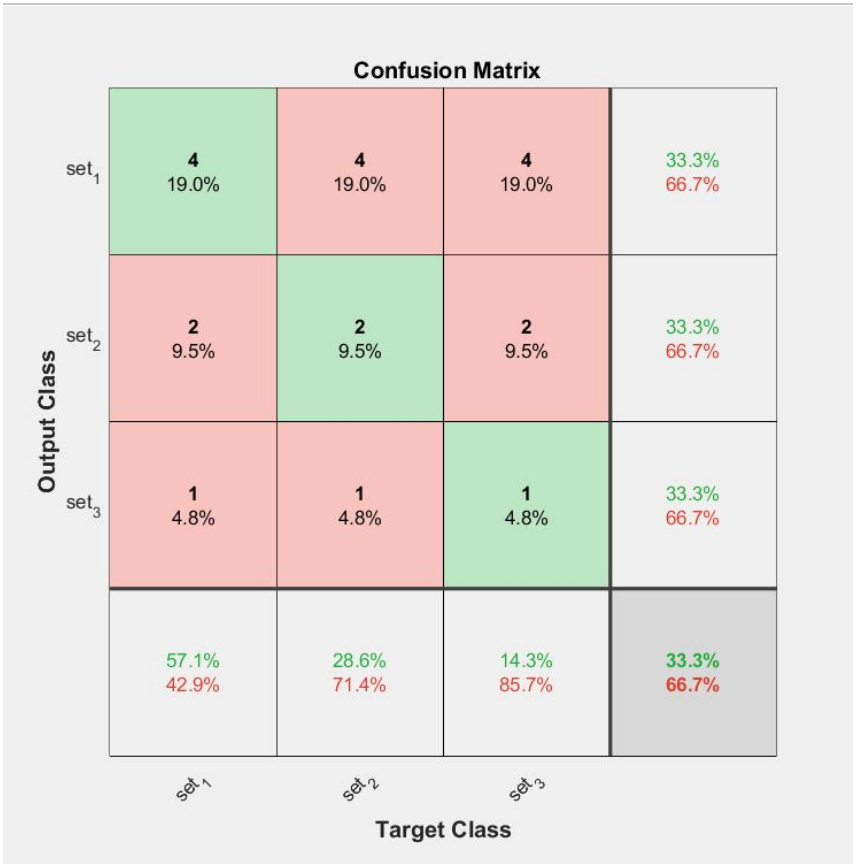

TABLE 5
Performance parameters corresponding to the proposed method

	SET_1	SET_2	SET_3
TP	4	2	1
TN	6	10	12
FP	8	4	2
FN	3	5	6
Accuracy	0.48	0.57	0.62
Misclassification Rate	0.52	0.43	0.38
Precision	0.33	0.33	0.33
Recall	0.571	0.286	0.143
Specificity	0.428	0.714	0.857
F1 score	0.421	0.308	0.2
MCC	0	0	0
FM	0.436	0.308	0.218
Z score	0.84	0.84	0.84
T score	58.4	58.4	58.4
P score	0.4009	0.4009	0.4009

IV. CONCLUSIONS

The lung cancer dataset has been run on both the Sobel edge detection and proposed technique and it can be concluded that since the accuracy of our proposed technique is more than the Sobel edge detection, our technique is a better algorithm than the Sobel edge detection. In future, we plan to compare our results with other classical edge detection techniques.

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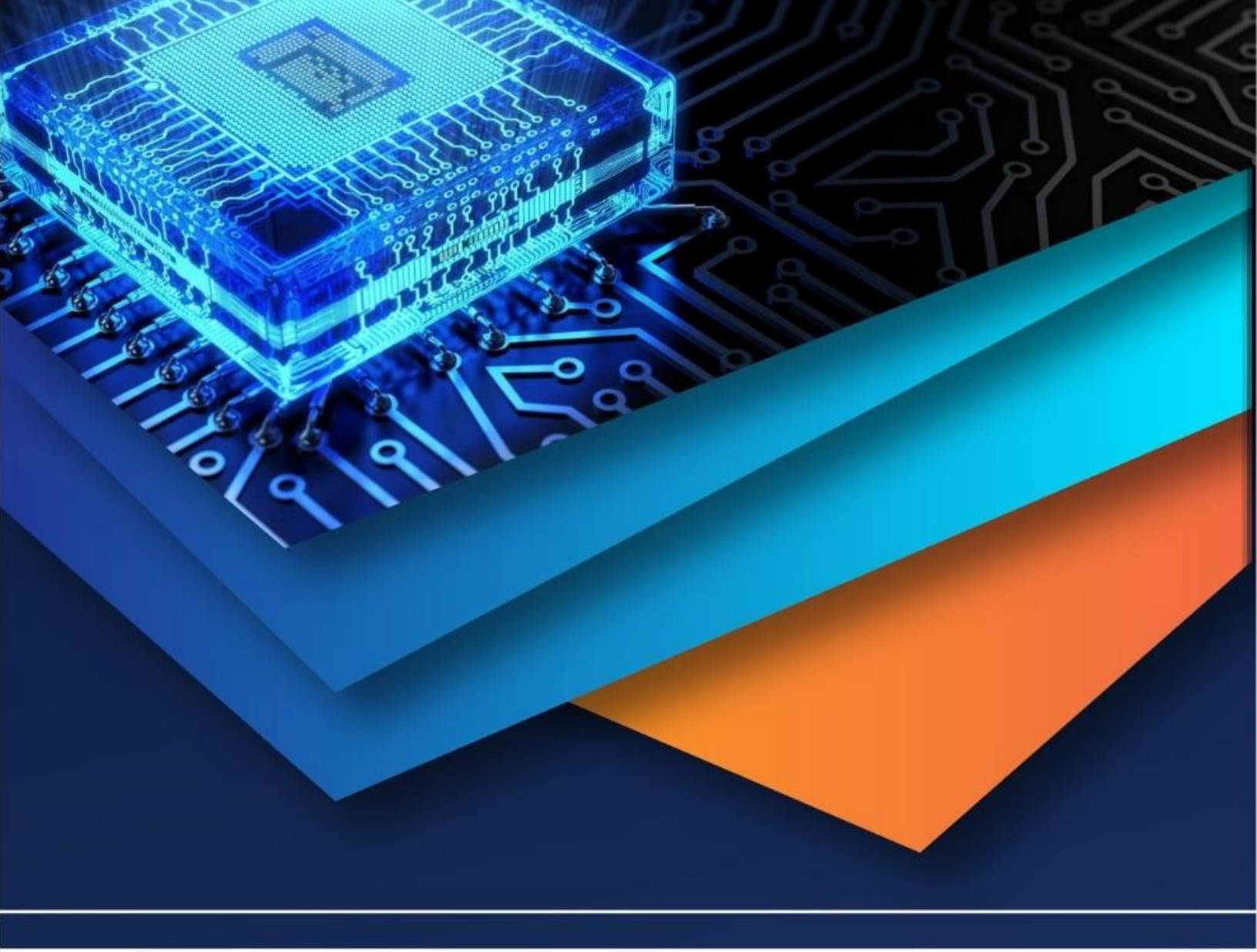

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