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Lung Cancer Detection Using Artificial Neural Network

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ABSTRACT
Lung Cancer is the most debilitating sort in one of the deadliest malignancies type of tumor. Over the most recent couple of years the event of destructive tumor has always extended, in light of the fact that the fix of the illness relies upon its underlying judgment. Non-small cell & small cell are two specific sort of lung cancer. The lungs are typically expansive in measure; subsequently tumors can develop in them for quite a while before they are found. Notwithstanding when the manifestations, for example, fatigue and coughing happen, individuals think they are because of different causes. The approach of new ground-breaking equipment and programming strategies has activated endeavors to create personal computer helped symptomatic frameworks for Cancer identification in help of reasonable mass screening in creating nations. In this paper an efficacious feature techniques for detection of lung cancer is presented. The Scaled conjugate gradient back propagation algorithm (SCG-BPNN) mainly utilized for training work. The fact that the SCG-BP performs faster convergence than primary back propagation differ them from one another. The efficiency of neural network is estimated by MSE.The accuracy is achieved up to 97.3 %.
Keywords: CT scan, Lung Cancer, ANN, SCG-BPNN, Mean Square Error

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I. INTRODUCTION

Lung Cancer (LC) is an irresistible ailment produced by bacillus mycobacterium lung cancer, which influence lungs [1-3, 35]. The rise of new medication safe strains is starting to fuel the issue, rendering the current medications incapable, and requiring steadfast represent exertion to dispose of the affliction. Furthermore, extensive quantities of patients through HIV/cancer co-diseases need to be screened for dynamic cancer to affirm a fitting treatment of their infection(s). Taking CT scans is a cheap method to screen for the nearness of cancer. Appallingly, the elucidation of CXRs is at risk to human oversight and depends upon the aptitude of per user [2-5]. Additionally, mass screening of a generous people is a tedious and dull task, which requires impressive exertion when done physically. Consequently, there is extensive enthusiasm for creating CADs that can identify cancer naturally in CXRs. These frameworks can possibly lessen the danger of discovery blunders and increment the effectiveness of mass screening efforts [6].

Lung cancer left over main reason of disease connected demises in US. There were roughly 2, 29,447 new instances of lung cancer& 1, 59,124 linked demises in 2012[3]. Early conclusion can enhance the adequacy of treatment and increment the patient's shot of survival [31]. Computed tomography (CT), Positron emission tomography (PET), Contrast-enhanced computed tomography (CE-CT) & Low-dose computed tomography (LDCT) are most widely recognized noninvasive imaging modalities for identifying and diagnosing lung knobs. PET sweeps are utilized to separate among harmful and good lung knobs. Early recognition of the knobs can be founded on LDCT and CT filters that take into consideration reproducing the life systems of & identifying anatomic variations in chest. CE-CT considers reproducing the life structures of the chest and surveying the identified knob's qualities. An abundance of known productions has examined the advancement of CAD frameworks for lung cancer from a large group of various picture modalities [7, 9]. The achievement of a specific CAD framework can be estimated as far as precision of conclusion, speed, and robotisation level. The division of lung tissues on chest pictures is preprocessing venture in building up CAD framework so as to diminish look space for lung knobs. Detection & segmentation of lung knobs from the obtainable search space are compulsory phases [8].

Contribution of a CAD framework in medical pictures got utilizing a suitable methodology. A lung division step is utilized to diminish scan space for lung knobs. Knob identification is utilized to recognize the areas of lung knobs. The recognized knobs are sectioned. At that point, an applicant set of highlights, for example, volume, shape, & additionally features are utilized for determination [9].

The remaining paper is as a survey with previous work is described in section II. Section III explains the proposed methodology. Analysis of results given in section IV while in section V conclusion is done.

II. RELATED WORK

The brief description, contribution, remarks and factors of the work done by the researchers is given below in table 1.

Table: 1 Major finding by the researchers

Ref.	**Investigator**	**Type of Image**	**No. of Images**	**Research Methodology used**	**Major Findings**
[1]	L.A. Haryanto	CT Images	50	The GLCM feature extraction consequences then trained utilizing ANN. Technique used is back propagation network	GLCM Co-occurrence parameter calculated
[2]	Moffy Vas et.al	CT Images	216	Feed forward-NN with back propagation algo. was utilized	Accuracy calculated
[3]	Shubhangi Khobragade et.al	X- Ray Images	80	Feed forward neural network used 7 input neuron of chest radiographs 3 hidden layer signifies lung diseases as LC	Accuracy calculated
[4]	S.KalaivaniPramitet.al	CT-Diagnosis database	70	Feed forward back propagation NN. 3 Layers.	Efficiency calculated
[5]	Shraddha Deshmukhet.al	MRI Images	32	Fuzzy min- max neural network	Accuracy calculated
[6]	Qing Wu et.al	CT Images	12	Entropy Degradation Technique	Accuracy calculated
[7]	Fatma Taheret.al	Sputum Color Images	100	ANN & Support Vector Machine (SVM)	Accuracy calculated
[8]	Rachid Sammouda, et.al	CT Images	10	ANN of Hopfield model (HNN) & GA	Eliminate isolated pixel
[9]	Lei Fan, Zhaoqing, et.al	CT Images	1500	Convolution neural network	Accuracy calculated
[10]	Taolin Jin1, Hui Cui, Shan Zeng, Xiuying Wang	CT Images	1397 1035 – Cancer 362 – non Cancer	3D CNN model	Accuracy calculated
[11]	Ryota Shimzu et.al	CT Images	57	Supervised deep learning neural network	Accuracy calculated
[12]	Hao Tanget.al	CT Images	600	Deep convolutional neural network	CPM score calculated
[13]	Emre et.al	CT Images	128	Multi-layer FF perceptron model was used in ANN.	Accuracy calculated
[14]	Sridevi et.al	X- Ray	5	Levenberg marquardt back propagation algorithm	Boundary region identified
[15]	Allison et.al	CT Images	1500	Convolution neural networks	Accuracy calculated
[16]	Zirong L et.al	X – Ray	626	Residual network based on CNN	Recall estimated
[17]	Sheng Chenet et.al	CT Images	233	Massive-training artificial neural networks	Sensitivity calculated

[18]	Chaofng Liet et.al	JSRT CT Images	93	Outline of ensemble of convolutional NN	Sensitivity calculated
[19]	Hewon Chung et.al	CT Images	42	Global LC extraction with Chan Vese model	Performance parameter calculated
[20]	Mathew S et.al	CT Images	31	Fuzzy & refined fuzzy set	Shape feature calculated
[21]	Arnaud et.al	CT Images	1018	False positive reduction	Sensitivity calculated
[22]	Nikolas Lessmann et.al	CT Images	1744	Deep neural networks with dilated convolutions	Sensitivity calculated
[23]	Sandeep et.al	CT Images	12	Machine learning & multinomial Bayesian	Abnormality calculated
[24]	Kingsley Kuan et.al	LUNA dataset CT Images	16	Nodule classifier patient classifier	Sensitivity calculated
[25]	Mehdi FatanSerj, Bahram Lavi, Gabriela Hoff	CT Images	10	Deep convolutional neural network	Sensitivity, specificity and F1 score calculated
[26]	Aqeel Mohsin Hamad	CT Images	4	GLCM neural network classifier	GLCM Parameter
[27]	M Lavanya, P Muthu Kannan	CT Images	20	Fuzzy Local Information Cluster Means Back Propagation Network Classification	Accuracy calculated
[28]	Gurpreet Kaur, Jaspreet Kaur	X- Ray	10	Fuzzy Logic based Multi Thresholding	Accuracy calculated
[29]	JinsaKuruvilla K Gunavathi	CT Images	10	FISANFIS Modified ANFIS	Accuracy calculated
[30]	Atın et.al	CT Images	10	Fuzzy Logic	Accuracy calculated

Above table 1 demonstrates the research methodology used by various researchers along with their major findings i.e. sensitivity, efficiency, accuracy etc. Accuracy is the most calculated parameter to measure the efficiency of the proposed techniques by the researchers.

III. PROPOSED METHODOLOGY

JSRT CT Scan80 Images are taken out. This technique comprises of three primary advances: an extraction advance to distinguish the lungs; a detachment venture to isolate the privilege & left lungs; & a discretionary smoothing advance to flat lung limits. Every one of these means is portrayed in part straightaway.

1**. Lung Extraction:** The objective of lung extraction step is to isolate voxels relating to lung tissue from voxels comparing to encompassing life systems. As opposed to utilizing a settled edge to fragment the lungs, rather utilize ideal thresholding to consequently choose a division edge for picture volume. Availability & topological examination are utilized to further refine locales that speak to removed lungs [11-15].

i) Threshold Selection: Optimal thresholding is a programmed edge determination technique [32] that enables to accommodate the little varieties in tissue thickness expected over a populace of subjects and two kinds of voxels are:

a) voxels inside extraordinarily thick body & chest divider structures
b) low-thickness voxels in lungs or discernible all around including the body of the subject. This will use perfect thresholding to pick a division limit to disconnect the body from the voxels, and after that recognize the lungs as the low-thickness cavities inside the body.

The division limit is chosen through an iterative methodology. Give T^i a chance to be the division limit at step i. To pick another division limit, T^iapplied to the picture to isolate voxels into body & non-body voxels. Let $\mu_b$band μ_n be mean dark level of body voxels &nobody voxels after division with limit T^ias shown in eq. 1. At that point the new limit for step $i + 1$ is [14]

$$T^{i+1} = \frac{\mu_b + \mu_n}{2} \qquad \text{eq.1}$$

This iterative limit refresh technique is repeating until there is no adjustment in the edge, i.e., T^(i+1)=T^i. The underlying edge T^0 is chosen dependent on the CT number for perfect air (1000 HU) and the CT number for voxels inside the chest divider/body (0 HU).

ii) Network and Topological Analysis: Subsequent to applying the perfect edge, the non body voxels will contrast with the air enveloping the body, lungs, and other low-thickness regions inside the image volume. 3-dimensional related parts naming is used to recognize the lung voxels. The establishment air is wiped out by deleting districts that are related with the edge of the image. Little, withdrew areas are discarded if the region volume is too little [15-16]. To recognize the lungs, we hold the fundamental the two greatest sections in the volume, with the additional basic that each part ought to be greater than a fated minimum volume. In this paper, we hold only the portions with a volume more critical than one percent of the total picture voxel count. The high-thickness vessels in the lung will be named as body voxels in the midst of the perfect thresholding step. In this way, the 3-D lung regions will contain unwanted inside melancholies. Topological examination, similar to that used in, is used to fill the lung areas and take out within pits [17].

iii) Division of the Large Airways: To perform quantitative examinations on the lung tissue, the trachea and considerable flying courses must be perceived and separated from the left and right lungs. This movement is moreover critical to energize the left and right lung division delineated [18].

The trachea and left and right fundamental stem bronchi are recognized in the main dull dimension image data using a close space expansion with a unit extend divide. This procedure is proportionate to facilitate cut by-cut territory creating. To instate the close scattered enlarging, the region of the trachea is normally perceived by means of chasing down the broad, round, air-filled region near the point of convergence of the underlying couple of cuts in the enlightening file. Territories in the present cut give potential seed coordinate positions toward the accompanying cut. The cut by-cut creating technique is ended when the proportion of the district on another cut augmentations definitely, demonstrating that the avionics courses have merged into the low-thickness lung tissue [19].

Fig. 1 shows the proposed working of lung nodule segmentation and classification based on neural network. At the point when seen on transverse CT cuts, front & back intersections between left & right lungs might be thin with frail differentiation [18].

Much of the time, dark scale thresholding neglects to isolate left & right lungs close to these intersections, Objective of the lung partition step is to find these intersection lines and totally isolate the privilege and left lungs. Utilizing a method like that utilized in, dynamic writing computer programs is connected to locate the greatest cost way through a chart with weights corresponding to pixel dim level. The greatest cost way compares to the intersection line position. Be that as it may utilize an alternate methodology to locate the dynamic programming seek areas. In this strategy, a hunt area is found on a 2-D cut and it is proliferated to progressive cuts. In light of the smooth pneumonic life systems, the intersection line position differs gradually through the informational index [20-22].

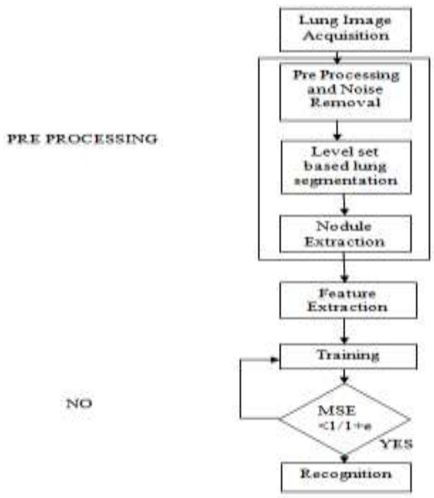


Fig: 1 Flowchart showing the methodology used.

To find the region for applying dynamic programming look for on one cut, 2-D morphological breaking down is associated with detach the benefit and left lungs. An unforeseen growth is then used to restore the harsh exceptional limit shape, without re-partner the two lungs yet again. Let address the plan of lung pixels on a singular cut. To disconnect the left and right lungs to enroll another set S using a n-overlay breaking down [22] as shown in eq. 2.

$S = A \Theta n B_4$ eq. 2

where Θ is a parallel morphological disintegration and B_4 is a four-associated (precious stone molded) paired organizing component. The scaling term is chosen with the goal that $nB_4$is the slightest homothetic that outcomes in A and S having an alternate number of 2-D associated parts. Subsequent to isolating the lungs by disintegration to frame S, the limit is reestablished utilizing a restrictive enlargement. The restrictive widening continues iteratively. Effect of contingent expansion at step i+1 is [24] as shown in eq. 3.

$C^{i+1} = C^i \cup \{\{p\} \oplus B_4\}$ eq. 3

where $\oplus$ is a parallel morphological widening &$p \in C^i \cap A$, with choice of additional compelled so C^i&C^{i+1} have a similar no. of 2D associated parts [18-19].

$C^o = S$ is utilized to introduce the contingent widening. This plan ensures that lung limit is recuperated without responding left & right lung parts. The restrictive expansion in eq. 1 is rehashed until no pixels $p \in C^i \cap A$ are left that can be included deprived of altering the network of districts is C^i.

Let C signify outcome after restrictive widening. While left & right lungs had been isolated now, the division was expert utilizing district shape properties (by means of the morphological administrators) without counting dim scale qualities of front & back intersection lines. Since intersection lines are marginally more brilliant than encompassing LC, dim scale data can be utilized to all the additional precisely characterize division between 2 lungs [25].

IV. RESULT ANALYSIS

The toolboxes used for proposed work are image processing toolbox and wavelet toolbox. These tool stash give specialists and researchers a broad suite of hearty computerized picture handling and investigation capacities. Picture handling tool stash is intended to free specialized experts from the tedious undertakings of coding and investigating essential picture preparing and examination activities sans preparation. This converts into huge efficient and cost decrease ~~benefits, empow~~ers to invest less energy coding calculations and additional time investigating and finding answers for various issues. The tool stash underpins an extensive variety of picture handling tasks, including the accompanying:

a) Displaying and exploring images
b) Spatial transformations
c) Morphological operations
d) Analyzing and enhancing images
e) Linear filtering and filter design
f) Neighborhood and block operations
g) Image deblurring
h) Region based processing

Fig. 2 Original Lung Image

Fig. 3 CLAHE Image of Proposed Lung Image

Fig. 2 & 3 represents original Lung Image & CLAHE image. These image are enhanced by preprocessing of the image.

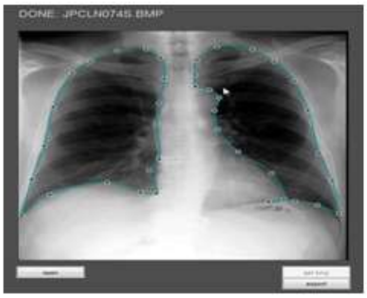


Fig. 6 GUI Image Import Section

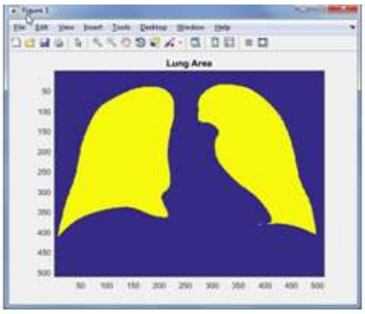
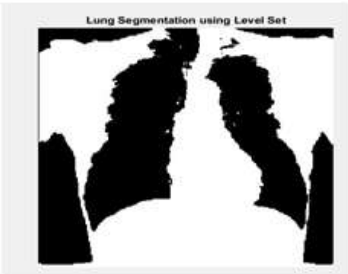


Fig. 7 Lung Area Detection



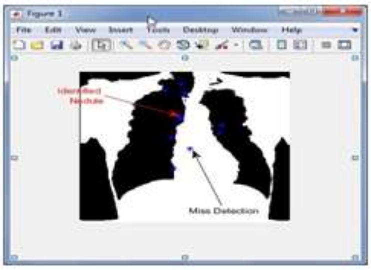


Fig. 8 Lung Area Segmentation using level set Fig. 9 Identification of Nodule and Miss Detection

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Fig. 4 & 5 represents CLAHE & NBPC Image and ROC of lung image. The tumor area is find out from these images. The lung cancer is detected after import the given CT scan images, The dataset of CT images are import in GUI import section as shown in Fig.6. The Lung area detection as shown in Fig. 7.

Lung area segmentation using level set algorithm is shown in Fig. 8. Level Set [33-34] algorithm is used for segmentation. Identification of nodule and miss detection is arranged in Fig.9.

Table 2Performance Parameter of Lung Image

Sr. No.	**Performance**	**Mean**	**Standard Deviation**
1.	Orientation	21.91421	55.34241
2.	Perimeter	178.2021	38.42679
3.	Solidity	0.902295	0.070057
4.	Entropy	0.201344	0.033201
5.	Eccentricity	0.6240096	0.16005135
6.	Area	0.6987201	0.9875214
7.	Convexa	0.728954	0.875412

Table 2 gives the performance parameter of lung images. The parameter like orientation, solidity and entropy, eccentricity etc. are shape parameters.

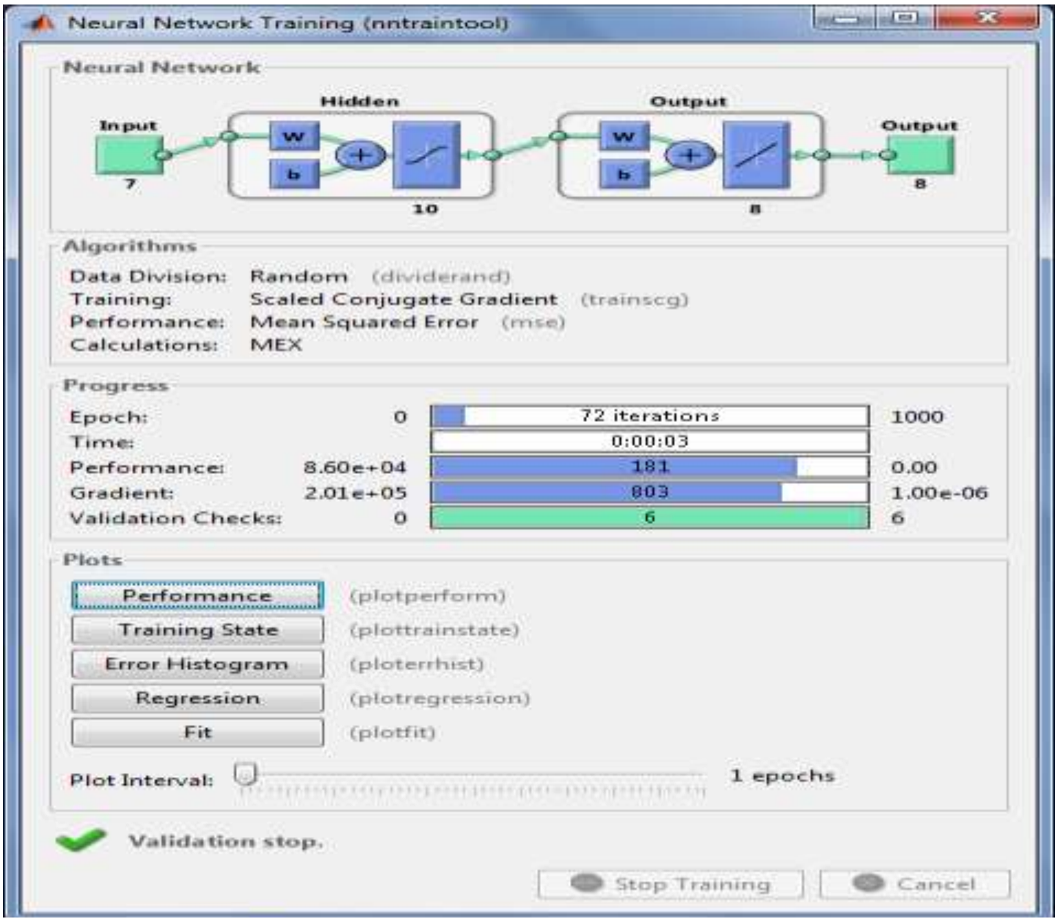

Fig. 10 Neural Network Training tool

Neural network training tool is given in Fig. 10.The back propagation neural network selected with scaled conjugate training function. For 1000 epochs, 72 iteration the performance is calculated. There are 6 validation check points given

.

Table 4: Network Parameters

Parameters	**Value**
Input layer	7
No. of epoch	72
No. of error	0.5
Min. learning rate	0.001
Hidden layers	10
Activation function	$1/1+e^{x}$
Learning rule	Gradient momentum
Training	Scaled conjugate gradient back propagation
Output layer	8

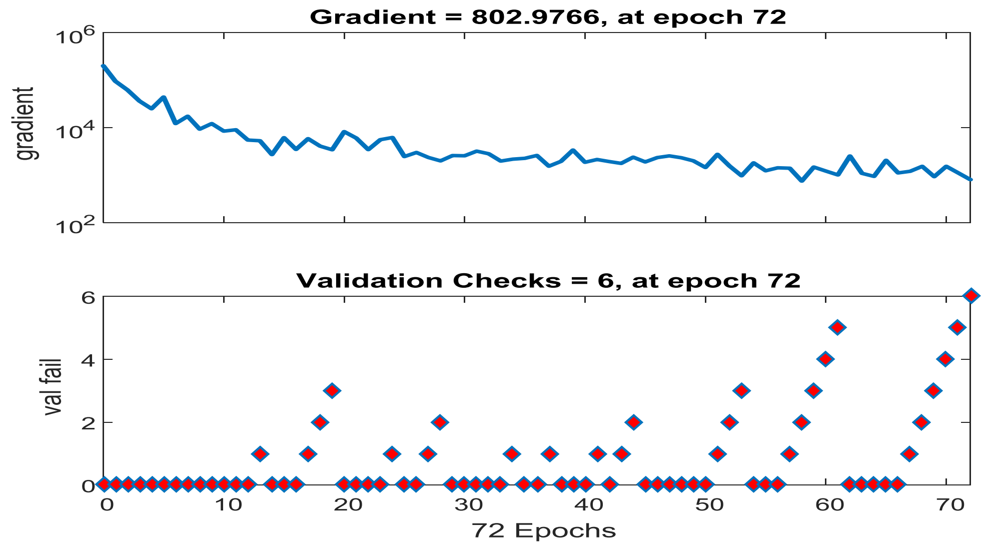

Fig. 11 Validation Check at 72 epochs

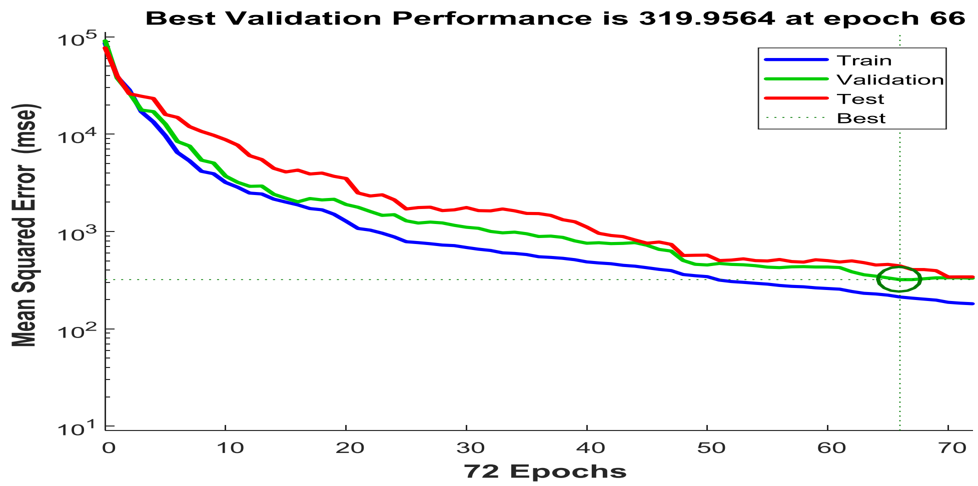

Fig. 12 Validation Performance for different Epochs.

Fig.11 represent validation checks at 72 epochs. In this gradient& validation checks are 802.9766 & 6 respectively.

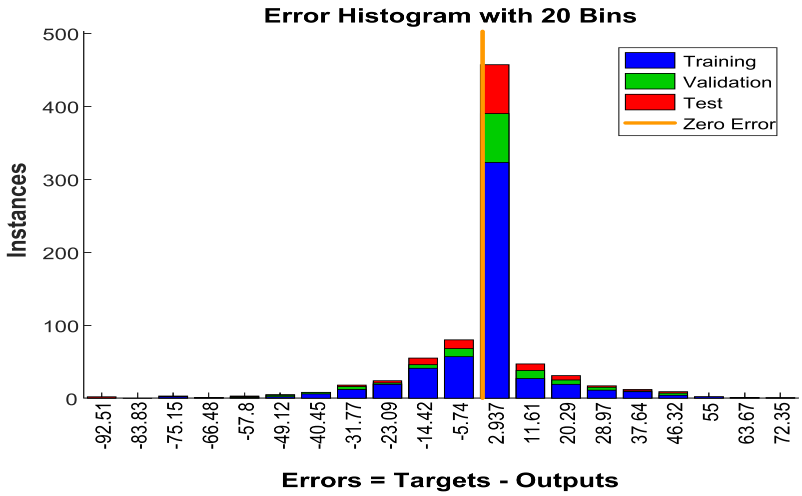

Fig. **13** Error Histogram with 20 bins

For 20 bins error histogram contains training, testing, validation and also zero error index is given above in fig. 13.

Table 3 Comparative Analysis of Accuracy with different Methods

Sr. No.	Dataset	Methodology	Accuracy
1.	216 CT Images	Feed Forward Neural Network 20 hidden nodes	92 %
2.	80 X- Ray Image	Feed Forward Neural Network (7 Neurons)	92 %
3.	70 CT-Diagnosis database	Feed Forward Neural Network (14 Neurons)	80 %
4.	12 CT Scan Image	Entropy Degradation Method	77.8 %
5.	100 sputum color images	ANN & SVM	ANN: 90 % SVM : 97%
6.	1500 CT Scan Image	CNN	65 %
7.	80 CT Scan	SCG-BPNN, 10 hidden layer	97.3 %

Table 3 analyses the comparative analyses of 80 CT Scan image. The accuracy is improved up-to 97.3 %.

Table 5: Network Performance

Parameter	Value
Recognition accuracy	97.3%
Mean square error (MSE)	1.00e-06

Table 5 shows network performance parameters i.e. recognition, accuracy & mean square error. Table 3 represents that proposed method is efficient in comparison to other methods and provides 97.3% recognition accuracy.

V. CONCLUSION

Precise division of objects of intrigue is one of the fundamental prerequisites of any medicinal imaging and CAD framework. At present, a wide range of shape/appearance highlights and choice procedures in light of these highlights are created, tried, and utilized for taking care of utilization particular division issues. The best methodologies consolidate numerous picture/question highlights and information preparing strategies. Be that as it may, however tests bring more precise outcomes, the division frequently turns out to be excessively mind boggling and tedious. The created computerized lung division techniques that give a critical piece of our CAD inquire about for Lung filters. The accuracy is improved up to 97.3 %.

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