CAD System for Non Small Cell Lung Carcinoma using Laws' Mask Analysis

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***Abstract*— Lung carcinoma is most occurring death through cancer across the world. For diagnosis and detection of lung cancer there are different techniques used. The most encouraging techniques for early detection of cancerous cells are Computer Aided Diagnosis (CAD). CAD depends on the analysis of quality of ultrasonic images by detecting lesions that may indicate the presence of lung cancer. The CAD system envelopes four main processing steps: preprocessing, feature selection, feature extraction, and feature classification. Different classifiers are used to allocate the cells into adenocarcinomas, squamous cell carcinomas and large cell carcinomas which are the parts of Non Small Cell Lung Carcinoma. This paper proposes a CAD system using Laws' mask and SVM classifier. The accuracy of 95.65% is obtained from laws' mask 3. The results will be further used for a CAD system for early analysis of lung cancer to improve the chances of survival of patient.**

Keywords — Lung carcinoma, classifications, Laws' mask Feature Extraction, Ultrasonic images, CAD.

I. INTRODUCTION

Lung carcinoma, commonly known as lung cancer, a malevolent lung tumor defined as unchecked growth of undesirable tissue of the lungs. If it is uncured, then this unwanted growth may spread beyond the lung which is known as the process of metastasis into the nearby tissue or even to the other parts of the body. Maximum cancerous growth that begins in the Lungs is known as carcinomas or primary lung cancers. Smoking is main cause of lung cancer. Approximately there are 23 times more chances of lung cancer growth in men who smoke. Women are 13 times more likelyto be effected than compared to never smokers. Most commonly diagnosed cancer worldwide is lung cancer. More than 225000 new cases of lung cancer will be diagnosed in U.S in 2016. An estimated 158,090 Americans are expected to die from lung cancer in 2016, accounting for approximately 27 percent of all cancer deaths. The rate of new cases in 2016 showed that men develop lung cancer more often than women (60.9 and 49.7 per 100,000, respectively).[1]

Early detection of the disease doesn't only help in the proper diagnosis but also minimizes the risk of the unwanted result of the disease (death). Various early detecting techniques are available these days that include X-Ray, Sputum cytology, Ultrasonography, Magnetic Resonance Imagining (MRI) and Biopsy. In biopsy, a sample of lesion is taken out for the analysis that results in unbearable pain to patient. To help the patient and reduce unnecessary biopsies, the most frequent method includes CT scan, Ultrasonography [2]. The CT scan could show some small lesions in infected lungs which may not be detected by X-ray. Lung cancer is categorized as:Non small cell Lung cancer(NSCLC) and Small cell lung cancer (SCLC).The Ultrasound imaging provides the non-radioactive, non invasive, real time display, low cost and better penetration ability as compared to the X-ray. Modern ultrasound also helps to distinguish between the SCLC and NSCLC types. Small cell lung cancers are twenty percent of lung cancer and are growing rapidly cancer among lung cancers [3]. NSCLC- The commonly seen lung cancer type which is approximately 83% among all cases. NSCLC commonly divided in three types: *Adenocarcinomas*, *large cell carcinomas* and *Squamous cell carcinomas* [4].

Adenocarcinoma of the cancer of lungs, one of the most common kind of lung carcinoma that contain some defined molecular feature or malignant tissue architectural, including the doctor gland development or the construction of the significant amount of mucus[5]. It comprise up to 50% of Non small cell lung cancer. Computer Aided Design (CAD) system is used to classify the type of lung cancer.

II. METHODOLOGY

The system follows a sequence of experimental flow as shown in Fig1

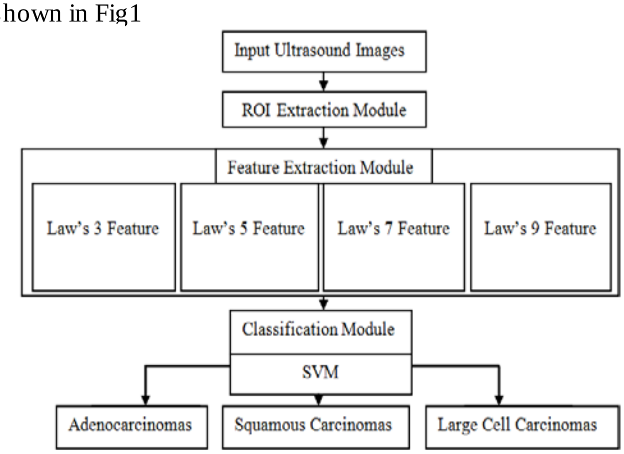


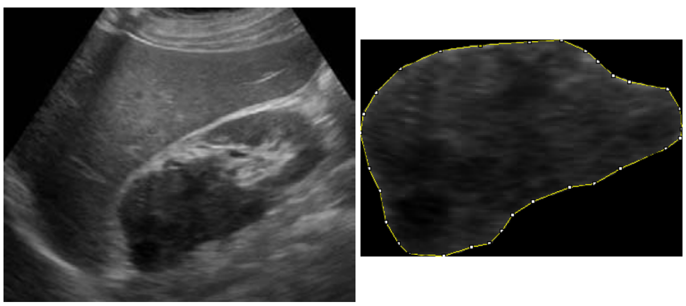
Fig. 1. Overview of the system

A. Database Ultrasound Images

For analsis, the data is taken from [6] this is the NSCLC andSCLC. We have taken data of 92 cases and discarded the cases of biopsy and cases having the blood vessels. Our database contains cases of Adenocarcinomas, large cell carcinomas and Squamous cell carcinomas of NSCLC type.

B. ROI Extraction Module

The abnormalities in the ultrasonic images are detected and remarked with the help of the radiologist and then images are segmented using *imageJ* software[7]. The ImageJ software is used to mark the abnormal area and segment it in parts. Further segmented area is encased in a elongated box adjoining the boundaries of abnormality as shown in Fig 2.



(a) (b)

Fig. 2. (a) : ROI marked in Adenocarcinomas (b): Boundaries enclosing ROI of Adenocarcinomas

C. Feature extraction Module

The abnormal area which has been damaged by any disease is known as lesion. The feature extraction module contains Texture Features which are classified as 1). Signal Processing Based Methods 2).Statistical Methods 3).Transform Domain Methods [8-11]. In our work the lesions are characterized with the use of Signal Processing Based methods.

1) Signal Processing Method

A set of coherent mask that are also known as Texture Energy Masks are used in Laws' Based Textures Features[12]. The texture feature are calculated by convolution of the images with these masks. The filters are designed up by the combination of two or more one dimensional kernel vectors. The dimensions (*d*) of these vectors can take value *d*=3, 5, 7, 9. The characteristics of the texture feature are determined by execution of Edge detection (E), Level detecgtion (L),Ripple detection(R),Spot detection (S) and Wave detection (W) by using filters [13-25].The resolution of dimension 3 vector is: L3 is 1, 2, 1; E3 is -1,0,1 and S3 is -1,2,-1 And of dimension 5 is: L5 is 1,4,6,4,1; E5 is -1,-2,0,2,1; S5 is -1,0,2,0,-1; W5 is -1,2,0,-2,1 and R5 is 1,-4,6,-4,1

Different features are extracted by using masks of different dimensions. The mask for different dimensions d= 3 and d=5 are shown in Fig 3 and Fig 4.

L3L3	E3L3	S3L3
L3E3	E3E3	S3E3
L3S3	E3S3	S3S3

Fig. 3. Laws' mask of dimension 3

In dimension 3 Laws' Mask as in the figure 3, there are 9, 2-D masks which include three masks of identical pairs, so rotation invariant texture image will be 6. There are 5 descriptors that are derived from ROI, so feature vector length will be 6×5=30.

L5L5	E5L5	S5L5	R5L5	W5L5
L5E5	E5E5	S5E5	R5E5	W5E5
L5S5	E5S5	S5S5	R5S5	W5S5
L5R5	E5R5	S5R5	R5R5	W5R5
L5W5	E5W5	S5W5	R5W5	W5W5

Fig. 4. Laws' mask of dimension 5

Dimension 5 in Laws'mask as shown in Fig 4, there are 25 2-D masks in which rotation invariant texture images of identical pairing are 10, so total invariant texture images will be 15.There are 5 descriptors that were derived from ROI ,so the feature vector length or number of features extracted will be 15×5=75.

The laws' mask Filter with 7 length will be of dimension 3 × 3 and the laws' mask filter of 9 length will be of dimension 5 × 5 and will have same feature vector length as dimension 3 and 5. To analyze Laws' Mask, there is a procedure to be followed. The sequence for dimension 5, [26-32]

a) The Texture Image (*TI*) is obtained by convolving the 2-D mask with input image I (i, *j)*

$$TI_{E5E5} = I_{i,j} \otimes E5E5 \qquad (1)$$

b) The disparity from equation (1) of the texture image obtained which is normalised

$$Normalise\,(TI_{mask}) = \frac{TI_{mask}}{TI_{L5L5}} \qquad (2)$$

c) The Texture Energy Measurement (TEM) filters are used to pass the Texture image

$$TEM_{i,j} = \sum_{u=-5}^{5}\sum_{v=-5}^{5} Normalise\,(TI_{i+u,j+v}) \qquad (3)$$

d) By collaborating 25 TEM descriptors, 15 rotationally invariant TEM's are obtained that are denoted as TR.

$$TR_{E5L5} = \frac{TEM_{E5L5} + TEM_{L5E5}}{2} \qquad (4)$$

e) Five statistical parameters Mean, Standard Deviation, Skewness, Kurtosis, Entropy are determined. These five statistical parameters are elaborated in [15].

D. Classification Module

Characterization of classification can be done as unsupervised classification and supervised classification. Supervised classification is one for which the classes are defined for training sets else vice-versa.In our work we have used classifier named SVM. This classifier comes under the class of supervised classification. SVM classifier can be implemented by LibSVM library [33]. SVM works on fundamental approach of decision planes, where decision boundaries are defined. Kernel based classifiers; the aligning of non linear training date of higher dimensional feature space from input space has been done using the kernel functions [34-35]. For classification task, Gaussian radial basis function kernel's attainment is analyzed. To chose the regularisation parameter C and kernel parameter γ is always an analytical step for having a desired abstract performance. By doing the expanded search, that is carried out in the parameter space for the values of C ϵ $\{2^{-4}, 2^{-3} \ldots 2^{15}\}$, γϵ $\{2^{-12}, 2^{-11} \ldots 2^{4}\}$,the excellent values of the C and γ are obtained.

III. Results and Discussions

The results of classifications are computed by using different dimensions (3, 5, 7, 9) of Laws' Mask are tabulated from Table 1 to Table 4 respectively. Diferent terms are used in the table are : Adenocarcinomas, CON: Confusion Matrix, LC: Large cell Carcinomas ,SC: Squamous Carcinomas, TFV: Texture Feature Vector, , *l*: length of TFV ,OCA: Overall Classification Accuracy.

TABLE I. SVM classifier resultusing Laws' Mask dimension 3

TFV(*l*)	CON				Sensitivity	OCA
			SC	LC		
	AC	16	0	0	100%	95.65%
TFV(30)	SC	1	14	0	93.3%	
	LC	1	0	14	93.3%	

TABLE II. SVM classifier resultusing Laws' Mask dimension 5

TFV (*l*)	CON				Sensitivity	OCA
		AC	SC	LC		
TFV(75)	AC	15	0	1	93.8%	89.13%
	SC	2	12	1	80%	
	LC	1	0	14	93.3%	

TABLE III. SVM classifier resultusing Laws' Mask dimension 7

TFV(*l*)	CON				Sensitivity	OCA
		AC	SC	LC		
TFV(30)	AC	14	0	2	87.5%	84.78 %
	SC	3	12	0	80%	
	LC	2	0	13	86.6%	

TABLE IV. SVM classifier resultusing Laws' Mask dimension 9

TFV(*l*)	CON				Sensitivity	OCA
		AC	SC	LC		
TFV(75)	AC	14	0	2	87.5%	82.6 %
	SC	2	12	1	80.%	
	LC	2	1	12	80%	

In this experiment, the highest accuracy obtained was 95.66% by using Laws' Mask dimension 3. The classifier used for analysis purpose is SVM classifier. For dimension 5 we got the result 89.13%, for dimension 7 we got the result 84.78% where as for dimension 9 the results were 82.6%.

IV. Conclusion and Future Work

The best result is 95.65% and is coming out by Laws' Mask with dimension 3. The results in dimension 9 are misclassified, so in future authors will focus to improve the result of the system with dimension 9 and improve the performance overall of system. For improvement of this work, the author will use various filters (Gabor Wavelet) and classifiers for achieve more accuracy in results.

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