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Cancer Detection Using Neuro Fuzzy Classifier in CT Images

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***Abstract*—** In this study, we have implemented an adaptive neuro fuzzy inference system (ANFIS) for detection of mass in CT images for early diagnosis of lung cancer. After completion of preprocessing and segmentation process four features have been extracted from images and given to ANFIS classifier as an input. The fuzzy system detects the severity of the lung nodules depends on IF-THEN rules. Feature based data set has been created with five fuzzy membership functions of each input. The proposed model is applied on more than 150 images and the computer added diagnosis (CAD) system achieved sensitivity of 97.27% and specificity of 95% with accuracy of 96.66%.

Keywords- *Computed tomography (CT), Adaptive neuro fuzzy inference system (ANFIS).*

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I. INTRODUCTION

To improve the diagnosis accurate interpretation is required in cancer detection. For this several features are needed to feed into the classifier to make robust CAD system. Neuro fuzzy can be designed with three facts: create optimal no of rules, discovering membership function and tuning of both with training. The past research has been introduced to improve cancer diagnosis with intelligent evaluation. Lin et al. (2005) presented an extension of neural network based fuzzy model for the detection of lung nodule .After the thresholding stage, some part of the blood vessels or the large airways may also be removed. So, in order to fill these areas, morphological closing and labeling was done. In order to make distinction between the nodules and other structure in lung region, three main features area, brightness and circularity were calculated. This neural network based fuzzy model consists of four layers: input layer, fuzzification layer, rule inference layer, defuzzification layer. With this system, the classification accuracy of 89.3% was achieved. The false positive value was 0.21. The system was faster and no prior knowledge was required, the fuzzy rules were defined using learning procedure and Detection rate was high [1]. Al-Daoud et al. (2010) proposed modified fuzzy c-means radian basis function network for breast cancer images and compared with adaptive neuro fuzzy inference system (ANFIS) and obtain 97% classification rate with less rule set as compare to ANFIS [3]. Bastawrous et al. (2005) developed a CAD system used for the detection of Ground Glass Opacity (GGO) nodules in chest CT images. Gabor filter has been applied in order to enhance the detection process with some morphological operations to extract the objects having high intensity values. The algorithm was applied on 715 slices containing 25 GGO nodules and achieved detection sensitivity of 92% with false positive rate of 0.76 FP/slice. Lastly, Artificial Neural Network (ANN) used to reduce the number of FP rate to 0.25 FP/slice and achieved sensitivity up to 84 % [6]. Ramaraju et al. (2015) presented a neural network base technique for the detection of lung cancer after segment the image using fuzzy c-means (FCM).The extracted feature are provided to network for training purpose and also to verify the type of nodule whether it is benign or Malignant[14].

Ada et al. (2013) presented some feature extraction process and neural network classifier to predict the actual stage of lung cancer. Various Extraction methods were discussed to achieve proper feature of images such as grey level co-occurrence method, binarization method, principle component analysis, and neural network classifier [16]. Samuel et al. (2007) described a method for recognizing the lung nodules for different diagnosis of lung cancer based on CT images which followed steps such as preprocessing using wavelet technique and bi orthogonal wavelet for image enhancement using Bi-Histogram equalization. The resultant image was more accurate and sharp. The enhanced image is binarised using the thresholding. Then the binarised image is subjected to Morphological transform. The filtered image is segmented and features are extracted. The extracted features are given to the fuzzy inference systems (FIS) to find the severity of the lung nodules based on the If-then rules [23]. Manikandan et al. (2016) designed a Hybrid Neuro Fuzzy System (HNFS) based on the observed symptom values for prediction of lung cancer stages. The study was made by asking 167 lung cancer subjects and 50 normal subjects, aged between 37-81 years, to respond to the CASQ-L. The significant symptoms were identified on all the observed data. The proposed system has achieved the mean accuracy of 96.5% for a fivefold cross-validation analysis [31]. Marya et al. (2015) proposed a system

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for malignant nodule detection by using Linguistic Fuzzy Modeling (LFM) and Precise Fuzzy Modeling (PFM) classifier with two stages i.e. lung segmentation with enhancement and feature extraction and classification to calculate abnormal area. Several feature like area, energy, entropy, intensity and eccentricity are fed to both the classifier to detect nodules and found both the methods are accurate [32].

II. PROPOSED METHODOLOGY

The main aim of the proposed system is to diagnosis the cancer mass inside lung area by using fuzzy rule with some membership function. We have been implemented the adaptive neuro fuzzy classifier with four input parameters such as area, perimeter, diameter and length (cm) to produced final output. Adaptive neuro fuzzy inference system is a combination of neural network and fuzzy logic getting advantages of both. The block diagram of ANFIS has been shown in Fig. 1 with input and output.

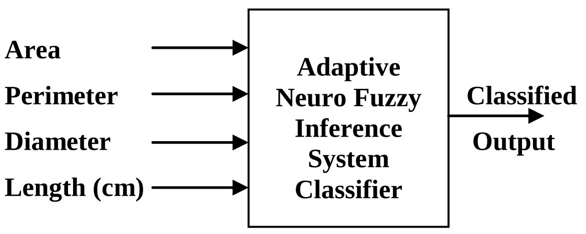

Fig.1 Input and output structure of ANFIS

Five membership functions have been created for each of the input as a representation of degree of truth. The graphical representations of one of the input i.e. length with degree of membership have been shown in Fig 2.

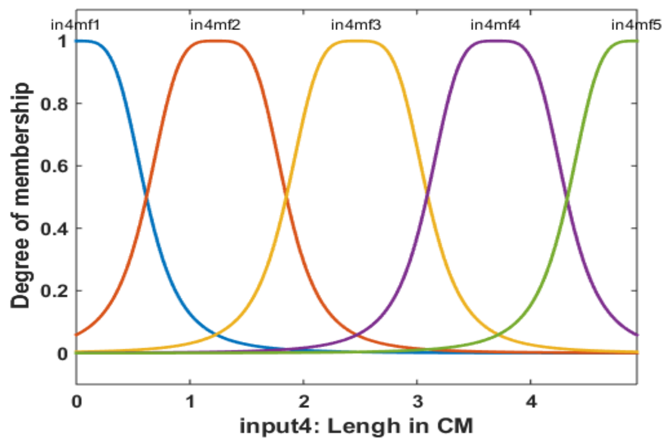

Fig.2 Membership function of length input

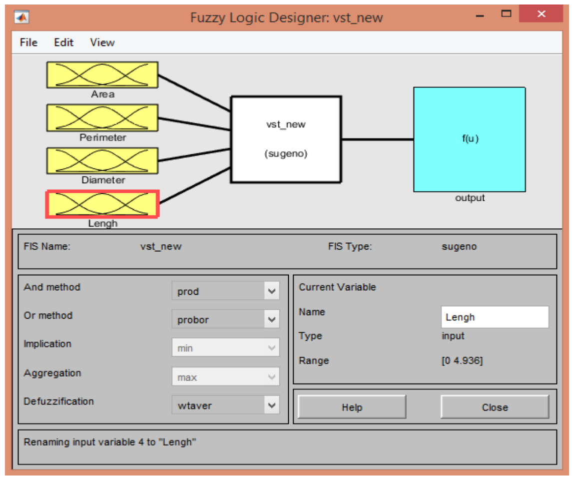

Fig.3 Layout of developed ANFIS Classifier

All these input parameters has been tested and trained and then fed into ANFIS classifier. The layout of developed ANFIS classifier has been shown in Fig. 3. The database for the training of ANFIS classifier on the basis of these four features has been created. The database has been saved for training by ANFIS classifier. Working of ANFIS classifier shown in Fig 4.The A and B phase of Fig 4 representing the testing and training part respectively **Output** The output classified each region of image and displays the result in term of critical and not critical.

The developed model of ANFIS consist of five layers namely input layer, input MF layer, rule based, output MF and output respectively and adapted by supervised learning algorithm. On the basis of membership function 625 rules has been created to generate output. The Developed model of ANFIS classifier has been illustrated in Fig. 5. The ANFIS works on If-Then rules based on the various membership function values of input parameters. These rules have been designed for the developed ANFIS classifier.

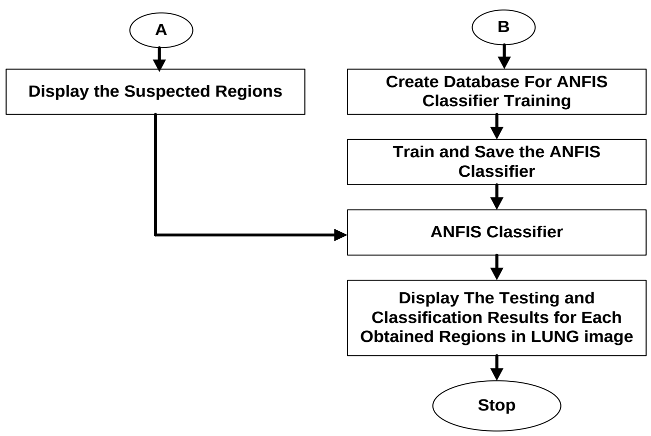

Fig.4 Working of ANFIS classifier

The structure of if –then rule is given below.

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if (input1 is membership function1) **and/or** (input2 is membership function2) **then** (output$_n$ is output membership function$_n$)

The some of the rules are shown in table 1 as a sample. These rules are used for accurate detection of mass region with accurate values in lung CT images which is the input of classifier. The value of mf1 means smallest range and mf5 means highest range.

Table 1 ANFIS rules

Rule 1	If (input1 is in1mf1) and (input2 is in2mf1) and (input3 is in3mf1) and (input4 is in4mf1) then (output is out1mf1) (1)
Rule 2	If (input1 is in1mf1) and (input2 is in2mf1) and (input3 is in3mf1) and (input4 is in4mf2) then (output is out1mf2) (1)
Rule XXX	--
Rule 625	If (input1 is in1mf5) and (input2 is in2mf5) and (input3 is in3mf5) and (input4 is in4mf5) then (output is out1mf625) (1)

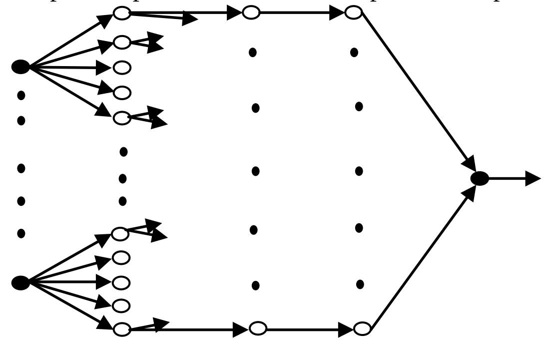

Fig 5 Developed model of ANFIS classifier

III. RESULT AND DISSCUSION

Various non cancer and cancer images have been tested through CAD system with ANFIS classifier using K-means and FCM. A comparative study of 36 images with both the clustering methods is shown in table 2. We found that FCM is better for our ANFIS model.

Table 2 Performance evaluation of CAD

Methods	TP	FP	TN	FN	SE	SP	AC
K-means	16	3	2	15	88.88	83.33	86.11
FCM	17	2	1	16	94.44	88.88	91.66

The 110 cancerous and 40 non cancerous images out of 190 images have been tested with our ANFIS dataset. The CAD system achieved sensitivity (SE) of 97.27% and specificity (SP) of 95% with accuracy (AC) of 96.66%.

IV. CONCLUSION

In this study, ANFIS model has been used with two segmentation processes K-means and FCM. The experimental result shows that we can use FCM for higher accuracy as compare to K-means. The fourth input parameter length of ANFIS used to find the tumor (T) stage of lung cancer which can be used to detect the cancer at early stage. In this paper we have shown how ANFIS is used in actual clinical diagnosis of lung cancer.

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