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LUNG CANCER DIAGNOSIS BY USING FUZZY LOGIC

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Abstract: Lung cancer is one of the most serious cancers in the world, with the smallest survival rate after the diagnosis, with gradual increase in number of deaths every year. Lung cancer is cause due to uncontrolled growth of abnormal cells in one or both lungs. The best way to protection from this danger disease is to detect it early, the early detection gives higher chance of successful treatments. The detection of lung cancer in early stage is difficult because the cancer cells cause many dangerous effect due to their overlapped structure. In this paper we proposed a diagnosis system to detect lung cancer based on fuzzy logic and neural network, we have used neural network to classify the normal and abnormal images , in the abnormal result , we use other parameters (symptoms) as input to fuzzy logic system to find the case of the patient (effected or not) depending on the membership function of inputs like 'smoking', 'persistent', 'coughing', 'coughing up blood', 'hoarseness of voice,', chain pain', 'etc. several images was used and good results has been satisfied.

Keyword- Computed Tomography(CT),lung cancer, fuzzy, GLCM.

1-Introduction

Lung cancer is considered to be the main cause of cancer death worldwide, and in its early stages it is difficult to detect because only in the advanced stage symptoms appear causing the mortality rate to be the highest among all other types of cancer. Lung cancer is cause due to uncontrolled growth of abnormal cells in one or both lungs. Lung cancer is a malignant lung tumor Characterized by uncontrolled cell growth in tissues of lung, if its missed with any treatment, this growth can be spread away from lung in a process called metastasis into nearby tissue of chest or other parts of the body.

Most lung cancer have already spread widely and are at advance stage when they are first found, these cancers are very hard to cure .Computed tomography scan (CT) can be used to show lung tumor than routine chest x-rays, aCT scan can also provide precise information about the size ,shape and position of any lung tumors and can help find enlarged lymph nodes that may contain cancer that has spread from the lung.

This image can be modified to get better information and to isolate the region of interest to help in diagnosis the disease, then there are several processing operation can be used on this image such as image capture, image enhancement, which increase the necessary details that can be differentiate the strange part from the image, and segmentation such as binarization ,watershed that can be used to divide the image into its constituent region or object. It is used to simplifying or change the representation of the image into something that is more meaningful and easier to analysis, the features

extraction stage is to extract the properties of the image such as entropy, correlation e.t.c to be the input to the classification stage which have two classifier, first is neural network that is used to detect the normal and abnormal image, while the second classifier is fuzzy inference system that can be used to determine the stage of cancer by use the symptoms of the disease as inputs for the system [1][2].

2-Related Work

In 2012, S.A.PATIL and M.B.Kuchanur used the texture feature extraction process that is applied on chest x- ray image for small cell and non small cell types, the identifying features are obtained using image processing , then they are applied these feature to expert system to classify the lung cancer. The features that is used in this work was the geometrical features such as area, perimeter, diameter and irregular index, also they are used the first and second order statics features [3].

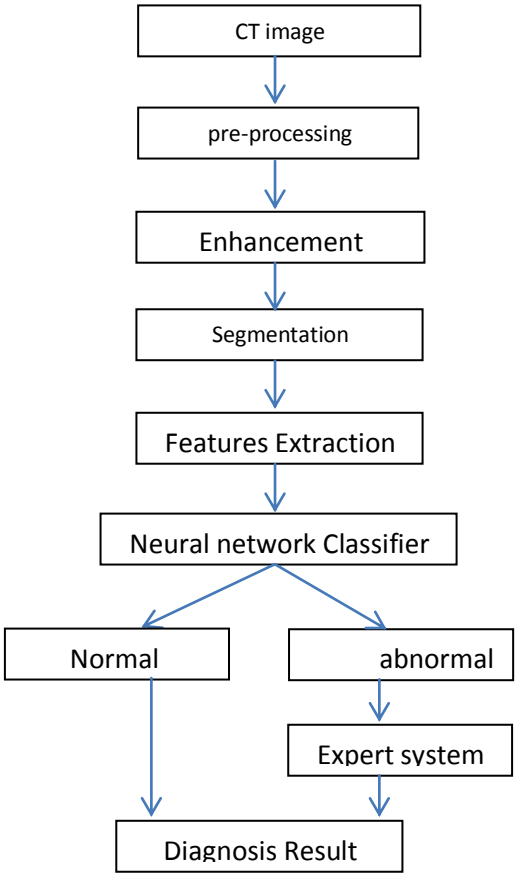
In 2013, Ada and Rajneet are proposed a methodology work based on binarization approach and gray level co-occurrence method to predict the probability of lung cancer presence .They are used principle component analysis(PCA)to standardize the data in image, also in this work supervised feed forwarded back propagation neural network was used as classifier tool , survival rate measure how many people remain alive with lung cancer after contain amount of time, a five year survival rate 40% for condition would mean that 40%of people , or 40 out of 100 people will be alive after five years [4].

In 2014, Mr.Vijay A.Gajdhane and prof.Deshponde L.M. are discussed image processing using Gabor filters with different frequencies for extract the features of the images , they are used watershed segmentation to separate the touching object in the image of the lung ,it has no smoothing /generalizing properties this method can segment the unique bounders from an image .According to their experimental subjective assessment in the segmentation stage ,the watershed method has more accuracy and quality than thresholding method.[5]

In 2015, Eman Magdy, Nourhan Zayed, and Mahmoud Fakhr proposed CAD system to analyze and automatically segment the lungs and classify each lung into normal or cancer. They are used Wiener filtering based on estimating the local mean and variance from a local neighborhood of each pixel then they are combine histogram analysis with morphological operations to segment the lung regions and extract each lung separately. Amplitude and Frequency-Modulation (AM-FM) method was used to extract features for ROIs. Then, the significant AM-FM features have been selected using Partial Least Squares Regression (PLSR) for classification step. Finally, they are used nearest neighbour (NN), support vector machine (SVM), and linear classifiers with the selected AM-FM features [6].

3- Proposed Methodology

In this paper, we proposed a system to diagnosis lung cancer disease based on fuzzy logic system , we have used different methods to processing the input image by enhancement the image and separate the different properties of the image , then extract the features of the image by using different approaches , this features will be used as input to neural network that will be used as classifier tool to detect the normal and abnormal image that may contain lung nodule which is small growths in the lung, then we used other lung cancer symptoms such as coughing, blood in sputum, shortness of breath, pain in chest e.t.c as input to expert system to determine the condition of the patient. Figure(1) show the flowchart diagram for the proposed system.



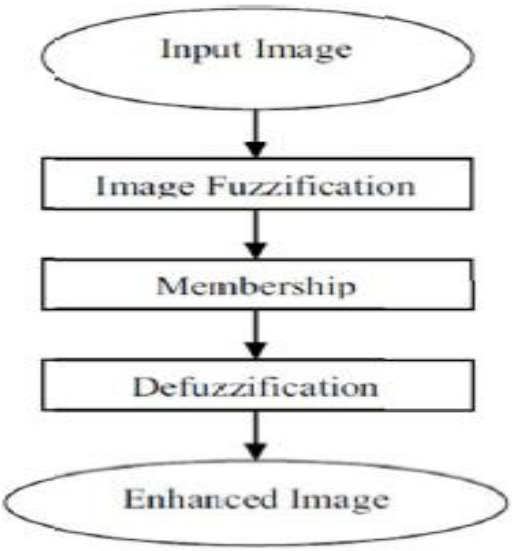
Figure(1) flowchart diagram for the proposed system

3-1 pre-processing

In the image pre-processing stage, we start with rearrange the computed tomography (CT) scan image, CT scan is more likely to show lung tumors than routine chest x-ray image ,its provide precise information about size, shape and position, we rearranged the CT image by extract the important section of the image and resize the image and convert it to gray scale 8-bit image to perform the processing.

3-2 Enhancement

We used fuzzy logic system to enhance the image of the lung in order to separate the properties of the image, by using membership function to increase the brightness and darkness of the image, this is achieved by making dark pixel more darker and bright pixel brighter, the pixel having middle intensity value is not changed much. At first we transform image into fuzzy function, modify the member ship function then defuzzification which is the inverse of fuzzification process, figure(2) show the structure of the enhancement system.[7]



Figure(2) structure of the enhancement system using fuzzy logic

3-3 Segmentation

There are different methods that can be used for image enhancement such a watershed, binarization, etc, in this work we used modified threshold method to separate the properties and to isolate the infected region of the lungs, modified threshold technique is used to segment the lung images[8][9] , this can be performed by the following steps:

1. chose initial threshold T according to the average value of the image.
2. the image is thresholded by T
   G1=f(I,j) if f(I,j)>T
   G1=f(I,j) if f(I,j)<=T
3. then we find the average of each set(G1 and G2)
   Mean1=average of G1
   Mean2=average of G2
   Then the average of mean1 and mean2 are calculated
   newT=(mean1+mean2)/2
4. repeat step2 and step3 until convergence has been reached. Then we use this threshold to segment the image.

3-4 Features extraction

In this step we extract the most important features from the segmented image to be the input to the classifier , there are more properties for image that can be used to differentiate the abnormal from the normal lung image, to get the feature of the image we have used GLCM.

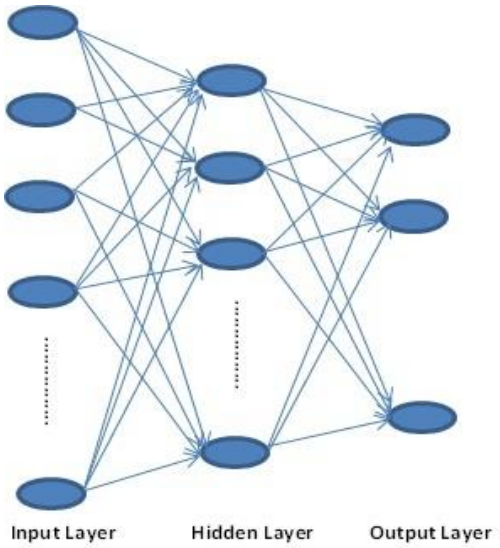
3-4-1 Gray Level Co-occurrence Matrix for Feature Extraction

The GLCM functions differentiate the texture of an image by estimated how often pairs of pixel with particular values and in a prescribed spatial relationship appear in an image, generating a GLCM, and then extracting statistical measures from this matrix. GLCM is a technique used to determine the spatial relationship of pixels it is also known as the gray level spatial dependence matrix. It estimated how often pairs of pixel with particular values and in a prescribed spatial relationship appear in an image, generating a GLCM, A GLCM represents the frequency of the occurrence of a gray-levels and separated by distances Δx and Δy along x and y directions. Co-occurrence matrices usually computed for specific displacements Δx and Δy and four directional angles: 0^{o}, 45^{o}, $90^{o,}$ and 135^{o}. This process leads to four GLCM matrices. i ,j and the values of Δx and Δy may be positive or negative integer to determine the neighbor pixel we used a matlab graycomatrix function to create GLCM and by determining how often a pixel with the intensity (gray level) value i occurs in a specific spatial relationship to a pixel with the value j, then we can find the different features[10],[11].

3-5 Neural network classifier

Neural network provide suitable solutions for problems, that characterized by high dimensionality noisy, complex, imperfect or error prone sensor data, imprecise, and lack of a clearly stated algorithm. This benefit of neural network is that a model of the system or subject can be built just from the data[12].

The feed forwarded neural network is constructed from input layer, hidden layer that may have one or more layers, the third layer is the output layer. This type of network may be fully connected or partially connected depending on the confection of the nodes between the layers, activity pattern (input vector) is applied to the sensory nodes of the network, and its effect propagates through the network, layer by layer. Finally, a set of outputs is produced as the actual response of the network, figure(2) show the diagram of feed propagation neural network [13].



figure(3) diagram of feed propagation neural network.

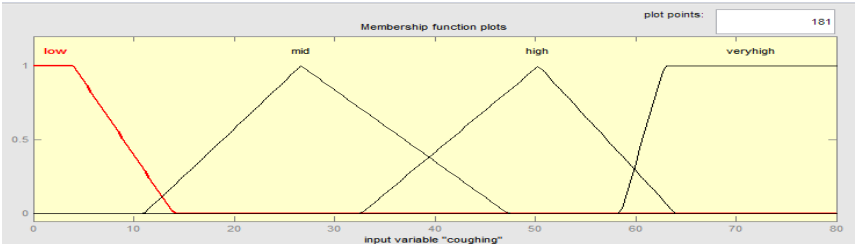
3-6 Fuzzy Inference System

Fuzzy inference system is the process of mapping from given input to an output using fuzzy logic. Fuzzy inference system is widely used such as control analysis in field of data classification, expert system, decisions analysis and computer vision[14].

Fuzzy inference associates a weighting with each of the inputs that are processed, define functional overlap between inputs, and ultimately determines an output response. These weighting is called membership then The rules use the membership values as weighting factors to determine their influence on the fuzzy output sets of the final output conclusion. Once the functions are inferred, scaled, and combined, they are defuzzified into a crisp output, which drives the system. There are different memberships functions associated with each input and output response[12] **,**in this paper we use different input that is the symptoms of the lung cancer disease, it is processed by specific membership function according to its effect on the patient and the result of the diagnosis is detected depending on the combination of these function, we used six lung cancer symptoms that is appear at local disease (restricted to the area where the cancer started).

1-Coughing up blood

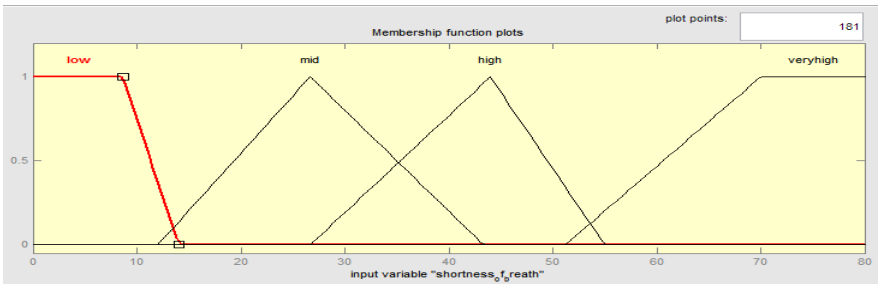
This input symptom measure the number of days that patient suffered from persistent bloody coughs which has not gotten better. This symptom being more important than other symptoms, if it takes longer than three weeks, or a long-term cough that gets worse. Figure(4) show the membership function for coughing up blood input.



Figure(4) membership function for coughing up blood

2-shorteness of breath

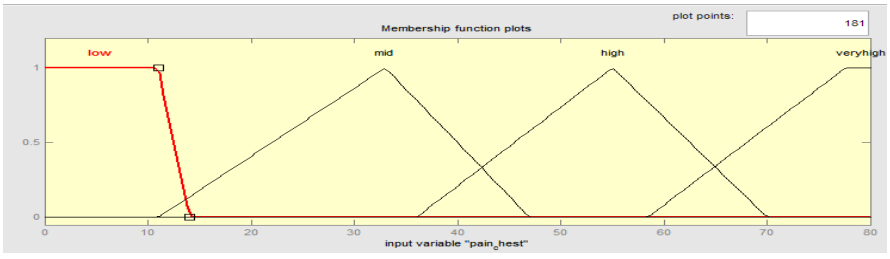
Persistent breathlessness with no obvious explanation with several times can be sign of cancer if take from two to three weeks, figure(5) show the fuzzy membership function for this symptom.



Figure(5) membership function for shortness of breath input.

3-pain in chest

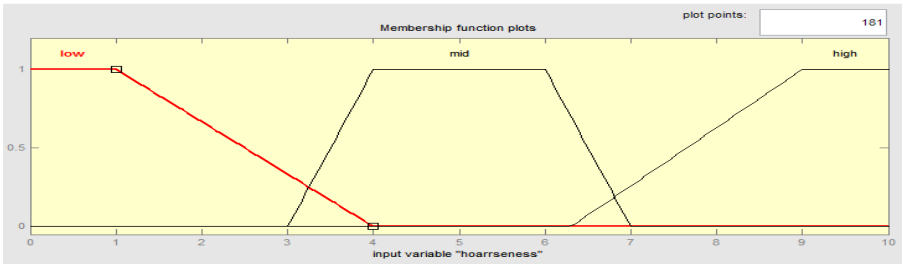
This input measure the number of times that patient suffered from pain in chest, this symptom is appeared at late time from the stage of the disease, figure (6)show the membership function of pain of chest symptom.



Figure(6) membership function for pain of chest input.

4-Hoarseness

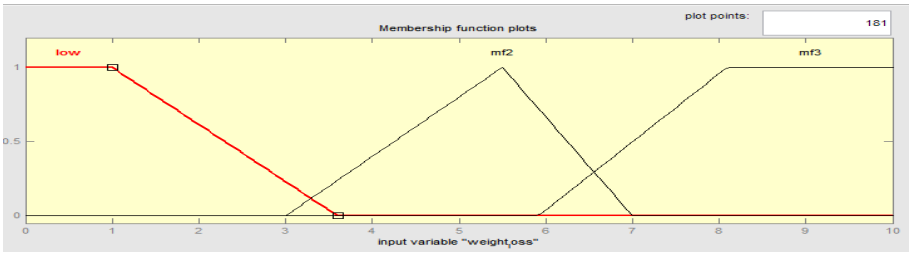
This input is determine the number of times that the person suffered from Hoarseness in the month, figure (7)show the membership function of Hoarseness symptom.



Figure(7) show the membership function for hoarseness input.

5-weight loss

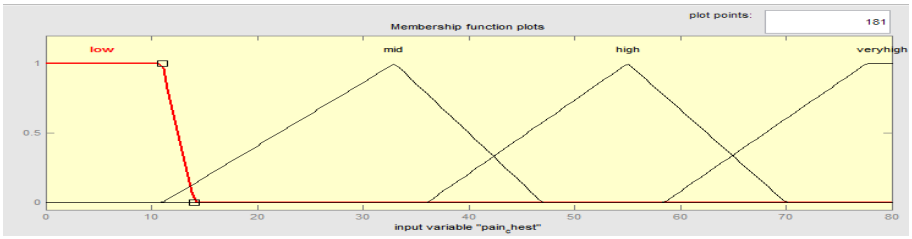
In this type of input, If there is more than 10 percent weight loss in less than a month, with the presence of other symptoms it is a sign of lung cancer, figure (8)show the membership function of weight loss symptom.



Figure(8) show the membership function for weight loss input.

6-headache

This symptom determine the number of times that the person suffered from headache, figure (9) show the membership function of this input.



Figure(9) show the membership function for headache input.

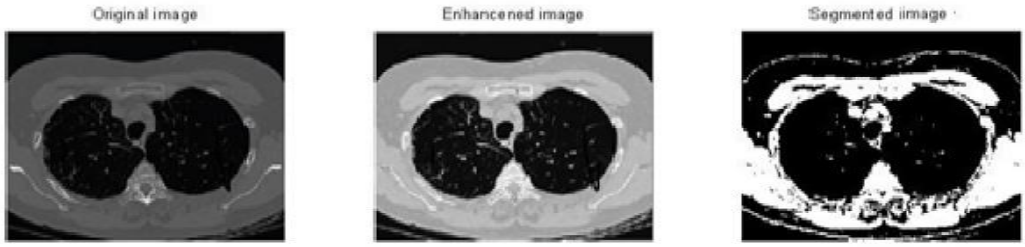
4-Result and Discussion

We are used proposed system to diagnosis the lung cancer depending on processing the CT images of the lung, these image are processing to enhance the properties of it to make it more easer in analysis, Table(1) describe the Peak Signal to Noise ratio and root mean square error for the enhanced image, for four different images ,figure(10),(11) and(12) show the original and the corresponding enhanced and segmented images.

Table (1) PSNR , RMSE and AMBE values for the enhanced image

image	RMSE	PSNR	ABME
Image1	3.85	24.71	14.8342
Image2	1.08	27.16	1.18
Image3	5.01	20.12	25.18
Image4	5.013	20.12	25.14

As shown in figures(10,11,12), the techniques that used can increase the brightness and darkness of the image by using fuzzy membership modification as enhancement method which can help in isolate the strange region of the lung.



Figure(10) original, enhanced and segmented image for normal image

Figure(11) original, enhanced and segmented image for abnormal image

Figure(12) original, enhanced and segmented image for abnormal image

We are use GLCM with different offset value as technique to extract the features from the modified image , Table (2) show the values of features for image with offset value (0,1),(-1,1),(-1,0),(-1,-1). While Table(3) show the properties of the image by using the GLSM technique with offset values (0,2),(-2,2),(-2,0),(-2,-2).

Table (2) image features using GLCM with offset value(0,1),(-1,1),(-1,0),(-1,-1)

features	(0,1)	(-1,1)	(-1,0)	(-1,-1)
contrast	2.2866	2.9720	2.5161	2.9968
correlation	0.8931	0.8606	0.8823	0.8595
Energy	0.5177	0.5067	0.5140	0.5063
homogenity	0.9586	0.9463	0.9545	0.9459

Table (3) image features using GLCM with offset value(0,2),(-2,2),(-2,0),(-2,-2)

features	(0,2)	(-2,2)	(-2,0)	(-2,-2)
contrast	3.019	3.5852	3.1410	3.6178
correlation	0.8552	0.8309	0.8525	0.8293
Energy	0.5041	0.4984	0.5043	0.4979
homogenity	0.9442	0.9354	0.9434	0.9349

We note that the values of correlation, energy and homogeneity are decreased from Table(1) to Table(2) because of the difference in offset values, while the value of contrast is increased because of the position of the pixels. Figure (9) show the normal lung image, while figure(13) show the abnormal image that can be the output of the neural network classifier .

Figure(13) original, enhanced and segmented image for abnormal image

If the image is abnormal, the patient must repeat the CT scan after a specific time to get more information about the lung if it has cancer or not, and the other symptom of this patient will be used as input to fuzzy inference system to determine the stage of the cancer if its is exist depending on several fuzzy rule , we are used symptoms with different membership function to diagnosis the stage of the cancer which can be one of the following[15] :

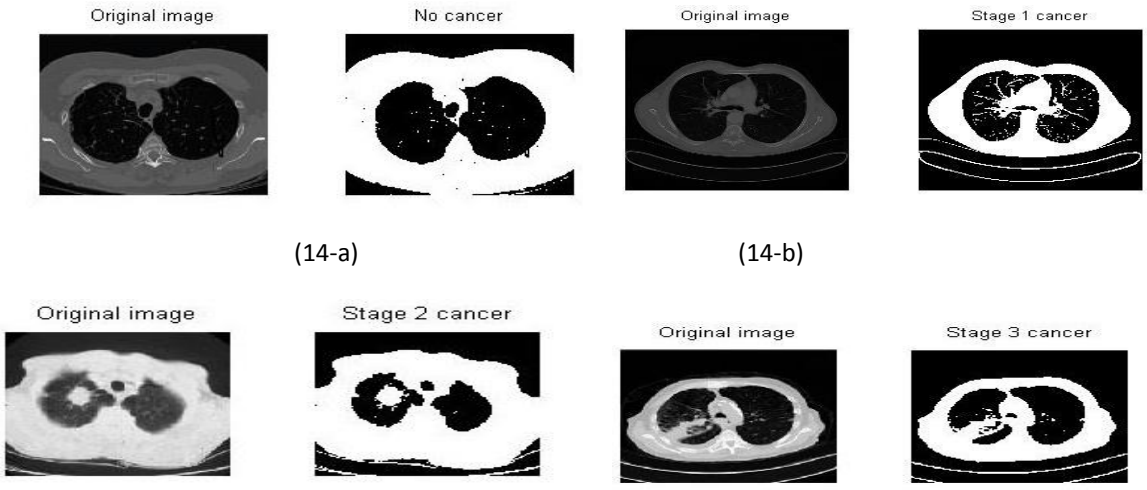
1-Stage1: Tumor 3 cm or less in greatest dimension, surrounded by lung or visceral pleura, The cancer is very localized and hasn't spread to the lymph nodes.

2-Stage2: Tumor more than 3 cm but 7 cm or less in greatest dimension, The lung may have collapsed or there may be two or more tumors in the same lobe of the lung.

3-Stage3 Tumor more than 7 cm or one that It may affect nearby structures or it may have spread to areas such as the chest wall or heart.

4-Stage4: Tumor of any size that the cancer has spread to the opposite lung.

Figure (14-a) show that the lungs have no cancer, while in figure(14-b) there is a tumor in the lungs which is in the first stage, figure (14-c) and (14-d) show lung cancer in stage 2 and stage 3 respectively.



Figure(14)a- no cancer b-stage 1 cancer c stage2 cancer d-stage 3 cancer

5- Conclusion

Lung cancer is the second most common cancer in both men and women and is by far the leading cause of death in both man and women, each year more people is die of lung cancer than colon, breast, and prostate cancers combined . The best way to protect from this danger disease is to detect it early, in this paper we proposed diagnosis system for lung cancer disease based on fuzzy logic system and neural network, several techniques are used to enhance the lung image and segment it in order to get more information about the characteristic of the CT lung image , then GLCM method is used to extract the features of the image that is used as input to classify stage , neural network is used in classification ,at this stage the image is defined normal or abnormal, the result of neural network is combined with fuzzy inference system that is used to determine the stage of the cancer depending on the symptom of the patient, different image of lung was used and good result have been satisfied.

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