A Detection of Lung Cancer based on Hybrid Optimization and SVM Classification

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***Abstract*—**Cancer is the leading life-threatening disease for people in today's world. Although cancer formation is different for each type of cancer, it has been determined by studies and research that stress also triggers cancer types. Lung cancer is very challenging to detect at its early stage with medical examinations. Early detection of lung cancer can help for the commendable decrease in the lung cancer mortality rate. In recent years, the image processing methodologies are widely used in medical image diagnosis, especially in detection of lung cancer tumors. One of the major reasons for non-accidental death is cancer. It has been proved that lung cancer is the topmost cause of cancer death in men and women worldwide. The death rate can be reduced if people go for early diagnosis so that suitable treatment can be administered by the clinicians within specified time. For any type of cancer, firstly image of internal parts of the body should be obtained. CT scan also known as X-ray computed tomography makes use of X-ray for capturing the images from various angles and merge these images to generate cross sectional tomographic image of particular areas of scanned tissues i.e. it allows the person to see the status inside body without non-invasive techniques. This sort of evolution could possibly initiate metastasis that is also an occurrence linked with subsequent tissues and also access outer the lung region. Treatment along with diagnoses depend on histological sort of cancer malignancy degree, accompanied by the patient's efficiency. Some feasible treatment options comprises of surgical method, chemical therapy, along with radio therapy. In this the features are extracted using independent component analysis, feature optimization is done using firefly swarm optimization and classification is done using support vector machines.

In this paper the fuzzy technique has been used for the feature extractions of DICOM images and we have also optimized the best features for lung cancer detection using firefly optimization and PSO method. Further, the classification is performed using the SVM classifier and also computed the best survival rate and accuracy for the proposed research work.

Keywords*—*CT; CAD; MRI; NSCLC;SCLC;PT machine

I. INTRODUCTION

Cancer is still the major cause of death in the world, further more lung cancer is the most frequently seen type of cancer among others (WHO, 2015). As there is no cancer registry system in TRNC, there is not any official data about cancer statistics. Yet, lung cancer is the leading cancer in males in Turkey as it is in the world male rates (T.C. Sağlık Bakanlığı, 2016). Early diagnosis and proper treatment may pull down the death rates, hence the CAD systems are increasingly becoming the preferred aid in diagnostic procedures by the doctors (Doi, 2007). CAD becomes a significant research topic in the diagnostic radiology and medical imaging. In fact, CAD systems help the doctors in interpreting the images of computed tomography (CT), magnetic resonance imaging (MRI), ultrasound, positron emission tomography (PET), conventional projection radiography as well as all other imaging methods. Practically, diagnosis process incorporates the assistance of computers from medical imagery, lab work, and electronic medical records and more. When it comes to radiology, CAD is the essential system of procedures in medicine that help doctors in the medical image interpretation. The use of the digital processing and hybrid optical technologies afford the reduction in a processing time as well as enabling more enhancements in specificity and sensitivity. The computer aided diagnosis holds the great potential for the radiology and its utilization is based on its capability to speed up a diagnostic process as well as lessen probable errors. The concept of the automated diagnosis exists from the year 1960, however the attempts in research and development were failed mostly (Doi, 2007).Now, there are many institutions all over the world that involved in the development and research of CAD aspects. Day by day, CAD systems are giving more confidence in the medical area therefore CAD systems become a superior method for the cancer detection in interpreting X-ray, CT, MRI and other medical images. Using the outputs of CAD systems as a reference helps the doctors not only to accomplish their tasks more accurately and precisely but also in a shorter time. The CAD systems ensure its reliability and efficiency to the integration of various scientific disciplines such as artificial intelligence, image processing, pattern recognition, etc.

II. LUNG CANCER

The unrestrained expansion [5] of abnormal cells in lungs causes lung cancer. These abnormal cells disturb the smooth functioning and development of lung tissues. If this condition is left untreated, abnormal cells grow and form tumors and ultimately damage the lungs that are proving oxygen to the whole body via blood [9].

A. Types of Lung Cancer

Two main types of lung cancers are non-small cell and small cell. Because of the large size of lungs, nodules can grow for a time until they are detected.

1) Non small cell lung cancer (NSCLC): The NSCLC is the commonly prevailing form of lung cancer, also according to AmericanCancer Society; NSCLC is responsible for 85 percent of the total lung cancers in America(American Cancer Society, 2016). The common tumors of lung cancers are following;

- Adenocarcinoma is the lung cancer in non-smokers, and equally found among menand women.
- Squamous cell carcinoma or sepidermoid carcinoma is the lung cancer that ispositively correlated with the tobacco smokers. This tumor is formed mainly in atthe center of large bronchi. Males are more vulnerable to this type of tumor.
- Large cell carcinomas are the tumor cells that have comparatively larger size withexcess cytoplasm. Unlike adenocarcinomas and epidermoid, these cells lackmicroscopic characteristics.

2) Small cell lung cancer (SCLC): The remaining 15 percent contribution in lung cancers is of SCLC. Tobacco smoking is theleading cause of SCLC and gets birth quickly as compared to NSCLC. In the body, thistype of cancer is relatively spread quickly, higher growth rate and shorter multiplying time.Chemotherapy is a more effective treatment for the SCLC [7].

B. Imaging Technologies Used for Diagnosis and Treatment:

Following are the some imaging technologies that are used for diagnosis and treatment [8].

1) Chest x-ray: X-ray machine discharges radiation that goes into the body and imaging picture of the organs on the film. To diagnose lung cancer, x-ray imaging is used as step that helps in theidentification of lung tumors. As mentioned, x-rays are not the final authority because theyare unable to differentiate between the cancer and other lung diseases.

Fig.1 Typical x-ray machine

2) CT scan: CT scan [6] stands for computed tomography, and it is an extended version of X-ray in whichcomputer is attached to the X-ray machine. Pictures that are taken from taken angles anddistances are processed in the computer and presented in the 3-dimenionsal, cross-sectional(tomographic) and in slices form. In this way, bones, tissues, blood vessels, and organs areshown up clearly. The imaging of CT scan is useful for diagnosis, treatment and progress of medication. Recently, helical or multi-slice scanning is introduced that almosteliminated gaps in the collection of slides.

Fig.2 Typical CT machine

4) MRI (magnetic resonance imaging): It is imaging technique [9] in which radio waves and strong magnetic fields are used by thescanners to form the inside images of the body. The powerful magnet is aligned with thenuclei of atoms, and then magnetic field triggers atom to resonate. In this way, nucleigenerate its own magnetic field and then the field is detected by the scanner for creating animage. The advancement in technology has helped to take detailedpictures from different angles. MRI is particularly helpful when there is a need for theidentification of soft tissues. This is the reason; this technique has more reliability [17].

Fig.3 Typical MRI machine

5) PET scan(positron emission tomography scan): If X-ray or CT scan diagnoses or doctor predicts any chances of lung cancer, PET scan issuggested for detailed results. In this imaging technique, tracer or radioactive glucose isinjected and then scanners are rotating to take pictures which tissues or organs used tracer(Mac Manus et al., 2003). When malignant tumor cells use glucose, they are showing upbrighter and more active in images [11]. The integration of PET-CT scan is very useful fordetecting the cancer. The CT scan gives a detailed view of tissues and organs, and PETgives pictures of abnormal activities and active cells. Researchers also concluded that

PETCT scan are producing more accurate results as compared to PET or CT scan alone.

Fig.4 Typical PET machine

C. Literature Review

Punithavathy Kannuswami, et.al, (2017), have main objective is to develop a Computer Aided Diagnosis system (CAD) based on Artificial Neural Networks (ANN). They have detected the lung cancer by extracting fractural and texture features from Positron Emission Tomography/Computed Tomography (PET/ CT) images. In lung PET/CT images contrast has been improved along with suppression of noise using fuzzy image processing and Wiener filtering method. The significant features are extracted by analyzing fractal and texture features and dataset is tested and trained by designing a ANN with optimal network parameters. The proposed system performance is evaluated by taking 80 testing samples and 1072 training samples that shows an improvement from existing systems. The 10 fractal and 3 texture features are identified for detecting cancerous regions and better results has been seen in terms of testing and training classification accuracy. The92.4%, 95% and 92.5% of accuracy has been achieved in training by texture, fractal and combined features [13].

Snehal Dabade, et.al, (2017), have analyzed that lung cancer is comes from lung tumor that is characterized by control cell growth in lung tissues. Throughout the world out of all cancer lung cancer is most normally occurred and even the death rate is increase for it. The detection of of cancer on early stages in required so that patient can be recovered from it. So, number of soft computing and image processing techniques has been proposed for determining cancer cells from medical images. The low distortion, less noise, better clarity and high resolution is the properties of CT images due to which its use of been found in image processing. The small nodules are very perfectly detected by the use of CT images. The patient survival rate has been increase by early detection of lung cancer. New CAD systems have been proposed for lung cancer detection in which three steps are involved. The pre-processing, lung segmentation and nodule candidate's classification are three steps involved in CAD. In this paper, authors have proposed a new segmentation method in which lung region is extracted from human chest CT.

Agus Maman Abadi, et.al, (2017), have recommended the use of chest radiograph for detecting lung cancer. In this paper, authors have used high frequency image enhancement with filer and histogram equalization that helps in enhancement of chest radiograph. Addition of it results in getting enhanced results for lung cancer detection. The lung has normal or cancer condition is detected using radial basis function neural network (RBFNN) classifier [19]. The Gray Level Co-occurrence Matrix method chest radiograph extracted features are evaluated using RDFNN. The energy contrast, correlation, inverse difference moment, and entropy are five features that are involved in it. The result demonstrated the effectiveness of image enhancement of high frequency emphasis filter and histogram equalization for increasing the accuracy of RBFNN classifier to detect a lung cancer using the chest radiograph.

Qing Wu, et.al, (2017), have analyzed that throughout the world total 10,000 billion of cost has been spent by labor as a cancer related medical expenses. The number of death rates getting increased every year. The late stage detection is the main cause of deaths related to lung cancer. So, best strategy will be the early detection of not only lung cancer but also for other cancer that results in saving life. An algorithm based on novel neural network has been proposed in this paper that is one of the entropy degradation methods (EDM). It detects cell lung cancer (SCLC) from computed tomography (CT) images. This new approach helps in lung cancers detection. The training data and testing data are high-resolution lung CT scans provided by the National Cancer Institute. They have selected 12 lung CT scans from the library, 6 of which are for healthy lungs, and the remaining 6 are scans from patients with SCLC. They have trained their model by taking 5 scans from each group and tested it using remaining two scans. The proposed algorithm is tested and proved to be 77.8% accurate[15].

Ratih Wulandari, et.al, (2017), have concluded that lung cancer is caused due to uncontrolled cell growth in lung. The count of lung cancer patients is maximum throughout the world. CT scan Thorax is a method for lung cancer patients' early detection. However, cancer detection in lung CT scan image still done manually. In this paper, authors have segmented the lung image then it is process as the lung CT-Scan as an input and cavity area is cut off using watershed process. The results have been calculated in terms of standard deviation and mean value calculated by color histogram calculation. This value is useful for evaluate non-cancer area and produce cancer image. Segmentation process will be followed by measurement of cancer and cavity area. The overall output is percentage between the large of cancer area and cavity area. The experiment represented that this method is able to detect lung cancer automatically. The performance segmentation for assessment errors obtained average cavity area segmentation 12.75% and cancer area segmentation 31.74%.

Taolin Jin, et.al, (2017), have recommended that detection of accurate early lung cancer is required towards precision oncology and would effectively improve the patients' survival rate. In this paper, they have used deep spatial lung features learning is used for exploring the capacity of early detection lung cancer capacity. The segmented CT lung volumes are used for constricting a 3D CNN network architecture as testing and training samples. The new model extracts and projects 3D features to the following hidden layers, which preserves the temporal relations between neighboring CT slices. There are total 11 layers in 3D CNN model is built that generates 12,544 neurons. A very large number of parameters are classified that gives whether the patient is diagnosed as cancer or not. The classification and activation methods used are sigmoid and RELU nonlinearity functions. The model achieves a prediction accuracy of 87.5% where only the biomedical images themselves are used as the input dataset. The model's lowest error rate reaches 12.5% that improves the traditional Alex Net architecture by 2.8%.

Bhagyarekha U.Dhaware, et.al, (2016), have recommended the use of classification and image enhancement as a big task mainly performing in medical field. The texture computed CT images are analyzed using image classification and enhancing. In this paper, different texture parameters are computed by taking lungs images. The normal and abnormal are two categories of lungs CT images and then based on extracted features classification is performed. The Grey Level Co-occurrence matrix (GLCM) texture based features are main focus of system implementation that plays an important role in medical field. Selection is based on the twelve various statistical features and seven shape for extraction by applying sequential forward selection algorithm. After application of sequential forward selection algorithm Bayesian classifier was applied among classified data to get best classification. Main types of lung cancers are non-small cell and small cell. Because of the large size of lungs, nodules can grow for a time until they are detected [19].

III. PROBLEM FORMULATION

Cancer is the most serious health problems in the world. In 2012, cancer is leading cause of death worldwide, accounting for 8.2 million deaths. The mortality rate of lung cancer is the highest among all other types of cancers, contributing about 1.3 million deaths per year globally [1]. There are many types of cancer, Lung cancer is one of the common types causing very high mortality rate. The best way of protection from lung cancer is its early detection and diagnoses. With the fast development of the technology of computed tomography (CT) technology, medical test images become one of the most efficient examination methods to detect clinically the lung disease. As the image processing field is growing day by day, researcher moves towards bio medical field to emerge new techniques and to diagnose various medical diseases using automated image processing algorithms. Among them Lung Cancer Segmentation also known as Cancer Detection and other lung cancer diseases (Silicosis, Interstitial Lung Disease) are very crucial. Initial stages of lung cancer having similar symptoms like silicosis, TB, Interstitial Lung Disease (ILD) due to which it result in delay in treatment process. Due to delay, treatment leads to high mortality rate. Therefore, early detection of lung cancer is the major factor in successful cancer treatment. Computational methods have good potential to predict cancer in early stages. But, these methods are not available today. So an efficient method is needed to which needs to be classified and detect the Lung Cancer disease whether it is in normal or abnormal state automatically with high precision and less error probability.

A. *Objectives*

Now a day lung cancer is the leading cancer among both men and women. Earlier detection of cancer is the only method to improve the survival rate. Presence of lung cancer can be diagnosed with the help of cancerous and non-cancerous images of lung. The research objectives of the work are:

- To study and analyzed the existing techniques of lung carcinoma.
- To input the DICOM images as a training set and perform pre-processing using segmentation of the image using edge detection
- To perform feature extraction and extract the feature vector using independent component analysis
- To perform instance selection using firefly and particle swarm optimization to optimize the features
- To perform classification to classify the normal lungs and abnormal lungs using Support Vector machines and evaluates the performance in terms of recognition rate, sensitivity and specificity.

IV. RESULTS AND DISCUSSUION

Lung cancer is customarily a contagion which takes place because of the element linked with unimpeded cell or conveniently progress in zones present in lung area. This sort of evolution could possibly initiate metastasis that is also an occurrence linked with subsequent tissues and also access outer the lung region. Treatment along with diagnoses depend on histological sort of cancer malignancy degree, accompanied by the patient's efficiency. Some feasible treatment options comprises of surgical method, chemical therapy, along with radio therapy. In this the features are extracted using independent component analysis, feature optimization is done using firefly swarm optimization and classification is done using support vector machines. The performance is evaluated in terms of false acceptance rate, false rejection rate, survival rate, and accuracy for the recognition.

Below are the result explanations or simulations done in MATLAB environment which are discussed briefly.

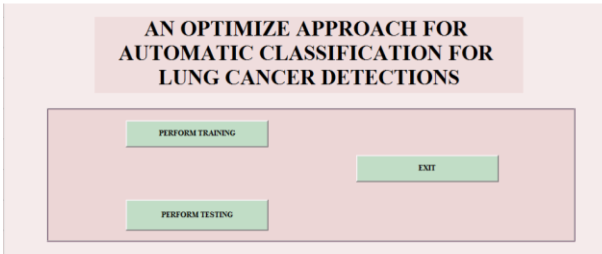


Fig.5 Main Panel

The figure 5 shows the main panel in which the GUI pushbuttons are used. The one is for the training process and other is the testing process and the third and last button is to exit from the whole process

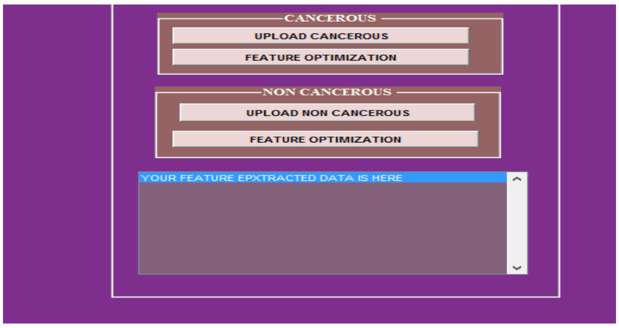


Fig.6 Front Panel

The figure 6 shows the training panel in which two categories are given one is cancerous and other is non-cancerous. In this you have to upload the cancerous image and then after all the images will be uploaded then you have to click on the feature optimization button. The above figure is made using graphical user interface which uses the user interface controls like pushbuttons, panels, edit texts and static texts.

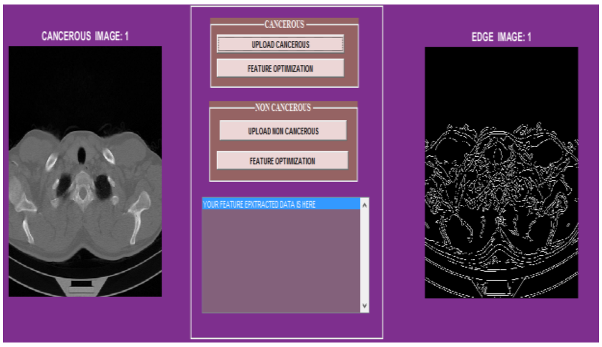


Fig.7 Uploading Images

The figure 7 shows the uploading of the cancerous samples for the training scenario and shows the uploading of the original image and edges of the image. The edge are detected to detect the boundary regions which will make the processing of the image easy. The edges are detected using canny edge detection technique.

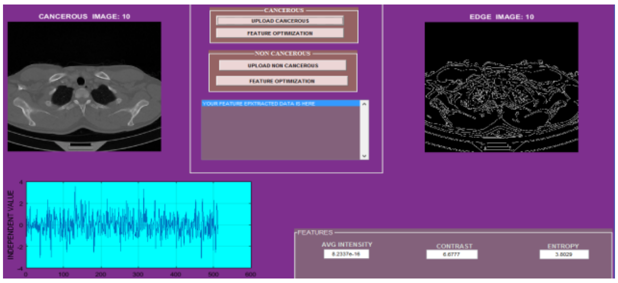
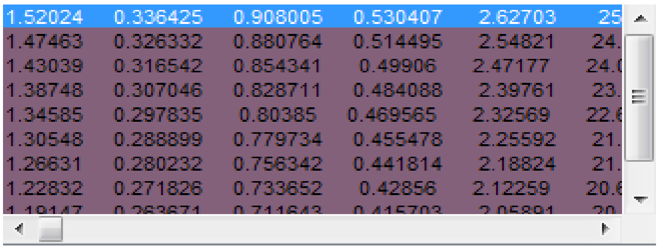


Fig.8 Feature Extraction

The figure 8 shows the feature extraction process of each uploaded sample side by side as the process of uploading is completed for the cancerous sample. In the same manner the process of uploading and feature extraction is done for the non-cancerous category. The features are extracted using independent component analysis which shows the independent characteristic values for each uploaded sample in terms of average intensity, contrast, centroid, entropy, number of white pixels, extrema.



1.52024	0.336425	0.908005	0.530407	2.62703	25
1.47463	0.326332	0.880764	0.514495	2.54821	24.
1.43039	0.316542	0.854341	0.49906	2.47177	24.(
1.38748	0.307046	0.828711	0.484088	2.39761	23.
1.34585	0.297835	0.80385	0.469565	2.32569	22.6
1.30548	0.288899	0.779734	0.455478	2.25592	21.
1.26631	0.280232	0.756342	0.441814	2.18824	21.
1.22832	0.271826	0.733652	0.42856	2.12259	20.6

Fig.9 Optimized feature values

The figure 9 shows the optimization process which is also known as the instance selection process which will deal with the optimize feature vector which is used to evaluate the performance of the system in the testing phase. This optimization process is done using firefly swarm optimization and the optimization is used to find out the relevant feature vector to reduce the redundancy of the system.

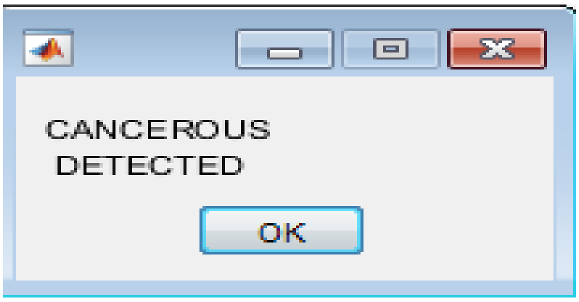


Fig.10 Detection

The figure 10 shows the detection of the category automatically by the system. Firstly the random image which is also known as the test sample is considered for the recognition of the right sample whether it is cancer or non-cancer. The above message box shows that the uploaded test sample is the cancerous. It is done using the classification approach which is known as the support vector machines and classifies the category based on the training optimized feature vector and test features

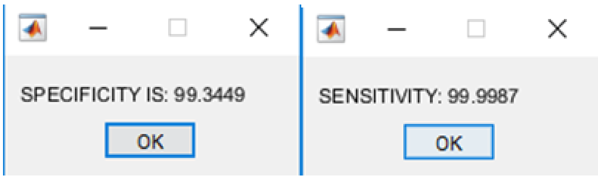


Fig.11 Sensitivity & Specificity

The figure 11 shows the sensitivity and specificity of the system which must be high for the true positive rates which shows that the system is able to achieve high true recognitions for less error rate probabilities.

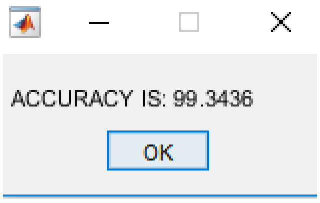


Fig.12 Accuracy of the system

The above figure shows the accuracy rate which must be high for the right recognitions. These are tested on various test samples and shows that how much you system is well accurate for the recognition.

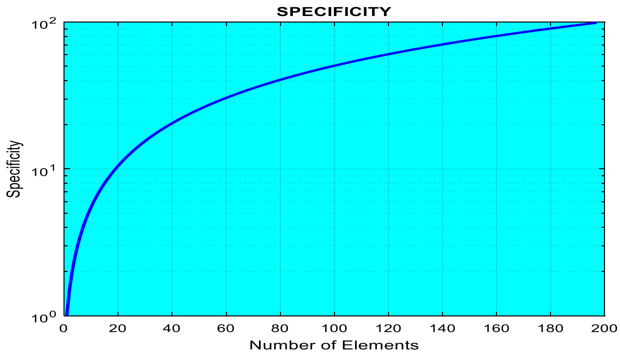


Fig.13 Specificity (Cancer)

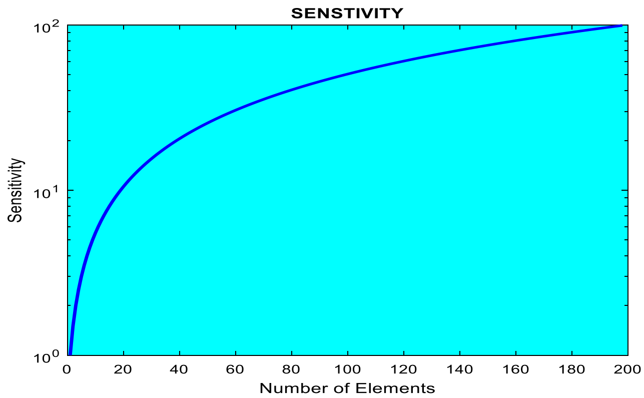


Fig.14 Sensitivity (Cancer)

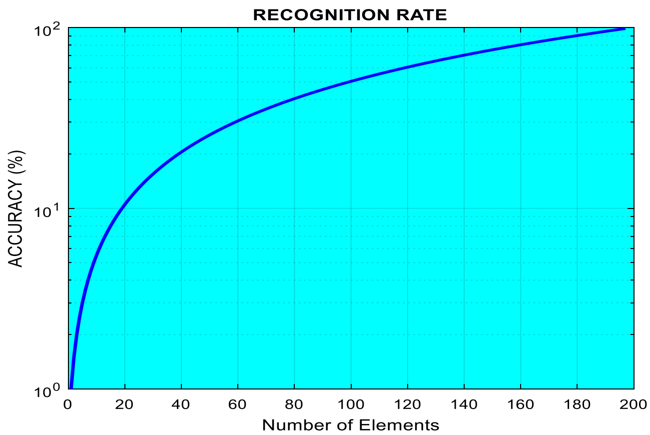


Fig.15 Recognition rate (Cancer)

Non-Cancerous Detection Results are given below

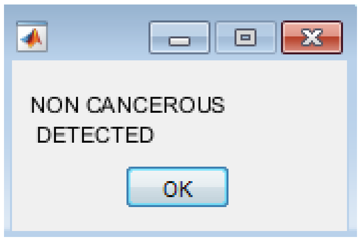


Fig.16 Non-Cancerous Recognition

Figure 16 shows the recognition of the system in the non-cancerous category

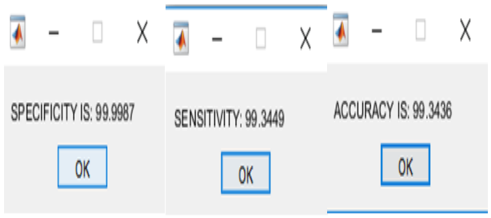


Fig.17 Specificity, sensitivity and accuracy (Non-Cancerous)

The figure shows that Specificity rate and sensitivity of the non- cancerous category and shows that our proposed approach is able to achieve high sensitivity rate, Specificity and high accuracy rate for recognition of non-cancer

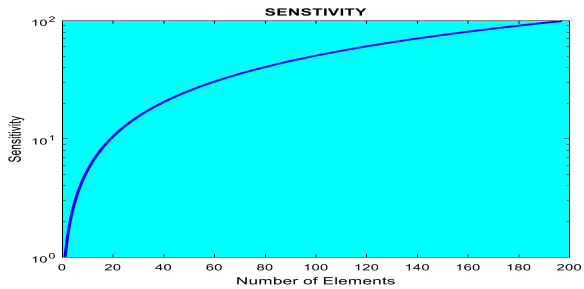


Fig.18 Sensitivity Rate (Non Cancer)

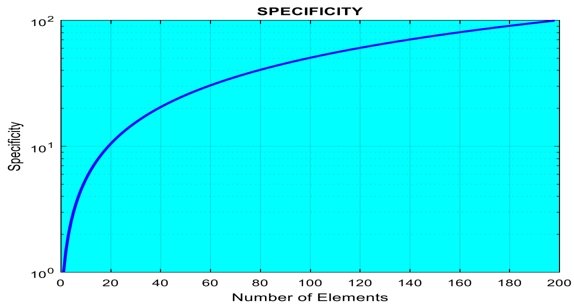


Fig.19 Specificity Rate (Non Cancer)

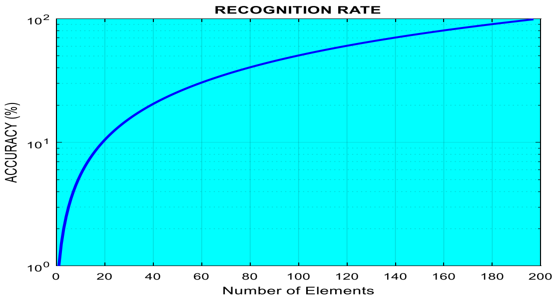


Fig.20 Recognition Rate (Non Cancer)

The above graphical results shows the proposed recognitions in a true positive and negative manner in case of non -cancerous category

Test 2: Result for non- lung Cancer Detection

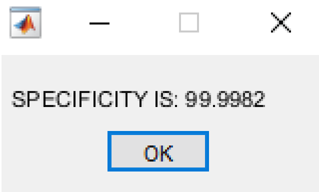


Fig.21 Specificity

Fig.22 Sensitivity

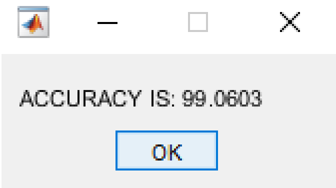


Fig.23 Accuracy

The above figures proposed the cancer detection system which shows the testing of the cancer image from the random image and shows the robust results for the automatic classification.

Test 3: Results for lung Cancer Detection

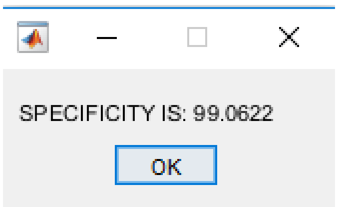


Fig.24 Specificity

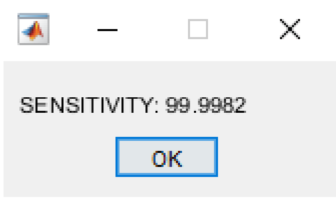


Fig.25 Sensitivity

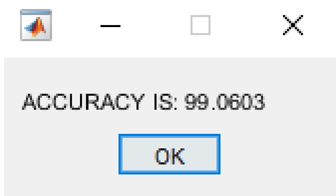


Fig.26 Accuracy

The figures show the result performance of the non- cancer classification and shows that the proposed approach is able to achieve high performance in terms of automatic classification. So in our proposed approach we have tested various classifications and is able to achieve high recognitions.

TABLE I. Proposed Performance

Parameter	Cancerous	Non Cancerous
Specificity	99.3449	99.9987
Sensitivity	99.998	99.3449
Accuracy	99.3436	99.3436

Table 1 shows the proposed performance evaluation based on feature extraction, instance selection and classification approach

TABLE II. Performance Comparisons

Images	Specificity	Senstivity	Accuracy
Cancer Image 1	99.365	99.3449	99239
Cancer Image 2	99.298	99.227	99.998
Cancer Image 3	99.436	99.290	99.431
Cancer Image 4	99.0622	99.9982	99.0603
Cancer Image 5	99.1757	99.9984	99.1741
Cancer Image 6	98.6104	99.9973	98.6077
Non- Cancer Image 1	99.572	99.498	99.999
Non- Cancer Image 2	99.419	99239	99.390
Non - Cancer Image 3	99.290	99.998	99.419

Non- Cancer Image 4	99.9982	99.0622	99.0603
Non- Cancer Image 5	99.9984	99.1757	99.1741
Non- Cancer Image 6	99.9973	98.6104	98.6077

CONCLUSION AND FUTURE WORK

As we know that unnecessary growth of tissues which are responsible for increasing cancerous is one of the major problems in medical field. Lung cancer is one of them. The proposed approach is divided into two phase. The very first is training because it is a learning process in which human is interacting with machine. The training approach deals with the feature extraction which is done by independent component analysis which is used to extract the feature vector which act as a characteristic value of the particular uploaded sample for the training purpose. Then the feature optimization is used to extract the relevant features form the feature vector using firefly algorithm and particle swarm optimization. This completes the whole training approach. Then we have moved to the testing process in which the detection process is done using svm classification. The SVM acts as a classifier and the performance is evaluated using false acceptance rate, false rejection rate and accuracy or recognition rate. So from the above result and discussions the proposed approach achieves high recognitions with less error rate probabilities.

In the future the work can be done for the comparative analysis in terms of feature extraction and classification processes and on the basis of that the performance parameters are evaluated. The optimizations methods and feature to detect the cancer symptoms for lung cancer detections can also use.

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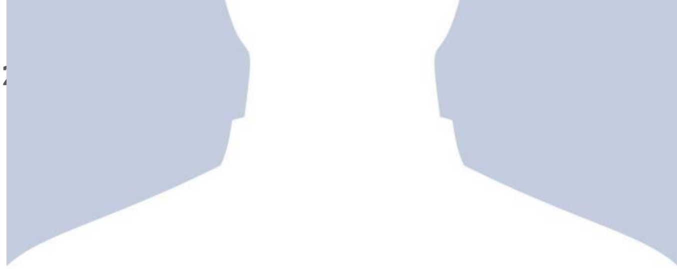

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