A Systematic Approach for Lung Cancer Detection using Firefly Optimization

Simranjeet Kaur, Er. Gaurav
SUSCET, Tangori, Punjab, India

Abstract— 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. Cancer is, when a group of cells go irregular growth uncontrollably and lose balance to form malignant tumors which invades surrounding tissues. 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. 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. In the research work, 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 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— *DICOM; CT; PET; AES, DWT; Firefly; Accuracy;*

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. 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. 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. 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.

A. What is 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. 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 detecting them (Lung Cancer, 2016).

B. 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 men and women.
- Squamous cell carcinoma or sepidermoid carcinoma is the lung cancer that is positively correlated with the tobacco smokers. This tumor is formed mainly in at the 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 with excess cytoplasm.

Unlike adenocarcinomas and epidermoid, these cells lackmicroscopic characteristics.

C. Small cell lung cancer (SCLC)

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

D. Screening for Lung Cancer

The first step to diagnosing the lung cancer is the identification of symptoms. Symptomsare largely showing the damage to lungs and their functionality. Chest pain and cough are the most common symptoms of lung cancer. The cough gets worst on each passing day and also increases chest pain. Besides these, breath shortness, feeling weak, weight loss, blood in cough and fatigue are also commonly appeared symptoms among the lung cancer patients. Unfortunately, the scientific community has not developed any screening tool that could identify the lung cancer at early stage. Chest X-rays are commonly available tools for the screening, but they are not reliable enough yet. The development of screening tool is the necessity of time as many researchers have concluded that early-stage tumors are easy to cure. The low-dose computed tomography (LDCT) is recommended screening on the annual basis to smokers and those who quit smoking with last 15 years. According to American Society of Clinical Oncologists, people who are in the age group of 55-74 and smoked more than 30 years are at more risk of lung cancer. In addition to LDCT, following are the some imaging technologies that are used for diagnosis and treatment [8].

II. PREVIOUS WORK

Apoorva Mahale et al. [1] represented the significance of data analytics and machine learning (both burgeoning domains) in prognosis in health sciences, particularly in detecting life threatening and terminal diseases like cancer. Here, we consider lung cancer for our study. For this purpose, preexisting lung cancer patients' data are collected to get the desired results. Data set (in the form of diagnostic images) is run past Matlab for analysis and forecasting. Image processing is employed for this purpose. Medical image segmentation and classification are done to achieve this. The patients' Computed Tomography (CT) lung images are categorized as normal or abnormal. The abnormal images are subjected to segmentation to focus on the tumor portion. Classification depends on features extracted from the images. The emphasis is on the feature extraction stage to yield better classification performance. This information is then fed to machine learning algorithms to discern a pattern that can give some good insights into what combination of features are most likely to result in an abnormality. The ultimate goal is to identify effective and common methods for classification using some well-established machine learning algorithms like FPCM and its improved versions.

Athira PK et al. [2]proposed the image processing techniques that are widely used in several medical areas for image improvement in earlier detection and treatment stages, where the time factor is very important to discover the abnormality issues in target images, especially in various cancer tumours such as lung cancer, breast cancer, etc. Lung cancer has been attracting the attention of medical and sciatic communities in the latest years because of its high prevalence allied with the difficult treatment. Statistics from 2008 indicate that lung cancer, throughout world, is the one that attacks the greatest number of people. Detection of lung cancer is very important for successful treatment. To cure the disease, its detection in its earlier phase is essential. Therefore, the need to develop new techniques for the detection of cancer nodules is on an all time increase. Image processing seems to be a supportive tool to solve this problem. lung cancer detection using image processing mainly carried out in two steps. Image processing and classification. In image processing image preprocessing, segmentation, feature extraction are carried out. And neural network is to classify the cancer nodule.

Kamil Dimililer et al. [3] explained about the cancer detection and researches on early detection solutions play vital role for human health. Computed tomography images (CT) are widely used in radiotherapy planning because they provide electronic densities of tissues of interest which are mandatory to a correct dose computation. Furthermore, the good spatial resolution and soft/hard tissues contrast allow precise target delineation. Also, CT techniques are preferred compared to X-Ray and MRI images. Image processing techniques have started to become popular in use of CT images. In this study, image pre-processing, image erosion, median filtering, thresholding and feature extraction of image processing techniques are applied on CT images in detail. The aim of this study is to develop an image processing algorithm for lung cancer detection on CT Images.

PrathameshGawade et al. [4] The proposed method is more about diagnosing at early and crucial stages with intelligent computational techniques with various distortion removals by segmentation techniques and algorithms which is the root concept of image processing. Detection of CT images obtained from cancer institutes is analyzed using MATLAB. The diagnosis of lung cancer at an early stage is of utmost importance if it is meant to degrade high mortality rate. The global lung screening program points to visualise positron emission tomography (PET) and computed tomography (CT) examinations amongst most aged groups at risk to enhance the early detection rate. Although use of invasive techniques, symptoms hardly appear until disease is advanced making it difficult for radiologist to identify lesions. Unfortunately, most lung cancer patients suffering at advanced stages result in dismal with five-year survival rate of 17.8% and for distant tumours, being only 4%.

Genuine and precise information is the basis of disease control initiatives. More than 85% of the disease is related to tobacco consumption. In addition, genetic factors, exposure to environmental pollutants, second hand smoking inflate disease rapidly. Remedies including chemotherapy, radiotherapy, surgery, epidermal receptive drugs escalate survival rate and quality of life.

AqeelMohsinHamad et al. [5] they 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 , they 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. 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.

Neelima Singh et al. [6] presented work proposes a method to detect the cancerous cells effectively from the CT, MRI scan and Ultrasound images. Super pixel Segmentation has been used for segmentation and Gabor filter is used for Denoising the medical images. Simulation results are obtained for the cancer detection system using MATLAB and comparison is done between the three medical images. The research deals with formation of a lung cancer detection system. The system formed can take any type of medical image within the three choices consisting of CT, MRI and Ultrasound images. Here the proposed model is developed using the various techniques of image processing. The result of image processing may be either a set of features or parameters associated with the image or an image itself. The system formed accepts any one of medical image within the three choices consisting of MRI, CT and Ultrasound image as input. After preprocessing of image, Canny filter is used for Edge detection.

A. Asuntha et al.[7] theydiscussed the formation of Lung cancer detection system by using the techniques of Image processing. The system formed can take any type of medical image within the three choices consisting of CT, MRI and Ultrasound images. Here the proposed model is developed using PSO, Genetic Optimization and SVM algorithm used for feature selection and classification. The work is an extension of image processing using lung cancer detection and produces the results of feature extraction and feature selection after segmentation. The system formed accepts any one of medical image within the three choices consisting of MRI, CT and Ultrasound image as input. After preprocessing of image, canny filter is used for Edge detection. The present work proposes a method to detect the cancerous cells effectively from the CT, MRI scan and Ultrasound images. Super pixel Segmentation has been used for segmentation and Gabor filter is used for De-noising the medical images. Simulation results are obtained for the cancer detection system using MATLAB and comparison is done between the three medical images.

Shraddha G. Kulkarni et al.[8] The proposed method uses Gaussian filter and anisotropic diffusion filter for pre-processing of CT images. Features such as energy, standard deviation, entropy and mean absolute deviation are calculated for the extracted lung nodule. Comparative study of classifiers is done using SVM and KNN classifier.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.

Ezhil E. Nithila et al. [9] proposed to develop a region based active contour model and FuzzyC-Means (FCM) technique for segmentation of lung nodules. Ultimately, detection and assisteddiagnosis of nodules at earlier stage increase the mortality rate. Among many imaging modalities,Computed Tomography (CT) is being the most sought because of its imaging sensitivity, high resolutionand isotropic acquisition in locating the lung lesions. The proposed methodology focuses onacquisition of CT images, reconstruction of lung parenchyma and segmentation of lung nodules.Reconstruction of parenchyma can be employed using selective binary and Gaussian filtering withnew signed pressure force function (SBGF-new SPF) and clustering technique was used for nodulesegmentation. Comparative experiments demonstrate the advantages of the proposed method interms of decreased error rate and increased similarity measure.

AmitaKashyap et al. [10] had defined the detection of Lung Cancer in using various methods. Lung Cancer has been an issue of concern these days as there is an alarming toll of rising deaths every year. A good amount ofresearch is pursued on aspects of the genetic and hereditary and also computational methods to detect Lung cancer. Even thoughthere is a lack of awareness about this disease due to a colossal gap between technical and clinical research areas. Accordingly thisresearch paper presents a comprehensive study on Lung Cancer detection in terms of simulation of medical images and clinicalanalysis wherein one of the KRAS mutations has been analysed in lung cancer patients and their lung images have been used fordeveloping medical images with better tumour spot detection. The computational technique used for simulation purpose involvesmorphological image processing methods, which

mainly work on the topological and shape content of the images acquired.

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/year globally [1].There are many types of cancer, Lung cancer is one ofthe common types causing very high mortality rate. The best way of protection from lung cancer is its earlydetection 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.Lung cancer seems to be the common cause of death among people throughout the world. Early detection of lung cancer can increase the chance of survival among people. The overall 5-year survival rate for lung cancer patients increases from 14 to 49% if the disease is detected in time.Lung carcinoma is a disease that occurs because of uncontrolled cell growth in tissues of the lung. This growth may lead to metastasis, which is the invasion of adjacent tissue and infiltration beyond the lungs. Treatment and prognosis depend on the histological type of cancer, the stage (degree of spread), and the patient's performance status. Possible treatments include surgery, chemotherapy, and radiotherapy. In the research work, we will detect the lung carcinoma using the fuzzy technique using the DICOM images for training and will also apply the firefly optimization method for the optimality. The results will be compared and analyzed on the basis of performance parameters for both proposed and existing technique.

IV. RESEARCH 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 DICOM images of lung. The research objectives of the work are:

1. To study and analyzed the existing techniques of lung carcinoma.
2. To input the training DICOM images using Fuzzy technique for preprocessing (image enhancement and image segmentations).
3. To use the segmented images for the features extractions for DICOM images (normal and abnormal).
4. To the identification of the carcinoma is based on the firefly optimization method.
5. To compare and analyzed the proposed work on the basis of various performance parameters such as:

— Average intensity
— Contrast
— Dissimilarity
— Entropy
— Survival/Detection rate
— Number of white pix
— Abnormal/ Normal Lungs
— Correlation
— Homogeneity
— Cluster prominence

6. To compare and analyze the existing and propose techniques on the bases of performance metrics such as PSNR and MSE.

V. RESEARCH METHODOLOLGY

Input of the work: Input the DICOM images for the training purpose.

Outcomes: Detection of the lungs carcinoma based on the trained normal and abnormal DICOM images.

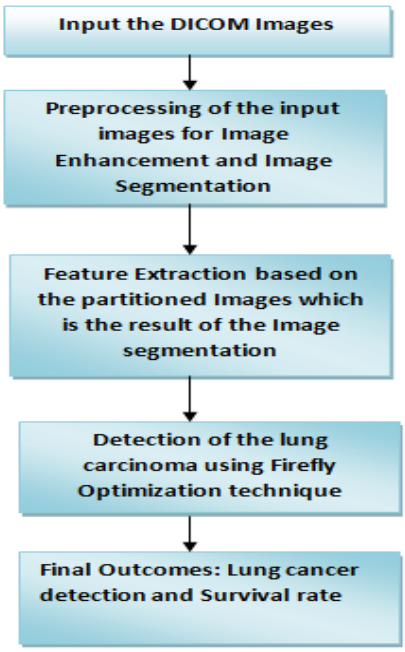

Fig.1: Research Methodology

VI. RESULT & DISCUSSION

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.

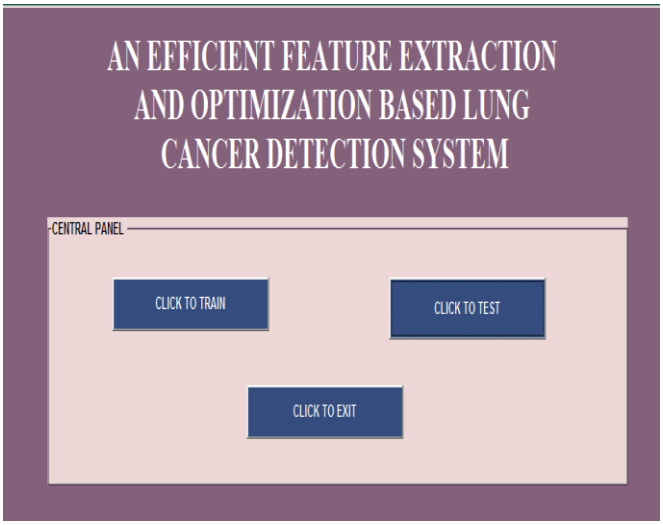

Fig.2: Main Panel

The figure 1 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

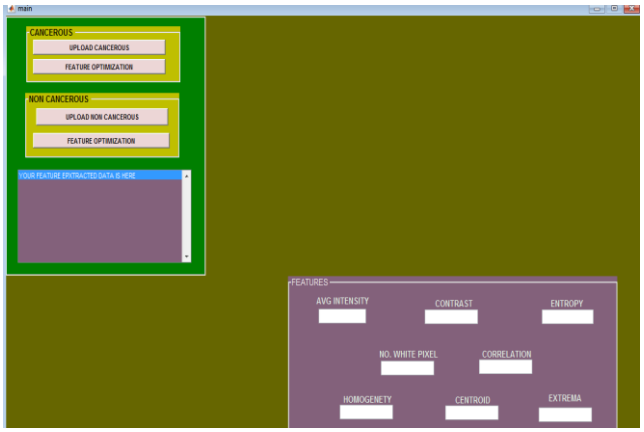

Fig.3:Front Panel

The figure 2 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.

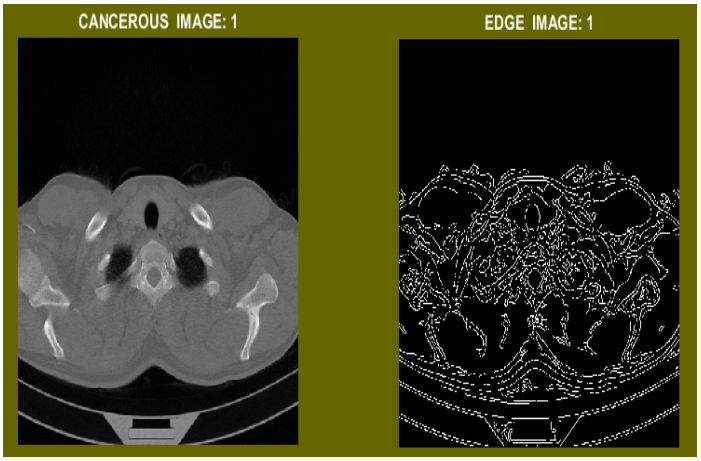

Fig.4: Uploading Images

The figure 3 shows the uploading of the cancerous samples for the training scenario and shows theuploading of the original image and edges of the image. The edge are detcted to detect the boundary regions which will make the processing of the image easy. The edges are detected using canny edge detection technique. The above images we have taken for the training purpose are the dicom images which are medical images.

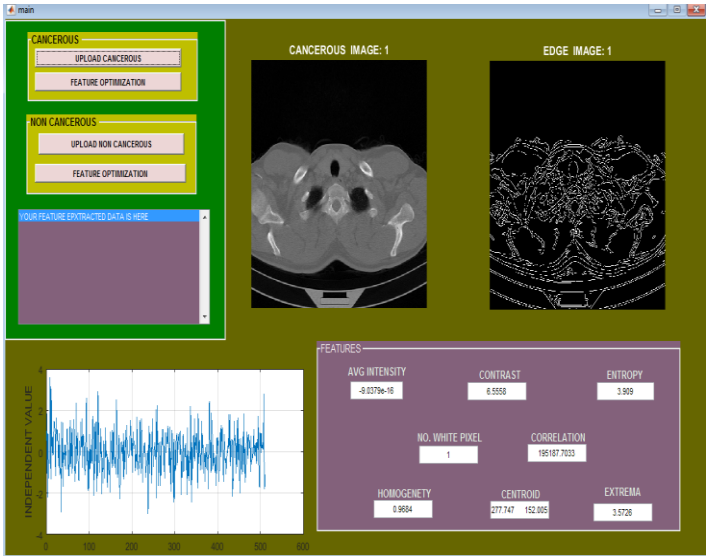

Fig.5: Feature Extraction

The figure 4 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 uplaoding and feature extraction is done for the non ancerous category. The features are extracted using independent component analusis which shows the independent characteristic values for each uploaded sample in temrns of average intensity, contrast, centroid, entropy, number of white pixels, extrema.

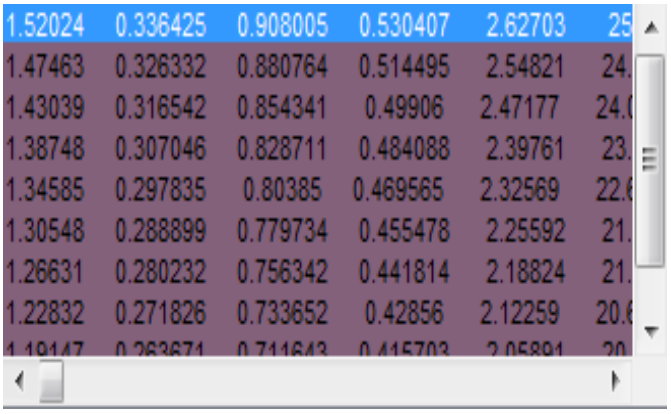

Fig.6: Optimized feature values

The figure 5 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 evalaute 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.

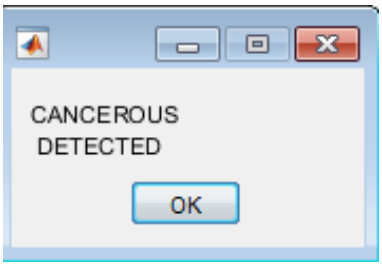

Fig.7: Detection

The figure 6 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 cenceorus. 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

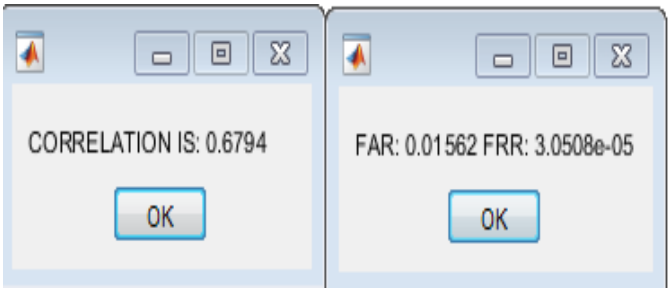

Fig.8: Correlation, FAR and FRR

The figure 7 shows the correlation of the test features with the training feature vector on which the classification is done and false acceptance rate and false rejection rate. These are the error probabilities which must be low for high accuracy of the system.

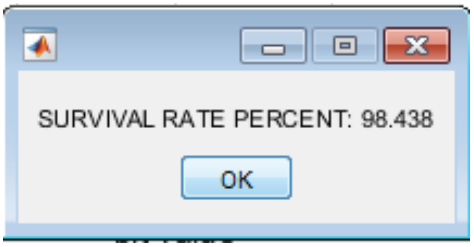

Fig.9: Survival rate

The figure 8 shows the survival rate of the detection of the system which must be high for the precise recognition of the category. It shows that how much your system is robust to predict the right catrgoty based on flase acceptance rates and false rejection rates

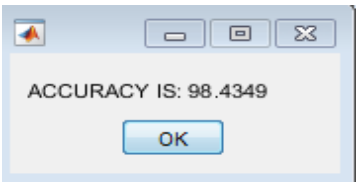

Fig.10: Accuracy of the system

The above figure shows the accuracy rate which mustbe 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

VII. OUTPUT TABLES AND GRAPHS

Table 1: Proposed Performance

Parameter	Performance values
Correlation	0.67
False Acceptance Rate	0.015
False Rejection Rate	3.05×10^{-5}
Survival rate	98.438
Accuracy	98.4349 %

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

VIII. CONCLUSION AND FUTURE WORK

As we know that unnecessary growth of tissues which are responsible for increasing cancerous is one of the major problem 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. 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.The FAR deals with how much your system is able to accept the wrong samples based on feature extraction which must be low, The FRR deals with how much your system is able to reject true samples which also must be low. If FRR and FAR is low then the recognition rates will be high. So from the above result and discussions we have notices that our propsoed approach is able to achieve high recognitions with less error rate probabilties. 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. We can also use another optimizations methods and feature to detect the cancer symptoms for lung cancer detections.

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