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Analysis of Lung CT Images Based on Fisher Criterion and Genetic Optimization

Sree Sankar. J

Assistant Professor, Dept. of ECE, Gojan School of Business and Technology, Chennai, Tamil Nadu

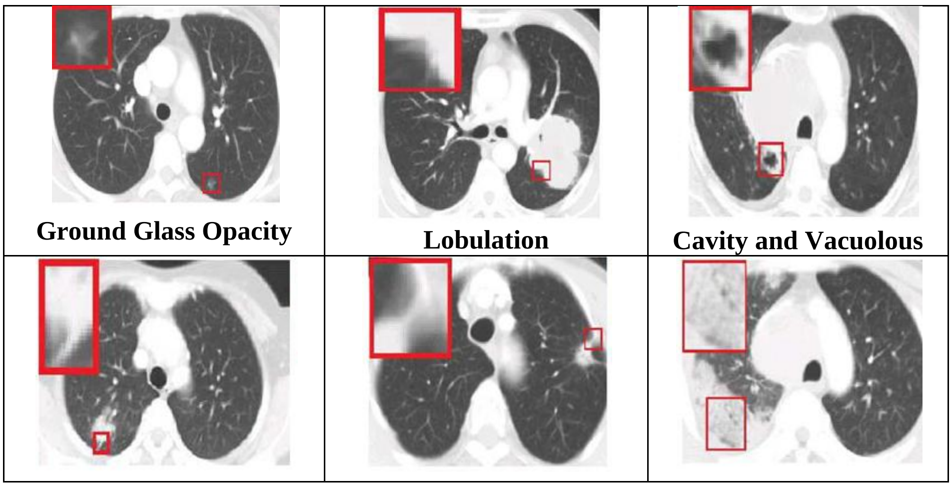
Abstract: In this paper a simple technique for the identification of lung diseases from CT (Computed Tomography) image is proposed. The overall performance of the classification process is improved by the proper classification and selection of optimal features from the Common Computed Tomography (CT) Imaging Signs of Lung diseases (CISLs). Here the feature selection process is performed based on the Genetic algorithm in which the fisher criterion is used for the objective function and used to employ the best fitness function. Now the selected features are classified using the different classifiers such as Support Vector Machine (SVM), Bag of Features, Bayesian, k-Nearest Neighbor (k-NN) and Ada Boost (Ada) classifiers. Eventually the comparison among the classifiers is done based on performance.

Keywords: Computed Tomography (CT)**,** Common CT Imaging Signs of Lung diseases (CISLs), Genetic Optimization, Fisher Criterion

I. INTRODUCTION

The major causes of lung diseases are due to cigarette smoking and inhaling the drugs, smoke and allergic materials. The lung diseases are usually identified by the symptoms. The antibiotics that are taken on a regular dosage will cure the diseases. Suppose if the antibiotic does not respond to the disease then for the detailed analysis and detection of the severity of the lung diseases is assessed by using Computed Tomography. There are many types of diseases that are responsible for the lung infection such as Chronic Obstructive Pulmonary Disease (COPD), Emphysema, Chronic Bronchitis, Pleural Effusion, Inflammatory Lung Diseases and Lung Carcinoma. Out of all above mentioned diseases the Lung Carcinoma or the Lung Cancer is one of the most frequently diagnosed cancers. The Lung Carcinoma is found to be the most common cause of cancer mortality among males all over the world. The major cause for Lung Carcinoma is the cigarette smoking.

The CT images of the chest are taken into consideration for analysis of lung diseases. The Computed Tomography scans have the ability to provide crucial information regarding the diagnoses of lung diseases. Today more research works are carried out to support Computer - Aided Diagnosis (CAD) and Content-Based Medical Image Retrieval (CBMIR) application, so that the detection and classification of CT findings denote what the radiologists see and infer from the CT scans for diagnosing diseases, which are commonly known as CT manifestations or CT features. The Common CT Imaging Signs of Lung Diseases (CISLs) are one of the well known categories of CT findings of the Lung lesions that are frequently appearing in patients Lung CT images. Here 9 categories of CISLs are taken into account. These CT images are commonly used for the diagnoses of lung diseases. The Figure 1(a) shows the most commonly found Nine categories of CISLs.



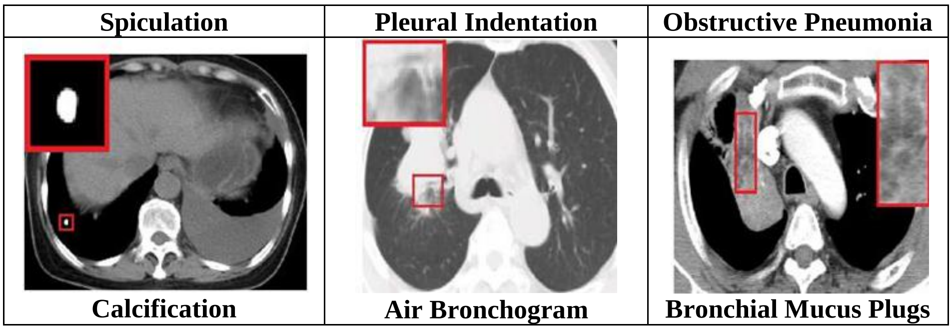


Figure 1(a) Nine categories of CISLs

II. PROPOSED METHODOLOGY

Here the main objective is to identify the CISLs in the Region of Interests (ROIs) of lung CT images. For the correct identification of CISLs firstly the features are extracted from ROI. For lung CT image classification 3 main types of features are usually considered. The 3 types of features are geometric features, textual features and intensity based features. The geometric features include geometric shape features, radius features and profile features, the boundary and circularity information, major and minor axes and their ratio, the eccentricity of a fitted ellipse. The textual features include the features such as run length features, Local Binary Patterns(LBP), Co-occurrence features, vector quantization generating texture descriptor, Histogram of Oriented Gradient (HOG) features and wavelets. The intensity based features includes gradient magnitude features, edge- gradient features, CT Value Histogram (CVH) and intensity distributions. Here 4 features were extracted from the CT lung images. The 4 features are B-HOG features, wavelet features, LBP features and CVH features. 18 B-HOG features, 26 wavelet features, 96 LBP features and 40 CVH features are extracted. Thus totally 180 features are extracted from the ROI of the particular lung CT images under consideration.

Here the extracted features were very large in number and therefore it is very necessary to select the best features from the extracted features. So the best features are taken into consideration by using the Fisher criterion and Genetic optimization and thus a feature vector representing the ROI is formed. The figure 2(a) shows the flowchart for the feature selection based on Fisher criterion and Genetic optimization. The major processes that are involved here are Population Initialization, Fisher Fitness Evaluation, Selection operation, Crossover operation, Mutation operation and Termination operation.

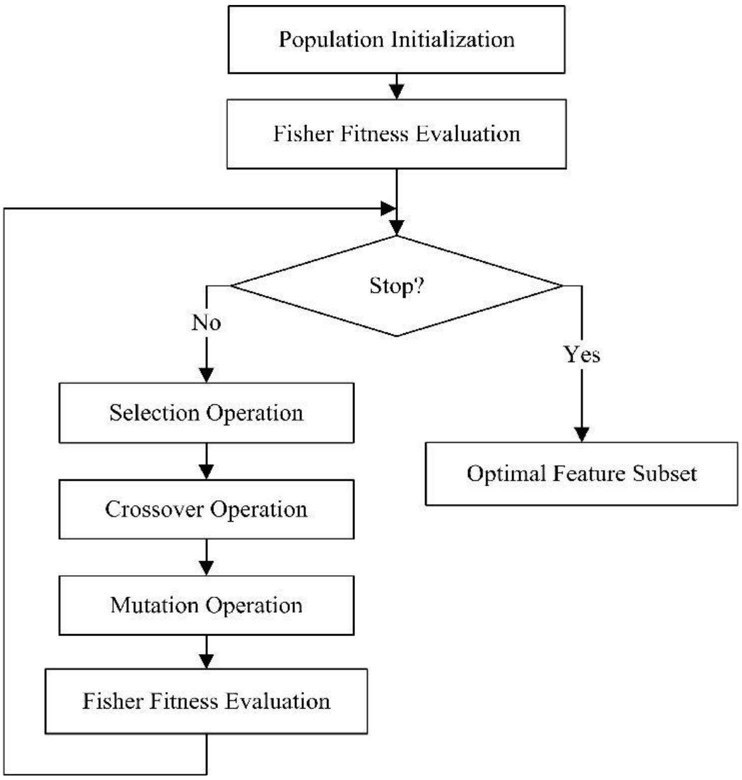


Figure 2(a) Flow chart for the Fisher's criterion and Genetic optimization

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Now the ROI is classified into corresponding CISL category by using classifiers.For classification of the ROI 5 classifiers are employed. The classifiers used are Support Vector Machine (SVM), Bag of features, Bayesian, k-Nearest Neighbor (kNN) and Adaboost (Ada).
Finally, a performance analysis is made among the 5 classifiers based on Sensitivity, Specificity and Accuracy. Sensitivity is the ability of a classifier to identify he abnormal cases. Sensitivity = TP / (TP+FN), where TP represents True Positives and FN represents False Negatives. Specificity is the ability of a classifier to identify normal cases. Specificity = TN / (TN+FP), where TN represents True Negatives and FP represents False Positives. The Correct Classification Rate or Accuracy is the correct classification to total number of classification tests. Accuracy = (Corrected cases / Total cases).

III. EXPERIMENTAL RESULTS

This section deals with the experimental results obtained. Here Math Lab software is used for simulation.

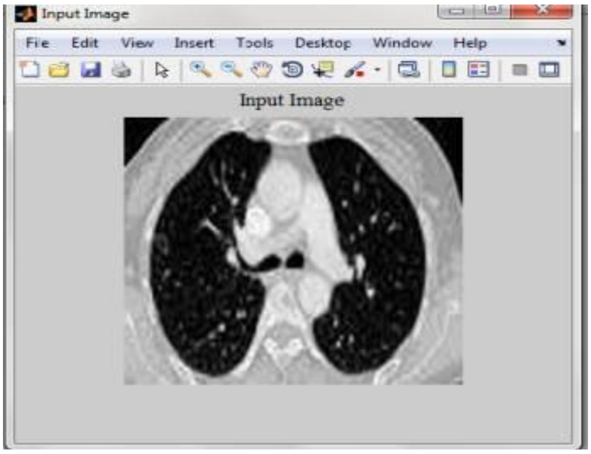

Figure 3 (a) Input Lung CT image

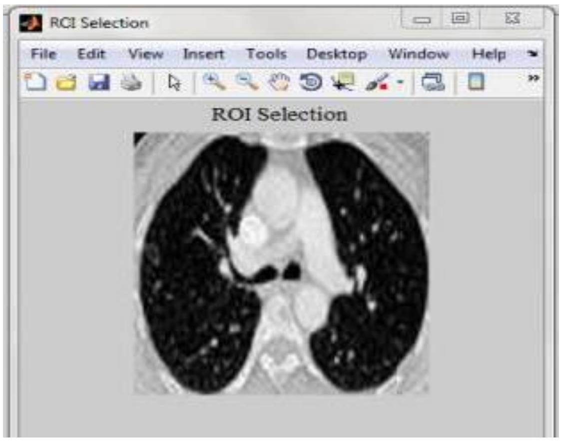

Figure 3 (b) Region of Interest (ROI) of Lung image

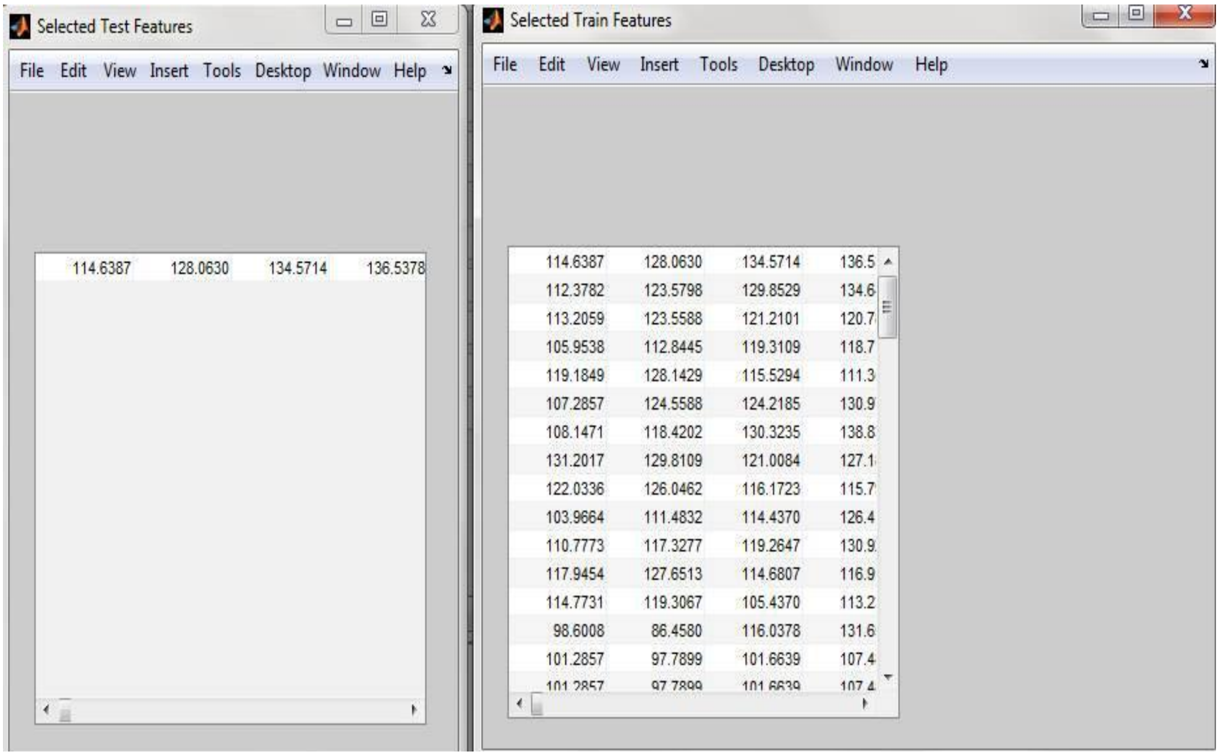

Figure 3 (c) Selected test and train features

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   4

   8

  16

  32

 8.4451e-115

Optimization terminated: average change in the fitness value less than options.TolFun
--------------------------------------------------------------------------------------
Iteration = 1 ; Crossover Population = 0.19461 ; Mutation Population = 0.19461
--------------------------------------------------------------------------------------
Iteration = 2 ; Crossover Population = 0.04734 ; Mutation Population = 0.04734
--------------------------------------------------------------------------------------
Iteration = 3 ; Crossover Population = 0.01152 ; Mutation Population = 0.01152
--------------------------------------------------------------------------------------
Iteration = 4 ; Crossover Population = 0.00280 ; Mutation Population = 0.00280
--------------------------------------------------------------------------------------
Iteration = 5 ; Crossover Population = 0.00068 ; Mutation Population = 0.00068
--------------------------------------------------------------------------------------
The Algorithm Converges At The Iteration = 5
--------------------------------------------------------------------------------------
Fitness Value = 6.814
```

Figure 3 (d) Calculated fitness function

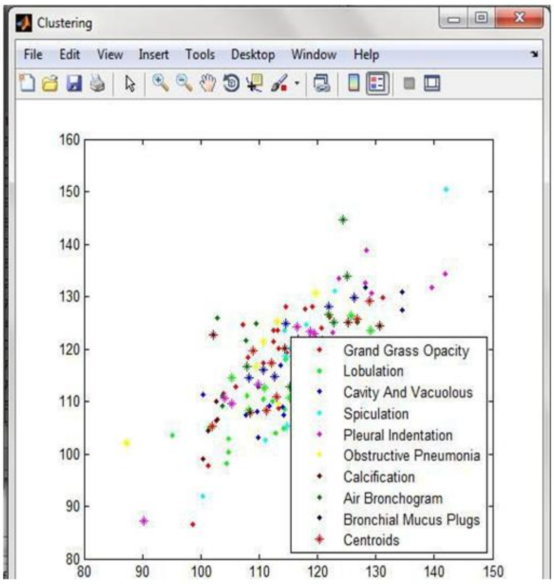

Figure 3 (e) Clustering

Classifiers	Defects Identified
SVM	Grand Grass Opacity Is Identified In The Lung
BAG	Grand Grass Opacity Is Identified In The Lung
Bayesian	Grand Grass Opacity Is Identified In The Lung
KNN	Grand Grass Opacity Is Identified In The Lung
Adaboost	Grand Grass Opacity Is Identified In The Lung

Figure 3 (f) Disease Identified from Input lung CT image

	Accuracy(%)	Sensitivity(%)	Specificity(
SVM	98.8889	100	98.75
BAG	92.2222	100	91.25
Bayesian	92.2222	100	92.50
KNN	88.8889	100	87.50
Adaboost	78.8889	100	87.50

Figure 3 (g) Performance Evaluation of Classifiers

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Table 3.1 Comparison of performance of classifiers

Sl. No	Performance Parameter	SVM	BAG	Bayesian	K-NN	Adaboost
1.	Accuracy	98.88	92.22	92.22	88.88	78.88
2.	Sensitivity	100	100	100	100	100
3.	Specificity	98.75	91.25	92.50	87.50	87.50

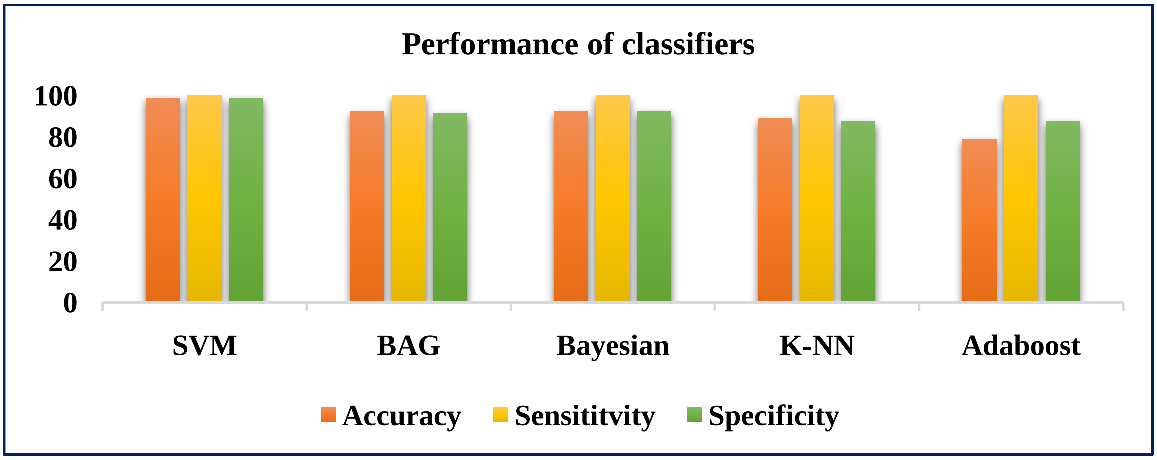

Figure 3 (h) Performance of classifiers

IV. CONCLUSION

The CT images of the lungs were taken in account. The dataset here consists of lung images that contains nine different types of lung diseases. The Region of Interest (ROI) were selected and taken into consideration from the lung CT images, since the other regions will contain unwanted information. Here four features such as B-HOG features, Wavelet features, LBP features and CVH features were extracted from CT images. Finally, five classifiers are used to classify the ROIs into CISLs categories and a comparison was made among the classifiers based on the performance. The experimental results show that the SVM classifier is the most efficient classifier using the selected best features. The accuracy of SVM here is found to be 98.88%. In future this work can be extended by combining the Fisher criterion with other feature selection methods and also by adding some image processing steps the possibility of correct classifications can be improved.

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BIOGRAPHY

Sree Sankar.J received his B.E. in Electronics and Communication Engineering from Sivaji College of Engineering and Technology in the year 2013. He completed his M.E. in Communication Systems from Sivaji College of Engineering and Technology in the year 2016. He has attended 5 National Conferences and 6 International conferences. He has authored ten publications in reputed Journals. His area of interest includes Antennas and Wave Propagation, Medical Electronics, Bio-Medical Imaging and Optical Communication. He is currently working as an Assistant Professor in the Department of Electronics and Communication Engineering, Gojan School of Business and Technology, Chennai.