DETECTION AND CLASSIFICATION OF TUBERCULOSIS USING CHEST X-RAY (CXR)

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Abstract

Tuberculosis is the major and ancient decease of humans. It is considered as a worldwide pandemic. Even though medical science is working from several years towards abolish of this pandemic, still the result is not as expected. It is [2]one of the top 10 killer decease in the world. It is the main cause of deaths in HIV patients. World Health Organization (WHO) came with a "STOP TB" program to abolish TB from earth by 2050. Microscopic examination, body fluid tests also skin tests are using in diagnosis of TB, which is costly and time consuming. As the technology improves, now a day's chest x ray (CXR) also used in detection of tuberculosis in lungs. Mortality rate of TB patients are high when it is not diagnosed and left untreated. Chest x ray is the main requirement in diagnosis of TB using medical image in CAD system. Here, we present a method for detection of TB in CXR images to classify the decease into several categories.

Keywords: CXR, CAD, TB, Automated System, Technology.

Introduction

Tuberculosis (TB) is a spreading decease caused by bacteria called mycobacterium tuberculosis (MTB). In 90% cases Lungs are the body parts which is severely affected by this bacteria, even other parts of our body can also be affected from this bacteria. One can easily get affected by this bacteria, when he get exposed to direct contact with the air where the TB infected person cough, droplet, spit, speak, or sneeze. The basic symptoms of active TB are, a cough with blood containing sputum, fever, sweating in night, and losing weight.

As per the global TB report 2020, 8 countries in a world have 2/3 part of total TB infected people. India, Indonesia, china, the Philippines, Pakistan, Nigeria, Bangladesh and south Africa are in the order. Tuberculosis is the top killer decease in the world. In 2019, 1.4 million people died from TB. TB is the leading killer of the people with HIV and a major cause of deaths related to anti microbial resistance. Treating, diagnosis, detection and classification are the major challenge now days. Detection and classification as an initial, middle or final stage, based on severity of decease is done in a short time means it will help to start a treatment early based on severity of an infection, which will help the patient to be well treated and also it will help to stop the spreading of this decease.

Objectives

➢ **To optimize the accuracy of the system.**

Accuracy of atomization system is increased by using appropriate algorithm that yields better results than done before. The proposed system includes proper noise removal, number of feature extracted, proper edge detection method and better classification method.
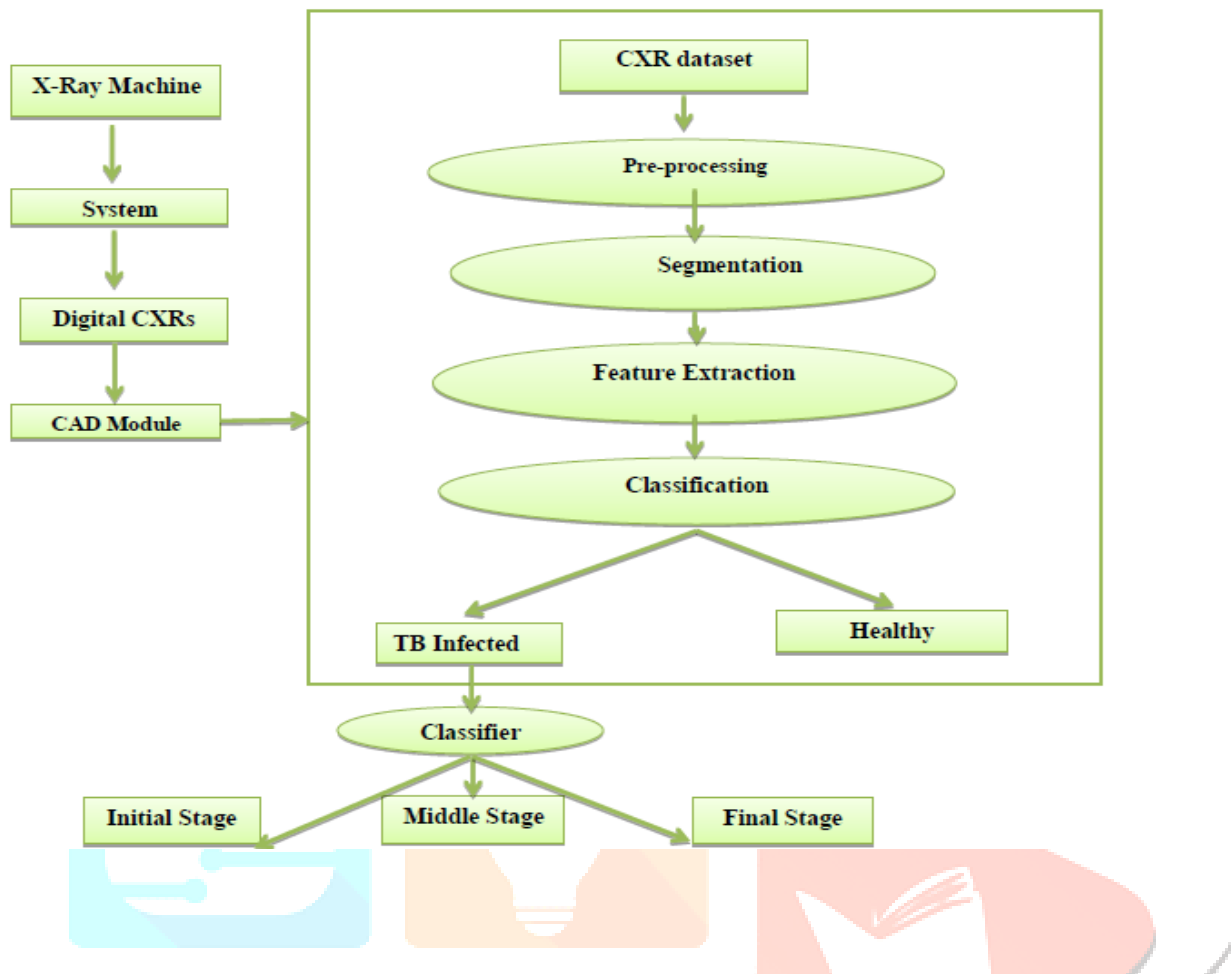
➢ **To get a better classification**

To train the machine in such a way that it should capable to distinguish whether the lung infection is in initial stage or in middle stage or in final stage.
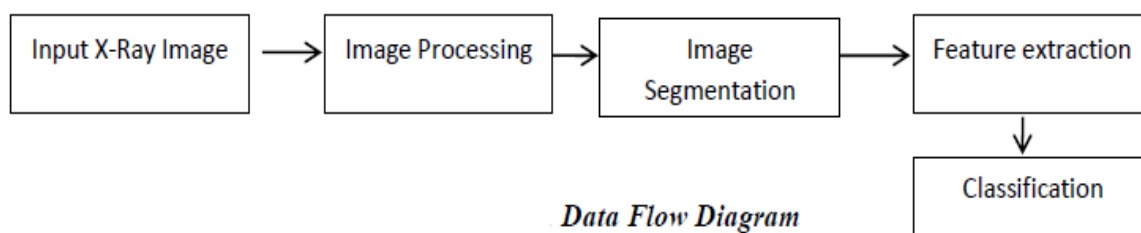
Data Flow Diagram

System architecture

Chest X-ray (CXR) Data Set

A chest X-ray (CXR) is obtained when a Chest is exposed to radiation from X- ray machine. CXR images are white and black or gray image which defines structure of lungs.

CXR data collection of both infected lung and healthy lungs is the very early process in this work. These samples are collected through internet and visiting hospitals. Around 505 images are collected which include both healthy and infected lungs.

The following image shows the how healthy and infected CXR are look like
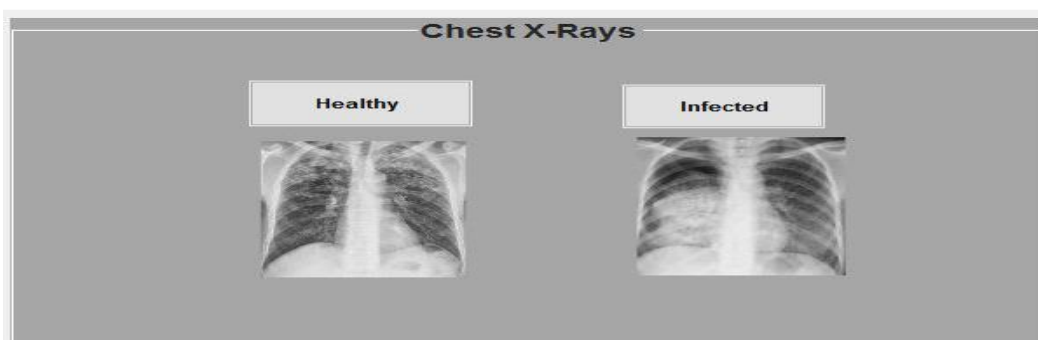
In preprocessing stage, the unwanted distortions are aborted and image features are enhanced. In the first stage, image is resized and brought into single fixed resolution. As a next step image is converted to gray scale also binarization is applied.

Further, a median filtering is used to abort noise from the image, which improves the image appearance that helped in future processing. By using median filtering edges and lines of lungs are extracted efficiently. Sharp edges and lines are preserved by using median filtering.

As a following step, a gray scale CXR image is converted into complete white and black image by fixing threshold value to the gray scale CXR image. The more appear it black, the more healthily.
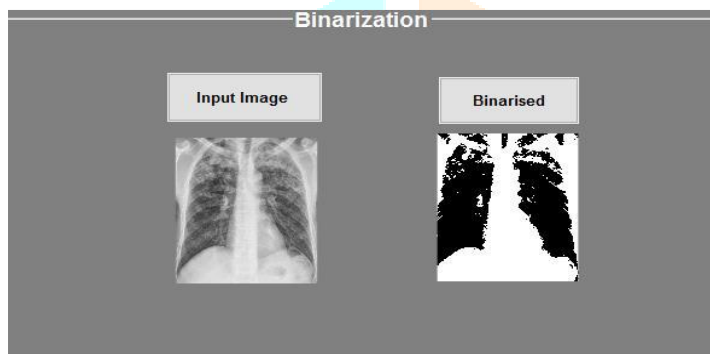
To effectively detect edges of lungs, a sobel technique is used which gave the most appropriate image for further processing.

In **feature extraction**, texture features are extracted using Gray-Level Co-occurrence Matrix (GLCM), which examines the texture using spatial relationship between pixels.

Correlation statistically measured the extent to which two or more variables fluctuate together

.
$$\textbf{Correlation} = \sum_{u=-h}^{h} \sum_{v=-h}^{h} I(r + u, c + v) T(u, v)$$

If correlation of an image I and a template T without normalization, the inner product between the vector version t of T and the vector version w(r, c) of window W(r, c) at position (r, c) in the image

The **contrast** (Con) is a measure of intensity of a pixel and its neighbor over the image (I).

$$Con = \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} (i - j)^2 I(i, j)$$

Where i & j are pixel co-ordinate values, N is the number of pixels.

Entropy whose value will be maximum when all the elements of the co-occurrence matrix are the same.

$$Entropy = \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} I(i,j)(-\ln(I(i,j)))$$

The **Homogeneity** is printed an originally uniform digital color image. Where i & j are pixel co-ordinate values, P is the pixel.

$$Homogeneity = \sum_i \sum_j \frac{P(i,j)}{1+|i-j|}$$

Histogram of Oriented Gradients (HOG)

HOG is an efficient way to extract features out of the pixel colors for building an object recognition classifier.

Matching

To find the similarity or dissimilarity measure between the Test feature and Train feature matrix Eucledian distance is used.

We can get The Result Feature Matrix by subtracting Tested Feature Matrix from the Feature Matrix of trained phase.

RFM = FM (ED w.r.t train phase) -TFM (ED w.r.t test phase)

Accuracy is obtained from dividing correctly classified samples from the total number samples by the system.

Error rate is obtained from dividing the wrongly classified samples from the total number samples by the system
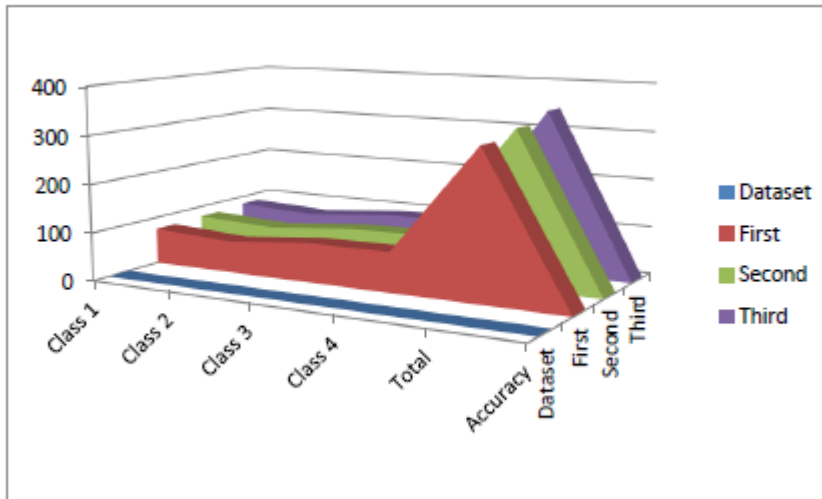
Classification

After features are extracted from the CXR classification methods are applied to both train set and test set.

It then computes pixel-to-pixel correspondences by matching

Two feature matrices are generated. Those are, Trained feature matrix (FM in Size M×N) and Tested feature matrix (TFM in Size M×N).

Support Vector Machine (SVM) classifier is used to classify the images as a normal or abnormal also classifies based on severity of infection. After the classification, the resultant image specifies whether it is a TB affected lung or not. If it is affected lung, then it classifies by stages.

Experimental result chart
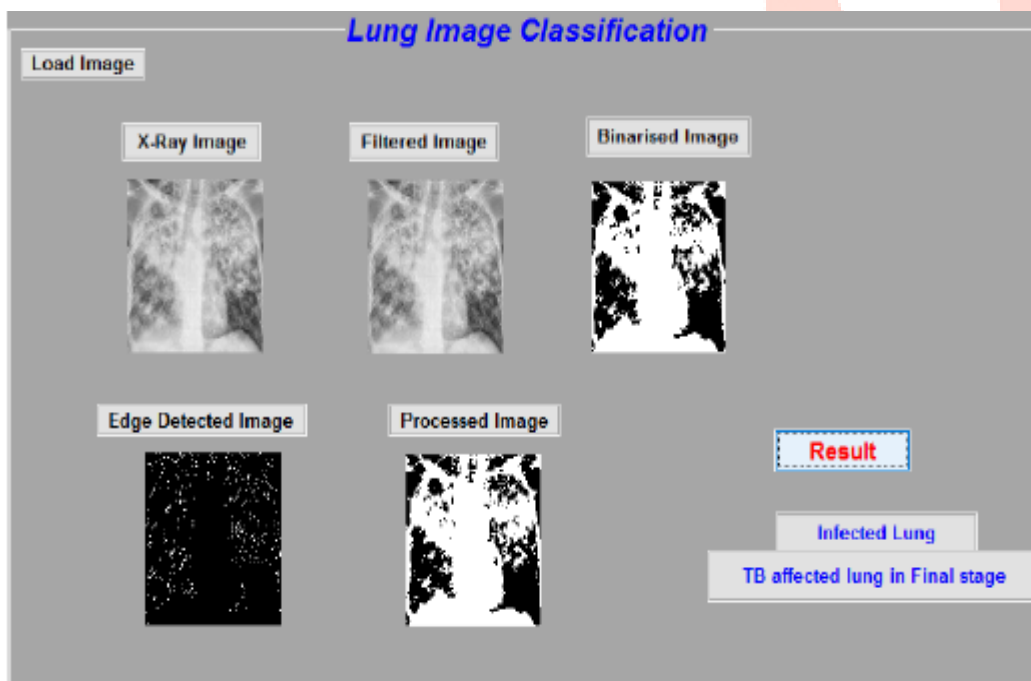
CONCLUSION

Detection and classification of tuberculosis in lungs is made easy by using this automated system. This technology of finding TB using CXR will help the people by reducing the cost and it saves time also, compare to traditional method like skin, cough and blood testing. Moreover, classifying them is bit difficult in those traditional systems. Classification will help to doctors to treat the patients based on their severity by providing proper medicine. In this paper we went through methods like filtering, Binarization, edge detection (using sobel detector), segmentation, feature extraction and classification using SVM classifier. As a first step, bacteria spread region is determined, because of this we can easily come to the conclusion of the percentage of lung area that is affected by TB. Experimental result showing that the method developed is effective and reliable. As a future enhancement, the accuracy can be increased more.

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