Analysis of Tuberculosis using Smear Image

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Abstract— An automatic method for the detection of Tuberculosis (TB) bacilli from microscopic sputum smear images is presented in this paper. According to WHO, TB is the ninth leading cause of death all over the world. There are various techniques to diagnose TB, of which conventional microscopic sputum smear examination is considered. However, the mentioned method of diagnosis is time intensive and error prone, even in experienced hands. The proposed method performs detection of TB, by image binarization and subsequent classification of detected regions using a convolutional neural network. We have evaluated our gist algorithm using a dataset of sputum smear microscopic images with different backgrounds (high density and low-density images). Experimental results show that the proposed algorithm achieves for the TB detection. The proposed method automatically detects whether the sputum smear images is infected with TB or not. This method will aid clinicians to predict the disease accurately in a short span of time, thereby helping in improving the clinical outcome.

Keywords- *Tuberculosis bacill, smear images, image binarization, gist algorithm.*

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I. INTRODUCTION

Fuzzy clustering techniques are best suited to segment the pressure ulcer images because the uncertainty of pressure ulcer image is widely presented in data. The most and powerful segmentation is the Fuzzy C Means (FCM) clustering algorithm because, more information is preserved. The focus is this work is to improve the FCM approach and applies it to pressure ulcer image segmentation for detecting Soft white tissue present in pressure ulcer image. The method used to improve FCM are Total Variation (TV) Regularization where noise from the image is eliminated but results in stair casing effect, which is further improved by Anisotropic Diffusion (AD) is to eliminate the stair casing effect (Zhu et al 2008).

II. OVERVIEW OF EXISTING SYSTEM

Gaussian-Fuzzy-Neural network for diagnosis of Tuberculosis Using Sputum Smear Microscopic Images:

This work proposes the Gaussian-Fuzzy-Neural network (GFNN) by combining the Gaussian Mixture Model (GMM) along with the fuzzy and the neural network for the TB detection. Initially, the input sputum smear microscopic image is subjected to a Colour Space (CS) transformation, for which the thresholding is applied to obtain the segmented result. Then, the texture feature and other features are extracted for GFNN-based classification which classifies the segments into few-bacilli, non-bacilli and overlapping bacilli. Again, the overlapping bacilli are applied to the classifier to find the number of bacilli in the overlapping bacilli.

III. PROPOSED SYSTEM ARCHITECTURAL DESIGN

The proposed method is implemented in stages. In the first stage, we used a simple segmentation approach to classify the foreground and background of the images. The foreground consists of single bacilli, touching bacillus and other artifacts. The segmented foreground objects are then given to a trained convolutional neural network (CNN) and the CNN will classify the objects into bacilli and non-bacilli. Both sections are explained in detail in the following subsections.

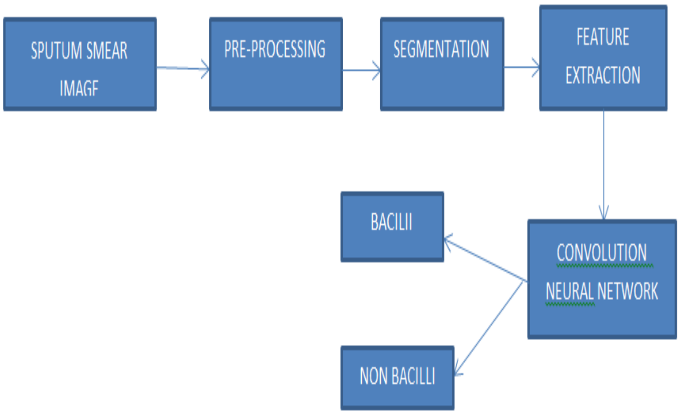


Figure 1: Overall Process of the System

IV. METHODS OF DATA ACQUISITION

Ziehl–Neelsen Sputum smear Microscopy image Database (ZNSM-iDB) is a repertoire of diverse smear microscopy digital images obtained from three different microscopes including one using Smartphone. This database assists to develop automated algorithms in the following domains:

1. Autofocusing of a view field
2. Auto stitching of view fields to get panoramic view of Ziehl–Neelsen (ZN) stained slide
3. Detection and grading of Mycobacterium tuberculosis bacilli for automatic detection of tuberculosis (TB)

In addition to above three related datasets, four other view field image datasets (without bacilli, single or few bacilli, overlapping (occluded) bacilli, and over-stained with bacilli and artifacts) are also provided to streamline the sensitivity and specificity of algorithms considering that the images are noisy with diverse background presentation due to staining. This database may also facilitate the development of mobile-based health monitoring methods using Smartphone-based datasets.

V. PREPROCESSING

The preprocessing of image aims at selectively removing the redundancy present in captured images without affecting the details that play a key role in the overall process. That involves the following basic steps:

Image Resizing

Re-sizing of an image is performed by the process of the interpolation. It is a process which re-samples the image to determine values between defined pixels. Thus, resized image contains more or less pixels than that of original image. The intensity values of additional pixels are obtained through interpolation if the resolution of the image is increased.

Filtering

Uncertainties are introduced into the image such as random image noise, partial volume effects and intensity non-uniformity artifact (INU), due to the movement of the camera. This results in smooth and slowly varying change in image pixel values and lead to information loss, SNR gain and degradation of edge and finer details of image. Median filters are used for noise reduction.

Median Filter

The best known order-statistics filter is the median filter, which replaces the value of a pixel by the median of the levels in the neighborhood of that pixel .The original value of the pixel is included in the computation of the median. Median filters are quite popular because, for certain types of random noise they provide excellent noise reduction capabilities, with considerably less blurring than linear smoothing filters of similar size

Segmentation:

In computer vision image segmentation is the process of partitioning digital images into multiple segments (set of pixels, also known as super-pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contour extracted from the image. Each of the pixels in a region are similar with respect to some characteristic or computed property, such as colour, intensity, or texture . Adjacent regions are significantly different with respect to the same characteristic. When applied to a stack of images, typical in medical imaging, the resulting contours after image segmentation can be used to create 3D reconstruction with the help of interpolation algorithms.

VI. GIST ALGORITHM

The GIST algorithm represents the scene information of the image well. Before extracting the GIST algorithm, the image is divided into several blocks. The blocks are processed by median filters of different scales and different directions in advance, and then average the calculated results of different regions to obtain the required features information. In order to avoid the loss of information and improve the feature accuracy, the image is divided into several blocks in advance, a “gist” descriptor provides a high-level—and hence, low-dimensional— representation of some important aspect of an image. Gist descriptors are designed to match human concepts with respect to various features of images. Intuitively, when used in tuberculosis analysis, gist algorithm in segmentation process segments the foreground and background of bacilli and non-bacilli.

Feature Extraction:

This section explains the various features extracted from the feature extraction process. The features, such as LGP, length, area, density and various histogram features, such as colour, mean and variance, are the important features extracted from the segmented portion of the input image to make the classification effective.

Convolution Neural Network:

Images are high-dimensional vectors. It would take a huge amount of parameters to characterize the network. To address this problem, bionic convolutional neural networks are proposed to reduce the number of parameters and adapt the network architecture specifically to vision tasks. Convolutional neural networks are usually composed by a set of layers that can be grouped by their functionalities. The segmented foreground objects are then given to a trained convolutional neural network (CNN) and the CNN will classify the objects into bacilli and non-bacilli.

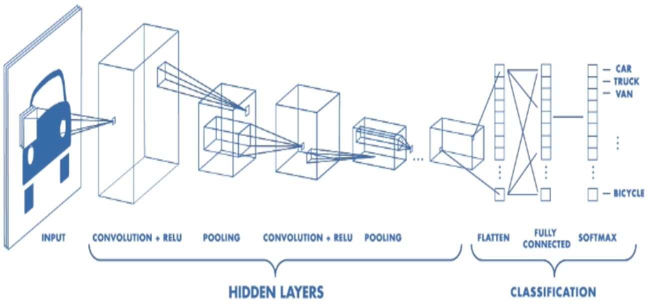


Figure 2: Convolution Neural Network structure

VII. EXPERIMENTAL RESULTS

The proposed method is implemented in stages. In the first stage, we used a simple segmentation approach to classify the foreground and background of the images. The foreground consists of single bacilli, touching bacillus and other artifacts. The segmented foreground objects are then given to a trained convolutional neural network (CNN) and the CNN will classify the objects into bacilli and non-bacilli.

Preprocessing of Image: The Original Image is taken from the dataset for segmentation. The input image considered is either colored image or gray image.

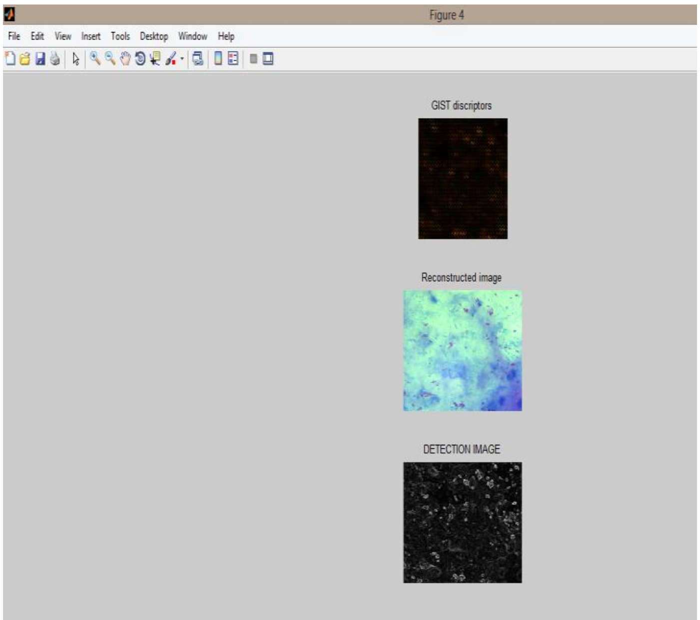


Figure 3: Preprocessing of image and obtained the detection image

Pre-processing (Pixel Normalization): In order to increase robustness, the noisy medical image is pre-processed using Bright Pixel Normalization.

GIST Algorithm: The GIST algorithm represents the scene information of the image well. Before extracting the GIST algorithm, the image is divided into several blocks. The blocks are processed by median filters of different scales and different directions in advance, and then average the calculated results of different regions to obtain the required features information. In order to avoid the loss of information and improve the feature accuracy, the image is divided into several blocks in advance, a "gist" descriptor provides a high-level—and hence, low-dimensional— representation of some important aspect of an image. Gist descriptors are designed to match human concepts with respect to various features of images. Intuitively, when used in tuberculosis analysis, gist algorithm in segmentation process segments the foreground and background of bacilli and non-bacilli.

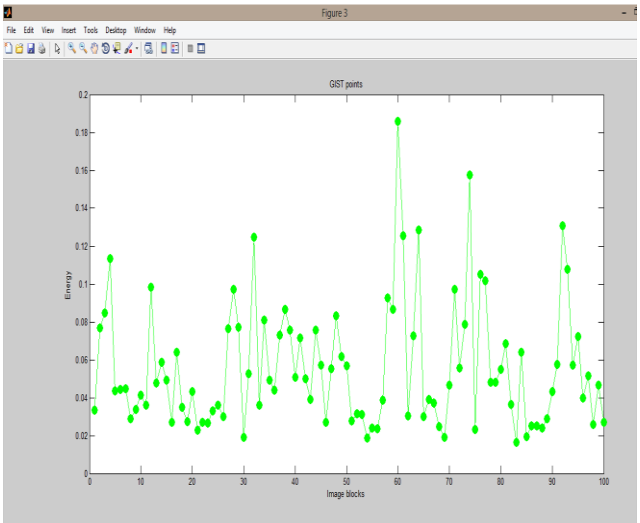


Figure 4: Comparison of simulation graph results

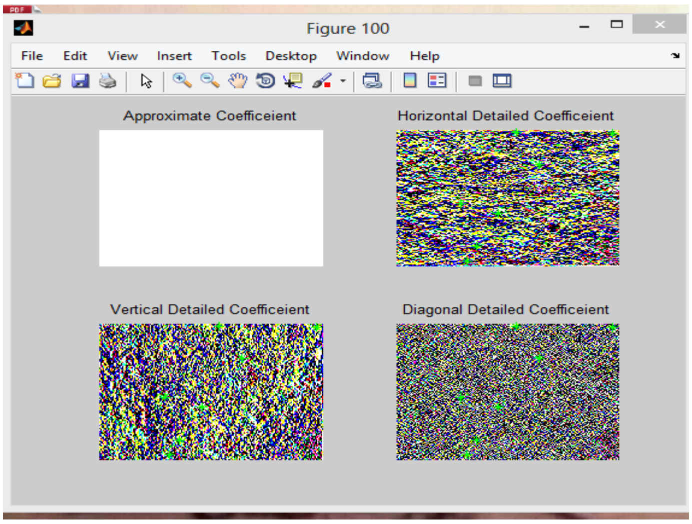
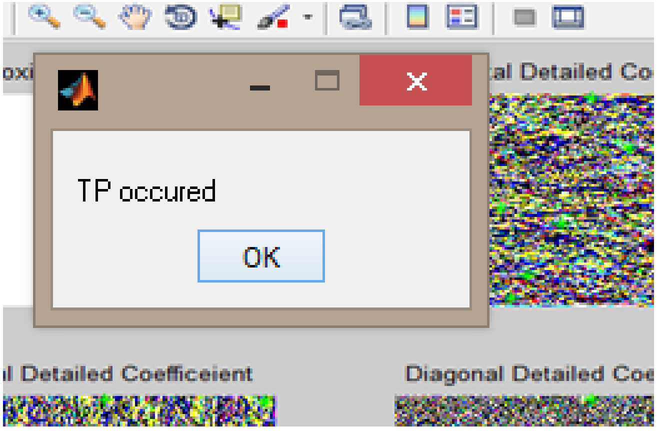


Figure 5: Comparison of coefficient simulation results



TP occured

Figure 6: Detection of TP

VIII. CONCLUSIONS

An automatic method for the detection of Tuberculosis (TB) bacilli from microscopic sputum smear images is presented in this paper. The proposed method performs detection of TB, by image binarization and subsequent classification of detected regions using a convolutional neural network. We have evaluated our gist algorithm using a dataset of sputum smear microscopic images with different backgrounds (high density and low-density images). Experimental results show that the proposed algorithm achieves for the TB detection. The proposed method automatically detects whether the sputum smear images is infected with TB or not. This method will aid clinicians to predict the disease accurately in a short span of time, thereby helping in improving the clinical outcome.

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