A Study On Detection Of Tuberculosis From Chest X Ray Images And Microscopic Images Based On Deep Learning Techniques

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Abstract: In this systematic review, the role of chest X-ray (CXR) and microscopy images in the diagnosis of tuberculosis has been evaluated. Many techniques using image processing and machine learning with different datasets have been implemented for the detection of tuberculosis. An important step in image classification is feature extraction. CNN (Convolutional Neural Network) is created and is used as feature extractor in most cases. It will be useful for classification and identification of TB (Tuberculosis) images. In some cases, the classifiers are combined with certain advanced tools and components for the analysis of better performance. A study of the use of deep learning techniques is presented in this article.

Keyword: Deep-learning, Classification, Feature extraction, Tuberculosis.

1 INTRODUCTION

Tuberculosis (TB) is a disease caused by a rod-shaped bacterium called Mycobacterium Tuberculosis. The bacteria usually attack the lungs and they can also affect other parts of the body. The number of deaths due to TB is high, as per World Health Organization (WHO) 10 million people are infected by TB and about 1.6 million people died of TB in the year 2018. A review on tuberculosis detecting techniques based on image processing published between 2010 and 2018. The review shows that the accuracy of algorithms for the detection of TB has increased over the years. This review could be useful to researchers and practitioners working in the field of TB, providing a comprehensive and precise overview of methods of this field of research. The following review consists of two sections, namely, detection of tuberculosis from chest X-ray images and detection of tuberculosis from microscopic images

2 DETECTION OF TUBERCULOSIS FROM CHEST X-RAY IMAGES:

Eang et al., (2012) has proposed a technique to examine the differences in the demographic characteristics, smear grades and treatment outcomes of tuberculosis. This paper consists of two approaches, Passive Case Finding (PCF) and Active Case Finding (ACF).The detection of negative tuberculosis through ACF is 71.4% and PCF is 40.5%. The overall success rate with ACF is 96.4% and 95.2% in PCF [1]. Chauhan A et al., (2014) has proposed a method for the extraction of features from the image that can be implemented into existing X-ray machines to differentiate between TB and non-TB CXR images using Gabor, Gist, Histogram of Oriented Gradients (HOG), and Pyramid Histogram of Oriented Gradients (PHOG). Two CXR image datasets were used for evaluating the performance. The best result was obtained from the Gist and PHOG feature for both the datasets [2]. Helen Ayles et al., (2015) has proposed a Computer Aided Detection (CAD) approach for detecting TB (Tuberculosis) on Chest X-ray images (CXRs) based on Multiple-Instance Learning (MIL). This method does not require detailed information for optimization. CAD system with MIL is used for the detection of tuberculosis. Three X-Ray datasets were used [3]. Jesus Peinado et al., (2017) has proposed a CNN (Convolutional Neural Network) model to deal with unbalanced, less category X-ray images. The accuracy for classifying multiple tuberculosis can be improved by this method. The dataset was collected from Peru and the total images collected was 4701. In which, 453 images were normal and 4248 images were abnormal. An accuracy of 85.68% was achieved [4]. Paras Lakhani et al., (2017) has proposed a Deep Convolutional Neural Network (DCCN) to detect tuberculosis on CXR images. The training (68.0%), validation (17.1%), and test (14.9%) phases were conducted using four datasets consisting of 1007 chest radiographs. Two different DCNNs, Google Net and Alex Net were used to classify the images. This method achieves a specificity of 100% and sensitivity of 97.3%. Maximum accuracy can be achieved with DCNNs that classifies tuberculosis with an AUC of 0.99 [5]. Rahul Hooda et al.,(2017) has proposed a method for tuberculosis detection using deep learning which classifies CXR images into normal and abnormal. CNN architecture with 7 layers and 3 fully connected layers were used. The two standard available datasets, Montgomery County (MC) dataset and Shenzhen dataset are used for testing and validation purpose. Achieves an accuracy of 94.73 percent and validation accuracy of 82.09 percent using adam optimizer [6]. Asmaa Abbas et al., (2018) proposed a pretrained CNN (Convolutional Neural Network) model to classify Chest X-ray images (CXRs) having TB (tuberculosis) or non TB. In this paper, various models using the Learning curve between the training set and validation set and ROC (Receiver Operating Characteristic) curve were evaluated and compared. This method achieves an AUC (Area Under the ROC Curve) of 0.998, specificity rate of 0.999 and sensitivity rate of 0.997 by fine tuning technique [7]. Peng Gang et al., (2018) has proposed a paper which includes CXR analysis of 2D images on the basis of deep learning to get reliable predictions for anatomical structure detection,

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segmentation, CADe of suspicious regions and CADx. A deep CNN architecture is used which contains a stack of 7 alternated convolutional layers and max pooling layers and two fully connected neural layer which returns probability of normal or abnormal results [8]. Rajaraman et al., (2018) proposed a CNN (Convolutional Neural Network) model for constructing non-linear classification (decision making functions) and to improve visual recognition. A stacking of classifiers with hand engineered and CNN features for improving TB (Tuberculosis) detection in Chest X-ray images (CXRs) was created. Four datasets of CXRs are used namely Shenzhen, Montgomery, India, Kenya. Firstly, GIST, HOG and SURF features extracted from CXRs and trained an SVM (Support Vector Machine) classifier that classifies into abnormal and normal classes. Secondly, four different pre-trained CNN have been used and the accuracy and performance of TB detection were developed [9]. Jingjing Cui et al., (2019) has proposed a CNN model for the detection of pulmonary tuberculosis in radiographs. This method makes use of CXR images. In this method two datasets namely Huiying dataset and Henan dataset are used. Firstly, feature extraction is done followed by the localization of tuberculosis. Ablation experiments are also done. The precisions are 0.9023 and 0.9332 [10]. Y Limpiyakorn et al., (2019) proposed three deep neural networks namely AlexNet, VGG-16 and CapsNet for classifying the CXR images of tuberculosis. The datasets are acquired from the National Library of Medicine and private Thai datasets. This measures the accuracy, sensitivity and specificity. The results show the shuffle sampling of size 3310, the VGG-16 classifier achieves a high sensitivity of 92.83% and the highest specificity of 96.06% [11].

3 DETECTION OF TUBERCULOSIS FROM MICROSCOPIC IMAGES:

Z. Saad et al., (2011) proposed an automatic K-mean clustering method based on C-Y color model. Firstly, after counter staining process the tissue images that are blue are removed. Secondly, segmenting the tuberculosis bacilli which remains red even after decolourization. Finally, a 5X5 median filter was used to eliminate small region noises. The resultant images would furnish more information for further analysis by pathologists [12]. Hee-Jin Kim et al., (2016) has proposed a paper which concludes that deep Convolutional Neural Network (CNN) is a very promising algorithm for various visual tasks. The CNN enables end to end training from feature extraction to classification. In this paper, a CAD system based on deep CNN for automatic TB detection which uses CXRs images [13]. Tao Yang et al., (2016) has proposed a model which fuses the convolution neural network with the tree bank information. Extraction of features from the matrix that is made up of the short text sentence tree bank is done using three convolutional layers. The model contains two parts, the first part is input data building, and the second part is network training. The dataset labels have five sentiment classes (very negative, negative, neural, positive, and very positive) [14]. Maria Brunette et al., (2017) has proposed a paper which focuses on reducing the tuberculosis patient wait time for being diagnosed. This paper aims at developing an X-ray image database and computational models to classify the image into different category of tuberculosis. A CNN (Convolutional Neural Network) model is developed to improve the performance of the deeper neural network algorithms [15]. Penny Chong et al., (2017) has proposed a paper that describes the methodologies to improve the accuracy of drug resistant tuberculosis and to identify the type of tuberculosis present in the patient. CNN is used to identify features in CT scans. RNN is used as classifier where CNN as feature extractor. Image slicing and data augmentation were done before training. By converting CT scans to images CNN transfer learning on MDR task and TB-type task were implemented. Both the methods gave good results [16]. Smriti Mishra et al., (2017) has proposed a paper for tuberculosis detection. In this paper, a diverse dataset which contains seven categories acquired from different microscopes has been developed namely the Ziehl–Neelsen sputum smear microscopy image database (ZNSM iDB). All categories of datasets were validated using different algorithm. For the development in automated microscopy the ZNSM-iDB is used [17]. U.K. Lopes et al., (2017) has proposed a paper which focuses on producing CNN (Convolutional Neural Network) as feature extractor to detect the tuberculosis is then used to train the SVM classifier. The datasets used in this method are Shenzhen and Montgomery. An accuracy of 0.782 and AUC 0.838 were obtained for the Montgomery dataset and were considered to be the best result of the two dataset [18]. Yadini Perez Lopez et al., (2017) has proposed a method that uses RGB,R-G and grayscale versions of patches as input to the CNN (Convolutional Neural Network) model for identifying Mycobacterium Tuberculosis. A patch image dataset named as original dataset was created with 9770 patches of 40X40 pixels. In which 50% of the patches is with bacillus (Positive images) and 50% of the patches is without bacillus (Negative images). From the original dataset an augmented dataset was created by applying two rotations 90 and 180 degree. An accuracy of 99% was obtained and the best input version was R-G [19]. Albert Jin Chung et al., (2018) proposed a method which uses Artificial Intelligence (AI) for the effective management of TB patients by using DOTS (Directly Observed Treatment, Short-course). A database namely e-PROMMS database was used, which consists of data when a patient receives prescription for Tuberculosis (TB) and real time data from patients while taking TB drug. Two phases namely screening phase and medication monitoring phase were done. This method reduces the overall cost of treating TB [20]. Sonaal Kant et al., (2018) has proposed a deep neural network model to diagnose tuberculosis. Three datasets from Ziehl-Neelsen Sputum Smear Microscopy image database (ZNSM-iDB) was used. It consists of 6 sets with each of 50 view fields. From this 60% were used for training, 20% for validation and 20% for training. A recall and precision of 83.78% and 67.55% were achieved respectively [21].

4 CONCLUSION

Tuberculosis is a deadly disease. This paper discusses about number of methods used for the detection of tuberculosis using CXR (Chest Radiography) and Microscopy images based on deep CNN (Convolutional Neural Network) has been developed. The CNN detects different features according to the objective. The CNN model is used for classifying and identifying the CXR images. The CNN model combined with advanced tools is used for the detection of Microscopy images. Noise and contrast is improved for improving the segmentation accuracy. Greater accuracy is achieved using the CNN models.

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