International Journal for Multidisciplinary Research (IJFMR)

E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Tuberculosis Detection and Air Purifier Suggestion

Arnav Singh

UG Student, SRM Institute of Science and Technology Kattankula

ABSTRACT

Tuberculosis (TB) is a disease that can be fatal if not promptly treated. Ensemble deep learning methods have shown promise in aiding the early detection of TB. Previous research typically trained ensemble classifiers using images with similar features, but for optimal performance, an ensemble requires a range of errors, achievable through diverse classification techniques or feature sets. This study focuses on the latter approach, presenting TB detection using deep learning alongside contrast-enhanced canny edge detected (CEED-Canny) X-ray images. CEED-Canny was employed to generate edge-detected lung X-ray images. Two sets of features were derived: one from the enhanced X- ray images and the other from the edge-detected images. By introducing this variation in features, the diversity of errors among the base classifiers was increased, resulting in improved TB detection. The proposed ensemble method achieved a comparable accuracy of 93.59%, sensitivity of 92.31%, and specificity of 94.87% compared to prior research.

CCS Concepts

Computing methodologies→Computer graphics→Image manipulation

Keywords: Artificial Intelligence; Tuberculosis; Pulmonary; Lung X-Ray; Chest; Neural Network; Rectification Linear Unit.

INTRODUCTION

Over the past decade, there has been a significant evolution in the digital medical industry, with most institutions transitioning from analog to digital operations. Digital software-driven healthcare is now utilized not only in radiology departments but across various clinical specialties. Technical staff members have recognized the potential of digital medicine [3]. The shift to digital patient data opens up opportunities for computerized diagnostics and artificial intelligence-based detection mechanisms. This research paper focuses on using neural networks to diagnose tuberculosis bacteria presence in digital X-ray data. Traditional machine learning and vision detection methods require manually crafted features, which is impractical due to the abundance of features in medical image diagnostics. Hence, deep learning neural networks, particularly convolutional neural networks (CNN), coupled with supervised learning, are considered the most suitable approach [2]. CNN architectures offer advantages in terms of universality and stability [1]. Given South Africa's high infection rates, it is crucial to swiftly identify infections. Leveraging existing state- of-the-art cellular networks, images can be digitized and remotely sent for diagnostics. If neural networks are employed for disease detection, with radiologists confirming the results, the process would be more efficient. Moreover, as more data is received, the network's learning improves, leading to enhanced accuracy. However, it's important to explore methods that yield higher accuracy. This paper investigates two deep learning methods using DCNN for classifying TB manifestations in chest X-ray images: various preprocessing methods and the hybrid method, which combines Computer-Aided Detection (CAD) and DCNN. Both methods demonstrate promising results, with the hybrid method achieving the highest accuracy. The structure of the paper is as follows: Section II provides a brief literature review on pulmonary tuberculosis and convolutional neural networks. Section 3 outlines the research methodology, while Section 4 describes the datasets and experimental settings. Section 5 elaborates on the evaluation of experimental results, followed by a discussion of the results' implications in Section 6. Finally, Section 7 presents the conclusion and avenues for future research.

LITERATURE REVIEW

Digital Imaging and Communication in Medicine (DICOM)

The abbreviation DICOM stands for Digital Imaging and Communication in Medicine, which plays a crucial role in the realm of digital chest X- ray (CXR) images. In the past, X-ray images were captured and developed on film to create the final image. However, DICOM represents a method where digitized image data along with patient demographics can be transmitted from a modality to a workstation or Picture Archiving and Communication System (PACS). Figure 1 illustrates an X-ray machine.

Pulmonary Tuberculosis (PTB)

Pulmonary Tuberculosis (PTB) refers to tuberculosis infection primarily affecting the lungs, as defined by the Oxford dictionary. While the lungs are predominantly affected when the tuberculosis infection becomes active, other parts of the body can also be involved. There are three main types of TB: Miliary TB, Active TB, and Latent TB. This paper specifically focuses on active TB, which occurs when the bacteria multiply and invade various organs. Common symptoms of active TB include cough, phlegm, chest pain, weakness, weight loss, fever, chills, and night sweats. Individuals with active PTB can spread the disease through the air. Symptoms experienced by patients include chest pains, night sweats, fever, fatigue, and a persistent cough. However, it's important to note that not all patients display symptoms; some may have minimal or no symptoms at all. Figure 2 depicts an electron microscope image of the Tuberculosis bacterium.

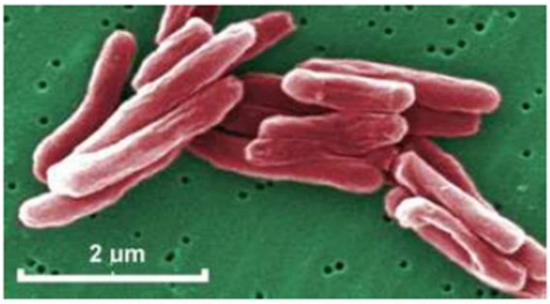


Figure 2. Image of an electron microscope enlargement of the Tuberculosis bacterium [10].

Convolutional Neural Networks

Normally in multi-layer neural networks (MLNN), the inputs are in vector form. For Medical Images, the neighboring pixels or voxels are another source of information. When using MLNN the vectorization process discards the voxel and neighboring pixel information, and thus CNNs are used.

When using convolutional layers coupled with pooling and finally fully connected layers, the spatial information in the voxels can be much better utilized, and the structure of CNN is shown in Figure 3 [4].

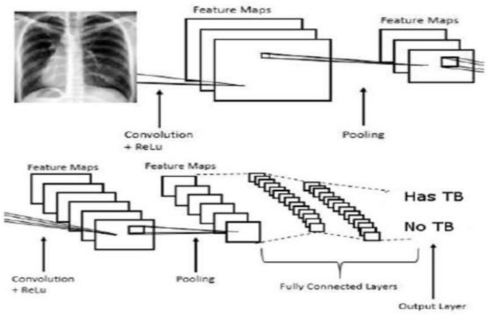


Figure 3. Multi-Layer neural network [4]

RESEARCH METHODOLOGY

Figure 4. Color depth and pre processing method

Figure 5. Hybrid approach

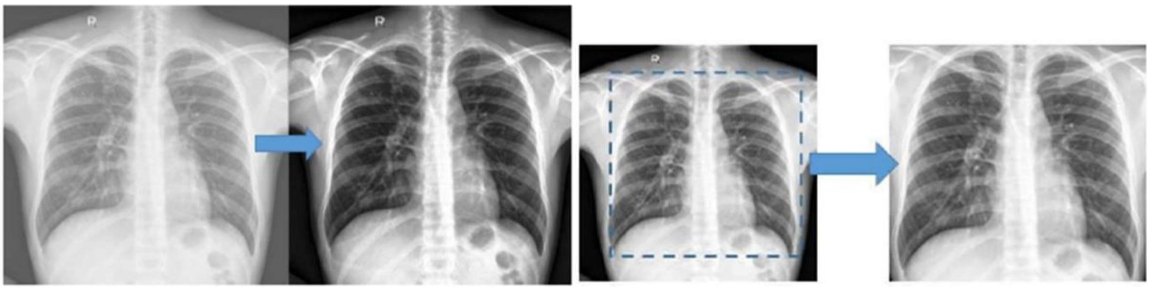
To enhance the accuracy of detection, it is crucial to examine different color depths and preprocessing techniques, as illustrated in Figure 4. Using a fixed random generator ensures more consistent results with less fluctuation. The testing involved comparing different color depths, with grayscale yielding similar results to RGB. Subsequently, various image preprocessing methods were evaluated, and the outcomes are detailed in the evaluation section.

To enhance accuracy further, an approach known as the hybrid method is explored. The preprocessed image set depicted in Figure 4 (output of the 3rd block) serves as the basis, undergoing additional processing where the Region of Interest (ROI) is extracted from these images. Once again, a fixed random generator is employed to ensure more consistent accuracy results. This method represents a hybrid approach combining elements from both Computer-Aided Detection (CAD) and DCNN. Specifically, the lung Region of Interest (ROI) is isolated and inputted into the DCNN as the dataset. The rationale behind this approach is to remove extraneous data, retaining only the image data relevant to the lung region. This focused training facilitates learning exclusively from pertinent features. This process is illustrated in Figure 5.

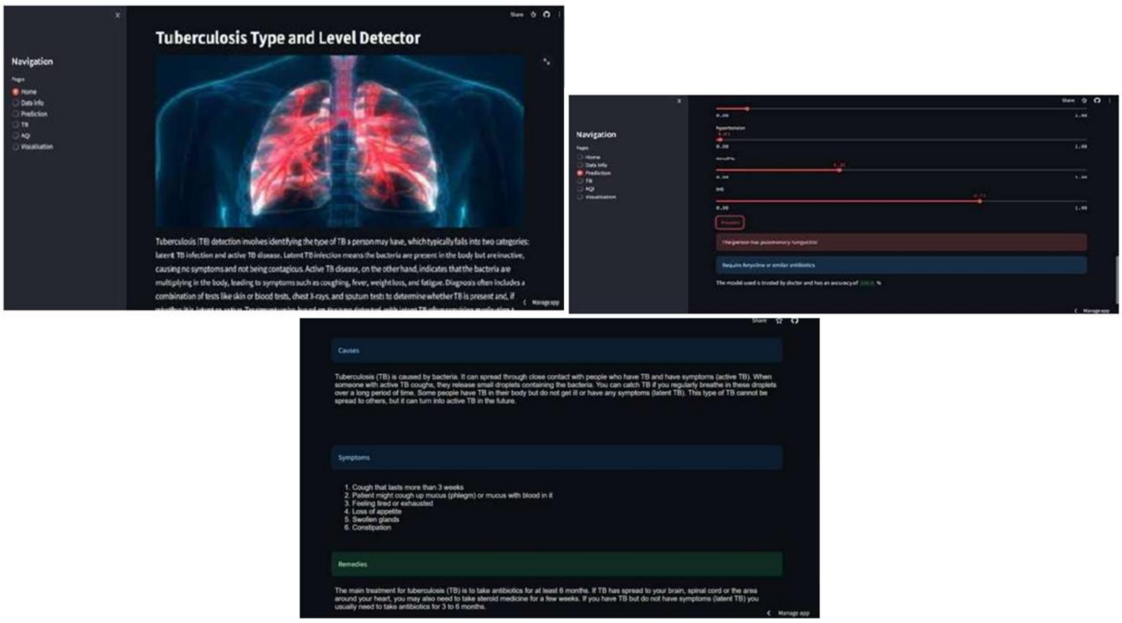
DATASETS AND EXPERIMENTAL SETTINGS

Datasets: Access the primary datasets used in this study via the following link: Tuberculosis Chest X-ray Image Data Sets. routine care at the hospital and are provided in JPEG format. It includes 336 normal X-rays and 326 abnormal X-rays displaying various tuberculosis manifestations.

Montgomery: The X-ray images in this dataset originate from the tuberculosis control program of the Department of Health and Human Services in Montgomery County, MD, USA. It consists of 138 posterior-anterior X-rays, among which 80 are normal and 58 exhibit tuberculosis-related abnormalities. All images are de-identified and are available in DICOM format. The dataset encompasses a wide spectrum of abnormalities, such as effusions and miliary patterns.



Shenzhen Hospital X-ray Set: This dataset comprises X-ray images collected by Shenzhen No.3 Hospital in Guangdong province, China. The X-rays were obtained as part of



SETTING

The simulations were conducted using Matlab, utilizing the Image Processing and Neural Network Toolboxes. The simulation settings were configured as follows:
Data shuffling was implemented to prevent repetition of the same data sequence.

- A mini-batch size of 80 was employed.
- A maximum of 30 epochs was specified.
- 10% of the total data was reserved for verification purposes.
- A fixed random generator was utilized for the initial weight selection.
- This ensured consistency across simulations, as all simulations commenced with the same randomly selected weight values.
- Consequently, the results remained consistent and did not vary across simulations.
- This method was consistently applied throughout all simulations.

CONCLUSION AND FUTURE WORK

The findings demonstrate compelling evidence that image preprocessing leads to higher accuracy compared to no preprocessing. Furthermore, extracting only the Region of Interest (ROI) from these preprocessed images results in even greater accuracy, with a maximum achieved accuracy of 92.54%. The primary advantage of the hybrid method is a significantly improved accuracy achieved by reducing overfitting.
In the future, our aim is to acquire additional clinical data to significantly enhance detection accuracy. Collaborating with organizations such as state TB hospitals could facilitate access to this data. With time, as more data is processed, the system will continue to learn and improve its accuracy. This system, or portal, could then be expanded to other institutions, aiding in the diagnosis of Tuberculosis across a broader spectrum.