Crossover Recognition Of Lung Infections With Chest X-Ray Images Utilizing Convolutional Neural Network

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***Abstract*— Nowadays, the COVID-19 and other chest infection diseases are growing rapidly worldwide and affecting the community.With an immense number of cases, a quick and efficient testing process is required. Healthcare systems all over the world are on edge due to the ongoing COVID-19 outbreak. The cases are increasing day by day. Governments, civil society, health professionals ,and scientists have been facing a relentless fight against the pandemic of the COVID-19 disease. The early and auto diagnosis helps people to be precautious. One of the ways to combat this disease is the effective screening of infected patients. With illnesses like pneumonia and lung cancer, COVID-19 offers a comparable pattern.Even very skilled medical professionals can be misled by this, leading occasionally to a false positive result. Integration of deep learning into radiology systems could be very helpful to suggest at the point of care, and it can enhance the quality, ease of use, and cost of chest diseases diagnosing from chest X-rays worldwide. In this regard, an image classification model can be used to detect and categorize the patient's chest X-ray (CXR) images into COVID-19, tuberculosis, pneumonia, and lung cancer and is an effective alternative due to its low cost, accessibility, and quick response.**

Keywords: lung disease detection, Covid-19, pneumonia, lung cancer, tuberculosis, Convolutional neural network, etc.

I. INTRODUCTION

As 2019 ended, coronavirus disease, known as COVID-19, started proliferating all over the world and has created an alarming situation worldwide. The virus originated in Wuhan, a town in Eastern China, in December 2019. In 2020, itwas declared by the World Health Organization (WHO) as a "Public health emergency of international concerns", andby March 2020 they classified the disease as a pandemic. The on-going COVID-19 outbreak made healthcare systemsacross the globe to be in the edge of the battle. Recent stats indicate that more than 660+ million confirmed cases are diagnosed globally, and the numbers keep rising. The early and auto diagnosis helps people to be precautious. One of the ways to combat this disease is the effective screening of infected patients. However, COVID-19 provides a similar pattern with diseases, such as pneumonia, and can misguide even very well- trained physicians.

Automating the diagnosis of many diseases nowadays has been based on artificial intelligence, which has proven its efficiency and high performance in automatic image classification problems through different machine learning approaches. Artificial Intelligence makes calculations and predictions based on analyzing the input data, then performstasks that require human intelligence such as speech recognition, translation, visual perception, and more whereas machine learning defines models that have the ability to learn and make decisions by using large amounts of input data examples. Deep Learning is a technique for implementing machine learning that mostly focus on the automatic feature extraction and classification of images and have shown great achievement in many applications, especially in health care . Deep learning efficiently generates models that produce more accurate results in predicting and classifying different diseases using images as in lung cancer, pneumonia, and recently COVID-19 diagnosis, without requiring any human intervention. The main reason for using deep learning is that deep learning techniques are learned by creating a more abstract representation of data as the network grows deeper.

II. LITERATURE SURVEY

[1] Kanakaprabha. S, D. Radha, "Analysis of COVID-19 and Pneumonia Detection in Chest X-Ray Images using Deep Learning", 2021 International Conference on Communication, Control and Information Sciences (ICCISc) | 978-1-6654-0295-8/21/$31.00 ©2021 IEEE | DOI: 10.1109/ICCISc52257.2021.9484888 - The proposed work aims to detect COVID-19patients and Pneumonia patients from X-Rays which is one of the medical imaging modes to analyze the health of patient's lung inflammation. The model detects COVID-19 patients and Pneumonia patients on the real-world dataset of lung X-Ray images. Images are pre- processed and trained for various classifications like Normal, COVID-19 and Pneumonia. After pre-processing, the detection of

the disease is done by selecting the appropriate features from the images in each of the datasets.

[2] Afonso U. Fonseca et.al., “Screening of Viral Pneumonia and COVID-19 in Chest X-ray using Classical Machine Learning”, 2021 IEEE 45th Annual Computers, Software, and Applications Conference (COMPSAC) | 978-1-6654-2463-9/21/$31.00 ©2021IEEE| DOI:10.1109/COMPSAC51774.2021.00294 The main goal of this work is to present a robust, light weight, and fast technique for the automatic detection of COVID-19 from CXR images. They extracted radiomic features from CXR images and trained classical machine learning models for two different classification schemes: i) COVID-19 pneumonia vs. Normal ii) COVID-19 vs. Normal vs. Viral pneumonia. They investigated extracted features from Haar wavelet transform to obtain a set of featuresrepresentative of this disease. Their best binary classification model (*CxN*) reached 100% in all metrics calculated with a set of only 18 features, while minimum accuracy was 99.61%.

[3] Mohammad Farukh Hashmi et.al., “Efficient Pneumonia Detection in Chest Xray Images Using Deep TransferLearning”, Diagnostics2020,10,417; doi:10.3390/ diagnostics 10060417 - A novel approach based on a weighted classifier is introduced, which combines the weighted predictions from the state-of-the-art deep learning models such as ResNet18, Exceptions, InceptionV3, DenseNet121, and MobileNetV3 in an optimal way. This approach is a supervised learning approach in which the network predicts the result based on the quality of the dataset used. Transfer learning is used to fine-tune the deep learning models to obtain higher training and validation accuracy.

[4] Saeed S. Alahmari et.al., “A Comprehensive Review of Deep Learning-Based Methods for COVID-19 Detection Using Chest X-Ray Images”, Received 30 August 2022, accepted 14September 2022, date of publication 20 September 2022, date of current version 28 September 2022. Digital Object Identifier 10.1109/ACCESS.2022.3208138 - In this paper, they review deep learning approaches for COVID-19 detectionusing chest X-ray images. They found that the majority of deep learning approaches for COVID-19 detectionuse transfer learning. A discussion of the limitations and challenges of deep learning in radiography images ispresented. Finally, they provide potential improvements for higher accuracy and generalizability when using deep learning models for COVID-19 detection.

[5] Vinod Kumar, Anil Saini, “Detection system for lung cancer based on neural network: X- Ray validation performance”, International Journal of Enhanced Research in Management & Computer Applications, ISSN: 2319-7471 Vol. 2 Issue 9, Nov.-Dec., 2013, pp: (40-47) -In this paper, the author represents Lung Cancer Detection System for finding of lung cancer by analyzing chest X-rays with the help of image processing mechanisms. This system assists radiologists with their X-ray image interpretation of lung cancer. This paper presents a neural network-based approach to detect lung cancer from raw chest X-ray images. The author usesan image processing technique to denoise, to enhance, for segmentation and edge detection in the X-ray imageto extract the area, perimeter and shape of nodule.

[6] Stefanus Kieu Tao Hwa, Abdullah Bade, et al., “ Tuberculosis detection using deep learning and contrast- enhanced canny edge detected X-Ray images.”, IAES International Journal of Artificial Intelligence (IJ-AI) Vol. 9, No. 4, December 2020, pp. 713~720 ISSN: 2252-8938,DOI: 10.11591/ijai.v9.i4.pp713-720. - This paper proposes an approach for tuberculosis (TB) detection using deep learning and Contrast-Enhanced Canny edgedetected x-ray images. The authors note that previous ensembles combining CNNs trained on similar featureshave limited the performance of the classifiers. To address this, the authors propose ensembles that combine CNNs trained on different features extracted from a different set of images, the Enhanced and Edge images.

III. PROPOSED SYSTEM

The proposed system for classifying lung diseases from chest X-ray images is a valuable tool in identifying the presence of normal, COVID-19, pneumonia, tuberculosis, or lung cancer with high accuracy of 97%. The process includes four main steps: pre-processing, feature selection, feature extraction, and classification. These steps involve enhancing the quality of images, selecting important features, extracting meaningful information from images, and classifying them into appropriate categories. The additional feature of sending SMS alerts to individuals with information about the disease diagnosed and the suitable hospital is also an added benefit. This system can provide quick and accurate results, allowing for early diagnosis and timely treatment of lung diseases, which can ultimately save lives.

IV. IMPLEMENTATION

Implementation is the process of converting a new system design into an operational one. It is the key stage in achieving a successful new system. It must therefore be carefully planned and controlled.

A. Module specification:

Module Specification is the way to improve the structure design by breaking down the system into modules and solving it as independent task. By doing so the complexity is reduced and the modules can be tested independently. The number of modules for our project is, namely collection, pre-processing, segmentation, feature extraction, training, and classification. So, each phase signifies the functionalities provided by the proposed system. In the data pre-processing phase noise removal using median filtering is done.

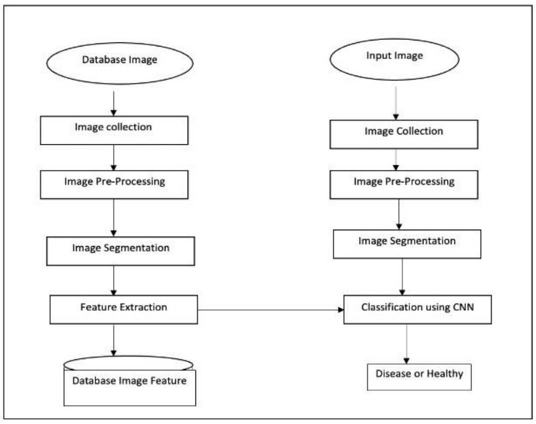

Figure 1: System Architecture

The System design mainly consists of

1. Image Collection
2. Image Pre-processing
3. Image Segmentation
4. Feature Extraction
5. Training
6. Classification

1. Image Collection:

The dataset that we have used in this project is from Kaggle website.

2. Image Pre-processing:

The goal of pre-processing is an improvement of image data that reduces unwanted distortions and enhances some image features important for further image processing. Image pre-processing involves three main things a) Grayscale conversion b) Noise removal c) Image enhancement.

a) Grayscale Conversion: Grayscale image contains only brightness information. Each pixel value in a grayscale image corresponds to an amount or quantity of light. The brightness graduation can be differentiated in grayscale image. Grayscale image measures only light intensity 8-bit image will have brightness variation from 0 to 255 where '0' represents black and '255' represent white. In grayscale conversion colour image is converted into grayscale image shows. Grayscale images are easier and faster to process than coloured images. All image processing technique are applied on grayscale image.

b) Noise Removal: The objective of noise removal is to detect and remove unwanted noise from digital image. The difficulty is in deciding which features of an image are real and which are caused by noise. Noise is random variations in pixel values. We are using median filter to remove unwanted noise. Median filter is nonlinear filter, it leaves edges invariant. Median filter is implemented by sliding window of odd length. Each sample value is sorted by magnitude, the centre most value is median of sample within the window, is a filter output.

c) Image Enhancement: The objective of image enhancement is to process an image to increase visibility of feature of interest. Here contrast enhancement is used to get better quality result.

3. Image Segmentation:

Image segmentation are of many types such as clustering, threshold, neural network based and edge based. In this implementation we are using the clustering algorithm called mean shift clustering for image segmentation. This algorithm uses the sliding window method for converging to the Centre of maximum dense area. This algorithm makes use of many sliding windows to converge the maximum dense region. Mean shift clustering Algorithm This algorithm is mainly used for detecting highly dense regions.

4.Feature Extraction:

There are many features of an image mainly color, texture, and shape. Here we are considering three features that are color histogram, Texture which resembles color, shape, and texture.

5. Training:

Training dataset was created from images of known Cancer stages. Classifiers are trained on the created training dataset. A testing dataset is placed in a temporary folder. Predicted results from the test case, Plots classifiers graphs and add feature-sets to test case file, to make image processing models more accurate.

6. Classification:

The binary classifier which makes use of the hyper-plane which is also called as the decision boundary between two of the classes is called as Convolution Neural Network. Some of the problems are pattern recognition like texture classification makes use of CNN. Mapping of nonlinear input data to the linear data provides good classification in high dimensional space in CNN. The marginal distance is maximized between different classes by CNN. Different Kernels are used to divide the classes. CNN is basically a binary classifier that determines hyper plane in dividing two classes. The boundary is maximized between the hyperplane and two classes. The samples that are nearest to the margin will be selected in determining the hyperplane is called support vectors.

B. CNN Algorithm Explanation:

The invention of the CNN in 1994 by Yann Le Cun is what propelled the field of Artificial Intelligence and Deep learning to its former glory. The first neural network named LeNet5 had a very less validation accuracy of 42% since then we have come a long way in this field. Nowadays almost every giant technology firms rely on CNN for more efficient performance. The idea to detect diseases in mulberry leaf incorporates the use of CNN before we dive into the "functionality and working of CNN" concept, we must have a basic idea on how the human brain recognizes an object in spite of its varying attributes from one another. Our brain has a complex layer of neurons , each layer holds some information about the object and all the features of the object are extracted by the neurons and stored in our memory, next time when we see the same object the brain matches the stored features to recognize the object, but one can easily mistake it as a simple "IF-THEN" function, yes it is to some extent but it has an extra feature that gives it an edge over other algorithms that is Self-Learning, although it cannot match a human brain but still it can give it a tough competition . Image is processed using the Basic CNN to detect the diseases in leaves. The data training in our CNN model has to satisfy following constraints:

1) No missing values in dataset.

2) The dataset must distinctly be divided into training and testing sets, either the training or the testing set shouldn't contain any irrelevant data out of our model domain in case of an image dataset all the images must be of the same size, one uneven distribution of image size in our dataset can decrease the efficiency of our neural network.

3) The images should be converted into black and white format before feeding it into the convolution layer because reading images in RGB would involve a 3-D numPy matrix which will reduce the execution time of our model by a considerable amount. Any kind of corrupted or blurred images should also be trimmed from the database before feeding it into the neural network. This is all about data pre-processing rules, let us dive right into the working of the convolution neural network.

C. Convolutional Neural Network layers:

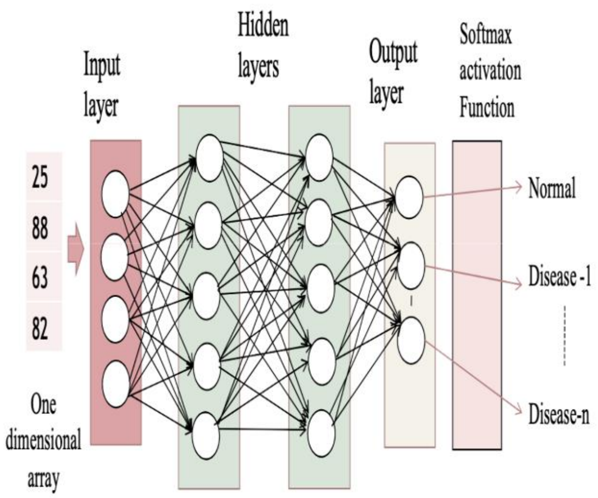

Figure 2 Convolutional Neural Network Layers

i. Convolution layer:

This layer involves scanning the whole image for patterns and formulating it in the form of a 3x3 matrix. This convolved feature matrix of the image is known as Kernel. Each value in the kernel is known as a weight vector.

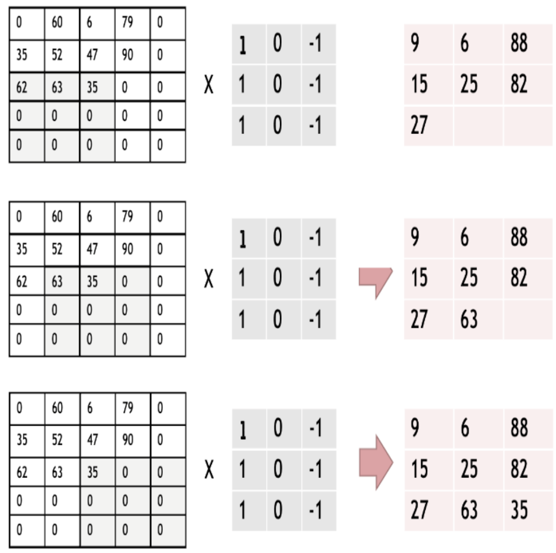

Figure 3 Convolutional Output: A 3*3 matrix

ii. Pooling layer:

After the convolution comes to the pooling here the image matrix is broken down into the sets of 4 rectangular segments which are non-overlapping.

There are two types of pooling, Max pooling and average pooling. Max pooling gives the maximum value in the relative matrix region which is taken. Average pooling gives the average value in relative matrix region. The main advantage of the pooling layer is that it increases computer performance and decreases over- fitting chances.

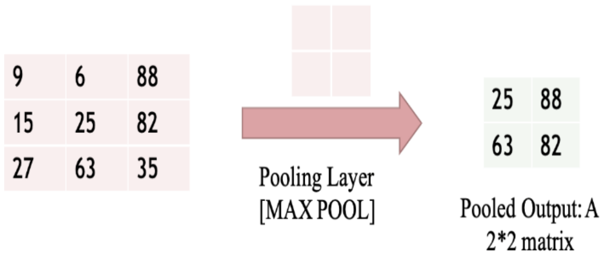

Figure 4 Pooling Layer Output

iii. Activation layer:

It is the part of the Convolutional Neural Networks where the values are Normalized that is, they are fitted in a certain range. The used convolutional function is ReLU which allows only the positive values and then rejects the negative values. It is the function of low computational cost.

V. FUTURE SCOPE

In future enhancements of this project, several key improvements can be implemented. The system can be expanded to include a larger dataset of chest X-ray images, encompassing diverse populations and a wider range of disease presentations. This would improve the system's generalizability and ensure its effectiveness across different patient demographics. Additionally, integrating cloud-based storage and processing capabilities can facilitate scalability and enable real-time analysis of X-ray images. The potential of this system can be explored by applying it to other medical imaging modalities, such as CT scans, could broaden its scope and impact in diagnosing various respiratory conditions. The SMS feature can also be further enhanced by sending an email alert to the patients.

CONCLUSION

The proposed work presents a CNN model for detecting different lung diseases from X-ray images, including Normal lungs, COVID-19 Infected lungs, Pneumonia Infected lungs, Tuberculosis infected lungs, and lung cancer-infected lungs. With an accuracy of around 97%,the model offers a valuable tool for medical practitionersand researchers, as it can provide a quick and cost-effective diagnosis of various lung diseases.

Furthermore, the model's low computational requirements make it ideal for use in resource- limited settings. This technology has the potential to revolutionize the field of medical imaging and aid in the fight against the COVID-19 pandemic, as well as other lung diseases.

The proposed work can be extended by combining multiple models into an ensemble, as this has been shown to improve accuracy even further. Additionally, incorporating additional features, such as patient demographics or clinical history, can help tailor the diagnosis to individual patients and further improve the model's accuracy.

In conclusion, the proposed work presents a promising solution for the detection of lung diseases from X-ray images, with the potential to improve medical diagnosis and treatment. The model's high accuracy, low cost, and computational requirements make it a valuable tool for medical practitioners, especially in resource-limited settings. Future research can further improve the model's accuracy and expand its application to a wider range of lung diseases.

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