COVID, PNEUMONIA, OR NORMAL X-RAY IMAGES CLASSIFICATION BY USING A CONVOLUTION NEURAL NETWORK

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***Abstract*—** The Covid-19 pandemic has presented a significant global challenge due to its highly contagious nature and severe respiratory symptoms. However, laboratory testing is not always widely available, leading to the need for alternative screening methods. Recent research has suggested that CT scans can play a crucial role in detecting and managing Covid-19 pulmonary symptoms. To address this need, researchers have developed a Neural Network model for Covid-19 and pneumonia classification based on TensorFlow and Keras. The model can accurately and efficiently classify medical images, including CT scans, with an impressive accuracy rate of 96% in testing. The model's efficiency enables rapid image processing and classification, providing healthcare professionals with timely information for informed decision-making. This Neural Network model provides an efficient and accurate screening method that is not reliant on laboratory testing, potentially revolutionizing Covid-19 diagnosis and management. Early detection of the virus can significantly impact disease transmission rates and improve patient outcomes, making this Neural Network a critical tool for public health officials and healthcare professionals worldwide. The study represents early detection capabilities of this Neural Network model can play a crucial role in mitigating the spread of the virus and provide an alternative method of diagnosis where laboratory testing is not available or accessible.

Keywords: Deep learning, CNN, EfficientNet, ResNet, VGG16, Django Framework

I. INTRODUCTION

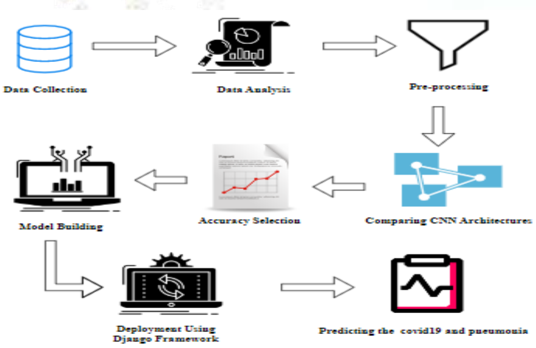
The ongoing COVID-19 pandemic has caused a significant impact on healthcare systems and economies worldwide. As the virus spreads rapidly, early detection and accurate diagnosis of COVID-19 are crucial for controlling the spread of the disease. Chest X-rays have become an essential tool for identifying and diagnosing COVID-19, as they provide a non-invasive and cost-effective imaging option. However, the manual interpretation of chest X-rays is time-consuming and prone to errors, making it challenging to identify COVID-19 cases accurately. To address this issue, automated methods for classifying chest X-rays into different categories have been proposed. In this study, we propose a deep learning-based approach for classifying chest X-ray images into three categories: COVID-19, pneumonia, and normal. Our model utilizes convolutional neural network (CNNs) techniques to achieve high accuracy with limited training data. We trained and evaluated our model on a publicly available dataset consisting of chest X-ray images from COVID-19, pneumonia, and normal patients. The dataset contains 5676 training and 790 testing images in total for Covid, Pneumonia, and Normal X-ray samples. The models performance is comparable to other state-of-the-art methods, demonstrating its potential for clinical use as a screening tool for COVID-19 and pneumonia. The proposed model has several advantages, including its ability to accurately classify chest X-ray images in a timely and cost-effective manner. Our approach can potentially help healthcare providers quickly and accurately diagnose COVID-19 cases, leading to more effective and timely treatment. Moreover, our models generalizability and transferability can be applied to other medical imaging tasks, making it a valuable tool in the medical field. In conclusion, our study presents a deep learning-based approach for classifying chest X-ray images into three categories: COVID-19, pneumonia, and normal. Our proposed model achieves high accuracy, demonstrating its potential for clinical use as a screening tool for COVID-19 and pneumonia. Our work can be extended to other medical imaging tasks, contributing to the development of more automated and accurate medical diagnosis systems.

II. LITERATURE SURVEY

Muhammad E. H. Chowdhury et al. [1] presented how the need of any technological tool enabling rapid screening of the covid-19 infection with high accuracy can be crucially helpful to healthcare professionals. The main clinical tool currently in use for the diagnosis of COVID-19 is the

Reverse transcription polymerase chain reaction (RT-PCR), which is expensive, less-sensitive and requires specialized medical personnel. X-ray imaging is an easily accessible tool that can be an excellent alternative in the COVID-19 diagnosis. This research was taken to investigate the utility of artificial intelligence (AI) in the rapid and accurate detection of COVID-19 from chest X-ray images. Gengfei Ling et al. [2] explores the efficacy of template-matching method and statistical pattern-based recognition method. Statistical pattern-based recognition methods include support vector machine, Adaboost algorithm, deep learning methods, and so on. It explains the usage of Support Vector Machine(SVM) as it is a learning algorithm based on the principle of structural risk minimization and VC dimension theory. Its basic model is to find the linear classifier with the largest classification interval in feature space. By extracting the texture features of lung LBP, Kaao uses support vector machine algorithm to identify lung types, and achieve side results. Furthermore, Adaboost algorithm the effect of strong classifier by combining weak classifiers. It is an iterative algorithm. Xi Ouyang et al. [3] worked on developing a dual sampling network in order to detect COVID-19 from Community Acquired Pneumonia in CT. They created a 3D convolutional network which focused on the infected regions of lungs when making decisions of diagnoses. The dual sampling strategy was created in order to counter the nature of imbalanced learning. It achieved an accuracy of 87.5%. Quili Wang et al. [5] propose a deep regression framework for automatic pneumonia screening, which jointly learns the multi-channel images and multi-modal information (i.e., clinical chief complaints, age, and gender) to simulate the clinical pneumonia screening process. It is beneficial for screening pneumonia with severe diseases, and for extracting multiple image features from multi-channel image slices as it treats the images of CT scans as short video frames and analyses them by RNN. Gaurav Srivastava et al. [6] proposed a novel model CoviXNet which offered minimum computational cost and comparable accuracies to ResNet V2 on a 3-class classification, and EfficientNet B0 on a binary class classification.

III. Proposed Methodology



System Architecture (Figure 1)

For this project, CNN models are proposed for comparison to get an optimal model that can deliver the output with minimal loss. This study aims to develop a classification model to identify Covid-19 and Pneumonia from chest X-ray images. To achieve this, data augmentation and classification techniques have been employed as shown in Figure 1. Furthermore, it is deployed on the Django framework where separate portals for doctors and patients have been created for immediate assistance. The dataset is pre-processed such as Image reshaping, resizing and conversion to an array form. Similar processing is also done on the test image.

A. Data Analysis and Data Augmentation

Firstly, we collect the data set from website. It includes 3 types of categories i.e. Covid, Pneumonia and Normal. It provided separate folder for training and testing data, so we did not have to separate the data set. For starting the process of data analysis, we store the path of each category in a separate variable in order to get a better read. Now, a deep learning framework keras is used for preprocessing via its ImageDataGenerator package. This package is used for data augmentation in order to normalize the data, and to obtain different orientation for the same image. We have given a rescale pixel value range of 0-255, a shear range of 0.2, a zoom range of 0.2, and put horizontal flip as True. This process is done both for the training and the testing data.

B. Deep learning models used

Having realized the importance of deep learning in medical image classification, we have performed a comparative study of three different architectures, namely- VGG 16, EfficientNet B0, and ResNet 50. Starting off the process, we convert the image to an array, and feed it as an input to the models used. The first model we used is VGG16 which is a deep convolutional neural network model that was proposed by the Visual Geometry Group (VGG) at the University of Oxford in 2014. The VGG16 architecture consists of 16 layers, including 13 convolutional layers and 3 fully connected layers. The convolutional layers use small 3x3 filters to extract features from the input image, and the pooling layers reduce the spatial dimensions of the features by a factor of 2. The fully connected layers at the end of the network map the extracted features to the output classes. Since it has been pre-trained on large datasets, such as ImageNet, it can be fine-tuned for specific tasks with smaller datasets.

The second model we used is EfficientNet B0, it is a convolutional neural network architecture that was proposed in 2019 as part of the Efficient Net family of models. It is designed to achieve state-of-the-art accuracy while maintaining a smaller model size and computational efficiency compared to other deep neural network models. The design of Efficient Net B0 focuses on achieving high accuracy by balancing model depth, width, and resolution. The model depth refers to the number of layers in the network, while the model width refers to the number of channels in each layer. The model resolution refers to the size of the input image. The Efficient Net B0 model achieves high accuracy by optimizing the trade-off between these three factors. Its design balances model depth, width, and resolution to optimize the trade-off between accuracy and computational requirements.

The third model we used is ResNet 50, it is a widely used convolutional neural network architecture that has shown remarkable performance in medical image processing tasks. The deep residual learning approach of the model allows it to learn complex features and capture subtle variations in medical images, leading to improved diagnostic accuracy. It reduces overfitting through its skip-connection feature, allowing for the preservation of information from previous layers and improving generalization performance. The simple architecture of ResNet-50 allows for efficient training and optimization, resulting in faster convergence and reduced training time. The model is versatile and can be used for various medical image processing tasks, including segmentation, detection, and classification, and has been successfully used for the diagnosis of medical conditions.

C. Custom Model

A Convolutional Neural Network has been built and compiled using the keras library. It has an input shape of (128,128,3) for images with 128x128 pixels and 3 color channels. The model includes a sequence of layers starting with a Conv2d layer with 32 filters and a kernel size of 3x3 followed by a MaxPool2D layer with a pool size of 2x2. Then, there is another Conv2D layer with 92 filters and a kernel size of 3x3. The output from the layer is flattened and passed through a Dense layer with 456 neurons, followed by another dense layer of 200 neurons, and finally a Dense layer with 3 layers and a 'Softmax' activation function to output the probability distribution over the three classes. The model is compiled using the Adadelta optimizer, categorical cross-entropy loss function, and accuracy metrics. To potentially improve accuracy, the model can be modified by adding more layers and regularization techniques like dropout or early stopping to prevent overfitting.

After the successful compilation of all the models, we define the number of set epochs, and run the code. The output gives the accuracy of the respective model which serves as the classification report.

D. Deploying the model in Django Framework and predicting output

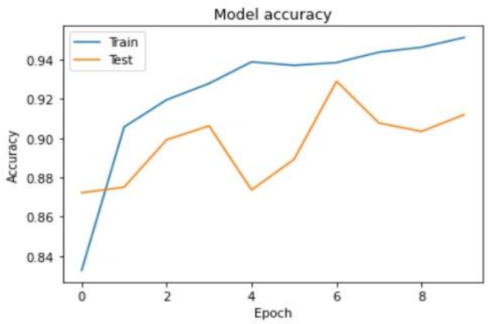
In this module, the trained deep learning model is converted into hierarchical data format file (.h5 file) which is then deployed in our Django framework for providing better user interface and predicting output. It is deployed using VS Code, and provides us with a user and doctor portal which can be accessed by signing up on the website. It provides a direct link between the doctor and the patient, where the doctor can provide feedback on the patient reports and serves an immediate assistance. It will prompt the patient to upload an X-ray which is required to be assessed. The correct output is therefore shown, that is, one of the three labels and thus the aim of the project is achieved successfully.

IV. PERFORMANCE EVALUATION

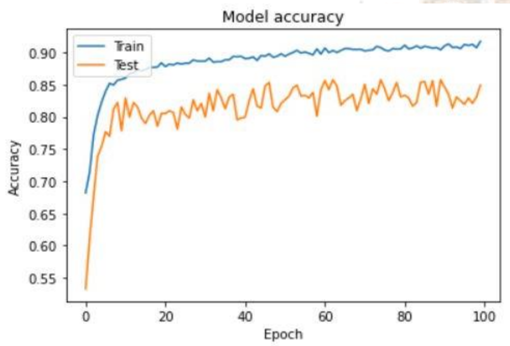
The study aimed to evaluate the effectiveness of three different convolutional neural network (CNN) models, VGG16, ResNet, and EfficientNet, in classifying images of X-Ray from the Kaggle dataset (https://www.kaggle.com/datasets/jtiptj/chest-xray-pneumoniacovid19tuberculosis), with which our own custom model can be compared. The classifiers were fine-tuned to classify X-ray images into three categories - Covid, Pneumonia, and Normal. Experiments conducted show that the VGG16 model achieved an accuracy of 70.3% in classifying the images into tertiary categories. EfficientNet achieved an accuracy of 96%, and ResNet outperformed the other classifiers, achieving an accuracy of 96.8%. The findings indicate that ResNet is the most effective classifier for X-ray classification. These results are significant because they highlight the potential of CNN models in accurately classifying medical images, which can be valuable for improving diagnostic accuracy and patient outcomes. The ability to quickly and accurately classify medical images could aid in identifying and treating diseases in a timely and effective manner. Furthermore, the study demonstrates the importance of fine-tuning pre-trained models to improve performance on specific tasks. In conclusion, the study presents promising results in the use of CNN models for X-ray classification, with ResNet proving to be the most effective classifier. These findings provide a foundation for future research in the development and refinement of CNN models for medical image processing.

Table 1. Comparison of accuracy and specificity

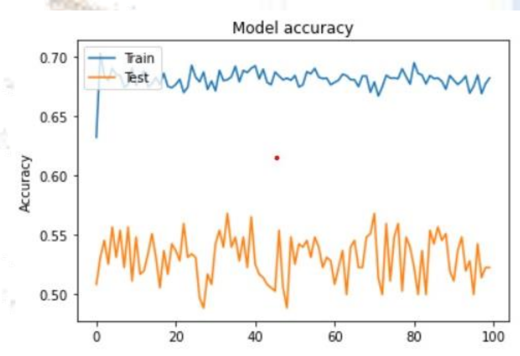
Classifiers	Accuracy (%)
Custom Model	**91.7**
VGG 16	**70.3**
EfficientNet B0	**96.25**
Resnet 50	**96.68**



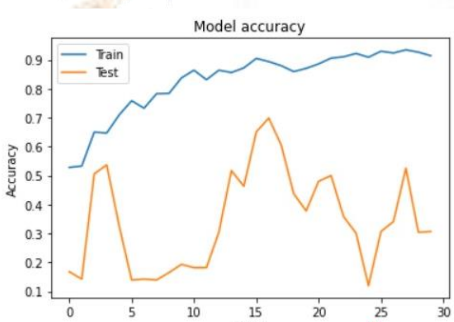
(Fig.2)Accuracy obtained for Efficient Net Architecture(96.25%)



(Fig.3)Accuracy obtained for custom model(91.7%)



(Fig.4)Accuracy obtained for VGG 16 Architecture(70.3%)



(Fig.5)Accuracy obtained for ResNet Architecture(96.68%)

V. Conclusion

This project aimed to classify COVID-19 and pneumonia over static X-ray images using deep learning techniques. While previous studies have achieved good results using feature engineering, this project focused on feature learning, which is a key promise of deep learning. While feature engineering is not necessary, pre-processing of images can enhance classification accuracy by reducing noise in the input data. Currently, COVID-19 and pneumonia detection software rely on feature engineering techniques, and a solution based solely on feature learning is not yet feasible due to a major limitation. However, classification of COVID-19 and pneumonia can be achieved through the use of deep learning techniques. The classification of COVID-19 and pneumonia over static X-ray images is a complex task that has been addressed using various techniques. This project's focus on feature learning aligns with the promise of deep learning to learn features automatically from raw data, without the need for manual feature engineering. This approach also offers the potential to improve classification accuracy by leveraging the ability of deep neural networks to learn complex patterns in data. However, the limitation of this approach is that it requires large amounts of data for training, which can be challenging to obtain for medical imaging applications. In summary, this project demonstrates the potential of deep learning techniques in the classification of COVID-19 and pneumonia from static facial images. While feature engineering techniques currently dominate the field, feature learning approaches offer an alternative that may provide superior classification accuracy with further development. Nevertheless, the success of this approach is dependent on the availability of large amounts of high-quality training data, which is an ongoing challenge in medical image processing.

VI. References

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