COVID-19 DETECTION USING X-RAY IMAGES

SATHISH KUMAR K R[1], BALLA DINESH [2], CHITTIBOYINA SUKUMAR [3], DIRISALA VENKATESH [4] GANGINENI MADHAV[5]
1 ASSISTANT PROFESSOR, 2,3,4,5 UG STUDENTS
DEPARTMENT OF COMPUTER SCIENCE
MAHENDRA ENGINEERING COLLEGE, TAMILNADU, INDIA

ABSTRACT

The coronavirus 2019(COVID-19), which first occur in wuhan city of China in December 2019, spread quickly around the world and became a plague. It is necessary to detect the positive cases as early as possible so as to prevent the further spread of this disease. Application of convolutional neural networks (CNN) techniques coupled with medical imaging can be helpful for the accurate detection of this disease. In this project a new model for automated COVID-19 detection using raw chest X-ray images is used. The model is developed to supply accurate diagnosis for binary classification (COVID vs No-Findings). Our model produced an accuracy of 98.44%. The sequential model was used to train a model using Keras and Tensorflow. We introduced convolutional layers and implemented different filtering on each layer.

Keywords: Covid-19 detection, X- Ray Image & Disease

1. INTRODUCTION

COVID-19 is a transmissible disease that was caused by the Severe Acute Respiratory Syndrome Coronavirus 2(SARS-CoV-2). The disease was first discovered in china and has spread among the world. As we know, on December 12, 2020 more than 12,847384 confirmed cases of COVID-19 and 55,587 confirmed deaths due to disease. Signs of infection include breathing problem, cough, fever. In more serious cases, the infection can cause severe acute respiratory syndrome, septic shock, multi organ failure and death. There is a limited number of COVID-19 test kits available in hospital due to increasing cases daily. Because it is required to implement an automatic detection system as an alternative diagnosis to prevent COVID-19 spreading among people. The sequential model was used to train a model using Keras and Tensorflow. We implemented convolutional neural network layers and implemented different filtering on each layer.

1.1 CONVOLUTIONAL NEURAL NETWORKS (CNN)

The objective of this project is to enhance COVID-19 detection accuracy from chest X-ray images. Convolutional Neural Networks (CNN) is one quite deep neural network. The Convolutional neural network structure includes two layers one is feature extraction layer, the input of every layer is connected to the local receptive fields of the previous layer and extracts the local feature. Once the local feature is extracted, the positional relation between it and other features also will be determined. In this regard, we consider a framework based on CNN, because CNN is a powerful feature extraction and classification methodology, and therefore excellent recognition performance in image classification. Of course, within the case of medical image analysis, significant diagnostic accuracy may be a prime objective alongside critical findings, and in recent years, the findings of critical facts related to medical imaging are comprehensively led by CNN-based framework hence it motivates us to try.

1.2 KERAS MODEL

Keras model could even be an arrangement about how we stack our neural network layers. We can stack our neural network layers mainly in three ways:

1) Sequential Model
2) Functional Model
3) Subclass Model

During this project we train a neural network using sequential model. A Sequential model is suitable for a transparent stack of layers where each layer has exactly one input tensor and one output tensor. Any of the layers has multiple inputs or multiple outputs. We created a Sequential model by passing an inventory of layers to the Sequential constructor. Once a model is made, you'll call its summary () method to display its contents.

However, it is often very useful when building a Sequential model incrementally to be ready to display the summary of the model thus far, including the output shape. During this case, we would like to start out the model by passing an input object to our model, so as that it knows its input shape from the beginning. When building a replacement Sequential architecture, it's useful to incrementally stack layers with add () and regularly print model summaries. As an example, this enables you to watch how a stack of Conv2D and MaxPooling2D layers is down sampling image feature maps.

1.3 TENSORFLOW

Tensor Flow is an open source library for large-scale deep learning and numerical computation. It uses Python to give a convenient front-end API for building applications with the framework. Tensor Flow can train and run deep neural networks for digit classification, word embeddings, image recognition, sequence-to-sequence models for MT, tongue processing, recurrent neural networks. Over all, Tensor Flow supports production prediction at scale, with an equivalent models used for training.

Tensor Flow gives access to developers to create dataflow graphs and structures that explains how data transfer through a graph, or a series of processing nodes. Each node within the graph represents a mathematical calculation, and every connection or edge between layers may be a multidimensional data array, or tensor. The final models created by Tensor Flow, are often works on any device where they are going to serve predictions.

2. LITERATURE REVIEW

Liu, S., Satapathy, S.C., Zhang, YD. et al [1] proposed a deep learning model that can treat COVID-19 on chest X-ray images more accurately. They introduced stochastic pooling to replace average pooling and max pooling and then combined conv layer with batch normalization layer and obtained the conv block and at last they merge dropout layer with fully connected layer and obtained the fully connected block. The accuracy of 93.64% is achieved in identifying COVID-19.

Ashad, Chowdhury, Md. Muhtadir & Kabir, Nihad & Rahman [2] proposed a parallel-dilated CNN based COVID-19 detection system from chest x-ray images, named as Parallel-Dilated COVIDNet (PDCOVIDNet). In their experiment, they used a complete of 905 chest X-ray images, comprising three cases (such as COVID-19, normal, and viral pneumonia), and empirical evaluations revealed that the proposed method extracted more significant features expeditiously associated with suspected disease. The experimental results demonstrate that the proposed method significantly improves performance metrics: the accuracy, precision, recall and F1 scores reach 96.58%, 96.58%, 96.59% and 96.58%, respectively, which is comparable or enhanced compared with the state-of-the-art methods.

Choi, W., Jeon, E., Kim, J., Lee, K. [3] proposed a model on transfer learning with a deep convolutional neural network (CNN)-based COVID-19 screening to identify efficient transfer learning strategies. The chest X-ray images used in this study were collected from publicly available repositories, and the collected images were classified into three classes: COVID-19, pneumonia, and normal. The CNNs models used in this experiment, VGG-16 and VGG-19 were used as neural networks. Then, each neural network was trained with different individual layers. The accuracy value of this experiment is 95% concerning COVID-19 classification.

Boran Sekeroglu1 and Ilker Ozsahi2 [4] proposed a deep learning for the detection of COVID-19 using chest X-ray images. Totally, 1583 healthy, 4292 pneumonias, and 225 confirmed COVID-19 X-ray images were used in their experiment, which involved the training of deep learning and machine learning classifiers. It uses minimized layers without preprocessing which is capable of detecting COVID-19 in a limited number of images.

Arman Haghanifar, Mahdiyar Molahasani Majdabadi, Younhee Choi [5] proposed a deep convolutional neural networks in a large dataset. Chest X-ray images from various sources are collected, and the dataset is prepared. By using the deep transfer learning model, the CheXNet model is utilized to develop COVID-CXNet. This model is capable of detecting the coronavirus based on relevant features.

3. SYSTEM ANALYSIS

3.1 EXISTING SYSTEM

The following are the methods used in the existing system:

Swab Test – It is a test in which a special swab is used to take sample from your nose and throat.

Nasal aspirate – Here, a saline solution will be injected into your nose and then a sample is taken with a light suction.

Tracheal aspirate – In this case, bronchoscope which is a thin tube with a torch is put into your mouth to reach your lungs from where a sample is collected.

Sputum Test – Sputum is a thick mucus that gets accumulated in the lungs and comes out with a cough that will be collected in a special cup or a swab to test.

3.2 PROPOSED SYSTEM

We have proposed an automatic prediction of covid-19 using a deep convolutional neural networks and Chest X-ray images. For this implementation, python programming language used with Tensor Flow Keras and OpenCV modules. We have deployed the previously trained CNN model in a web application using a python backend with a Flask web development framework. HTML and JavaScript are used as the frontend of the website. The proposed models will have end-to-end structure without manual feature extraction and selection methods. Chest X-ray is the best tool for the detection of covid-19.

4.SYSTEM DESIGN

4.1 BASIC SYSTEM DESIGN:

A basic system design represents the simplistic representation of the design of the project. It shows the processes involved in the sequential model in CNN that were followed in the project.

4.1.1 USE-CASE DIAGRAM

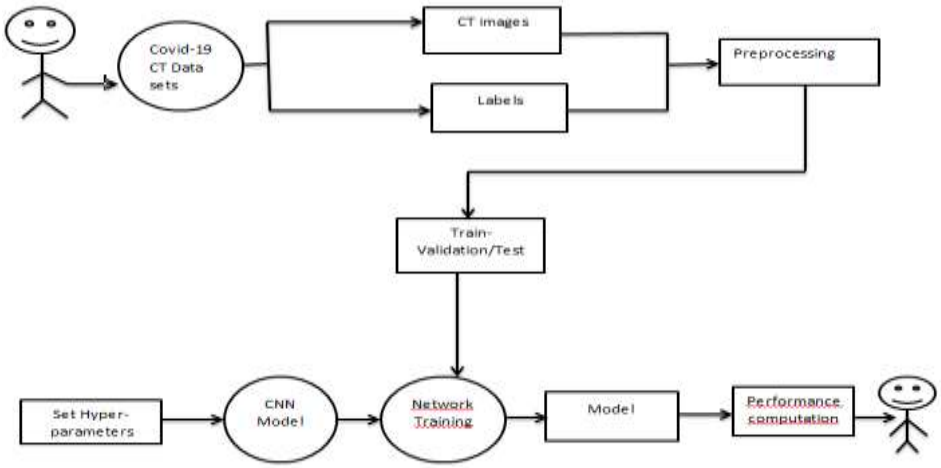

Figure 1 Use-case Diagram

The above figure represents the use-case diagram for detection of COVID-19 using X-ray images. A use-case diagram is representation of user interaction with the system. It shows the relationship between the user and different use cases involves

4.2 DESIGN CONSTRAINTS AND STANDARDS

4.2.1 DESIGN CONSTRAINTS

Social Impact:

The constraint of the project can be namely the image clarity. As the data set of the data set of the images can be blurry and undistinct sometimes may cause the testing yield the different results. However, this

problem can be compromised by getting the images suitable for testing and training the data. We should not reveal the patient names of the dataset collected. Time and cost of the people will be reduced by this system.

4.2.2 DESIGN STANDARDS

This project is based on IEEE 3333.2.1-2015 –Medical modeling and visualization

This standard focuses on the project demands arising when scientific results in the field of medical visualization are applied for the construction of a software system. It is targeted to aid the clinical work of medical professionals. This standard includes visualization techniques by the automated medical shape detection and reconstruction of three-dimensional (3D) models from two-dimensional (2D) medical images.

4.2.3 DESIGN ALTERNATIVES

A Design Alternative for this project is Machine learning method. It is also used to classify chest X-ray images into two classes, COVID-19 positive or COVID-19 negative.

5.1 FEATURE EXTRACTION USING MACHINE LEARNING FrMEMs:

The features extraction can also be done using new Fractional Multichannel Exponent Moments (FrMEMs). In this process, parallel multi-core computational framework is used to get the computational results.

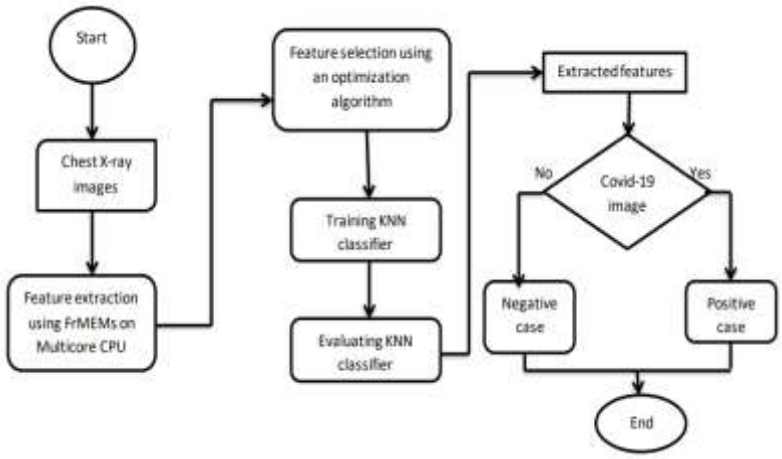

Figure 2 Feature Extraction using FrMEMs Design

5.2 MANTA-RAY FORAGING OPTIMIZATION USING MACHINE LEARNING:

It is another method in which modified Manta-Ray Foraging Optimization is used for feature extraction. It will evaluate using two COVID-19 X-ray datasets.

MODULES DESCRIPTION

Convolutional Neural Network (CNN) might seem intimidating for a beginner. However, this project will provide an overview of how to build a model to detect COVID-19 using Tensorflow and Keras.

The content of the project is listed as follows:

Creating Dataset

Data Preprocessing

Training the CNN

Webpage Creation

6.1 CREATING DATASET

6.1.1 Dataset

This experiment leveraging the data from Covid Chest X-Ray Dataset and Pneumonia dataset by Praveen from GitHub and Kaggle respectively. Using these two datasets, we have created a customized dataset as COVID19 Negative and COVID19 Positive. The two classes of dataset can be seen in the figure below:

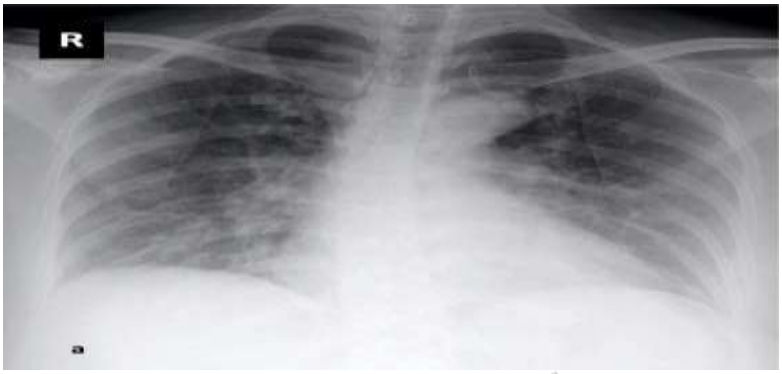

Figure 3 i) COVID-19 Positive X-ray Image

Figure 3 ii) COVID-19 Negative X-ray Image

6.2 WEBPAGE CREATION

The deployment of the previously trained CNN model have done in a web application using a python back end with a flask web development frame work. The front end of the website is created with HTML and Javascript.

Figure 4: Webpage

6.3 EVALUATION AND RESULTS

The data set for the COVID-19 image was utilized in this project. These Covid-19 images were collected from GitHub and KAGGLE. Where Jupyter notebook is the simulation tool here. In this method, the process was conducted with 579 covid-19 positive images and 1342 covid-19 negative images. The result from this project was obtained with sequential model and accuracy, loss will be calculated.

7.1 EVALUATION METHOD

The evaluation was carried out in the progress of knowing the performance of the proposed covid-19 detection process. The sequential model used in this project can identify two classes of covid-19. This can be done in several layers and the output contain two categories as 0 and 1.

Category	Output
0	COVID-19 Negative
1	COVID-19 Positive

Table 7.1.1 Categories of COVID-19

7.2 FINAL PREDICTION

At this stage, the model is ready to make a prediction in this process the front end and back end codes of this project allows the users to input an image and to determine whether the X-ray image is diagnosed with covid-19. It will give the prediction and probability when the user clicks the predict button after importing the input as X-ray image.

The following are the two prediction of this project:

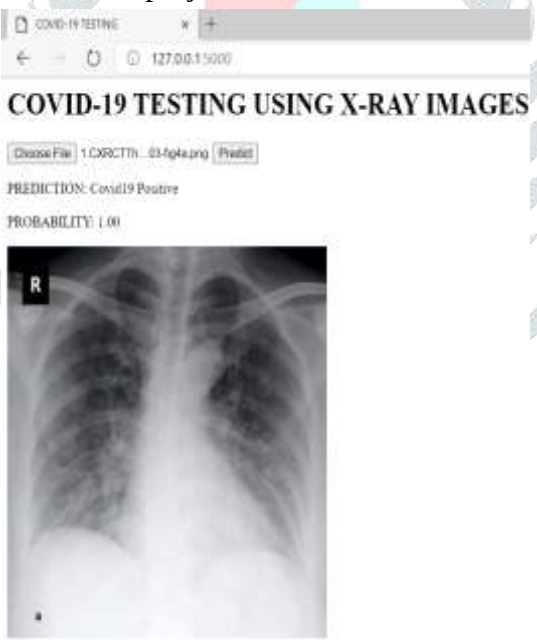

Figure 5 i) Prediction of COVID-19 Positive in Webpage

Figure 5 ii) Prediction of COVID-19 Negative in Webpage

7.3 PERFORMANCE EVALUATION METRICS:

This section is used for representing the project on the evaluation of the performance of the proposed system.

The following are the two metrics used in this project:

7.3.1 Accuracy

It is used to measure the model performance in an appropriate way. It will be determined after the parameters and these calculated in the form of a percentage. It will compare the measurement of our model's prediction to the through data.

Accuracy = (TP +TN) / All samples

Where,

TP = True Positives

TN = True Negatives

7.3.2. Loss

It is a number representing the bad prediction of the model. Is the loss value being zero then the model prediction is perfect? If the loss value is greater than zero, result is bad prediction. The loss will be calculated as a sum of the errors made for each epoch in training and validation. _The result is, where 80 percent images were used for training. 10 percent was used for validation. 10 percent was used testing. In testing, 98.44% accuracy was obtained which indicate a decent or good model.

8. SIMULATION OUTCOMES

8.1 IMPORTING LIBRARIES

Firstly, we need to import numpy, pandas, scikit-learn, tensorflow, matplotlib, pillow, flask libraries.

8.2 CREATING CUSTOM DATASET:

We have used the data from Covid Chest X-Ray Dataset and Pneumonia dataset by Praveen from GitHub and Kaggle respectively. Using these two datasets, we have created a customized dataset as COVID19 Negative and COVID19 Positive. At last, customized dataset contains 579 covid-19 positive images and 1342 covid-19 negative images as dataset.

8.3 IMAGE TRANSFORMATION:

We will be using python imaging library (PIL) for the python programming language that adds support for opening, manipulating and saving many different image file formats.

8.4 PREPARE DATA LOADER:

Data Loader will read, extract and load the data from comma-separated values (CSV) files or from a database connection when we import data and when we export data, it will give output as CSV files.

8.5 DATA VISUALIZATION:

Data visualization is the graphic representation of data. It involves to produce images that communicate relationships among the represented data to viewers of the images.

8.6 DATA PREPROCESSING:

In this process we have compressed the color image to gray scale image. Although we have resized the gray scale image into [100 100] and then appended the image and the label(categorized) into the list(dataset).

8.7 TRAINING A MODEL:

Here, we have used sequential model to train the CNN. The dataset used was randomly split into independent datasets with 80%, 10% and 10% for training, validating and testing respectively.

8.8 PREDICTING A RESULT:

The chest X-ray images have been used as a input for the prediction of corona virus disease patient (COVID-19) in the web page where we have used Keras with Tensorflow backend.

9. CONCLUSION

In this project, we proposed a deep learning CNN model called sequential model for detecting corona virus disease(covid-19) from chest X-ray images. As we have seen, this model can effectively capture covid-19 features in the parallel layers of convolutional network, so it has an excellent performance compared to some well-known CNN architecture. Our experimental evaluation clearly shows that this model gives an accuracy of 98.84%. Using our proposed model, user can get the results of COVID-19 through webpage instantly. Therefore, this model can help to stop the spread of the pandemic with less cost and time.

As future work, we can use transfer learning or pre-trained CNN models to make our proposed model more robust. Also, we can develop mobile applications for easier usage which makes COVID-19 prediction more effective.

10. REFERENCES

1. Liu, S., Satapathy, S.C., Zhang, YD. et al (2020). A five-layer deep convolutional neural network with stochastic pooling for chest CT-based COVID-19 diagnosis. Machine Vision and Applications 32, Article number: 14-2021.
2. Ashad, Chowdhury, Md. Muhtadir & Kabir, Nihad & Rahman (2020). PDCOVIDNet: A Parallel-Dilated Convolutional Neural Network Architecture for Detecting COVID-19 from Chest X-Ray Images. 10.31224/osf.io/myp6c.
3. Choi, W., Jeon, E., Kim, J., Lee, K. (2020). Evaluation of Scalability and Degree of Fine-Tuning of Deep Convolutional Neural Networks for COVID-19 Screening on Chest X-ray Images Using Explainable Deep-Learning Algorithm. J. Pers. Med. 10, 213.
4. Boran Sekeroglu1 and Ilker Ozsahi2 (2020). Detection of COVID-19 from Chest X-Ray Images Using Convolutional Neural Networks SLAS TECHNOLOGY: Translating Life Sciences Innovation Volume 25, Issue 6.
5. Arman Haghanifar, Mahdiyar Molahasani Majdabadi, Younhee Choi (2020). COVID-CXNet: Detecting COVID-19 in Frontal Chest X-ray Images using Deep Learning on 16 Jun 2020.
6. Cesar, P., Soares, Lucas, P., Soares (2020). Automatic Detection of COVID-19 Cases on X-ray images Using Convolutional Neural Networks on on 2 Jul 2020.
7. Yi Zhong (2020). Using Deep Convolutional Neural Networks to Diagnose COVID-19 From Chest X-Ray Images on 19 Jul 2020.
8. Chaimae Ouchicha, Mohammed Meknassi, Ouafae Ammor (2020). CVDNet: A novel deep learning architecture for detection of coronavirus (Covid-19) from chest x-ray images, Chaos, Solitons & Fractals,Volume 140, 110245, ISSN 0960-0779.
9. Abdelgawad, A., Farhan Haque, F., Foysal Haque, K., Gandy, L. (2020). "Automatic Detection of COVID-19 from Chest X-ray Images with Convolutional Neural Networks," 2020 International Conference on Computing, Electronics & Communications Engineering (iCCECE), Southend, United Kingdom, 2020, pp. 125-130, doi: 10.1109/iCCECE49321.2020.9231235.
10. Abbas Sharifi, Mohsen Ahmadi, Shayan Hassantabar (2020). Diagnosis and detection of infected tissue of COVID-19 patients based on lung X-ray image using convolutional neural network approaches, Chaos, Solitons & Fractals, Volume 140, 110170, ISSN 0960-0779. https://doi.org/10.1016/j.chaos.2020.110170.