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Deep Learning Approaches for Diagnosis and Treatment of COVID-19

Ayesha Fathima[1], Greeshma P K[2], Vijay Kumar[3]

[1]VIII Semester, Dept. of ISE, BNMIT
[2] VIII Semester, Dept. of ISE, BNMIT
[3]Asst. Professor, Dept. of ISE, BNMIT, Karnataka, India

Abstract – *The severe acute respiratory syndrome coronavirus, which is the source of the present deadly coronavirus epidemic, was discovered in Wuhan, China. Threats to human life have been created by this pandemic's effects. Covid-19 is a fatal virus that is fast spreading and has an impact on people's daily lives, health, and economies of nations. This sickness not only harmed a single nation; it also had an impact on the entire world. Millions of individuals have been impacted by the outbreak, and the death toll has been rising alarmingly. Forecasting and careful analysis of the pattern of disease spread in such a setting might motivate the creation of better strategies and more effective decision-making.*

Key Words: **COVID-19, CNN, VGG, Deep Learning, Lung CT Scan Images.**

1. INTRODUCTION

Artificial neural networks, a class of algorithms inspired by the structure and operation of the brain, are the focus of the machine learning discipline known as deep learning. Although they can also include propositional formulas or latent variables organised layer-wise in deep generative models like the nodes in deep belief networks and deep Boltzmann machines, the majority of contemporary deep learning models are based on artificial neural networks, specifically convolutional neural networks (CNN). Deep learning models are sometimes referred to as deep neural networks because the majority of deep learning techniques use neural network topologies. The number of hidden layers in the neural network is typically indicated by the term "deep." While deep networks can have up to 150 layers, traditional neural networks only have two or three hidden layers. Large collections of labelled data and neural network topologies that automatically learn characteristics from the data are used to train deep learning models. Convolutional neural networks are among the most often used varieties of deep neural networks. Convolutional neural networks use 2D convolutional layers and combine learnt characteristics with input data, making this architecture ideal for processing 2D data, such as photos. Additionally, it does away with the necessity for manual feature extraction, so you are not required to know which features are utilised to categorise photographs. The CNN works by extracting features directly from images. The relevant features are not pretrained but they are learned while the network trains on a collection of images.

Using dozens or even hundreds of hidden layers, CNN learns to recognise various elements in an image. Every hidden layer makes the learnt picture features more complex. For example, the first hidden layer could learn how to detect edges, and the last learns how to detect more complex shapes specifically catered to the shape of the object we are trying to recognize. A particular type of machine learning is deep learning. A machine learning workflow starts with relevant features being manually extracted from images. The features are then used to create a model that categorizes the objects in the image. Relevant features are automatically retrieved from photos using a deep learning approach. In addition to this deep learning performs end-to-end learning where a network is given raw data and a task to perform, such as classification, and it learns how to do this automatically.

1.1 Problem Statement

One of the most serious health issues at the moment is the COVID-19 virus, also known as the SARS-CoV-2 coronavirus or just corona virus. Coronavirus sickness is a highly contagious illness brought on by the coronavirus that causes severe acute respiratory syndrome. The disease first originated in 31 December 2019 from Wuhan, Hubei Province, China and since then it has spread globally across the world. Coronavirus disease is highly contagious with limited treatment options. The rapid spread of the novel coronavirus has caught much of the world off-guard. This includes medical professionals attempting to heal the sick at risk to their own health, public health officials tracking the virus and vigilantly researchers are now engaged in the development of diagnostics, treatments and vaccines.

Governments can interrupt the transition chain and flatten the epidemic curve by detecting the hazardous severe acute respiratory syndrome coronavirus early and using clinical competence. Therefore, preventing the spread of Covid-19 and the associated mortality requires an early and correct diagnosis. Although RT-PCR is a quick procedure, it only has a 70–75% accuracy in detection. For doctors, governments, organisations, and nations to stop the deadly virus's rapid spread in any location, early diagnosis of COVID patients is a crucial task. In this case, the researchers were motivated to play a big part in the detection of Covid-19 by

the prior epidemic evidence on machine learning and deep learning approaches.

1.2 Objective and Scope

• The purpose of selecting this problem statement is to aid in the quick and precise diagnosis of Covid-19.

• To provide innovative computer-assisted diagnosis methods for quick and affordable screening in locations where extensive traditional testing is impractical.

• To assess and compare the effectiveness of deep learning methods for detecting Covid-19 infections from patient CT scan pictures.

• The problem statement's major focus is on developing solutions for high-risk groups facing COVID-19. The basic goal is to achieve the finest outcomes.

• It will be very beneficial to medical professionals for early detection that could result in an accurate diagnosis of Covid-19 patients.

2. LITERATURE SURVEY

A recognised and accepted element of contemporary society is the survey. It is one of the ways society keeps itself updated while staying out of situations that are becoming larger and more complex in order to attain common perceptions and standards. A survey is a map rather than a precise plan that provides an overview of a field, differentiating it from a type of study that entails a microscopic investigation of a turf. Before the survey is conducted, it must be planned. The project heavily depends on the literature review. It serves as a starting point for project ideas that are then developed into concepts and, ultimately, theories.

The study by Yujin Oh, Sangjoon Park, and Jong Chul Ye, "Deep Learning COVID-19 Features on CXR Using Limited Training Data Sets,"[1] illustrates how deep learning approach on chest X-ray for Covid-19 classification have been actively researched. It is challenging to compile a systematic set of chest X-ray data for deep neural network training. They suggested a patch-based convolutional neural network technique with a manageable number of trainable parameters for Covid-19 diagnostics to solve this issue. The proposed method was inspired by statistical analysis of the potential imaging biomarkers of the chest radiographs. Experimental results showed that the method achieved state-of-the-art performance and provided clinically interpretable saliency maps, which are useful for Covid-19 diagnosis and patient triage. In this approach images are first pre-processed for data normalization, after which the pre-processed data are fed into a segmentation network, from which lung areas can be extracted then from the segmented lung area, classification network is used to classify the corresponding diseases using a patch-by-patch training and inference, after which the final decision is made based on the majority voting but the drawback of this study stated that CT scan has shown better performances. It offers better contrast and creates detailed quality images.

A presentation of ANN-based techniques that can be used for big data analysis is made in the publication "Artificial Intelligence and COVID-19 Deep Learning Approaches for Diagnosis and Treatment" [2] by Mohammad Jamshidi and Ali Lalbakhsh. It has been suggested that ANN-based strategies could be employed in addition to conventional ones to keep patients involved. The Covid-19 registry emphasises clinical factors and cardiovascular complications because it helps to identify the pattern of cardiovascular complications, advance the development of a risk model for cardiac complications, and help identify or predict the response to various treatment modalities. However, the study's main limitation was the use of a small number of data, which led to underfit or overfit issues. . A deep learning-based method was presented by Ghoshal and Tucker to quantify the degree of uncertainty and interpretability in coronavirus detection. The authors discovered that the correlation between prediction accuracy and prediction uncertainty is quite strong using a Bayesian convolutional neural network using publically available Covid-19 CXR pictures. Using the pretrained VGG-16 model, the performance results show an increase in detection accuracy from 85.2 percent to 92.9 percent. In order to better understand the outcomes produced by the proposed approach, they have also demonstrated the model's interpretability by creating saliency maps.

Another study by Hamed Tabrizchi and Amir Mosavi titled "Rapid COVID-19 Diagnosis Using Deep Learning of the Computerized Tomography Scans"[3] showed how SVM is used to solve non-linear classification problems by transforming the problem using the kernel method, which causes SVM calculation in the higher dimension. One of the often employed algorithms in both research and industry, Support Vector Machine derives its strength from machine learning methods. This algorithm's capacity to handle non-linear issues is its key benefit.

By changing the issue using the kernel approach, which performs SVM calculation in the higher dimension, nonlinear classification issues can be solved using SVM. SVM was first presented by Vapnik in 1995. He introduced this idea using the Structural Risk Minimization (SRM) and Statistic Learning Theory (SLT), respectively.

In their article "Covid-19 Detection Using Deep Learning Model," Ghada A. Shadeed and Abdullah A. Jabber[4] compared and scored the accuracy of the GoogLeNet, ResNet-101, Inception v3 network, and DAG3Net models. Inception net was picked because it has 316 layers, compared to the GoogLeNet model's 22 layers, ResNet-101's 101 layers, the DAG3Net's three layers, and ResNet-101's

101 layers. To ensure that the classification levels between the two groups (Covid-19 and Non-Covid-19) were equivalent and that the classification model's requirements were met, all of the models in this study were trained using standardised X-ray pictures of a specific size and dimension. The final layer with complete connectivity was then removed and a new one added.

A new COVID-19 patients detection strategy (CPDS) based on hybrid feature selection and improved KNN classifier is described in the research. According to [5] by Warda M.Shabana, Asmaa H.Rabieb, and Ahmed Covid-19 Patients Identification Strategy is a brand-new Covid-19 diagnostic strategy that has been introduced. A revolutionary meta - heuristic optimization methodology is the first (HFSM). The second addition is an improved K-Nearest Neighbor (EKNN) classifier, which has been shown to be very effective and capable of handling challenging pattern classification issues. KNN is a handy and quick approach in general. HFSM selects the important features for the subsequent detection phase as a hybrid methodology. By including reliable heuristics while selecting the neighbours of the tested item, EKNN eliminates the trapping issue of the conventional KNN.

On "Deep Learning-Based Decision-Tree Classifier for COVID-19 Diagnosis From Chest X-ray Imaging"[6], another effort by Seung Hoon Yoo1, Hui Geng1, and Tin Lok Chiu proposed a classifier that consists of three binary decision trees, each trained by a deep learning model with convolution neural network based on the PyTorch frame. The CXR images are categorised as normal or abnormal in the first decision tree. The third tree performs the same function for COVID-19 whereas the second tree identifies the aberrant images that contain symptoms of tuberculosis. For each step in this study, training data were taken from an acceptable data group; nevertheless, training data should be verified with pathological data. The conclusions of the model are unreliable without the use of pathologically verified data. New pathology information was thus necessary for the prediction of new instances. Third, a deep learning model was expanded with more training data using simple techniques like horizontal flipping, rotations, and shifts. There are various data augmentation methodologies for picture data. The performance of the obtained model may have been enhanced by taking into account image processing techniques like stochastic region sharpening, elastic transforms, randomly erasing patches, and many others to augment data.

In order to improve models and develop a system that does not require collecting a large amount of training data in order to obtain a credible statistical model, further research is therefore required on sophisticated augmentation approaches. Additionally, in this case, a slight change in the data could result in a significant change in the decision tree's structure.

Stefano Cabras' "A Study Bayesian-Deep Learning Model for Estimating COVID-19 Evolution in Spain" [9] offered a semi-parametric methodology to estimate COVID-19 (SARS-CoV-2) evolution in Spain. It blends traditional Bayesian Poisson-Gamma models for counts with cutting-edge Deep Learning methods for sequence analysis. The observed time series of counts can be adequately described by the DL model. The well-known Poisson-Gamma model is used in a basic Bayesian analysis to generate the posterior predicted distribution of counts. The model enables estimation of the effects of potential scenarios or future sequence evolution across all regions. LSTM models' consistency, despite the fact that they have other useful applications. The suggested hybrid models also lack any theoretical coherence.

3. SYSTEM DESIGN AND DEVELOPMENT

Software requirements should be converted into an architectural diagram that outlines the software's top-level structure and lists its constituent parts. This is achieved through architectural design, which also goes by the name of system design. It serves as an initial blueprint from which software can be created. The process of identifying a group of hardware and software components, as well as their interaction, in order to provide the framework for the creation of a computer system, is known as IEEE architectural design. By looking at the software requirement document and creating a model for delivering implementation details, this framework is created. The system's components, their inputs, outputs, functionalities, and interrelationships are all described using these specifics. A design for an architectural structure serves many purposes.

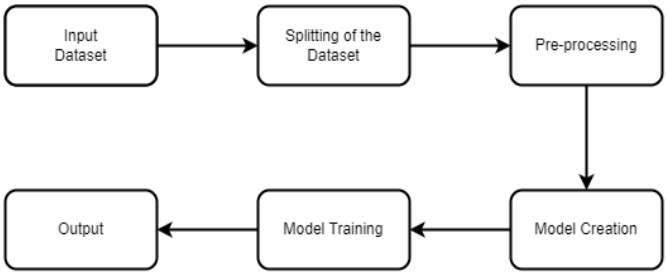

Fig - 1: Architectural Design

4. IMPLEMENTATION

To build the best model or a system with high fidelity, deep learning models are data-hungry and need a lot of data. Even if you have a brilliant algorithm in place, the quality of the data is just as crucial as the quantity. Finding a high-quality dataset is a crucial component of developing any application. The datasets in the actual world are more complicated, disorganised, and unstructured. The size, quality, and

relevance of the dataset all affect how well a deep learning model performs. Finding the ideal balance is a difficult task.

The planned study focuses on the detection of COVID-19 utilising lung CT images. By gathering CT scans from actual patients, the dataset comprises of a lung CT scan image dataset with two groups, COVID and non-COVID. Visit https://github.com/UCSD-AI4H/COVID-CT/tree/master/Data-split to access it in the open.

The training file complies to a programming abstraction paradigm. All the functions necessary for the project's effective completion and model creation are called in this file in a methodical manner. This file, which has a modular design, includes multiple steps or function calls, as seen below:

Importing data, data visualisation, data preparation for processing, data splitting, increasing the variety and variance of the data, pre-processing, model creation, model training, and model analytics.

Numerous project-related tasks are requested and carried out within the training module. This is also the primary file needed to create the model. It gathers the necessary data, processes it, divides it, builds a neural network model, and then saves it offline in.md5 format to the disc.

A vital function to the overall project is the vgg-pred() function. The model cannot accurately grasp the data since it is not linear. Additionally, this function uses the idea of binning to balance the data. To produce bins, data must be binned, or divided into intervals. By using binning to transform visual data into numerical data, the model is made more adaptable. The model has already been built and stored by this Python application. A server socket is made and configured to listen on the correct port. The code in this file is in charge of importing the images from the dataset, preprocessing them, putting them through the neural network model, and accurately producing the desired outcome. Convolutional Neural Networks (CNN) learn to do tasks like object detection, image segmentation, and classification by taking in an input image and applying filters to it. First, since not all of the images in our dataset have the same dimensions, we resize each image before feeding it into the model. We crop or scale the other images to 256 × 256 because more than half of the training images have this size. A different function is used to generate subsequent batches with a user-defined size. In the network training phase, the model receives these batches. A list transformation is what makes up batches.

One or more convolutional layers make up CNN. One or more neural network-connected layers come before it. These were motivated by the visual cortex of animals. Convolutional layers, also known as land pooling, are used in the CNN Architecture that is being displayed. Pooling is a technique for arbitrary experimentation that is frequently used when adding pooling layers to reduce the parameters and get rid of extra features during training in order to prevent the network from being overfit. The numerous proportional arrays are flattened into a two dimensional array in a fully linked network following the convolutional layers. The CNN model's performance was then assessed using a variety of performance indicators. These measurements include sensitivity, accuracies, and precision.

5. PROPOSED MODEL

There may be one or more convolutional layers in CNN. One or more layers related to neural networks come before it. Animal visual cortex served as inspiration for these. Convolutional layers, also referred to as land pooling, are used in the CNN Architecture. Pooling, a technique for arbitrary experimentation, is frequently used in conjunction with the addition of pooling layers to reduce the parameters and get rid of extra features during training in order to prevent overfitting in the network. In a fully linked network, the several proportional arrays are flattened into a two-dimensional array following the convolutional layers. After that, the CNN model's performance was assessed using several performance measures. Accuracy, precision, and sensitivity are some of these measurements.

6. RESULTS AND DISCUSSIONS

The confusion matrix is a two-dimensional array that contrasts the true label with the inferred category labels. These categories for binary classification include True Positive, True Negative, False Positive, and False Negative.

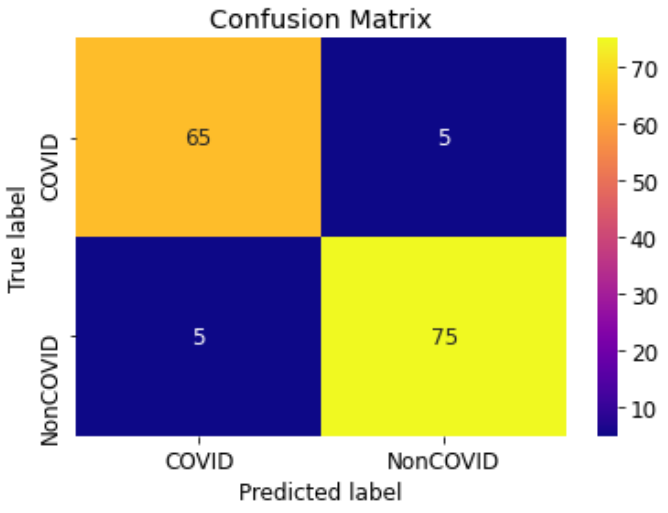

Fig – 2: Confusion Matrix without Normalization

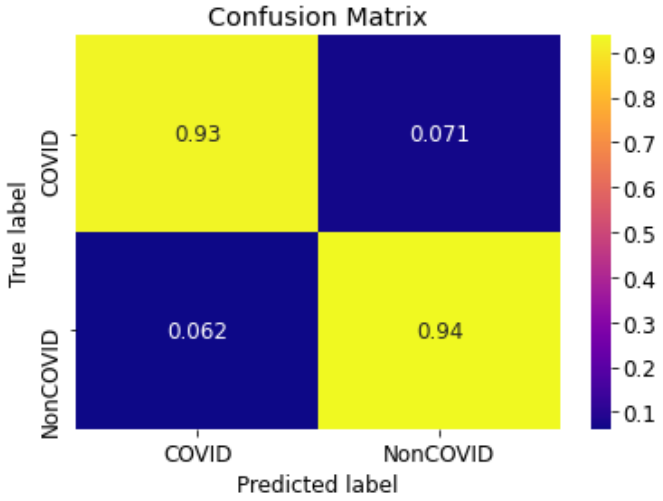

Fig – 3: Confusion Matrix with Normalized Values

Fig – 4: Home Page

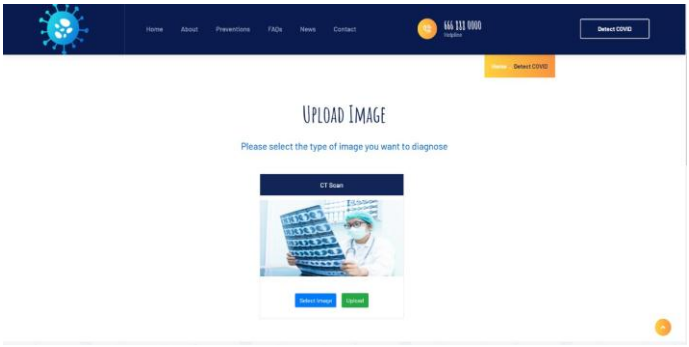

Fig – 5: Upload Page

7. CONCLUSION

The fundamental steps in stopping the sickness and the spread of the pandemic are early detection and diagnosis of COVID-19 using DL techniques, with the least amount of expense and problems. The equipment of radiology centres will soon include DL algorithms, making it possible to diagnose this condition more quickly, affordably, and safely. In order to limit human error and help radiologists make decisions under pressure and at the height of the disease, these strategies can be used to make speedy diagnostic decisions for COVID-19. This study lends credence to the notion that DL algorithms offer a viable means of enhancing healthcare and the efficacy of diagnostic and therapeutic operations.

Since COVID-19 DL diagnostic models must be trained on sizable, heterogeneous datasets to fully exploit the available data space, developers must be careful to avoid overfitting and to maximise the generalizability and usefulness of COVID-19 DL diagnostic models. DL is one of the most powerful computing tools for diagnosing pneumonia.

8. FUTURE ENCHANCEMENT

By training the models on more photographs in the future and perhaps integrating additional variables like age, nationality, gender, etc., we hope to increase the performance of the algorithms. We are currently considering combining the three models that were suggested in this work and training each layer separately as a novel strategy to provide better results in the future. Finally, it can be said that the COVID-19 pandemic was predicted, classified, screened for, and kept from spreading significantly by the use of ML and DL approaches.

9. REFERENCES

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