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ANALYSIS OF COVID-19 CASE DETECTION FROM CHEST X-RAY IMAGES USING VGG16, RESNET50 AND CUSTOMIZED CNN MODELS

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Abstract: The effective screening of Covid-19 cases has been become extremely important to mitigate and stop the spread of the disease during the current period of Covid-19 pandemic worldwide. Radiology examination of using chest X-ray images, is one among the effective screening approaches for Covid-19 case detection. Deep learning is a powerful tool and framework for image analysis, and many studies have been conducted to detect Covid-19 cases using deep learning models trained on X-ray images. Although some of them claim to have good prediction results, their proposed deep learning models may suffer from high variance, overfitting and generalization errors due to noise and a limited number of datasets. As multilayer Convolution neural network (CNN) can overcome the short comings of deep learning by making predictions with more precision and processed inputs. In this proposed work the analysis of covid-19 case detection from chest x-ray images using VGG16, RESNET50, and customized CNN models is done and achieved maximum accuracy.

Index Terms **– COVID- 19, Convolution neural networks (CNN), RESNET50, VGG16, Chest X- Ray images.**

I. INTRODUCTION

Right from education to administration, Health of people to the Wealth of the economy all underwent huge losses. It is said that "Health is Wealth." Following the same, this project contributes on the theme of predicting and detecting Covid-19, an infectious disease caused by the SARS-CoV-2 virus. The outbreak in early December 2019 in the Hubei province of the People's Republic of China has spread worldwide. [1] This pandemic continues to challenge medical systems worldwide in many ways, including sharp increase in demand for hospital beds and shortages in medical equipment, while many healthcare workers have themselves been infected.

Thus, the capacity for immediate clinical decisions and effective usage of healthcare resources is crucial. Effective screening enables efficient and quick diagnosis of Covid-19 and can mitigate the burden on healthcare systems. [1] Thus, by using chest X-ray we can predict whether the patient is diagnosed with Covid-19 or not.

Thus, we focus on analysing and detecting COVID-19 using the practices of Machine learning like CNN (Convolution Neural Networks).

1.1 MACHINE LEARNING

This is a viewpoint on teaching robots to learn and build their own programmes in order to improve their behaviour and decisions. This is accomplished with as little human interaction as possible, i.e. without the need for human intervention. It is a component of artificial intelligence. The learning process is automated and improved over time based on the experiences of robots. High-quality data and a variety of methodologies are provided to computers in order for them to build or construct machine-learning models. The algorithm to use is determined by the type of data and the job to be automated.

1.2 TYPES OF MACHINE LEARNING

1.2.1 SUPERVISED MACHINE LEARNING

It is a type of machine learning in which computers are trained to produce results using labelled training data. As indicated by labels, some of the input has already been assigned an appropriate output. In supervised machine learning, the training data provided to the computers acts as supervisor, teaching machines how to correctly predict outputs. It works in the same way that a student is taught with the help of a tutor. In supervised learning, models were taught using labelled data, and the model reads about every single category in the input. The model is evaluated using test data from the training dataset, and it estimates the outcome once the training phase is complete.

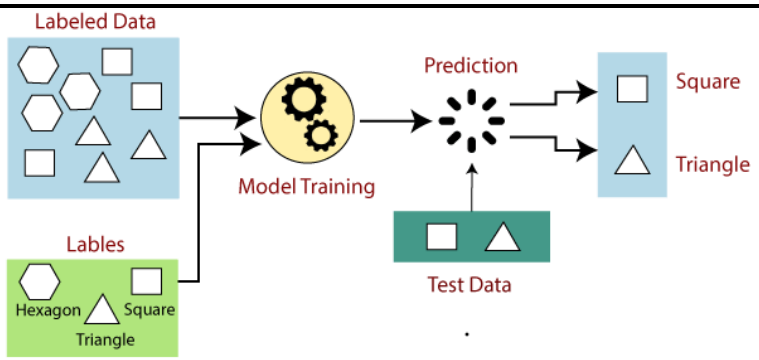

Fig-1: Supervised machine learning

1.2.2 UNSUPERVISED MACHINE LEARNING

Unsupervised machine learning is subset of machine learning in which models are trained on unlabelled data sets and then allowed to operate on it without supervision. Unsupervised learning benefits from the ability to deal with unlabelled data. When no human inference is required to make the data sets machine-readable, the computer can handle significantly larger datasets. Labels from supervised machine learning will assist the algorithm in determining the essence of any link that exists between two data points. Furthermore, unsupervised learning suffers from a scarcity of labels, which influences the format of the hidden structures. The application detects connections between data points in an abstract manner, without the assistance of a human. In place of a predetermined and fix problem statement, unsupervised machine learning algorithms may dynamically alter the data by modifying remote systems.

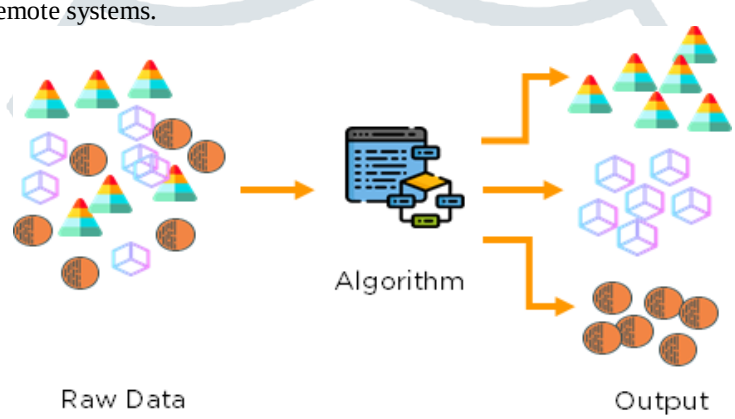

Fig-2: Unsupervised machine learning

1.2.3 REINFORCEMENT MACHINE LEARNING

It is a sub set of machine learning. It is all about taking appropriate actions to maximize the raise in whatever situation you were in. A variety of applications and machines are used to determine the best in a specific situation of a viable action or path. Reinforcement learning is different from supervised machine learning in that supervised learning includes the required key, allowing its system to be taught by the correct answer, whereas reinforcement machine learning does not, instead relying on the reinforcement agent to determine how to complete the work. This training dataset, in its absence, is intended for learning from its own mistakes. Reinforcement machine learning is based on the cognitive concept of conditioning and entails implementing the algorithm in a working environment, complete with an interpreter and a reward system.

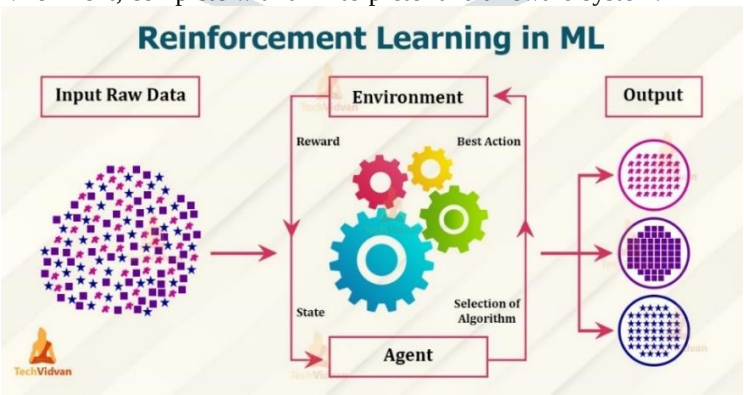

Fig-3: Reinforcement machine learning

1.3 NEURAL NETWORKS

Neural networks were systems that resembled biological neural networks. These systems learn to do tasks by being exposed to various datasets and examples in the absence of any job rules. Instead of being programmed with a pre-coded understanding of these datasets, the system derives identifying characteristics from the data it is given.

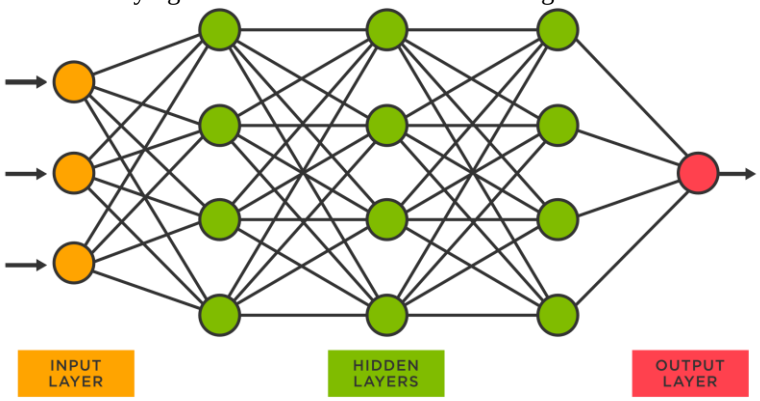

Fig-4: Neural Network

In ANN, a node layer consists of an input layer, one or more hidden layers and one output layer. Every node is linked to the others and has its own threshold and weight. When a node's output reaches a certain level, it will activate and send data to the next node in the network. Aside from that, no data will be directed to the network's next layer. Artificial neurons were nodes in deep learning models that allowed information and operations to pass through them. One or more signals are sent to them. These input signals could be derived from the raw data collection of neurons in a previous neural net layer.

1.4 DEEP LEARNING

Deep learning is a subset of neural networks. The neural networks attempt to mimic brain functions by corresponding the capacity for being taught by massive data. Single layer neural networks, on the other hand, can make predictions by combining more than one hidden layer, which improves accuracy. Deep learning techniques improve as more datasets are collected, but empty learning is a type of approach. Learning empty algorithms are Machine Learning algorithms that plateau as a given standard of presentation when many instances and training datasets are combined with network. Most machine learning algorithms require data in a structured format. Deep Learning models, on the other hand, can work with both structured and unstructured data because they rely on artificial neural network layers. The problem-solving method of a deep learning model differs from that of a machine learning model in that it accepts input for a problem and produces the final result. As a result, it adheres to the end-to-end approach.

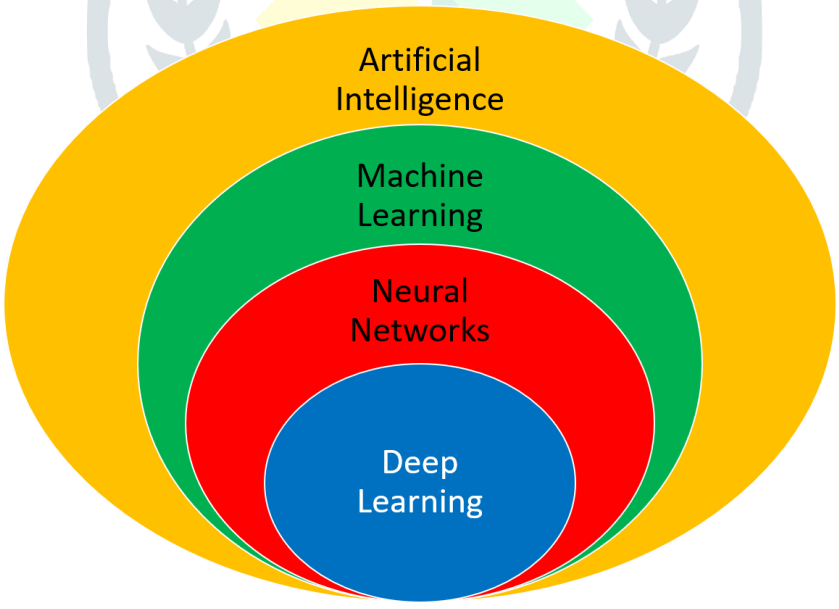

Fig-5: Deep Learning

Deep learning is one of the few methods available for dealing with feature extraction problems. This is because deep learning models may learn to focus on the excellent features with little input from the programmer. Deep learning operates in the same way that the human brain does. That is, it learns from its mistakes. The brain, like the body, is made up of billions of neurons that allow it to perform specific tasks.

As a result, Deep Learning overcomes the disadvantage of Machine Learning by completing a data set.

1.5 CONVOLUTIONAL NEURAL NETWORKS

A Convolution Neural Network (CNN) is a type of artificial neural network that is used in deep learning to evaluate visual data. CNNs are very good at detecting design elements in input images like gradients, lines, circles, and even eyes, ears, and faces. Convolutional neural networks are so effective in image analysis because of this feature. CNN does not require any pre-processing and can be applied directly to an underdone image. CNN is made of multiple convolutional layers stacked on top of one another, each capable of recognising increasingly complex structures. These are among the most widely used types, particularly in image recognition. Many of the most advanced AI applications, such as facial recognition, text digitization, and natural language processing, have used this neural network technique. Convolution, Pooling, and Flattening are the three Convolution Neural Network layers used.

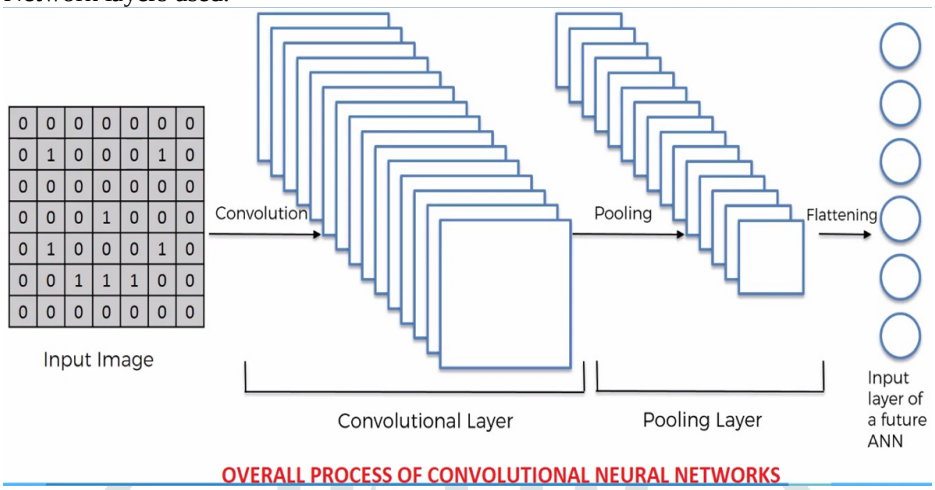

Fig-6: Convolutional Neural Networks

1.5.1 Convolution

It is a mathematical operation performed between the original image/other feature map and a kernel. It is a method for assisting the neural network in extracting features from data. Kernel size and the number of filters are important considerations.

1.5.2 Pooling

Pooling layers are similar to convolutional layers and are frequently used for dimensionality reduction. Pooling functions such as max-pooling, min-pooling, and average-pooling take the maximum, minimum and average values in a specific kernel region, respectively.

1.5.3 Flattening

After pooling, the 2-Dimensional arrays generated from feature maps are flattened into a long contiguous linear vector. The flattened matrix is fed in to the fully connected layer to identify image.

1.6 CNN ARCHITECTURES

1.6.1 RESNET50

ResNet50 is a 50-layer deep Convolutional Neural Network [2]. This ResNet Variant model has 48-Convolution layers, one Max Pooling layer and one Average Pooling layer. It is capable of loading a pre-trained version of the network that has been trained on over a million images from the ImageNet data base. An identity block or residual block is a ResNet building block. A residual block is simply when activation of a layer in the neural network is fast-forwarded to a deeper layer.

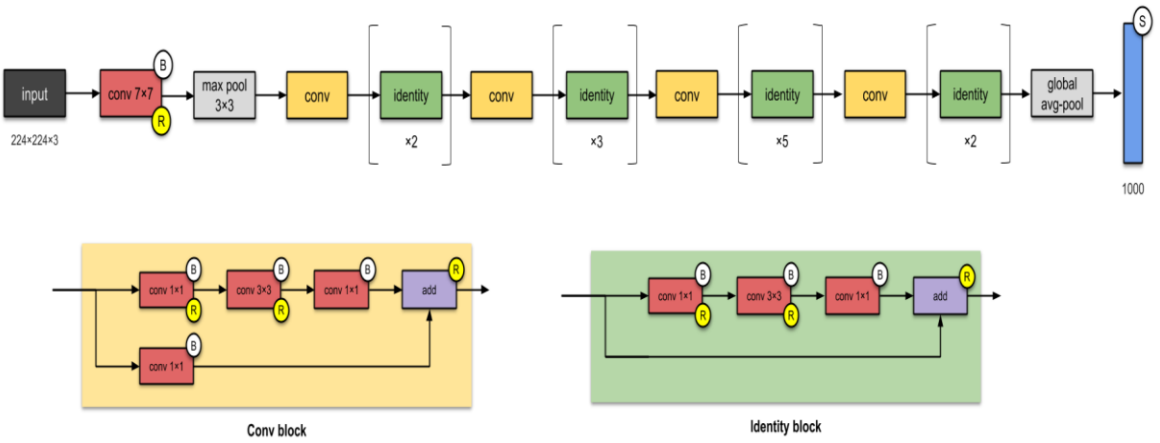

Fig-7: RESNET50 MODEL

1.6.2 VGG16

VGG16 is made up of thirteen convolutional layers, five maxpooling layers, and three fully connected layers. As a result, total number of layers with tuneable parameter is 16 (13 convolutional layers and 3 fully connected layers) [2, 3].

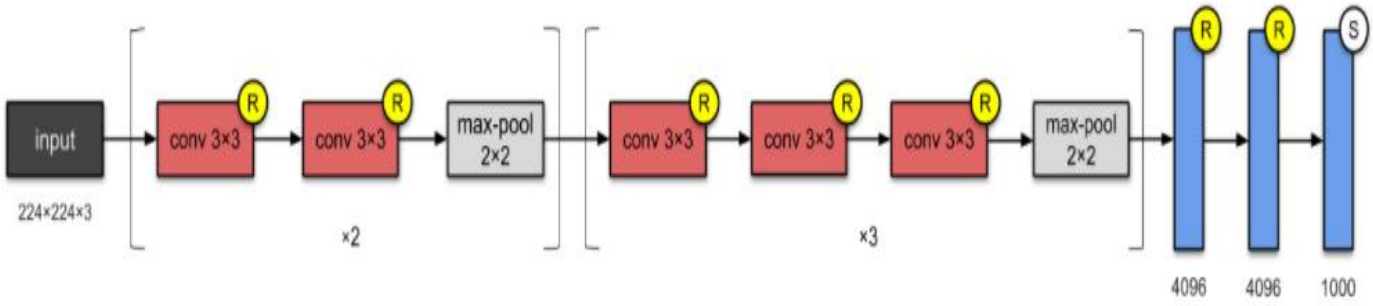

Fig-8: VGG16 MODEL

1.7 COVID-19

COVID 19 is caused by SARS- CoV- 2, a corona virus 2 that has never been detected in humans before December 2019. SARS-CoV-2 is a contagious and fatal disease that is unique to the world. Corona viruses are named after their appearance: "corona" means "crown" in Spanish and spike proteins encircle the virus's outer layer, forming a crown.

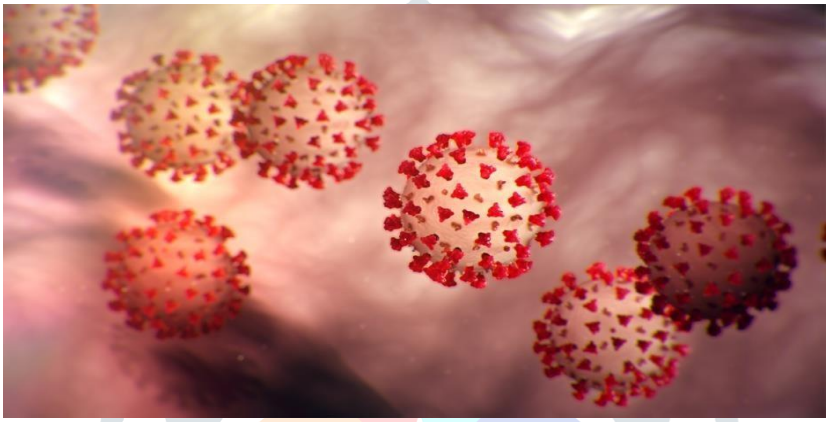

Fig-9: Corona Virus

The major number of people infected with the covid virus will experience mild to moderate respiratory symptoms and will recover on their own. Some people, however, will become ill and require medical treatment. People over the age of 60 are at a high risk, as are those with underlying medical conditions such as chronic lung disease, diabetes, or cancer. COVID-19 has the potential to sicken or kill anyone, regardless of age. In most cases, infected people experience only mild respiratory symptoms and recover on their own. Some people, however, are chronically infected and require medical attention.

1.7.1 COVID-19 VARIANTS

Viruses, such as SARS- CoV- 2, evolve over time and continue to evolve as they spread. Virus variants can appear at any time. A virus variant is one that differs from the original in at least one way.

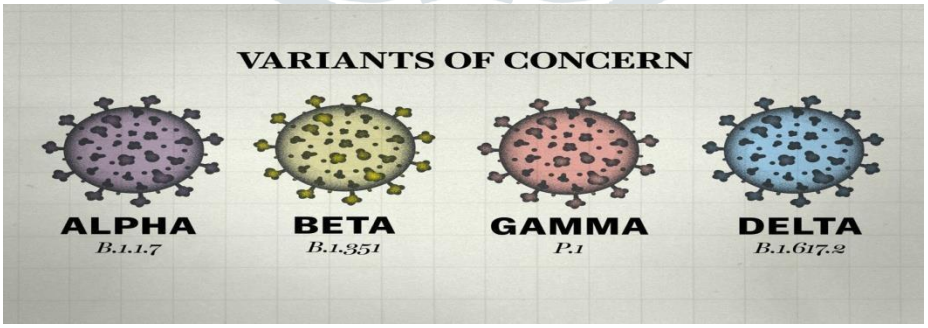

Fig-10: COVID-19 Variants

- Alpha
- Beta
- Gamma
- Delta
- Omicorn

II. PROPOSED METHODOLOGY

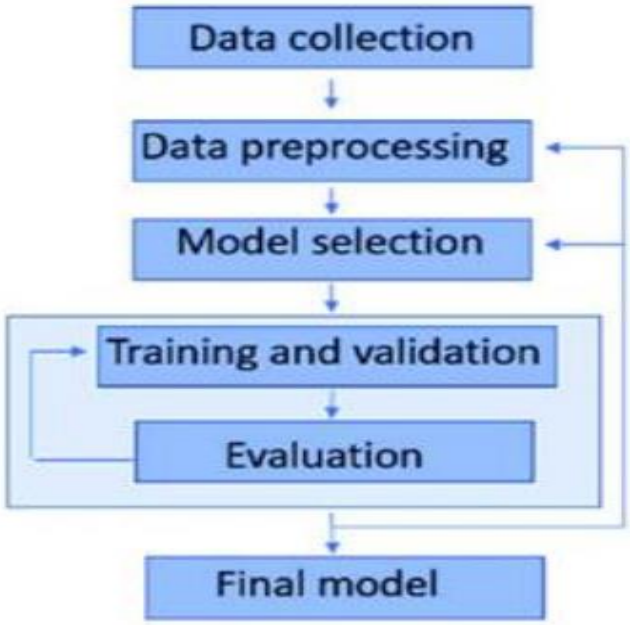

Fig-11: System Architecture

As shown in Figure-11, it contains multiple steps. The phases are broken down into the five steps below [4]:
Step 1: Collecting the chest X-ray images for the data set from Covid-19 patients and healthy persons.
Step 2: Generating chest X-ray images using data augmentation.
Step 3: Representing images in a feature space and applying deep learning.
Step 4: Splitting the data set into 2 sets, a validation set and a training set.
Step 5: Evaluating the performance of detector on validation dataset with various CNN models i.e, VGG16, ResNet50 and Customized CNN model.

III. RESULTS AND DISCUSSION

The results for three models are as follows in Table-1:

Models	ResNet50	VGG16	Customized CNN
Accuracy	90.767	84.214	73.497
Loss	0.235	0.386	0.635

Table-1: Model performance of ResNet50, VGG16 and Customized CNN

Upon a comparative analysis of the three model performances in terms of accuracy and loss, it is clear that ResNet50 performed well with accuracy of 90.767, while VGG16 gave a decent accuracy of 84.214 and for customized CNN its less with accuracy of 73.497. The loss for ResNet50 and VGG16 does not varies much but for customized CNN has high loss when compared with ResNet50 and VGG16. The main reason for it is the number of layers containing in each model which varies as Customized CNN has only two convolutional layer and two max- pooling and a flattening layer. Thus, the accuracy and loss of customized CNN did not perform well when compared to ResNet50 and VGG16.

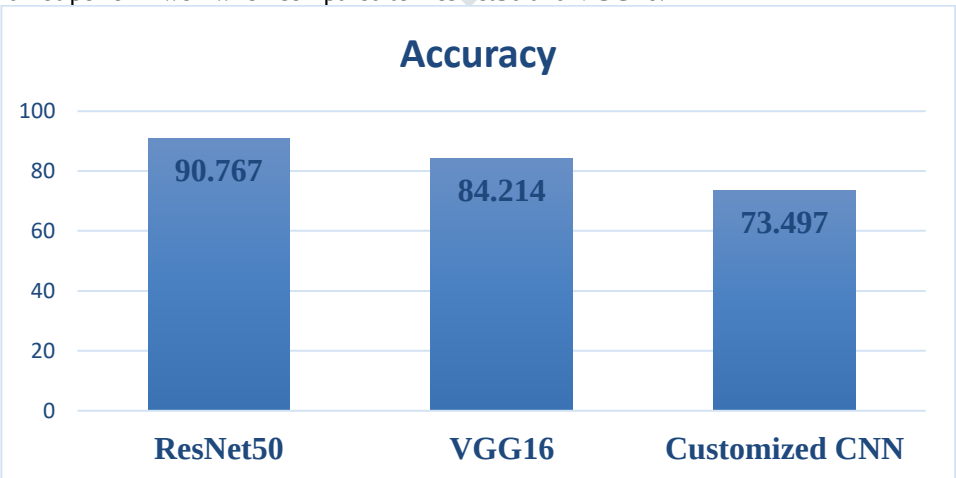

Fig-12: Accuracy graph between ResNet50, VGG16 and Customized CNN

IV. CONCLUSION AND FUTURE SCOPE

Numerous people remain un-diagnosed due to lack of diagnosis equipment and personnel in developing and rural areas. Due to this, there is a significant variation between the number of actual and confirmed cases. Such emerging challenges are addressed. X-ray scans can detect COVID- 19 in the lungs that can replace the time-consuming viral and antibody test. In order to overcome the problems with covid-19 detection that include dataset overfitting and noise of a particular deep learning model for enhanced performance on Covid-19, This project employs three distinct CNN models for detecting Covid- 19 from X-ray Scan image files.

We can see that, as the number of layers increases, the accuracy increases and loss decreases. The best example for this is the customized CNN model where the accuracy is 73.497 and loss is 0.635. The accuracy for ResNet50 is 90.767 and loss is 0.235. The accuracy for VGG16 is 84.214 and loss is 0.386. The future scope of this project is by adding Synthetic Minority Oversampling Technique (SMOTE) which can increase the accuracy and decrease the loss of customized CNN and other models.

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