

MDCNN - Modified Deep Convolutional Neural Network System for Classifying COVID-19 Image Dataset

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ABSTRACT

People affected by corona virus count are increasing day by day rapidly. Those affected people are facing a lot of health issues even though cured and back to normalcy. To address this challenge and taking preventive action measures to avoid disease spread, we propose a novel improved Modified deep CNN (M-CNN) architecture. This proposed system aims to construct a deep model for screening and predicting the chances of disease spread by monitoring human health changes using existing covid-19 CT scan images. The proposed model was trained using 1000 scan images collected from different resources and results in improved prediction accuracy of 93% which is comparatively higher than existing approaches.

Keywords: Convolutional neural networks, Covid, CT scan images, Disease prediction

INTRODUCTION

The International public healthcare agency World Health Organization (WHO) located at Switzerland has been informed of all countries about the outbreak of COVID-19 found at Wuhan city, located in China on 11 March 2020 [1]. The virus named SARS-CoV-2 spreads this aforementioned disease, made the year 2020 a global COVID-19 pandemic one. Whilst WHO reported 62,844,837 confirmed cases over the world, as of December 2020 which includes 1, 465,144 deaths [2]. COVID-19 was caused a drastic loss in human life around the world, some infected people realize small to medium level of symptoms and recovered back without hospitalization. The COVID-19 viruses are promulgated through droplets emitted by the infected person's cough or sneezes. These viruses are spreading majorly through air medium results in rapid growth [2]. The various symptoms of this disease are fever, dry cough, breathing problems, allergies, skin rashes, and loss of smell results COVID-19 Positive. According to the report of WHO medicines or preventing vaccines for COVID-19 is still at the research and testing level. Protecting ourselves by taking appropriate precautions only help to control the disease spread. Predictions and diagnosis are happening based on clinical trials. Although a lot of advancements in Medical Science and Technology, a huge amount of medical equipment available, and smart devices emerged for monitoring the health conditions, COVID-19 disease prediction using X-ray or chest CT scan images possess a lot of complex challenges in terms of image segmentation and recognition. [3-12].

Artificial Intelligence explored a monumental growth in developing and training machine learning models and deep learning models [13] similar to human cognitive intelligence. Researchers found amazing results in object identification and tracking using Computer Vision Techniques [14] with the help of deep neural models. The emergence of deep learning algorithms achieves impressive results in image and video recognition. The deep neural model handles the image or video data directly without applying traditional image processing algorithms and techniques. The study of neural networks grasped unimaginable results in image prediction. The popular widely known deep learning algorithm for image classification is Convolutional Neural Network (ConvNet/CNN). CNN achieved tremendous results in image recognition tasks by directly reading the images. CNN required less pre-processing tasks to be accomplished and highly capable to learn the required features from the scan images [15].

Deep learning reaches its prominent position in the area of computer vision using neural networks results in a powerful impact on benchmark datasets [16]. Popularly the ImageNet Challenge held in the year 2012 [17] CNN produces the second-best reduced error rate for an image classification task. The CNN architecture has been changed the trend in recognizing the natural images directly without complex tasks. The ConvNet architecture utilizes the neural network layer efficiently to mimic like human brain system represented as Visual Cortex. The CNN models are highly capable to capture spatial and temporal information using filter characteristics, fit the images for processing directly by reusing the weights calculated in each layering step. The convolution layer also known as kernel or filter performs convolution operation by traversing the entire image using a stride approach. This method finds features present in an image like edges and color. The padding techniques could be engineered for enhancing the dimensionality of an image. The next pooling layer reduces the dimensionality of spatial data. Fully connected layers are connecting all the previous connecting nodes and link it with the output layer and the Softmax layer yields the probability-based results of predictions.

The following table explores the variants of CNN architecture

Reference	Architecture	year	# Total number of Layers	# Convolution Layer	# Fully Connected Layers	# Parameters	Features
LeCun et al [18]	LeNet-5	1998	5	2	3	60,000	Pooling Layers
Krizhevsky et al [16,17]	AlexNet	2012	8	5	3	60 million	Pooling + ReLU
Zeiler et al [19,30]	ZFNet	2013	8	5	3	42 million	7x7 sized filters
Simonyan et al [20]	VGG-16	2014	16	13	3	138 million	ReLU
Simonyan et al [20]	VGG-19	2014	19	16	3	19.6 billion	Pooling + Softmax
Szegedy et al [21] and	GoogleNet	2014	22	2 – Conv, 5 – P, 14-I, 1 – SD		4 million	1x1 Convolution and Pooling +

Habibzadeh et al [22]	Inception-v1	2014	22			5 million	ReLU
Szegedy et al [23]	Inception-v3	2015	48	6 – Conv, 2 - P 3-I ,1 - SD		24 million	RMSProp Optimizer
He et al. [24,25]	ResNet-50	2015	50	49	1	26 million	Batch Normalization
Szegedy et al [26]	Inception-v4	2016	Modified version of Inception-v3			43 million	Changes in Stem module
Szegedy et al [26]	Inception-ResNets	2017	Changes in Hyper-parameter settings.			25 million	residual connections
Chollet et al.[27]	Xception	2016	71 layers	Improved performance		23 million	Slightly better performance than Inception-v3

Conv – Convolution layers, P - Pooling Layers, I-Inception Layers, SD- Softmax and drop out

Table 1: Analysis of Various CNN Architecture

The upcoming parts of this paper are segmented as follows. In the first part, the introduction is discussed and Section 2 explores the related works, and proceeding section 3 displays the proposed architecture, and section 4 deals with baseline experiments conducted and finally the conclusion.

2. Related Works

The outbreak of COVID-19 pandemic period changes the direction of researchers to focus the development of deep models to recognize and predict COVID-19 possibilities in X-ray based images and CT scan images. According to the WHO information the infected count has peaked up to ten percent of the world population [2]. Millions of people affected and most of them faced various difficulties in their physical body health systems even died. Consequently, screening the people and providing treatment is a major concern for governments, doctors, and intuitively possess complex challenges to researchers for developing Medical attention based assistive systems. Particularly, CT scans and chest X-ray images have been given a lot of attention in clinical trials. A lot of research effort has been made to analyze the barriers faced by the doctors that prevent people from infecting COVID-19. This research aims to design and implement an end to end prediction system for COVID19 that will ease the physician to suggest the treatment process.

Plenty of COVID19 datasets discussed in table 2 were created based on the CT scans and chest X-ray images for research purposes. However, analyzing these images did not get a lot of attention despite the widespread use of the deep models and the noticeable growth in the number of applications. The Proposed modified deep CNN model expertise the prediction system in an unimaginable way. The various existing models underline the fact that the insufficient attention given to recognizing the medical images has to be reconsidered. So, this research mainly focuses on the recognition of Medical Images.

Computerized tomography (CT) scan images are intelligent way of predicting COVID-19, gives reliable and accurate results and incurs low cost. The proposed model investigates disparate covid-19

dataset images detail discussed in the table.2, containing CT scan images of both positive and negative categories of covid-19 classes to direct the research activities towards prediction of covid-19 in real time cases. We have trained our model to find the pattern of the disease occurrences by learning the spatial features of images. The proposed model was developed to automatically classify and predicts the conformity of COVID-19 disease. The various COVID-19 datasets available on the internet for exploring the research in the area of image analysis and recognition systems summarized as follows.

DATASET	FILE SIZE	Number of CT scan Images	Publicly available
COVID19-CT dataset	95 MB	349	Yes
COVID-CT-Dataset	86MB	275	Yes
COVID-19 CT scans	1 GB	20	Yes
Novel Corona Virus 2019 Dataset	20.68 MB	Daily updated	Yes
Open Research Dataset for COVID-19 (CORD-19)	6 GB	Full text	Yes
The complete Our World in Data COVID-19 dataset	Daily Updated		Yes
CT-scan Dataset SARS-COV-2	2482		Yes
COVID-19 Lung CT Scans	86 MB	275	Yes
Extensive X-Ray images and CT Chest images Dataset	4 GB	Totally 17099 X-ray and CT images.	Yes
COVID-19 CT Segmentation Dataset [28]	1.1 GB	20	Yes
SIRM chest X-rays and CT images [29]	1 GB	68	No

Table 1: Summary of Various COVID-19 DATASETS

Medical image recognition systems are mainly concerned with finding a disease or predicting the possibility of getting an infection, which plays the role of the physician in the process of analyzing the scan images [4]. This system falls into the area of Medical Image Analysis (MIA) Systems. Furthermore, the proposed model helps to find intuitive information about disparate disease image analysis and recognition systems. This software model can be implemented as Assistive System for the physician to recognize the disease patterns to find the root cause of disease and explore the idea for the treatment process. In deep models, the expert is required to study the model to understand the outcomes. The main idea of this research work is to analyze various images of disparate diseases to explore a model similar to human intelligence. These models can be reliable and accurate; however, it has overhead to handle the various selections of scan images like Tomography, Nasal endoscopy, CBCT Scan, and RBC nuclear scan and other materials. On the other hand, deep learning algorithms overcome that burden so tedious pre-processing is not required providing more flexibility to the user than traditional machine learning-based systems. The proposed model encompasses research on disparate deep learning techniques to predict the presence of COVID-19 in medical images. This research focuses on a covid-19 scan image recognition system that can be used in real-time medical diagnosis. The proposed system will predict the covid-19 disease using modified deep CNN. Hemdan et al [31] proposed COVIDX-Net model to assist radiologists with the findings of X-ray images for diagnosing the COVID-19. In [48], author discussed attention based CNN model for image recognition using the dataset CUB-Birds, FGVC- Aircraft and Stanford-Cars. Mishra et al [49] proposed deep CNN Techniques for identifying the disease COVID-19 from chest CT images.

3. System Architecture

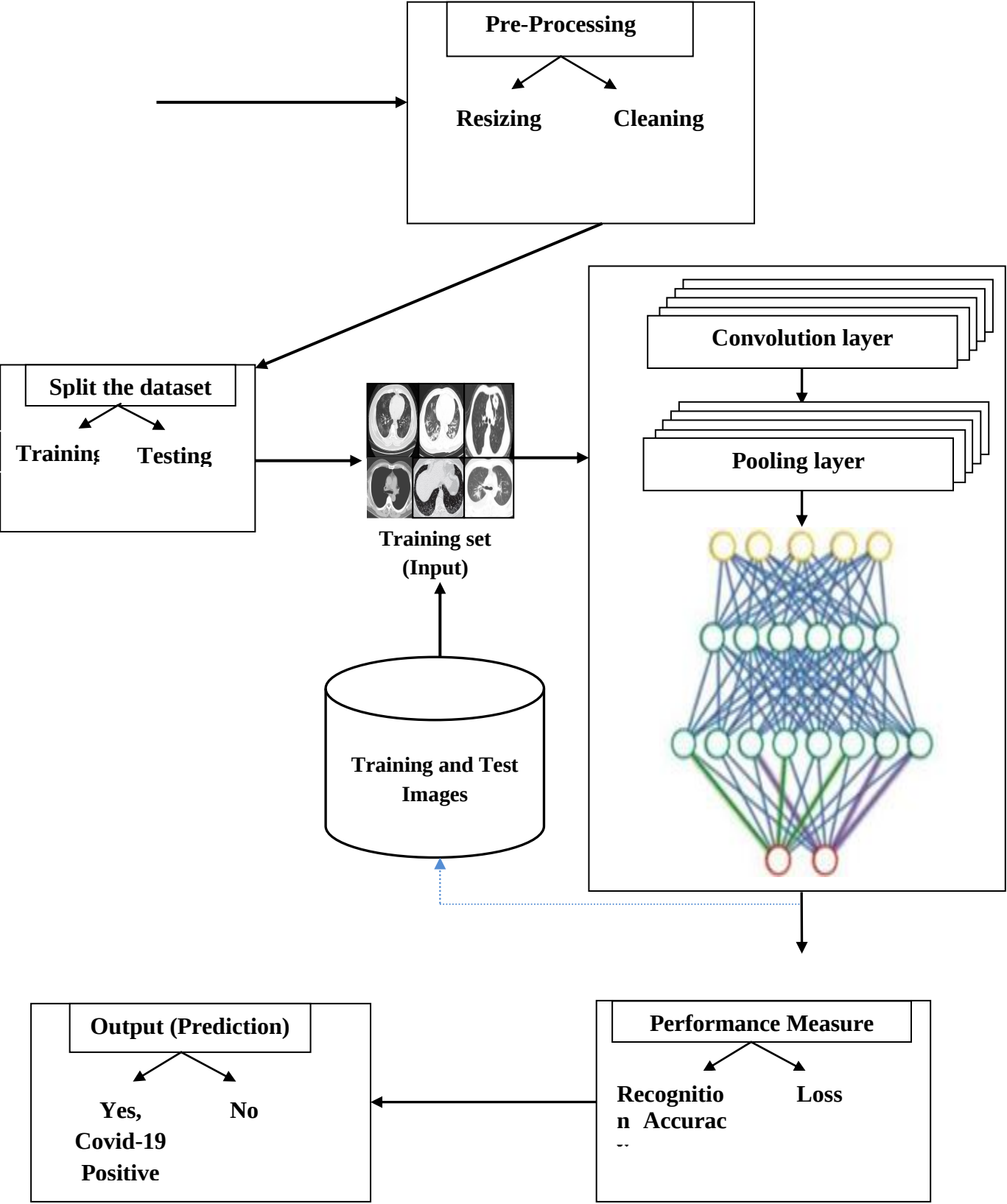


Fig.1 The Proposed M-CNN System Architecture

This model focuses decision fusion based approach combines the results for prediction. Wu et al.[38] discussed prediction of COVID-19 present in the CT scan images using various deep learning techniques. This model uses 618 CT samples collected from various age group male patients, in which infected regions are tracked by employing deep models, and performance was analyzed with the use of Noisy-OR Bayesian function, produces 86.7% accuracy. Wang et al. [8] employed the model using 3D deep CNN Techniques to find COVID-19 using chest CT segments. Chowdhury et al. [13] discussed a method for predicting COVID-19 by investigating chest X-ray Images. Xu et al [9] developed multiple CNN models to earlier identification of COVID-19 possibilities region present in CT scan images. Hussain et al [36] discussed Transfer learning method for CNN image classification especially for inception-v3 model to analyze the recognition accuracy of trained model for CIFAR-10 dataset. Zheng et al [43] proposed RA-CNN model use attention-based methods to recognize the images without using bounding boxes and annotations. In [50], the author introduced a customized CNN model to classify the intrinsic features in lung images. This model uses an ILD database made up of HRCT images, with annotations.

4. Experiments

The experimental evaluation of our proposed modified deep CNN model is summarized as follows. The proposed architecture uses 16 Convolution layers which perform convolution operation and 4 pooling layers for average pooling and ends with 2 fully connected layers. The outcome of fully connected layers is feed into the Softmax layers for finding the class of the given input image. Batch normalization layers were added in the middle part to accelerate the training of the model. We employ the activation function called Rectified Linear Unit (ReLU) to boost up the non-linearity in input images. We evaluate the proposed method to handle various kinds of COVID-19 chest CT scan image datasets detailed in table 2. The accuracy of the model showcases the un-comparable performance in image recognition. We also evaluated the proposed end-to-end model quantitatively in terms of segmentation, labeling, and infected region identification.

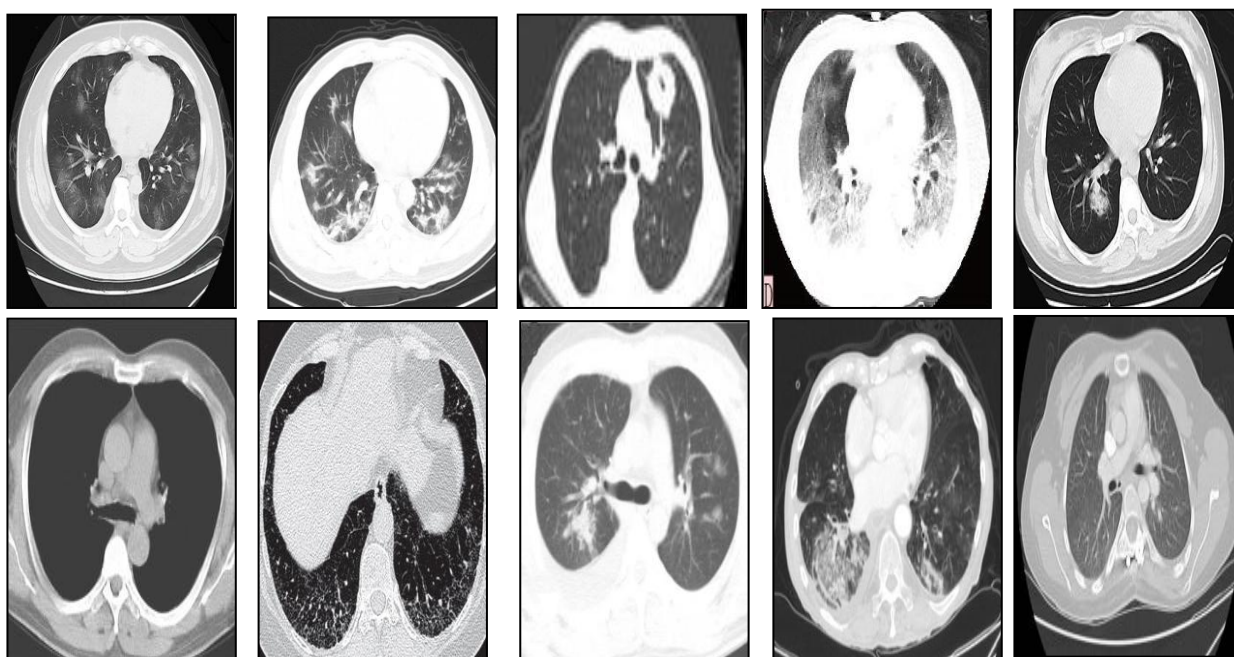
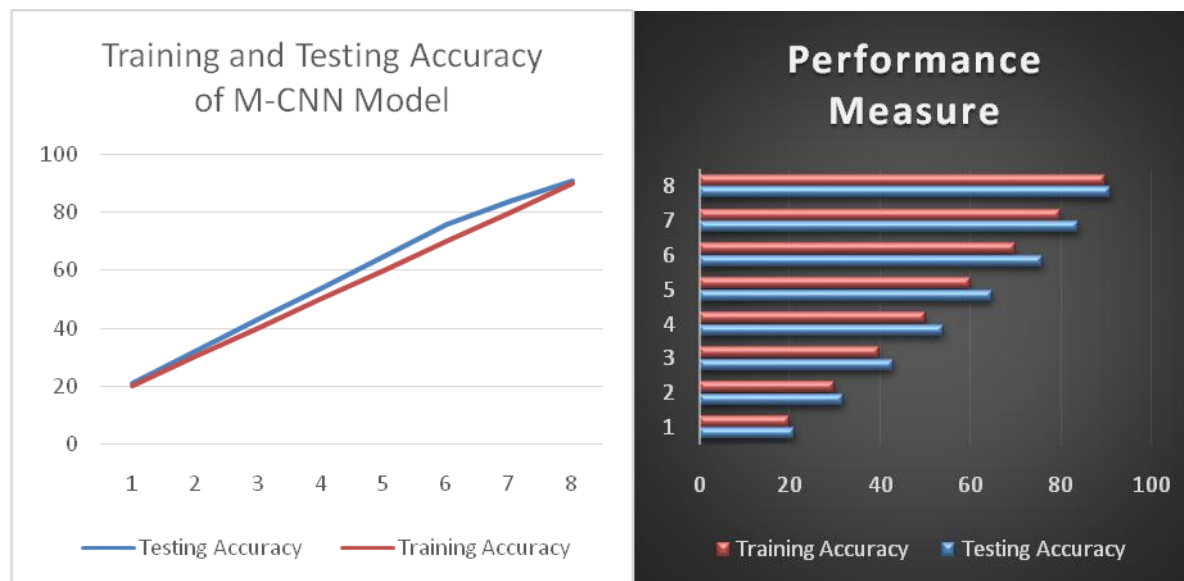


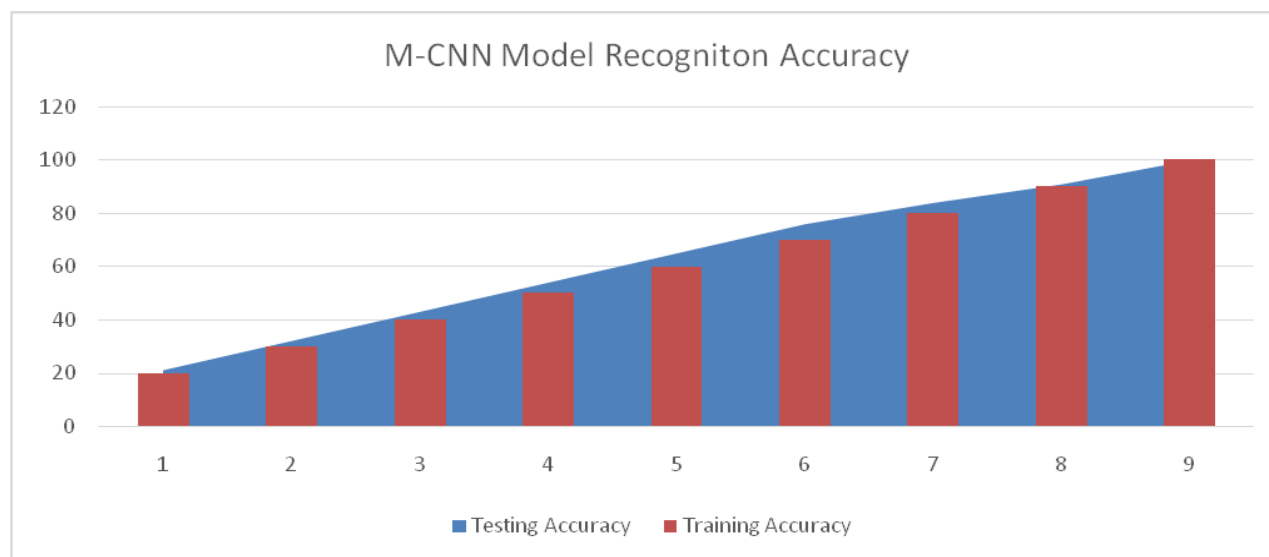
Fig.2 COVID19-CT Scan Images

The performance of M-CNN model during training and testing are evaluated and analyzed with loss function and the performance was improved using attention mechanism and regularization. The following charts depict the performance of M-CNN model during training and testing period.



(a)

(b)



(c)

Figure 3: (a) (b) (c) Training and Testing Accuracy of M-CNN Model

5. CONCLUSIONS AND FUTURE WORK

The proposed M-DCNN model gained significant performance in the image recognition system using a deep learning approach. Using the proposed model and collection of computerized tomography (CT) scan images medical practitioners can find the cause of COVID-19 disease and take treatment measures. By achieving better prediction results the model energizes its efficiency in terms of image recognition.covid-

19 patients and their families may face health-related consequences and mental health problems. To avoid this, many researchers have been put plenty of methods for predicting and diagnosing. The proposed novel M-CNN Model was developed to lower the recognition error and secure reliable performance. The Experimental results showcase the efficiency of our proposed model during training and testing. Our future work aims to improve the model for recognizing disparate kind of medical images for diseases prediction using different parameters results accurate prediction results. This model was developed to reduce the burden of physicians and radiologists while analysing ten COVID-19 CT scan images. The proposed deep model also provides assistance to find the Covid-19 positive cases easily and quickly without complication. Finally, the proposed M-CNN model can be used for predicting images of cancer, Allergies & Asthma, and Liver Disease.

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