Face Mask Detection

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Abstract

COVID-19 pandemic caused by coronavirus is progressively growing all over the world. The impact of COVID-19 has fallen on relatively all sectors of development. The healthcare system is going through a huge crisis right now. Wearing a face mask to reduce the growth of coronavirus is one of the precautionary approaches that many countries have taken. In this paper, we introduce a system that helps in finding out individuals who are not wearing any facial mask. A deep learning architecture is trained on a dataset that consists of images of individuals with and without masks gathered from unique sources. The trained architecture achieved 94.3% accuracy when we were using the CNN algorithm and 93.86% accuracy when we were using the MLP algorithm on recognizing people with and without a facial mask for a given test data. It is assumed that our study would be a useful tool to reduce the spread of this communicable disease in many regions of the world.

Keywords - Facial mask detection, Deep Learning,Convolution Neural Network, Face Mask

1 Introduction

A new strain which has not previously been identified in humans is novel coronavirus (nCoV). Coronaviruses (CoV) are a large group of viruses which cause illness that differ from colds to dangerous infections like Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). The first infected patient of coronavirus was indentified in December 2019. From that time, COVID-19 has grown into a pandemic all over the world. People all over the world are facing challenging situations due to this pandemic. Every day a huge number of individuals are being infected and died. At the time of writing this paper, almost 64,502,620 infected cases have been confirmed where 1,493,062 are death . This number is multiplying day by day. Fever, dry cough, fatigue, diarrhea, loss of taste, and smell are the major symptoms of coronavirus which is declared by the WHO. Many precautionary steps have been chosen to fight against coronavirus. Among them cleaning hands, maintaining a safe distance, wearing a mask, refraining from touching eyes, nose, and mouth are the main, where wearing a mask is the simplest one.

COVID-19 is a disease that spread from human to human which can be controlled by ensuring proper use of a facial mask. The spread of COVID-19 can be reduced if people strictly maintain social distancing and use a face mask. Very sadly, individuals are not obeying these rules properly which is speeding the spread of this virus. Detecting the people not obeying the rules and informing the corresponding authorities can be a solution in reducing the spread of coronavirus. A face mask detection is a technique to find out whether someone is wearing a mask or not. It is similar to detect any object from a scene. Many systems have been introduced for target detection. Deep learning techniques are highly used in medical applications. Recently, deep learning architectures have shown a remarkable role in object detection. These architectures can be incorporated in detecting the mask on a face. This paper aims at designing a system to find out whether a person is using a mask or not. The learning algorithm Convolutional Neural Network (CNN) is adopted for feature extraction from the pictures then these features are learned by multiple hidden layers.

2 Dataset Explanation

Masks play a very important in protecting the health of individuals against respiratory diseases,as is one of the precautions available for COVID-19 in the absence of immunization. With this dataset, it is possible to create a model to detect people wearing masks, not wearing them, or wearing masks improperly.

This dataset contains 854 images belonging to the 3 classes, as well as their bounding boxes in the PASCAL VOC format.

- With mask
- Without mask
- Mask worn incorrectly


3 Related Work

Digital technologies are playing crucial roles in major health sector problems including disease prevention, the present worldwide health emergency also seeking technological support to tackle COVID-2019. The possible applications of trending digital technologies such as IoT, big-data analytic, AI, DL (deep learning), and block chain technology to develop strategies for monitoring, detection, and prevention of epidemic; and also to identify the impact of the epidemic to the healthcare sector. In research work, the authors proposed an autoregressive integrated moving average (ARIMA) model to predict the spread of COVID-2019. The author forecasted the various parameters for the next 2 days based on the study about the prevalence and incidence of the COVID-2019 in this paper.
This research work also shows the correlogram and ARIMA forecast graph for the epidemic incidence and prevalence. The author of the paper proposed a time series method to analyze the estimated reproduction number and the incidence pattern of the COVID-19 outbreak. They performed statistical analysis to explore the trends of the outbreak to highlight the present epidemiological stage of a region so that various policies can be identified to address the COVID-19 pandemic in different countries. As per the present situation, it is essential to understand the early spread patterns of the infection to plan and control the effective safety measures. In this direction, the author proposed a scientific model of critical SARS-CoV-2 transmission by using different datasets to study the COVID-19 outbreak inside and outside Wuhan. With this, they explored the possible spread of disease outbreaks outside Wuhan. Recently there are several studies conducted on the outbreak of COVID-19 using exploratory data analysis (EDA) based on various available datasets. The studies mainly focus on the occurrence of confirmed, death, and recovered cases in Wuhan and the rest of the world to understand the suspected threats and subsequent planning of containment activities. One researcher, in their research work, raised the issue of the criticality of the incubation period for COVID-19. They studied 181 confirmed cases and identified that the incubation period may vary from 5 days to 14 days and based on this better surveillance and control activities can be planned. In recent research work, Singer analyzed data of 25 infected counties to follow short term predictions about the COVID 2019 outbreak. The research highlighted that the location-specific rate of disease spread follows either steady or explosive power-law growth with different scaling exponents. With this understanding, the authors analyzed the impact of lockdown in various parts of the world. Based on the above literature, it is evident that sufficient work is available on exploratory data analysis to understand the existing trend of the epidemic but still there is a lot of scopes to develop and test efficient machine learning-based prediction models so that proactive strategies could be identified to cater the immediate needs [9].

4 Proposed Model

Deep Learning Architecture - Our Deep Learning architecture learns various important nonlinear features from the given samples. Then, this learned architecture is used to predict previously unseen samples. To train our deep learning architecture, we used the Kaggle Datset provided. The architecture of the learning technique highly depends on CNN. All the aspects of deep learning architecture are described below.
i)Dataset Collection: Data is collected from Kaggle [1] for Training and Testing purpose . In the Dataset there are total 853 images and in that images there are total of 4072 faces which are extracted using the annotation, we have provided in the dataset itself. Out of these 4206 faces there are 3232 faces are With mask, 717 faces are without mask and 123 faces are wearing mask incorrectly. For training purposes, 80utilized for testing purposes.
ii) Architecture Development: Our proposed model is based on CNN which is widely used for pattern recognitions in images [6].The network comprises an input layer, several hidden layers and an output layer. The hidden layers consist of multiple convolution layers that learn suitable filters for important feature extraction from the given samples. The features extracted by CNN are used by multiple dense neural networks for classification purposes [11].The architecture of the developed network is illustrated in Table below

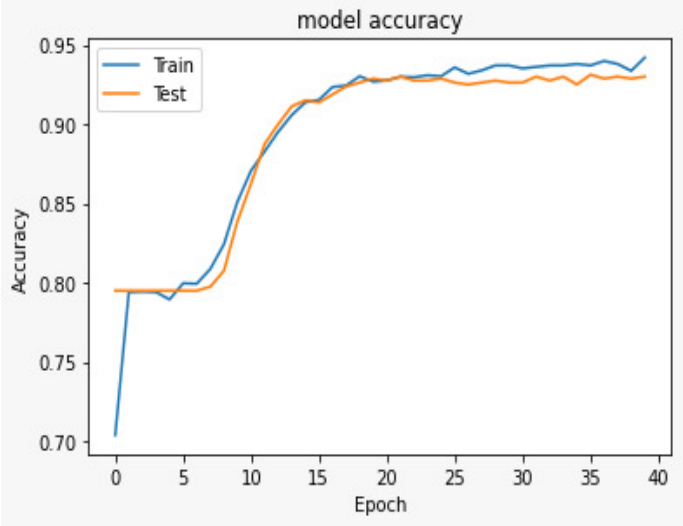
ARCHITECTURE OF THE DEEP LEARNING NETWORK

Layer	Type	Kernal	Kernal Size	Output Size
1	Convulation2D	16	(3x3)	298x298x16
2	MaxPooling2D	–	(2x2)	149x149x16
3	Convulation2D	32	(3x3)	147x147x32
4	MaxPooling2D	–	(2x2)	73x73x32
5	Convulation2D	64	(3x3)	71x71x64
6	MaxPooling2D	–	(2x2)	35x35x64
7	Convulation2D	64	(3x3)	33x33x64
8	MaxPooling2D	–	(2x2)	16x16x64
9	Flatten	–	–	16384
10	Dense	–	–	100
11	DroupOut	–	–	100
12	Dense	–	–	56
13	Dense	–	–	3

The architecture contains 4 convolution layers each followed by one max pooling layer. This layer reduces the number of parameters . We flatten the array into a single vector of 36992 neurons and pass them into further layers. Next we have a Dense layer followed by Dropout layer to prevent overfitting in the model. Then we have two Dense layer and atlast an output layer and then we applied stochastic gradient descent optimizer to optimize the model.

5 Result Analysis

The Machine Learning models could not handle the image of pixel size 300x300x3 as total feature size will be 270000. So it is not feasible to use ML architectures for such a huge feature dataset. So we have to change the pixel size to 100x100x3 so we can use the ML models. The SVM approach gives an accuracy of 93.6196%, the MLP approach gives an accuracy of 93.86% and random forest gives an accuracy of 93.9877%. But as discussed above, these are not feasible for larger pixel image size. So we jump on to the deep learning model of CNN. And using CNN, we can process an image of a large pixel value. By assigning 80%for the training set and 20% testing set, we have trained our model. So in total 3232 faces of pixel size 300x300x3 were used in the training process and 723 faces were used for testing purposes. The proposed Architecture converges in 40 epochs. The problem of over-fitting is resolved as we have Dropout 50% neurons in the 11th layer, i.e. Dense layer. Over-fitting occurs when a model learns the unwanted features of the training samples. The trained model shows a 94.3% accuracy after 40 Epochs on the training set and 93.00% accuracy on the testing set. The curve for training and testing is shown in figure below for 40 Epochs and from there we can eventually conclude that both the training and testing accuracy is almost the same. This means the model has a decent generalization ability for previously unseen data and it does not cause over-fitting of the training data.



6 Conclusion

This paper presents a deep learning model to detect if a person is wearing a mask or not. The aim of this work is to ensure the use of mask to stop the spread of deadly Coronavirus . The model contains a face detection algorithm using a Convolution Neural Network which detects face mask with an accuracy of 94.3%. The proposed model will help to identify people not wearing mask and ensure safety from COVID-19.
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