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(Deemed To Be University)

Submitted in partial fulfillment of the requirements for the award

of Bachelor of Technology Degree in

Information Technology

By

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SCHOOL OF COMPUTING

SATHYABAMA

**INSTITUTE OF SCIENCE AND
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Accredited with Grade “A” by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work **NITHYA M (38120055)** who carried out the project entitled "**FACE MASK DETECTION**" under our supervision from July 2021 to September 2021.

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DECLARATION

I **NITHYA M** hereby declare that the Project Report entitled “**FACE MASK DETECTION**” done by me under the guidance of, **Dr. SUBHASHINI, M.E., Ph.D.** is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Information Technology.

DATE: 12/11/2021

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SIGNATURE OF THE CANDIDATE

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ABSTRACT

COVID-19 pandemic has rapidly affected our day-to-day life disrupting the world trade and movements. Wearing a protective face mask has become a new normal. In the near future, many public service providers will ask the customers to wear masks correctly to avail of their services. Therefore, face mask detection has become a crucial task to help global society. This paper presents a simplified approach to achieve this purpose using some basic Machine Learning packages like TensorFlow, Keras, OpenCV and Scikit-Learn. The proposed method detects the face from the image correctly and then identifies if it has a mask on it or not. As a surveillance task performer, it can also detect a face along with a mask in motion. The method attains accuracy up to 95.77% and 94.58% respectively on two different datasets. We explore optimized values of parameters using the Sequential Convolutional Neural Network model to detect the presence of masks correctly without causing over-fitting.

INTRODUCTION:

Individuals with COVID-19 have had a wide scope of symptoms reported – going from mellow manifestations to serious illness. Respiratory problems like shortness of breath or difficulty in breathing is one of them. Elder people having lung disease can possess serious complications from COVID-19 illness as they appear to be at higher risk . Some common human corona viruses that infect public around the world are 229E, HKU1, OC43, and NL63. Before debilitating individuals, viruses like 2019-nCoV, SARS-CoV, and MERS-CoV infect animals and evolve to human corona viruses . Persons having respiratory problems can expose anyone (who is in close contact with them) to infective beads. Surroundings of a tainted individual can cause contact transmission as droplets carrying virus may withal arrive on his adjacent surfaces .

Face mask detection involves in detecting the location of the face and then determining whether it has a mask on it or not. The issue is proximately cognate to general object detection to detect the classes of objects. Face identification categorically deals with distinguishing a specific group of entities i.e. Face. It has numerous applications, such as autonomous driving, education, surveillance, and so on . This paper presents a simplified approach to serve the above purpose using the basic Machine Learning (ML) packages such as TensorFlow, Keras, OpenCV and Scikit-Learn.

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LIST OF ABBREVIATIONS

S. No	ABBRIATION	EXPANSION
1.	OpenCV	Open Source Computer Vision Library
2.	CNN	convolutional neural network
3.	LLE	locally linear embedding
4.	ReLU	Rectified Linear Unit
5.	ML	Machine language

CHAPTER 1

INTRODUCTION

1.1 Purpose:

The public should be aware of whether to put on the mask for source control or aversion of COVID-19. Potential points of interest of the utilization of masks lie in reducing vulnerability of risk from a noxious individual during the "pre-symptomatic" period and stigmatization of discrete persons putting on masks to restraint the spread of virus. WHO stresses on prioritizing medical masks and respirators for health care assistants. Therefore, face mask detection has become a crucial task in present global society..

1.2 Scope:

Here the main challenge of the task is to detect the face from the image correctly and then identify if it has a mask on it or not. In order to perform surveillance tasks, the proposed method should also detect a face along with a mask in motion.

1.3 Functional components of the project:

Following are the functional needs of the software:-

In face detection method, a face is detected from an image that has several attributes in it. According to , research into face detection requires expression recognition, face tracking, and pose estimation. Given a solitary image, the challenge is to identify the face from the picture. Face detection is a difficult errand because the faces change in size, shape, color, etc and they are not immutable. It becomes a laborious job for opaque image impeded by some other thing not confronting camera, and so forth. Authors in think occlusive face detection comes with two major challenges: 1) unavailability of sizably voluminous datasets containing both masked and unmasked faces, and 2) exclusion of facial expression in the covered area. Utilizing the locally linear embedding (LLE) algorithm and the dictionaries trained on an immensely colossal pool of masked faces, synthesized mundane faces, several mislaid expressions can be recuperated and the ascendancy of facial cues can be mitigated to great extent. According to the work reported in ,

convolutional neural network (CNNs) in computer vision comes with a strict constraint regarding the size of the input image. The prevalent practice reconfigures the images before fitting them into the network to surmount the inhibition.

1.4 Technologies to be used:

This project will be a Web application to be developed in python having

- Machine Learning (ML)
- packages such as TensorFlow,
- Keras,
- OpenCV and
- Scikit-Learn.

CHAPTER 2

OVERALL

DESCRIPTION

2.1 Goals of proposed system:

- Develop a novel object detection method that combines one-stage and two-stage detectors for accurately detecting the object in real-time from video streams with transfer learning at the back end.
- Improved affine transformation is developed to crop the facial areas from uncontrolled real-time images having differences in face size, orientation and background. This step helps in better localizing the person who is violating the facemask norms in public areas/ offices.
- Creation of unbiased facemask dataset with imbalance ratio equals to nearly one.
- The proposed model requires less memory, making it easily deployable for embedded devices used for surveillance purposes.

2.2 METHODOLOGY :

We have devised a smart framework for detecting facemask in this paper. As the cases of covid19 are decreasing maximum workplaces are opening with half or full employees. Even the education institutes are planning to be opened. For screening the people not wearing masks, this system can be installed in the entrances of enterprises, educational institutes, public and private offices. If the system detects a person's face with no mask, it will generate a beep alerting them to wear mask. The block diagram of the developed framework .

2.3Proposed workflow

We decided to build a very simple and basic Convolutional Neural Network (CNN) model using TensorFlow with Keras library and OpenCV to detect if you are wearing a face mask to protect yourself. All the aspects of our work are described below.

2.4 Deep learning architecture :

The deep learning architecture learns various important nonlinear features from the given samples. Then, this learned architecture is used to predict previously unseen samples.

2.5 Image Processing:

Here Cascade Classifier will detect the input from videocam. The images captured by the system's webcam required pre-processing before going to the next step. In the pre-processing step, the image is transformed into a grayscale image because the RGB color image contains so much redundant information that is not necessary for face mask detection. Then, we resized the images into (150x150) size to maintain uniformity of the input images to the architecture. Then, the images are normalized and after normalization, the value of a pixel resides in the range from 0 to 1. Normalization helped the learning algorithm to learn faster and captured necessary features from the images. D.Dataset Collection To train our deep learning architecture, we collected images. The architecture of the learning technique highly depends on CNN. Data from source[10] is collected for training and testing the model. Dataset contains images of faces only. It consists of about 1,315 images in which 658 images containing people with face masks and 657 images containing people without face masks. For training purposes, 80% images of each class are used and the rest of the images are utilized for testing purposes. Fig. 2 shows some of the images of two different classes. E.Architecture Development The learning model is based on CNN which is very useful for pattern recognition from images. Neural Network need to see data from both the classes. The network comprises an input layer, several hidden layers and an output layer. The hidden layers consist of multiple convolution layers. The features extracted by CNN are used by multiple dense neural networks for classification purposes. The architecture contains three pairs of

convolution layers each 32 followed by one max pooling layer.

The convolution layer contains 100 kernels of window size 3x3. Max pooling layer of window size 2x2. This layer will be aggregating the results from the previous convolution layer and will be picking the max value in that 2x2 window. It decreases the spatial size of the representation and thereby reduces the number of parameters. As a result, the computation is simplified for the network. The output of the convolution layers will be flattened and will be converted into a 1-D array. Then there is one dropout layer and two dense layers. The dropout layer prevents the network from overfitting by dropping out units. The dense layer comprises a series of neurons each of them learn nonlinear features. The flattened result this will be fed to the first dense layer of 50 nodes. Then finally second dense layer containing two nodes as there are two classes.

2.6 Alert Generation: The purpose of our system is to screen person not wearing face mask. The learning architecture generates result on the input image, classifying the image into mask or no mask classes. If a person is detected not wearing a mask then a beep alert will be generated until mask is put on. And if everyone is wearing a mask then they will be safe from the virus. In this way our system would help greatly to limit the growth of COVID-19.

2.7 Training of Model

a) Building the model using CNN architecture

CNN has become ascendant in miscellaneous computer vision tasks [12]. The current method makes use of Sequential CNN.

The First Convolution layer is followed by Rectified Linear Unit (ReLU) and MaxPooling layers. The Convolution layer learns from 200 filters. Kernel size is set to 3 x 3 which specifies the height and width of the 2D convolution window. As the model should be aware of the shape of the input expected, the first layer in the model needs to be provided with information about input shape. Following layers can perform instinctive shape reckoning . In this case, *input_shape* is specified as which returns the dimensions of the data array from index 1. Default padding is “valid” where the spatial dimensions are sanctioned to truncate and the input volume is non-zero padded. The activation parameter to the Conv2D class is set as “relu”. It represents an approximately linear function that possesses all the assets of linear models that can easily be optimized with gradient-descent methods. Considering the performance and generalization in deep learning, it is better compared to other activation functions . Max Pooling is used to reduce the spatial dimensions of the output volume. Pool_size is set to 3 x 3 and the resulting output has a shape (number of rows or columns) of: $\text{shape_of_output} = (\text{input_shape} - \text{pool_size} + 1) / \text{strides}$, where strides has default value (1,1).

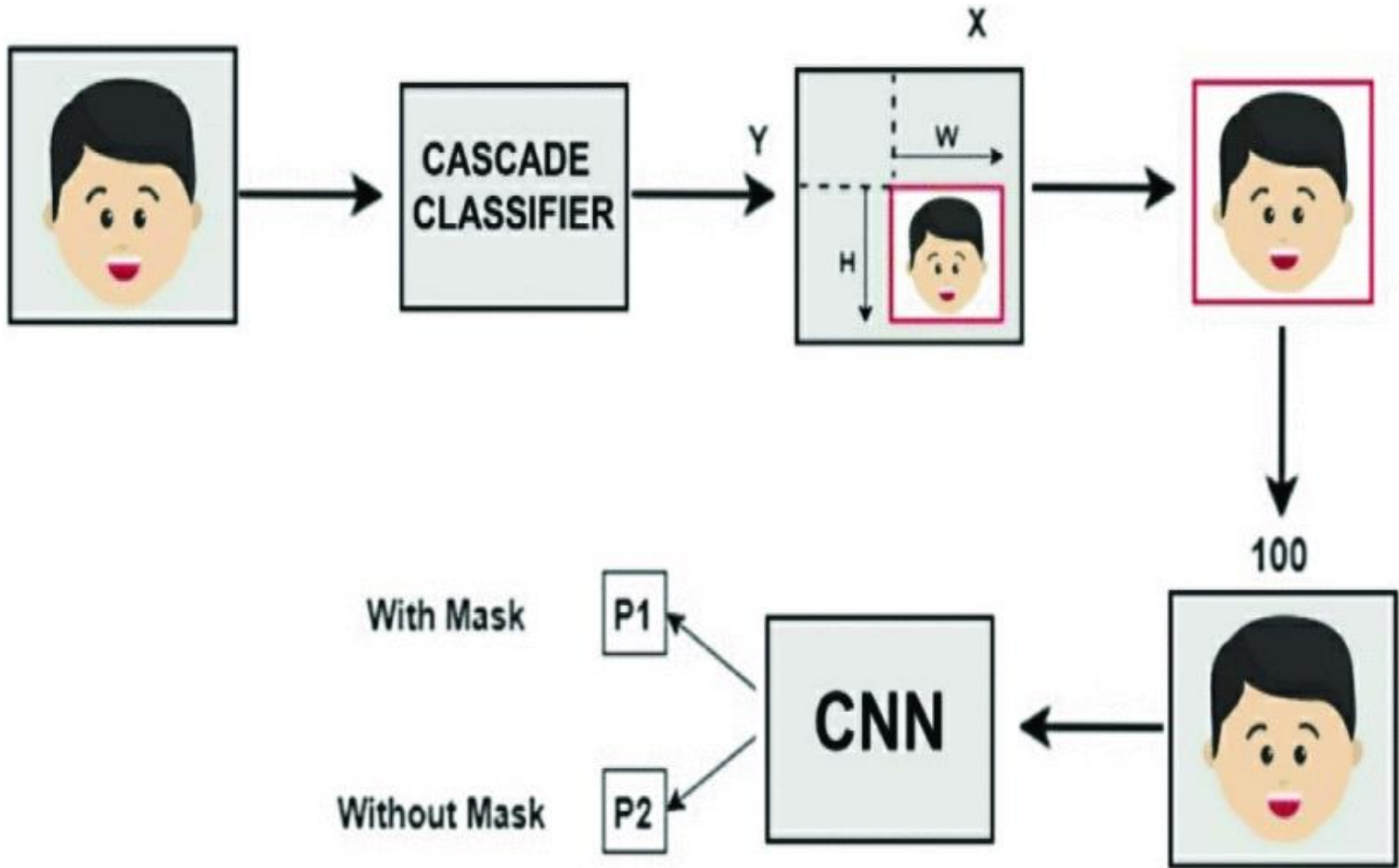
the second Convolution layer has 100 filters and Kernel size is set to 3 x 3. It is followed by ReLu and MaxPooling layers. To insert the data into CNN, the long vector of input is passed through a Flatten layer which transforms matrix of features into a vector that can be fed into a fully connected neural network classifier. To reduce overfitting a Dropout layer with a 50% chance of setting inputs to zero is added to the model. Then a Dense layer of 64 neurons with a ReLu activation function is added. The final layer (Dense) with two outputs for two categories uses the Softmax activation function.

The learning process needs to be configured first with the compile method [13]. Here “adam” optimizer is used. *categorical_crossentropy* which is also known as multiclass log loss is used as a loss function (the objective that the model tries to minimize). As the problem is a classification problem, metrics is set to “accuracy”.

b) Splitting the data and training the CNN model

After setting the blueprint to analyze the data, the model needs to be trained using a specific dataset and then to be tested against a different dataset. A proper model and optimized *train_test_split* help

to produce accurate results while making a prediction. The test_size is set to 0.1 i.e. 90% data of the dataset undergoes training and the rest 10% goes for testing purposes. The validation loss is monitored using *ModelCheckpoint*. Next, the images in the training set and the test set are fitted to the Sequential model. Here, 20% of the training data is used as validation data. The model is trained for 20 epochs (iterations) which maintains a trade-off between accuracy and chances of overfitting. Fig. 5 depicts visual representation of the proposed model.



The model is trained, validated and tested upon two datasets. Corresponding to dataset 1, the method attains accuracy up to 95.77% (shown in fig. 7). Fig. 6 depicts how this optimized accuracy mitigates the cost of error. Dataset 2 is more versatile than dataset 1 as it has multiple faces in the frame and different types of masks having different colors as well. Therefore, the model attains an accuracy of 94.58% on dataset 2 as shown in Fig. 9. Fig. 8 depicts the contrast between training and validation loss corresponding to dataset 2. One of the main reasons behind achieving this accuracy lies in *MaxPooling*. It provides rudimentary translation invariance to the internal representation along

with the reduction in the number of parameters the model has to learn. This sample-based discretization process down-samples the input representation consisting of image, by reducing its dimensionality. Number of neurons has the optimized value of 64 which is not too high. A much higher number of neurons and filters can lead to worse performance. The optimized filter values and pool_size help to filter out the main portion (face) of the image to detect the existence of mask correctly without causing over-fitting.

CHAPTER3

FEASIBILITYSTUDY

3.1 UNDERSTANDABLE FEASIBILITY:

First, mass use of facial protection requires that a sufficient and sustained supply of medical masks for healthcare staff is available.

3.2 ECONOMICAL FEASIBILITY:

Second, in the recurring scenario of insufficient supply due to shortage, the necessity of disinfection processes for lengthy usage or reuse of face masks must be acknowledged. The careless extension of intended operation limits could lead to self-contamination. Recent evidence shows that the virus might be particularly stable on the surface of surgical masks (one of the currently most widely used face mask types) for as long as 7 days.⁶ There are several feasible alternatives for disinfecting face masks, with some type of heat and ultraviolet germicidal irradiation standing out among them. These methods have been shown to successfully inactivate the virus⁶⁻⁸ without causing significant loss of mask functionality,⁹ and they are already being used in healthcare facilities, either by using autoclaves or by repurposing incubators, idle cabins, or whole rooms with ultraviolet type C (UVC) light bulbs.

3.3 BEHAVIOURAL FEASIBILITY:

Third, the accessibility of the general population to mask disinfection methods must be assessed. Chemical methods of disinfection, such as soap, ethanol, or sodium hypochlorite, are not viable because they would remove the electrostatic charge of the mask, impairing its filtration capacities.¹⁰ An alternative for mask disinfection is devices crafted to work with UVC or heat, and for which building instructions using commercially available materials can be found online for free. However, a large portion of the population will not have access to these devices; therefore, the use of washable cloth face covering should be favored; it is the current trend in some countries.

3.3 TECHNICAL FEASIBILITY:

Fourth, independent of the type of masks used, people must be systematically educated about its proper use and actual capabilities (eg, to change washable face masks every 3 hours with a clean one and maintain social distancing).

Overall, the application of mass masking has an intrinsic risk that must be evaluated. Latin American countries are particularly vulnerable because they are in general not self-sufficient to ensure an adequate procurement of masks during the outbreak, which will pose a threat to the safety of already vulnerable healthcare personnel, and the low income of the population will probably result in excessive reuse of masks. Moreover, this region has no prior experience with mask use, unlike many Asian countries, such as China, South Korea, or Singapore, which are usually the major reference for masking measures. Ultimately, sociopolitical constraints may prompt a premature end to social distancing, and negligent face mask usage could induce a false sense of security based on insufficient information.

CHAPTER 4

DESIGN

4.1 Project structure:

```
$ tree --dirsfirst --filelimit 10
```

```
.
├── dataset
│   ├── with_mask [690 entries]
│   └── without_mask [686 entries]
├── examples
│   ├── example_01.png
│   ├── example_02.png
│   └── example_03.png
├── face_detector
│   ├── deploy.prototxt
│   └── res10_300x300_ssd_iter_140000.caffemodel
├── detect_mask_image.py
├── detect_mask_video.py
├── mask_detector.model
├── plot.png
└── train_mask_detector.py
```

```
5 directories, 10 files
```

4.2 OVERVIEW :

The imports for our training script may look intimidating to you either because there are so many or you are new to deep learning. If you are new, I would recommend reading both my **Keras tutorial** and **fine-tuning tutorial** before moving forward.

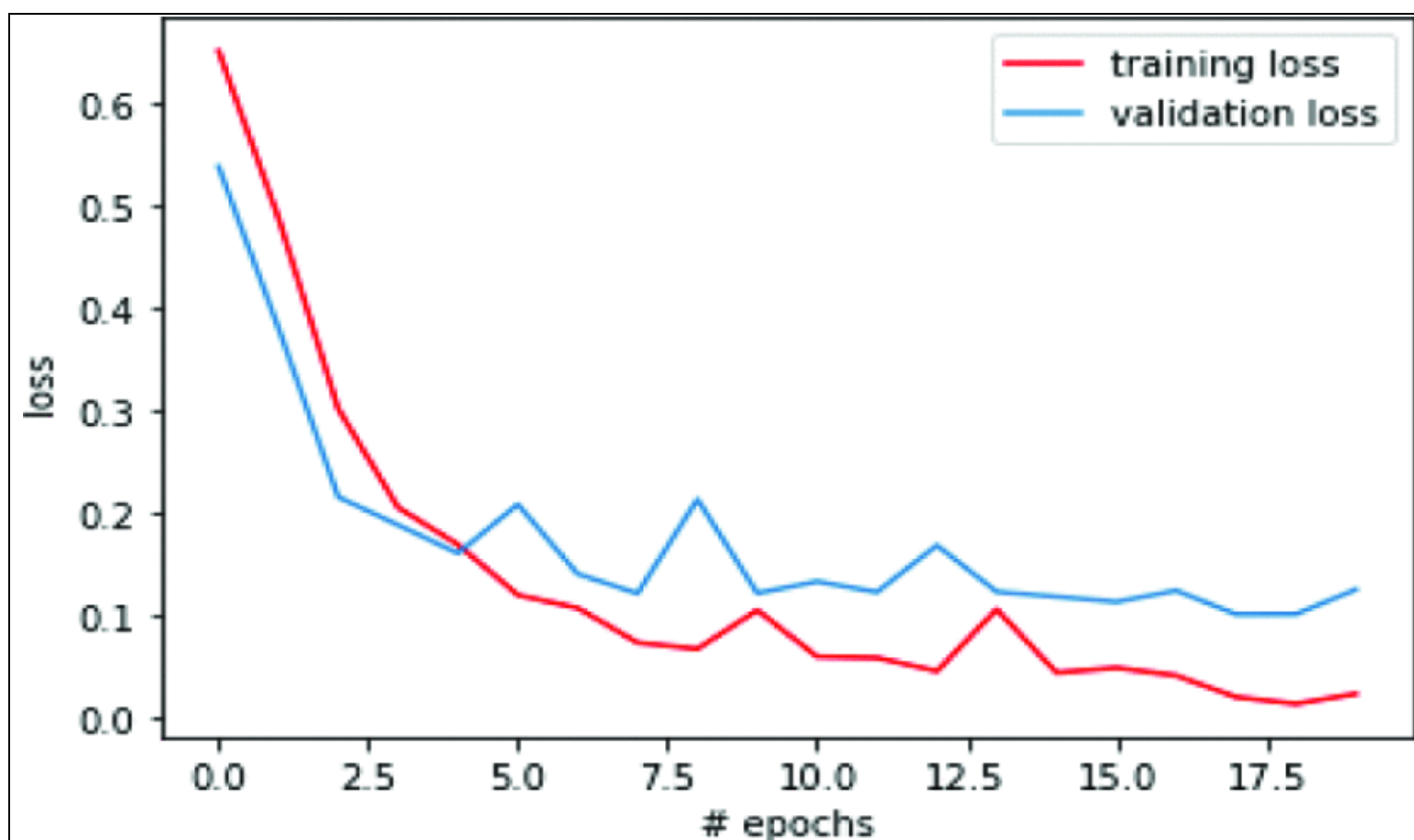
Our set of tensorflow.keras imports allow for :

- Data augmentation
- Loading the MobilNetV2 classifier (we will fine-tune this model with pre-trained **ImageNet** weights)
- Building a new fully-connected (FC) head
- Pre-processing
- Loading image data

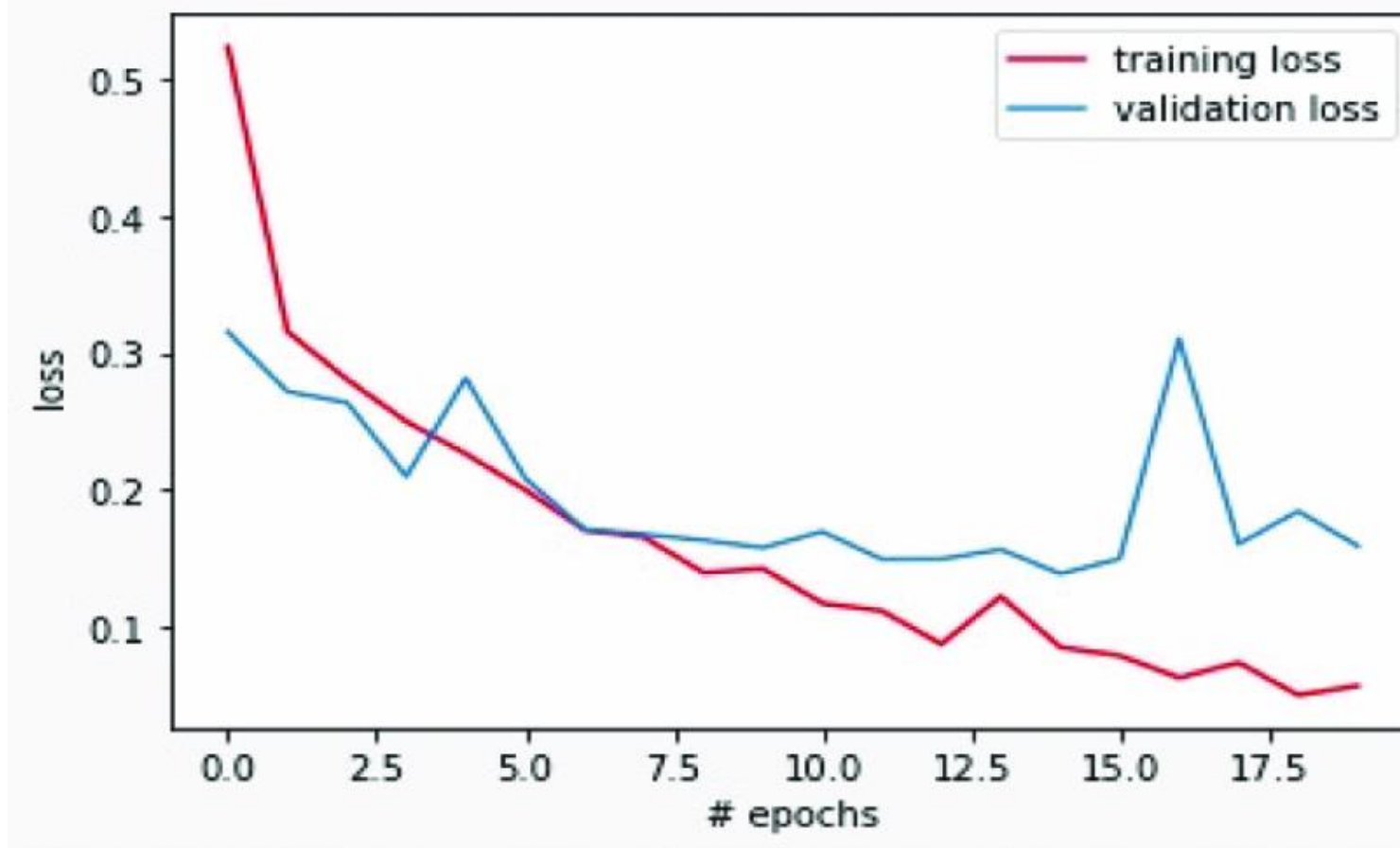
4.3 Result And Analysis:

The model is trained, validated and tested upon two datasets. Corresponding to dataset 1, the method attains accuracy up to 95.77% (shown in fig. 7). Fig. 6 depicts how this optimized accuracy mitigates the cost of error. Dataset 2 is more versatile than dataset 1 as it has multiple faces in the frame and different types of masks having different colors as well. Therefore, the model attains an accuracy of 94.58% on dataset 2 as shown in Fig. 9. Fig. 8 depicts the contrast between training and validation loss corresponding to dataset 2. One of the main reasons behind achieving this accuracy lies in *MaxPooling*. It provides rudimentary translation invariance to the internal representation along with the reduction in the number of parameters the model has to learn. This sample-based discretization process down-samples the input representation consisting of image, by reducing its dimensionality. Number of neurons has the optimized value of 64 which is not too high. A much higher number of neurons and filters can lead to worse performance. The optimized filter values and

pool_size help to filter out the main portion (face) of the image to detect the existence of mask correctly without causing over-fitting.

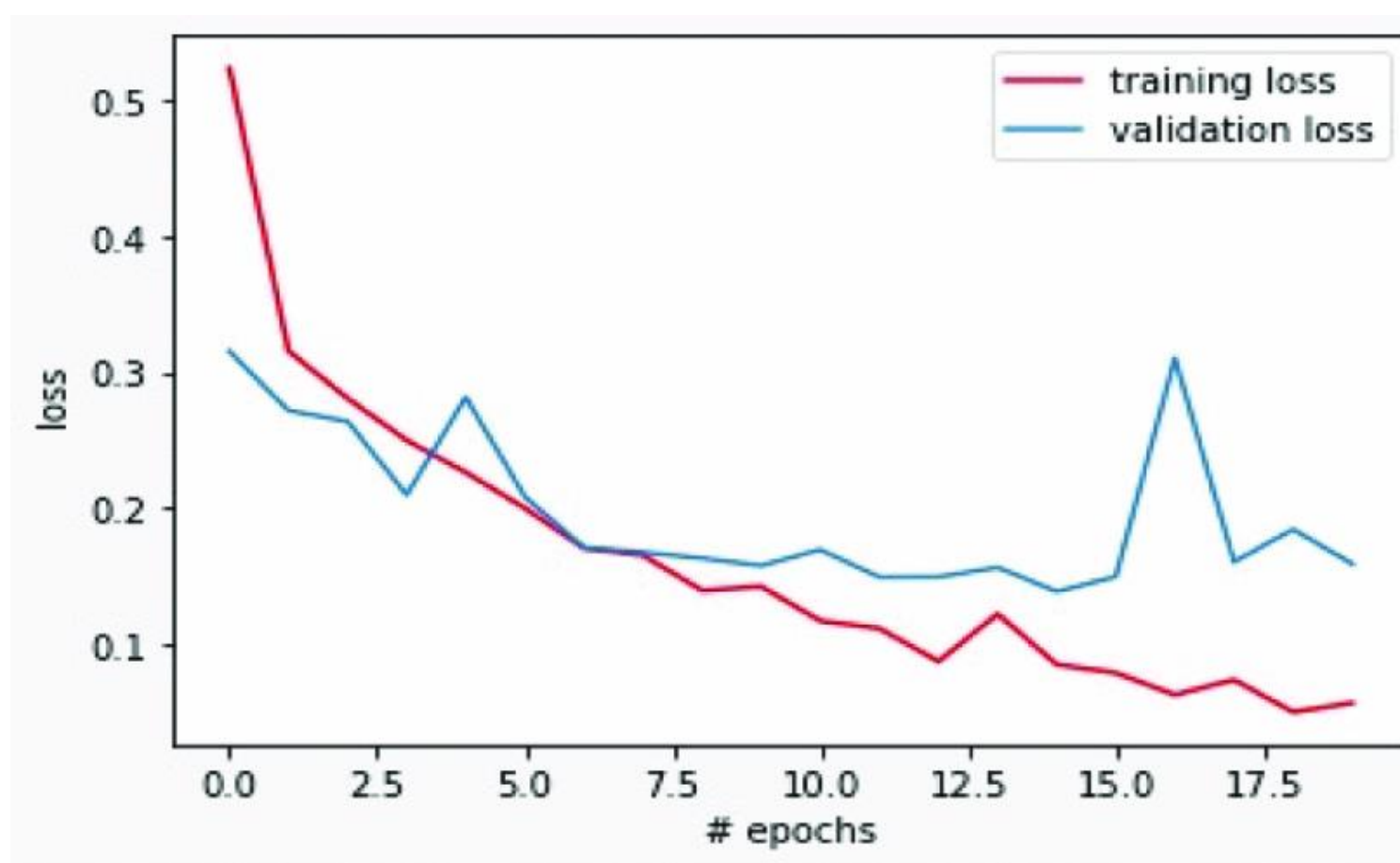


The system can efficiently detect partially occluded faces either with a mask or hair or hand. It considers the occlusion degree of four regions – nose, mouth, chin and eye to differentiate between annotated mask or face covered by hand. Therefore, a mask covering the face fully including nose and chin will only be treated as “with mask” by the model.



The main challenges faced by the method mainly comprise of varying angles and lack of clarity. Indistinct moving faces in the video stream make it more difficult. However, following the trajectories of several frames of the video helps to create a better decision – “with mask” or “without mask”, classification techniques. Quantification and performance of analysis can be done statistically with a strong fundamental background. Before finding its application to data mining algorithms on the basis of statistics can be modified and scaled.

4.4 OUTPUT:



CHAPTER 5

CONCLUSION
AND FUTURE WORK

5.1. CONCLUSION

In this paper, we briefly explained the motivation of the work at first. Then, we illustrated the learning and performance task of the model. Using basic ML tools and simplified techniques the method has achieved reasonably high accuracy. It can be used for a variety of applications. Wearing a mask may be obligatory in the near future, considering the Covid-19 crisis. Many public service providers will ask the customers to wear masks correctly to avail of their services. The deployed model will contribute immensely to the public health care system. In future it can be extended to detect if a person is wearing the mask properly or not. The model can be further improved to detect if the mask is virus prone or not i.e. the type of the mask is surgical, N95 or not.

5.2 FUTURE WORK

. The developed system can detect the live video streams but does not keep a record. Unlike the CCTV camera footage the admin can not rewind, play or pause it. As whenever a strict system is imposed people always try to break it. Hence when a person is detected with no mask, the head of the organization can be notified via mail that so and so person entered without mask. The proposed system can be integrated with databases of respective organizations to keep a record of the person who entered without mask. With more complex functions a screenshot of the person's face can also be attached to keep it as a proof

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