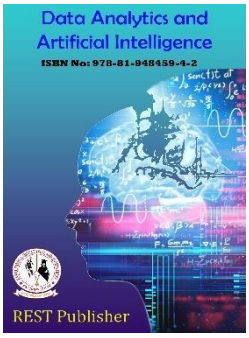
Data Analytics and Artificial Intelligence

Vol: 3(3), 2023

REST Publisher; ISBN: 978-81-948459-4-2

Website: http://restpublisher.com/book-series/daai/



Covid-19 Face Mask Detection Using Cnn, Tensor Flow, Open CV With Arduino Gate Control

G. Priyanga Me, *Mohammed Sajid F, Shifayath Khan J, Manjunath N, Dhanush P, Gopinath K

Adhiyamaan College of Engineering,Hosur, Tamil Nadu, India.

*Corresponding Author Email : sajidshaikfurkhan@gamil.com

Abstract: *Since 2019, the COVID- 19 epidemic's emergence has had a long- continuing effect on multitudinous nations around the world. Face- mask discovery has made substantial advancements in the disciplines of deep literacy andimage processing. The suggested system developed in this paper works to help mask-less people from entering an asked position (similar as a boardwalk, university, office, laboratory, etc.) by detecting face mask using deep literacy, Tensor Flow, and Open CV and transferring a signal to an Arduino device that's connected to the gate to be open. It recognizes faces in real- time and determines whether or not they're wearing masks. The fashion has a delicacy rate of overto 98.80%. The dataset used in this study was collected from a number of sources.*

Keywords: *Coronavirus, Covid-19, Machine Learning, Face Mask Detection, CNN, Tensor Flow, Arduino.*

1. INTRODUCTION

According to the World Health Organization (WHO)'s sanctioned Situation Report – 205, coronavirus complaint 2019 (COVID- 19) has encyclopedically infected over 20 million people causing over0.7 million deaths. individualities with COVID19 have had a wide compass of symptoms reported – going from mellow instantiations to serious illness. Respiratory problems like briefness of breath or difficulty in breathing is one of them. Elder people having lung complaint can retain serious complications from COVID- 19 illness as they appear to be at advanced threat. Some common mortal coronaviruses that infect public around the world are before enervating individualities, contagions like 2019-n COV, SARS- COV, and MERS- COV infect creatures and evolve to mortal coronaviruses. Persons having respiratory problems can expose anyone (who is in close contact with them) to pestilent globules. Surroundings of an alloyed existent can beget contact transmission as driblets carrying contagion may withal arrive on his conterminous shells. Wearing a clinical mask is absolutely necessary to treat some respiratory viral diseases, including COVID-19.WHO emphasizes the importance of giving medical masks and respirators for healthcare assistants top priority. Face mask detection is now a crucial task in today's global society. Face mask detection involves locating the face and then determining whether or not it is covered by a mask. 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 Tensor Flow, Kera's, Open CV and Scikit-Learn. The rest of the paper is organized as follows: Section II explores related work associated with face mask detection. Section III discusses the nature of the used dataset. Section IV presents the details of the packages incorporated to build the proposed model. Section V gives an overview of our method. Experimental results and analysis are reported in section VI. Section VII concludes and draws the line towards future works.

2. RELATED WORK

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. 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. 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.

3. EXISTING SYSTEM

The proposed method consists of a cascade classifier and a pre-trained CNN which contains two 2D convolution layers connected to layers of dense neurons. The algorithm for face mask detection is as follows:

- Visualize image into two categories and with less accuracy.
- Resize the gray scale image 100 x 100.
- Converting image into dimensions.
- Detection process is quite slow.
- It doesn't contain any controlling devices.
- Time taken during the face detection is high.

4. PROPOSED SYSTEM

- The system can detect partially occluded faces either with a mask or hand.
- It considers 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.
- However, following several frames of the video helps to create a better decision – "with mask" or "without mask" to control gate with Arduino.

5. METHODOLOGY

1. Data Processing

Data preprocessing involves conversion of data from a given format to much more user friendly, desired and meaningful format. It can be in any form like tables, images, videos, graphs, etc. This organized information fit in with an information model or composition and captures relationship between different entities. The proposed method deals with image and video data using Num Py and Open CV.

a) ***Data Visualization:*** Data visualization is the process of transforming abstract data to meaningful representations using knowledge communication and insight discovery through encodings. It is helpful to study a particular pattern in the dataset. The total number of images in the dataset is visualized in both categories – 'with mask' and 'without mask'. The statement categories=os. listdir (data path) categorizes the list of directories in the specified data path. The variable categories now look like: ['with mask', 'without mask'] Then to find the number of labels, we need to distinguish those categories using labels= [i for i in range(len(categories))]. It sets the labels as: [0, 1] Now, each category is mapped to its respective label using label dict=dict (zip (categories, labels)) which at first returns an iterator of tuples in the form of zip object where the items in each passed iterator is paired together consequently. The mapped variable label dict looks like {'with mask': 0, 'without mask': 1}

b) ***Conversion of RGB image to Gray image:*** Modern descriptor-based image recognition systems regularly work on grayscale images, without elaborating the method used to convert from color-to-grayscale. This is because the color to-grayscale method is of little consequence when using robust descriptors. Introducing nonessential information could increase the size of training data required to achieve good performance. As grayscale rationalizes the algorithm and diminishes the computational requisites, it is utilized for extracting descriptors instead of working on color images instantaneously

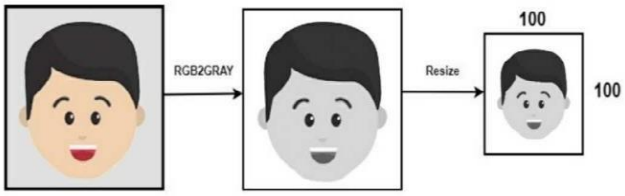


FIGURE 1.

We use the function *cv2.cvtColor(input image, flag)* for changing the color space. Here flag determines the type of conversion. In this case, the flag *cv2.COLOR BGR2GRAY* is used for gray conversion. Deep CNNs require a fixed-size input image. Therefore, we need a fixed common size for all the images in the dataset. Using *cv2.resize()* the gray scale image is resized into 100 x 100.

c) ***Image Reshaping:*** The input during relegation of an image is a three-dimensional tensor, where each channel has a prominent unique pixel. All the images must have identically tantamount size corresponding to 3D feature tensor. However, neither images are customarily coextensive nor their corresponding feature tensors. Most CNNs can only accept fine-tuned images. This engenders several problems throughout data collection and implementation of model. However, reconfiguring the input images before augmenting them into the network can help to surmount this constraint. The images are normalized to converge the pixel range between 0 and 1. Then they are converted to 4 dimensional arrays using *data=presage (data, (data. Shape [0], imp size, img size,1)*) where 1 indicates the Grayscale image. As, the final layer of the neural network has 2 outputs – with mask and without mask i.e. it has categorical representation, the data is converted to categorical labels.

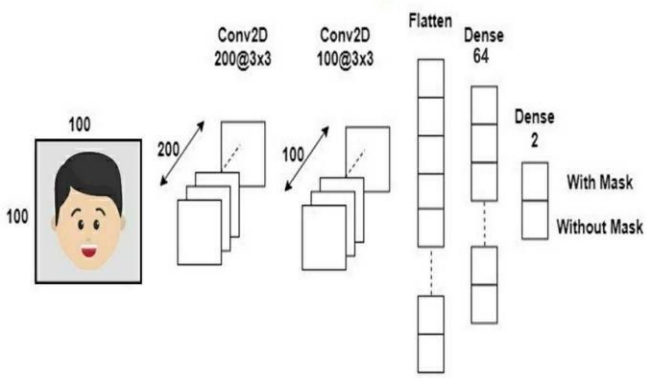


FIGURE 2.

The learning process needs to be configured first with the compile method. Here "Adam" optimizer is used. *categorical cross entropy* 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".

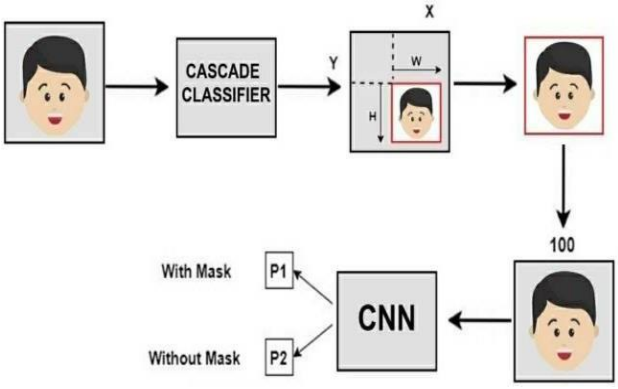


FIGURE 3.

2. Training of Model

a) Building the model using CNN architecture: CNN has become ascendant in miscellaneous computer vision tasks. The current method makes use of Sequential CNN. The First Convolution layer is followed by Rectified Linear Unit (ReLU) and Max Pooling 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 *data. Shape* 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: shape of output = (input shape - pool size + 1) / strides), where strides has default value (1,1). As shown in fig, 4, the second Convolution layer has 100 filters and Kernel size is set to 3 x 3. It is followed by REL 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 REL activation function is added. The final layer (Dense) with two outputs for two categories uses the Soft Max activation function.

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 *Model Checkpoint*. 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.

6. MATERIAL

Dataset: Two datasets have been used for experimenting the current method. Dataset 1 consists of 1376 images in which 690 imageswith people wearing face masks and the rest 686 images with people who do not wear face masks. Fig. 1 mostly contains front face pose with single face in the frame and with same type of mask having white color only. Dataset 2 from Kaggle consists of 853 images and its countenances are clarified either with a mask or without a mask. In fig. 2 some face collections are head turn, tilt and slant with multiple faces in the frame and different types of masks having different colors as well.

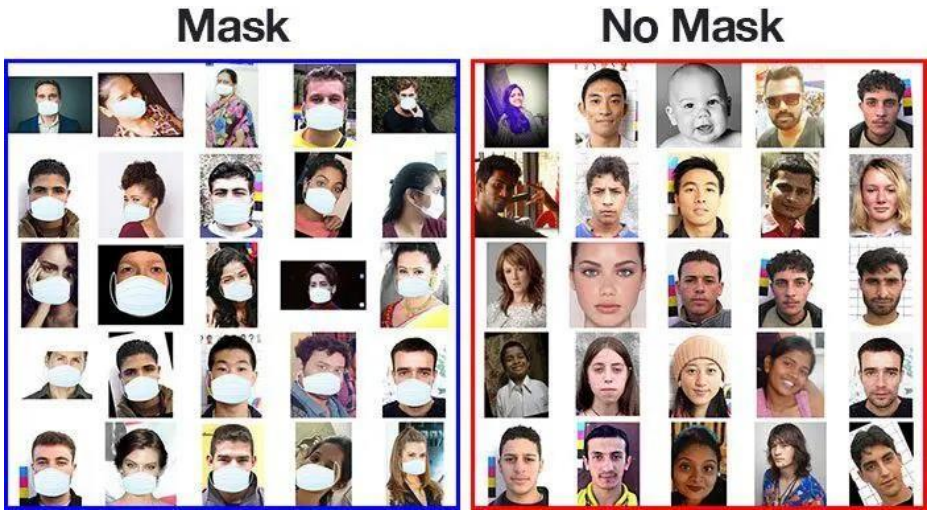


FIGURE 4.

A. Ten sorFlow

- Tensor Flow is an open source software library created by Google that is used to implement machinelearning and deep learning systems.
- These two names contain a series of powerful algorithms that share a common challenge—to allowa computer to learn how to automatically spot complex patterns and/or to make best possible decisions.
- TensorFlow, at its heart, is a library for dataflow programming. It leverages various optimization techniques to make the calculation of mathematical expressions easier and more performance.

B. CNN

- A Convolutional Neural Network, also known as CNN , is a class of neural networks that specializesin processing data that has a grid-like topology, such as an image.
- A digital image is a binary representation of visual data.
- It contains a series of pixels arranged in a grid-like fashion that contains pixel values to denotehow bright and what color each pixel should be.

C. OpenCV

- Open Source Computer Vision Library (OpenCV) is an open source computer vision and machine learning software library.
- It is utilized to differentiate and recognize faces, recognize objects, group movements in recordings, trace progressive modules, follow eye gesture, track camera actions, expel red eyes from pictures taken.
- OpenCV adds intelligence to Deep Learning models for visualization image processing.

D. Arduino

- Arduino is an open-source platform used for building electronics projects.
- Arduino UNO is a microcontroller board based on the ATmega328P.
- It has 14 digital input/output pins
- The Arduino UNO has 32K bytes of Flash memory & 2K bytes of SRAM.

7. RESULT

The model is trained, validated and tested upon two datasets. Corresponding to dataset 1, the method attains accuracy up to 95.77%. 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 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.

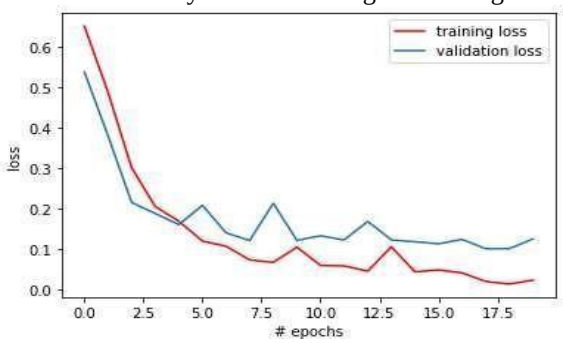


FIGURE 5. # epochs vs loss corresponding to dataset 1

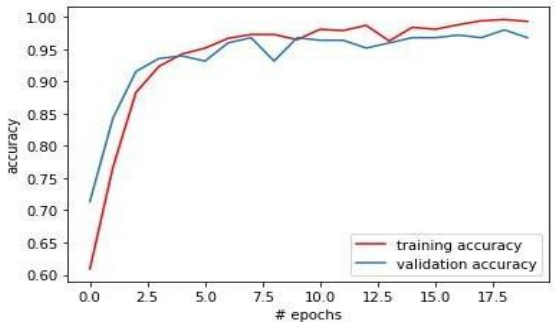


FIGURE 6.

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.

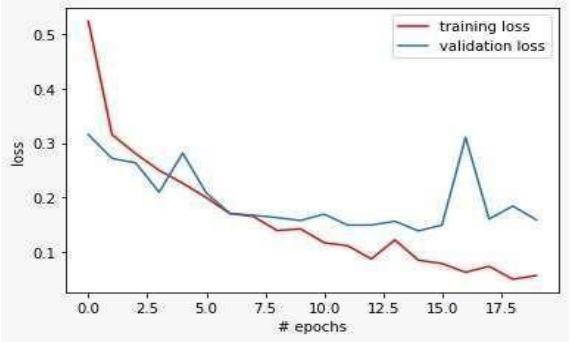


FIGURE 7.

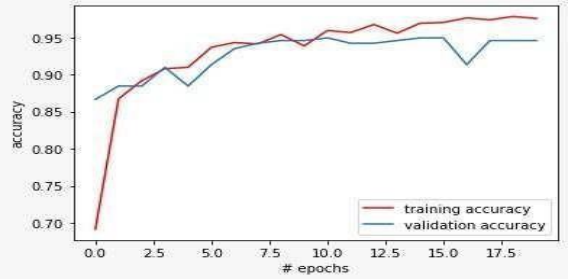


FIGURE 8. # epochs vs accuracy corresponding to dataset 2

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".

8. 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.

REFERENCES

[1]. Das, M. Wasif Ansari and R. Basak, "Covid-19 Face Mask Detection Using TensorFlow, Keras and OpenCV," *2020 IEEE 17th India Council International Conference (INDICON)*, New Delhi, India, 2020, pp. 1-5, doi: 10.1109/INDICON49873.2020.9342585

[2]. W.H.O., "Coronavirus disease 2019 (covid-19): situation report, 205". 2020

[3]. "Coronavirus Disease 2019 (COVID-19) – Symptoms", Centers for Disease Control and Prevention, 2020. [Online]. Available: https://www.cdc.gov/coronavirus/2019-ncov/symptomstesting/symptoms.html. 2020.

[4]. "Coronavirus — Human Coronavirus Types — CDC", Cdc.gov, 2020. [Online]. Available: https://www.cdc.gov/coronavirus/types.html. 2020.

[5]. W.H.O., "Advice on the use of masks in the context of COVID-19: interim guidance", 2020.

[6]. M. Jiang, X. Fan and H. Yan, "Retina Mask: A Face Mask detector", arXiv.org, 2020. [Online]. Available: https://arxiv.org/abs/2005.03950. 2020.

[7]. B. Suvarnamukhi and M. Seshashayee, "Big Data Concepts and Techniques in Data Processing", International Journal of Computer Sciences and Engineering, vol. 6, no. 10, pp. 712-714, 2018. Available: 10.26438/ices/v6i10.712714.

[8]. F. Hohman, M. Kahng, R. Pienta and D. H. Chau, "Visual Analytics in Deep Learning: An Interrogative Survey for the Next Frontiers," in IEEE Transactions on Visualization and Computer Graphics, vol. 25, no. 8, pp. 2674-2693, 1 Aug. 2019, doe: 10.1109/TVCG.2018.2843369.

[9]. C. Kanan and G. Cottrell, "Color-to-Grayscale: Does the Method Matter in Image Recognition?", PLoS ONE, vol. 7, no. 1, p. e29740, 2012. Available: 10.1371/journal.pone.0029740.

[10]. Opencv-python-tutroals.readthedocs.io. 2020. Changing Color spaces — OpenCV-Python Tutorials 1 Documentation. [online] Available at: https://opencv-python-tutroals.readthedocs.io/en/latest/py tutorials/ py import/py color spaces/py colorspaces.html. 2020.

[11]. M. Hashemi, "Enlarging smaller images before inputting into convolutional neural network: zero-padding vs. interpolation", Journal of Big Data, vol. 6, no. 1, 2019. Available: 10.1186/s40537-019-0263-7 . 2020.

[12]. S. Ghosh, N. Das and M. Nasipuri, "Reshaping inputs for convolutional neural network: Some common and uncommon methods", Pattern Recognition, vol. 93, pp. 79-94, 2019. Available: 10.1016/j.patcog.2019.04.009.

[13]. R. Yamashita, M. Nishio, R. Do and K. Togashi, "Convolutional neural networks: an overview and application in radiology", Insights into Imaging, vol. 9, no. 4, pp. 611-629, 2018. Available: 10.1007/s13244018-0639-9.

[14]. "Guide to the Sequential model - Keras Documentation", Faroit.com, 2020. [Online]. Available: https://faroit.com/keras-docs/1.0.1/gettingstarted/sequential-model-guide/. 2020.

[15]. Nwankpa, C., Ijomah, W., Gachagan, A. and Marshall, S., 2020. Activation Functions: Comparison Of Trends In Practice And Research For Deep Learning. [online] arXiv.org. Available at: https://arxiv.org/abs/1811.03378. 2020.

[16]. K. Team, "Keras documentation: MaxPooling2D layer", Keras.io, 2020. [Online]. Available: https://keras.io/api/layers/pooling layers/ max pooling2d/. 2020.

[17]. "prajnasb/observations", GitHub, 2020. [Online]. Available: https://github.com/prajnasb/observations/tree/master/experiements/data. 2020.

[18]. "Face Mask Detection", Kaggle.com, 2020. [Online]. Available: https://www.kaggle.com/andrewmvd/face-mask-detection. 2020.

[19]. "TensorFlow White Papers", TensorFlow, 2020. [Online]. Available: https://www.tensorflow.org/about/bib. 2020.

[20]. K. Team, "Keras documentation: About Keras", Keras.io, 2020. [Online]. Available: https://keras.io/about. 2020.

[21]. "OpenCV", Opencv.org, 2020. [Online]. Available: https://opencv.org/. 2020.

[22]. D. Meena and R. Sharan, "An approach to face detection and recognition," 2016 International Conference on Recent Advances and Innovations inEngineering (ICRAIE), Jaipur, 2016, pp. 1-6, doi: 10.1109/ICRAIE.2016.7939462.

[23]. S. Ge, J. Li, Q. Ye and Z. Luo, "Detecting Masked Faces in the Wild with LLE-CNNs," 2017 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Honolulu, HI, 2017, pp. 426-434, doi:
[1]. 10.1109/CVPR.2017.53.