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Automatic Face Mask Detection system In Public Place

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Abstract - *COVID-19 pandemic spreading continuously everywhere in the world. COVID-19 affects all the sector .Many precautions are taking place to reduce spreading of this disease that is social distancing, proper sanitization, wearing mask etc. This project present automatic face mask detection system in public place to help government and public to reduce COVID-19 cases. In this project we find whether people wearing mask or not as well as we find temperature of the person. If people without mask occur then immediately give alert signal and stop entry of that person in that place. After entering the building/place we contiously monitoring person through camera If that person identify without wearing mask then we send email to that person through database. In this project we use Python to build face mask detector also we use Arduino IDE to control the Appliances. We use Temperature sensor, Servo Motor, Buzzer etc.*

***Key Words*: COVID-19, face mask detector, Arduino, python, Temperature Sensor , Servo Motor, Buzzer, Speaker**.

1.INTRODUCTION

Novel coronavirus is a new strain that has never been seen in humans before (nCoV). Coronaviruses (CoV) are a family of viruses that cause illnesses ranging from colds to life-threatening diseases such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS) [9]. As a result of the pandemic, people all around the world are experiencing difficult situations. A high number of people are infected and die every day. COVID-19 is spread mostly through droplets that are produced when an infected person coughs, sneezes, or exhales. These droplets are too heavy to float in the air and fall to the ground or other surfaces. If you are in close proximity to someone who has COVID-19, you can be infected by breathing in the virus, or by touching a contaminated surface and then contacting your eyes, nose, or mouth. The WHO gave few guidelines to prevent the spread of novel corona virus. Many protection and safety measures were implemented by governments to reduce disease spread, including mandatory indoor mask wear, social distancing, quarantine, self-isolation, limiting citizens movement within country borders and abroad, and prohibiting or cancelling large public events and gatherings [12].

Despite the fact that the pandemic appeared to be weakening at times, due to the uncertain circumstances, most safety restrictions are still in place. Coronavirus sickness causes various changes in our daily routines, habits, and activities, ranging from professional conduct to social interactions, sport, and activities. To avoid getting infected or spreading it, It is essential to wear a face mask while going out from home especially to public places such as markets or hospitals. This prompted everyone in the society to put on a face mask in order to protect themselves from the spread of the corona virus. To avoid the above situation, we need to do what we can to turn this into a slow pandemic. A pandemic can be slowed down only by the right responses, mainly in the early phase. In this phase, everyone who is sick can get treatment and there is no emergency point with flooded hospitals. The device was created to ensure that everyone in society wear a face mask.

Face recognition has gotten a lot of attention in recent years as one of the most promising applications in the field of image analysis. Facial detection can make up a significant portion of face recognition procedures. Its strength is to concentrate computational resources on the part of a picture that contains a face. There are several approaches for detecting faces, and we can recognise faces with greater accuracy using these strategies. These techniques, such as OpenCV, Neural Networks, MATLAB, python and others, have a same approach for Face Detection.

Arduino is an open-source platform that may be used to create electronic creations. Arduino is made up of a hardware programmable circuit board (also known as a microcontroller) and software (called an IDE) that runs on your computer and is used to create and upload computer code to the physical board. [13].

The device is designed to detect faces and assess whether or not the person is wearing a face mask, allowing us to determine whether or not the individual can enter public spaces such as a building or a hospital etc. The hospital, Offices, market, bus terminals, restaurants, and other public gatherings where monitoring is required can all benefit from this project. We also monitor then person activities inside the particular place whenever person remove there mask then we give them the alert signal.

2. PROPOSED METHOD

In fig.1 we show component we are used in face mask detection. In that we used Temperature sensor to detect the Temperature at the entrance of building if temperature is low then buzzer remain off otherwise in on, when camera capture

the person image and process the image if person with mask occur then it open the door otherwise it closed the door. Inside the building processor monitor the person every time when without mask person occur it will identify the person in database then turn on the Buzzer, on the speaker and send the Email to that person.

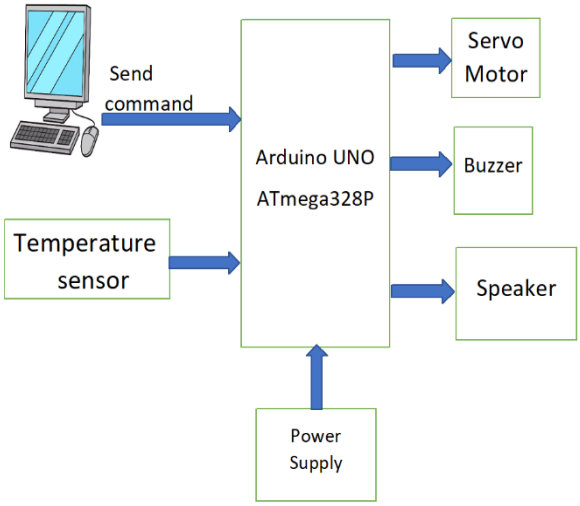

Fig.1 Block diagram of automatic face mask detection system

2.1 Methodology

In this paper we perform following method:-

1. Face Detection
2. Face mask detection

Face Detection:-

In this section, we will discuss about the algorithm, which is used to detect the human faces.

To perform this function, first perform face detection to locate the face in the image. The OpenCV method is a common method for face recognition. First extracts the images features into a large sample set by extracting the face Haar features in the image and then it used the AdaBoost algorithm as the face detector. In face recognition, the algorithm can effectively adapt to complex environments such as poor lighting and background blur, which greatly improves the accuracy of recognition.

A. Haar Feature Cascade classifier

This is an object detection algorithm used to identify faces in images or real-time videos. The algorithm uses edge or line detection features. The algorithm is provided with a large number of positive images with faces and negative images without faces to train on. These image features help identify edges and lines in an image, as well as areas with sudden changes in pixel intensity.

These can be broadly divided into three categories based on the feature each one is seeking. The first pair of rectangular features is in charge of determining whether an edge is horizontal or vertical. Determine whether a lighter zone is bordered by darker sections on each side, or vice versa, using the second set of three rectangular attributes. The determination of changes in pixel intensities across diagonals is the responsibility of the third group of four rectangle features. The darker areas in the haar feature are pixels with values 1, and the lighter areas are pixels with values 0. Each of these is responsible for finding out one particular feature in the image. Such as an edge, a line or any structure in the image where there is a sudden change of intensities

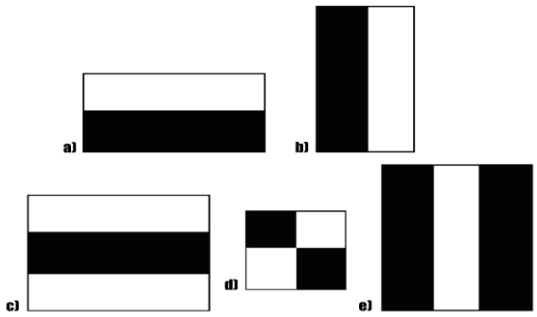

Fig.2 sample of Haar features

The objective here is to find out the sum of all the image pixels lying in the darker area of the haar feature *and* the sum of all the image pixels lying in the lighter area of the haar feature. by using haar feature we convert original image into integral image.

B. AdaBoost algorithm

AdaBoost, also known as Adaptive Boosting, is a machine learning method used in an ensemble setting.In basically, that there are a number of features that would capture specific face structures, such as the lips, the bridge connecting the two eyes, or the eyebrows. However, this was not the feature set's sole focus at first. About 180,000 of these made up the feature set, which was then reduced to 6000.In this situation, they need a feature selection technique to pick a small subset of characteristics from a large set that would not only pick features that performed better than the others but would also remove the irrelevant ones. They created weak learners by applying each of these 180,000 characteristics to the images separately using a technique called AdaBoost Some of them, however, produced low error rates because they distinguished between Positive and Negative images more effectively than the others.These weak learners are created so that they would incorrectly classify a minimum number of images. They are capable of doing better than a random guess. Their final collection of features was reduced using this method to a total of 6000 features

a. **Input:** Give sample set

$$s = (x_i - y_i) \ldots\ldots (x_n = y_n)$$

$x_i \in X, \quad y_i \in Y = \{-1, +1\}$ Number of iterations T

b. **Initialize:** $W_{i,j} = \frac{1}{N}, i = 1, 2, \ldots\ldots N$

c. **For** t = 1, 2 , ... T

i) Train weak classifier using distribution W

ii) Calculate the weight (w) training error for each hypothesis

$$h_n \in_n = \sum_{i=1}^{N} W_{i,j} \, | h_i - y_i |$$

iii) Set

$$a_t = \frac{1}{2} \log \left(\frac{1 - \in_t}{\in_t} \right)$$

iv) Update the weights

$$W_{t=1,\, i} = 1 + \frac{W_{i,t}}{Z_t} \cdot \begin{cases} e^{-at} \\ e^{at} \end{cases}$$

$$= \frac{W_{t,i} \exp\left(-a_t y_i h_t (x_i)\right)}{Z_t}$$

Z_t is normalization constant

d. **Output:** the final hypothesis, also the stronger classifier.

$$H(x) = sign \left(\sum_{t=1}^{T} a_t h_t (x) \right)$$

Fig.3 Mathematical representation of AdaBoost Algorithm

Face Mask Detection:-

To develop Face mask detection system we use OpenCV, TenserFlow and Keras.

A.OpenCV:-

OpenCV is a large open source library for image processing, machine learning, and computer vision. It now plays a vital role in real-time operations, which is crucial in modern systems. It can be used to analyze images and videos to find faces, objects, and even human handwriting. When Python is integrated with various libraries such as NumPy, it can process OpenCV array structures for analysis.We use vector spaces and apply mathematical operations on these features to identify visual patterns and their various characteristics.

B.Keras

Keras is an open source software library that provides a Python interface for artificial neural networks. A TensorFlow library interface is provided by Keras. Keras is an open source, Python-based, high-level neural network framework that can run on top of Theano, TensorFlow, or CNTK. It is user-friendly, extensible, and modular to enable more rapid experimentation with deep neural networks. It supports both convolutional and recurrent networks, either individually or in combination.

C.TenserFlow

An open source library called TensorFlow has a large number of pre designed models that are helpful for deep learning and machine learning in general. Tenser, which is considered of as an array of N-dimensional elements, and flow, which is considered of as a graph of operations, make up the word TenserFlow. Data flow graphs are used in TensorFlow, an open-source software library for numerical computing. TensorFlow is made for distributed training and inference on a big scale. The graph's nodes stand in for mathematical processes, while its edges stand in for the multidimensional data arrays (tensors) that are transmitted between them. The Google Brain team, a division of Google's machine intelligence research department, developed and maintains TensorFlow for machine learning (ML) and deep learning (DL). The distributed master and worker services with kernel implementations are part of the TensorFlow distributed architecture. There are 200 standard operations in all, including C++-written operations for manipulating arrays, controlling flow, and managing state. Systems for research, development, and production can all use TensorFlow. It can function on systems with a single CPU, GPUs, mobile devices, and massively distributed systems with a huge number of nodes. Python and C++ programming interfaces for TensorFlow are available, while Java, GO, R, and Haskell are also being developed. In the cloud environments of Google and Amazon, TensorFlow is also supported.

3. RESULT &DISCUSSION

Below Fig.4 & 5 show the scenario entrance of the building when camera capture the image, this capture image is process then find whether person wearing mask or not. If person wear the mask and then immediately open the door i.e turn on the motor. If person not wearing a mask then buzzer is On, door will not open and through speaker inform to wear the mask. If Temperature is high then buzzer is On.

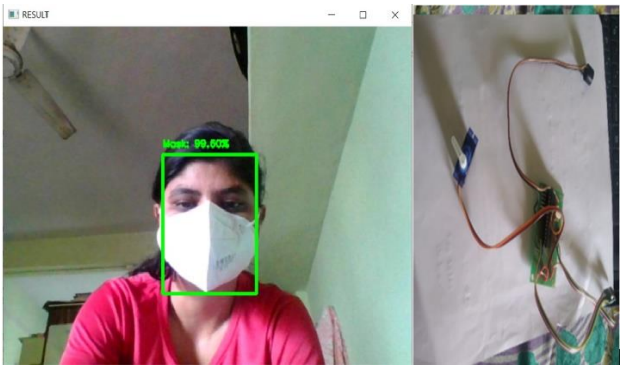

Fig.4 Person with mask at entrance

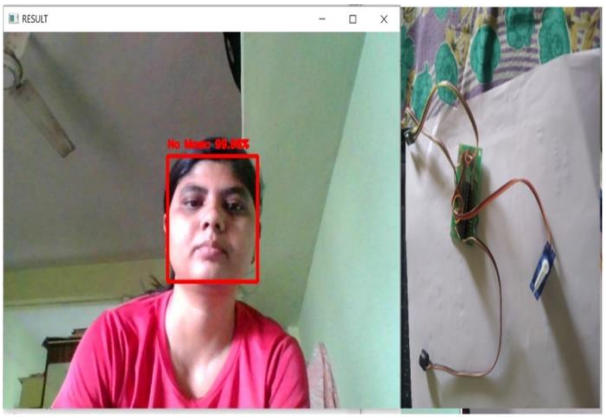

Fig.5 Person without mask at the entrance

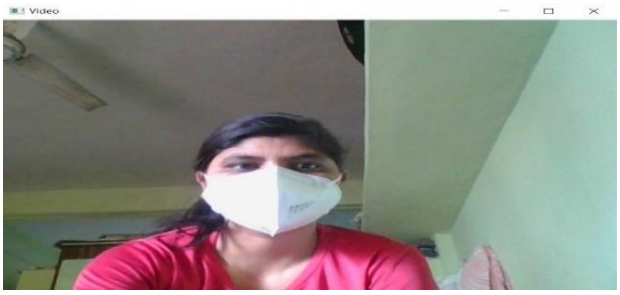

Fig.6 Person with mask inside the building

Above Fig.6 show the how the face mask detector work inside the building. Camera continuously monitor activities of person and face mask detector continuously find the mask. Person wear the mask then camera will not showed any response.

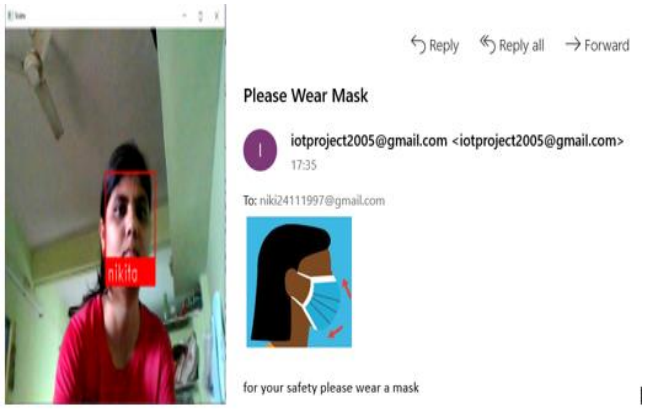

Fig.7 person without mask inside the building & Email

Above fig.7 shown if person without mask occur then then processor find that person in database if person shown in database then shown name of that person in check box, speaker will tell that person to wear the mask with name ,send the email to respective person &buzzer will on. If that person not shown in database then only speaker will tell that person to wear mask without name & buzzer will on .Otherwise buzzer will remain Off. If more than one person occur in camera then speaker will announce to wear mask but without name.

In Fig.8 shows curve of accuracy & loss of training and testing/validation phase for about 20 epoch. In that graph it shows the accuracy of training and accuracy of validation difference is low. Both training and validation accuracy value is above 90%. In terms of loss training loss is lower than validation loss.

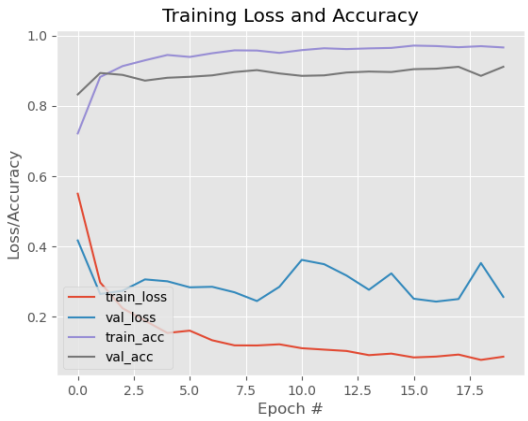

Fig. 8 Graphical representation of Accuracy & loss in training and testing phase

Below Table 1 Show the accurate detection of person with and without mask. In this table we individually calculate detection of person with mask and without mask.

Table 1 success percentage of detecting person

Sr. No.	Person name	Person detection out of 10				Average success Percentage
		Detect		Not detect		
		With mask	With out mask	With mask	Without mask	
1	Person 1	10	9	0	1	95%
2	Person 2	9	9	1	1	90%
3	Person 3	7	7	3	3	70%
4	Person 4	7	8	3	2	75%
5	Person 5	9	7	1	3	80%
6	Person 6	8	6	2	4	70%
7	Person 7	6	8	4	2	70%
8	Person 8	8	7	2	3	75%
9	Person 9	7	7	3	3	70%
10	Person 10	8	7	2	3	75%

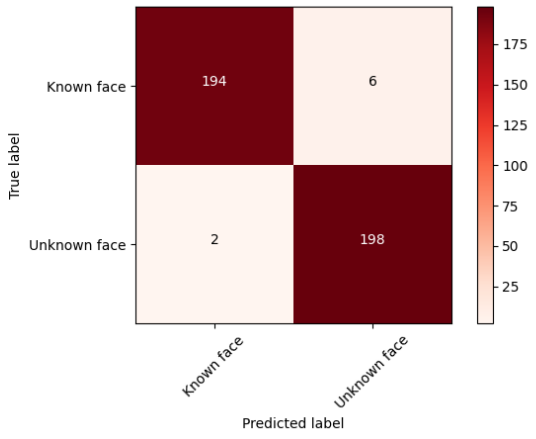

Fig. 9 graph of confusion matrix develop system

Table 2 shows different type of performance parameter of system.

Table 2 Performance parameter of system

Parameters name	Performance Parameters (%)
Accuracy	98
Sensitivity	98.98
Specificity	97.06
Precision	97
Negative Predictive Value	99
F1 Score	97.98
Matthews Correlation Coefficient	96.02
False Positive Rate	2.94
False Discovery Rate	3
False Negative Rate	1.02

In Table 3 shows comparison between proposed model with different face mask detection model. We check performance of system using precision and recall. Below Table II shows F1 score of 4 different model. The higher the F1 score better the performance of system. In Table II shows that out of this different model our proposed model give higher F1 score i.e 97.98 means performance of this proposed model is better than other model.

Table 3 Comparison between proposed model with different model

SR. NO.	Model	Precision (%)	Recall (%)	F1 Score (%)
1	Biparnak Roy et al[12]	83	95.6	88.85
2	Kaur et al [13]	88	90	89
3	Muhammad Zubair Asghar et al [14]	95	93	94
4	Proposed model	97	98.97	97.98

3. LIMITATION & CONCLUSIONS

In this system, the camera has a direct impact on video quality .Excellent cameras should be utilised to capture images from real-time video streaming that are higher quality and noise free. The model of the servo motor might vary depending on the size, angular position, and weight of the camera. It is evident from the analysis's findings that lighting conditions have an impact on a system's performance. This technique should therefore satisfy the criterion for daylight rather than for darkness.

This paper present automatic face mask detection system in public place. This system is design to reduce the spread of COVID-19 pandemic, measures must be taken. We use Arduino IDE & python software to simulate the code. This paper will help to limit spreading of COVID-19 virus in offices, mall, hospital etc. It will monitor the people wear mask or not the building.

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