# IMPLEMENTATION OF VISITOR ANALYSIS FOR COVID-19 (ViAC) USING MACHINE LEARNING AND IOT

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**Abstract -** The corona-virus COVID-19 pandemic is a global health crisis. Covid-19 virus is transferred between two people through the airborne transmission. One of the effective protection methods is wearing a face mask in public areas, which has been imposed as a compulsory measure to prevent the transmission all over the world. Also, temperature and oxygen level monitoring are the additional ways of monitoring of visitors. Manual monitoring of the face mask, temperature and oxygen level in congested and thronged places is a tedious task. The corona-virus epidemic has given rise to an extraordinary degree of worldwide scientific cooperation. Machine learning and Deep Learning can help to tackle Covid-19 pandemic in many ways. . Existing face detection system needs more enhancement and modifications to solve real world problems. In this paper we have implemented face-mask detection using the CNN algorithm and MobilenetV2 architecture, and we have also implemented face-recognition over the mask in our system. We are going to use Open-CV to do real-time face detection from a live stream via a camera, and then we are going to pass these frames(images) to our mask detector classifier to find out if the person is wearing a mask or not. After performing mask detection, the system will perform face-recognition over the mask to identify the visitor. Then we have used MLX90614 infrared temperature sensor for temperature check and MAX30100 Pulse oximeter for oxygen level check. ViAC will be highly beneficial for contact-less monitoring purpose and thus reducing the risk of guards to get infected and eliminating the tedious task of monitoring visitors. We have achieved 98% accuracy in face-mask detection.

**General Terms**

Face-mask detection, ViAC, corona-virus

**Keywords**

Machine Learning, Neural Network, Deep Learning, Convolutional Neural Network, Computer vision

## 1. INTRODUCTION

The prevention and control of the COVID-19 epidemic is a major challenge for all countries. How to predict the risk grade of the epidemic is an urgent problem for the prevention and control departments of all countries. At least 316 million people in 42 states have been asked to stay at home to slow down the pandemic. In this aspect, businesses have been susceptible to make substantial transformations. The top priority of all organizations and institutions is to maintain best of health, safety, and well-being of the community, on and off campus.

The global COVID-19 pandemic is easily spread by people in close proximity, especially in crowds with mobile individuals (e.g., city centers). A widely accepted strategy to mitigate its spread is social distancing, avoiding crowded areas. There is an urgent need for different mitigation strategies to slow the spread of this disease. Many efforts have been made recently to analyze the time-course of the Covid-19 pandemic daily data in various countries or region and to predict key aspects of its eventual growth in order to assist the proper planning for healthcare resources and related socioeconomic decision-making

The corona virus outbreak is ruthlessly disrupting the global economy. Almost all the nations are struggling to slow down the transmission of the disease by testing & treating patients. The Unlock 5 guidelines of the Home Ministry allowing all but a few activities that attract large crowds, with supportive measures by States, reflect deep economic distress. Along with India other nations have also lifted the lockdown in response to maintain and balance the falling economy due to lockdown. With this unlock, majority of the institutions and organizations have reopened. Right from schools, companies, Malls to Railway Stations and Airports every sector has reopened with a monitored operating capacity(humans).

With this unlock, every organization has allocated couple of employees/guards to monitor mask, temperature and oxygen level of every visitor/employee. During this process, the guard is susceptible to get infected by a potential COVID-19 visitor and also checking every visitor is a hectic task for the guards. Rather than checking the visitors manually, we will automate this task by using machine learning and IOT and try to solve a real-world problem by safeguarding the health of employees and improving the efficiency.

Fig 1: Manual visitor monitoring

The main objective of ViAC (Visitor Analysis for Covid-19) is to automate the monitoring process of visitors and safeguarding the health of the guards by performing visitor identification, mask detection, temperature and oxygen level check. This proposed system can also be used for an unpredicted disease with symptoms similar to Covid-19 (Ebola, H1N1). The proposed system can be achieved by using Convolutional Neural Network (for Mask detection and Face-recognition) and Internet of Things (for temperature and oxygen level check).


Fig 2: Automated visitor monitoring (ViAC)

## 2. RELATED WORK

In a [1] study of face detection is done. As there are different ways to perform mask detection, we can use any model according to our need. Though there are many ways to perform face detection, Viola-Jones algorithm is quite powerful, and its application has proven to be efficient in real-time face detection. This algorithm is slow to train but can detect faces in real-time with impressive speed. Given an image frame form video (this algorithm works on grayscale image), the algorithm looks at many smaller sub regions and tries to find a face by looking for specific features in each sub region. It needs to check many different positions and scales because an image can contain many faces of various sizes. Viola and Jones used Haar-like features to detect faces in this algorithm.

In a [2], an effort was made to reduce the LOC and CLS error and enhance the performance of the face detection system. The paper proposes a state-of-the-art single shot face detector by enhancing the regression and classification abilities. The system consists of five modules: Selective Two-step Regression (STR), Selective Two-step Classification (STC), Scale-aware Margin Loss (SML), and Feature Supervision.

Module (FSM) and Receptive Field Enhancement (RFE). To enhance the regression ability for high location accuracy, STR coarsely adjusts locations and sizes of anchors from high level detection layers to provide better initialization for subsequent regressor.

In a [3], an effort is made to develop a novel face detection network with three novel contributions that address three key aspects of face detection, including better feature learning, progressive loss design and anchor assign based data augmentation, respectively. The novel network has been developed by integrating Feature Enhance Module (FEM), Progressive Anchor Loss (PAL) and Improved Anchor Matching (IAM).

In a[6] this paper proposes a method called PCA which focuses on storage of only feature space and reducing size of storage using Local Binary Pattern (LBP) Is an easy, but very strong user of texture who marks the image's pixels with each pixel's proximity, and views the outcome as binary numbers. It was first defined in 1994 (LBP) and is a powerful component for the classification of texture since then. In addition, LBP has been calculated to increase significantly the detection efficiency on certain datasets when coupled with histograms of oriented gradients (HOG) descriptor. By using LBP combined with histogram, face pictures with a simple data vector can be described.

In a[9] review of Human face detection and study of Neural Networks and Haar Feature-based Cascade Classifier in Face Detection is done. The problem of complex environments are including gray-scale images with low quality or cluttered background, which were too complicated with high execution time and they cannot be applicable for real-time processing. Hence an approach has been presented which signifies extensive review of face detection techniques as well as the combination of two famous haar-like features and Neural Network in a complete system which can decrease the disadvantages of a classifier

## 3. IMPLEMENTATION DETAILS

**1.Face-mask Detection**: In this, we will take live video input and the face locations of visitor will be generated by using face detection model. Then these face locations will be passed on to the face-mask detection model and the model will predict, that if the person in the live video frame is wearing a face-mask or not.

**2.Temperature & Oxygen level detection:** After the face-mask detection, the temperature and the oxygen level of the visitor will be detected automatically using the MLX96014 and MAX30100 sensors.

**3.Visitor Identification**: Along with face-mask detection, our system provides face recognition over the mask (only for employees), and if the face isn't recognized then our system automatically classifies the person as visitor. We have built an android application which inputs the name and number of the visitor and generates a corresponding QR code. Then this QR code is scanned by our system, and thus the visitor details are authenticated and saved in the database.

**4.Assessing all constraints**: Here, all the detected constraints are checked, that if those constraints are in the safe levels eg : Temperature between 95-99, Oxygen between 96-100,etc. If all the constraints are satisfactory then the visitor/employee is given access else he/she is not given access and those constraints are saved in the database

.

**5.Displaying access details on GUI**: Lastly, all the details (Name, Mask status, temperature, oxygen level, category, access) of the visitor/employee is displayed on the GUI for the confirmation purpose.

**Algorithm Details:**

**Face-Mask Detection Model:**

The main aim of our system is to predict if the person is wearing a face-mask or not. For this purpose, we will need to train a model so that it can help our system to detect face-mask.

**Step 1** : The first step of model training includes data preparation and preprocessing . In this we perform the following tasks:

**1.** Declaring data structures for storing images and loading the paths of the dataset (masked and unmasked).
**2.** Re-sizing the images to 224 x 224 for better efficiency, as the machine learning models train faster on smaller images**.**
**3.** Converting the images to PIL(Python Imaging library) format so that we can perform multiple operations on the images siuch as color conversion, feature extraction etc.
**4.** Then this PIL format images are converted to array using keras img_to_array, and then passed on to the preprocess input to make the images compatible for Open CV.
**5.** Using LabelBinarizer () these training images are given a specific categorical value i.e., 1 or 0 depending upon the data-set they are from i.e., masked or unmasked.
**6.** After labeling the images with their respective categorical value, the training and testing dataset are split. 80% of the total data-set is used for training the model and the remaining 20% is used for testing the model.
**7.** The last step of preprocessing data is Data Augmentation using ImageDataGenerator () from tensor flow. keras. preprocessing. Image. It is a technique to artificially create new data from the existing data. Data augmentation is performed to create transformed versions of data such as flips, zooms, side angles, rotation, etc so that the model can get trained for more test cases and better accuracy.

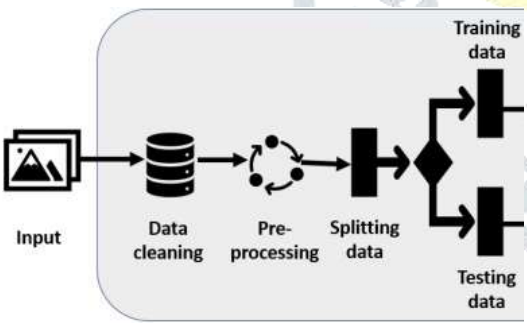


Fig 3 : Data preprocessing and preparation

**Step 2** : The second step of model training includes architecture initialization and actual model training . In this we perform the following tasks:

1.Firstly, we declare and initialize MobileNetV2 architecture as our base model. It is based on CNN architecture and is used mainly for feature extraction, object detection and image classification.
2.Then we initialize our head model with constraints such as pooling, Flatten, Dense with relu activation for image tuning and model training purpose.
3.Thirdly we declare the main model with base model as the input and head model as the output, and then compile this model with binary cross entropy loss.
This is the last and the main step of model training. Here start our model training with model.fit() and only the training

data set is used for training. We are using 20 epochs with batch size of 32. The learning rate is of 1e-4.

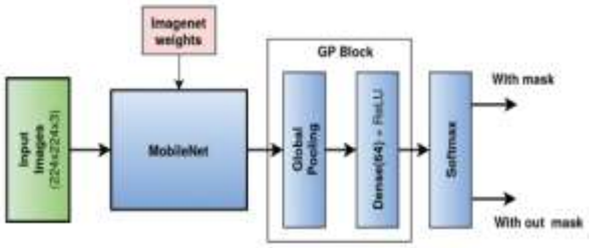


Fig 4: Model Training

**Step 3:** The last step of model training includes model testing and saving the model. In this we perform the following tasks:

1.After the model training, the testing data set is used with the trained model for the validation purpose and to check how accurate our trained model is. If the results are satisfactory and accurate the model is saved on the disk.

**ViAC Algorithm:**

1.By using Flask API in python, open the Web browser with relative HTML files and UI for user to interact. All the models that are needed will be loaded on to the disk when our host application starts.

**2.**Start the system by clicking on the start button in the GUI. The web cam will start and live video frame will be sent as the input to our system.
**3**.On this video frame, face locations of visitor will be generated by using face detection model that we have imported directly. Then these face locations will be passed on to the face-mask detection model that we have developed and the model will predict, that if the person in the live video frame is wearing a face-mask or not.
**4**.After face-mask detection our system will perform face-recognition over the face-mask using python face-recognition library.
**5.**Then the temperature and oxygen level of the visitor will be checked manually or automatically depending upon the resources. If the sensor is not available the levels can be manually entered in the system through HTML form.
**6**.If our system doesn't recognize the person in the live video frame then it will ask the visitor to download a very small android application and enter his details (name, phone number, etc) into it. The android app will generate a QR code based on the entered details and this QR code will be scanned by our system and hence all the visitor details are validated and saved in our database.
**7.** Lastly all the constraints such as temperature and oxygen are checked that whether they are in the safe levels (temperature between 96° and 99° C, oxygen level above 96, Mask status) and hence our system will decide that whether to give the visitor access or not.

**8.**All the details will be displayed on the GUI for the confirmation purpose.

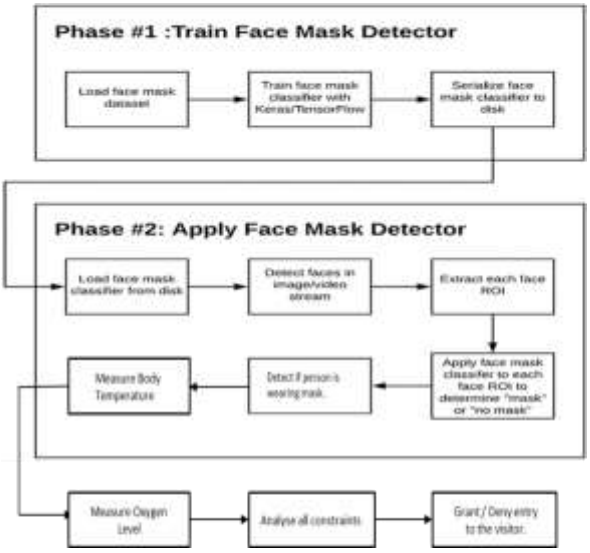


Fig 5 : System Architecture

**Mathematical model:**

System Description:

• Input: Image showing masked/unmasked faces

• Output: Detect face showing ‘Mask’ or ‘No Mask’ message.

• Functions: Extract (), Detect (), Classify (), Display ().

• Mathematical Formulation:

• S = (I, F, O)

• where, Input = (I1, I2, I3,,In)

• Function = (F1, F2, F3,,Fn)

• Output = (O1, O2, O3,…,,On)

• Success Conditions: Masked and unmasked faces are successfully detected and expected output is displayed on screen.

• Failure Conditions:

1. Camera is not capturing input frame.

2. Face is not available for detection purpose.

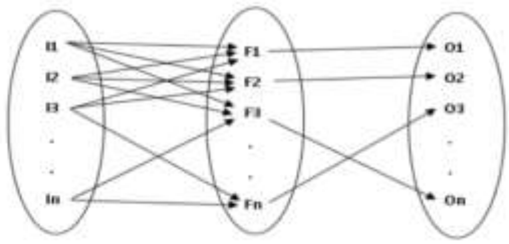


Fig 6 : Mathematical Model.

## 4. RESULT

The trained model is able to classify the face into two types (with mask, without mask) . Trained model has an accuracy of 99.14% and model is able to identify faces with and without masks. Graphical representation is shown in the below diagram

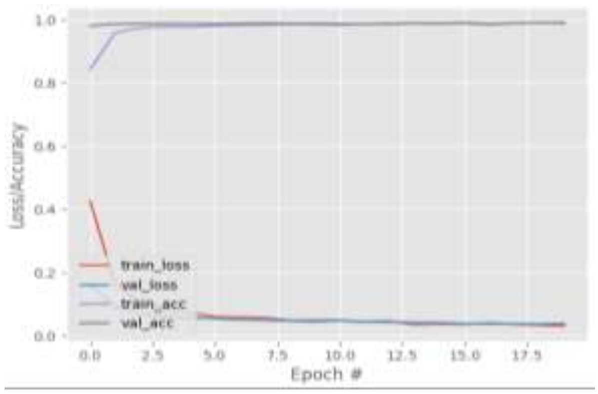


Fig 7 : Training Loss and Accuracy Graph Plot

[INFO] evaluating network...

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| with_mask | 0.99 | 0.99 | 0.99 | 433 |
| without_mask | 0.99 | 0.98 | 0.99 | 386 |
| accuracy | | | 0.99 | 819 |
| macro avg | 0.99 | 0.99 | 0.99 | 819 |
| weighted avg | 0.99 | 0.99 | 0.99 | 819 |

[INFO] saving mask detector model...

Fig 8 : Accuracy Statistics summary

### 1.1 TEST CASES & TEST RESULTS:

**Case 1:**

Visitor: Known (Face-Recognition)

Mask: Wore

Temperature and Oxygen level: Within safe limits

**Input:**


Fig 9: Case1 input

**Output:**

| TYPE | NAME | MASK | TEMPERATURE | SPO2 | TIME | ACCESS |
|---|---|---|---|---|---|---|
| Employee | Nehul | Yes | 97.0 | 98.0 | 17:15:45 | Access Granted |

Fig 10: Case1 output

**Case 2:**

Visitor: Known (Face-Recognition)

Mask: Not Wore

Temperature and Oxygen level: Within safe limits

**Input:**

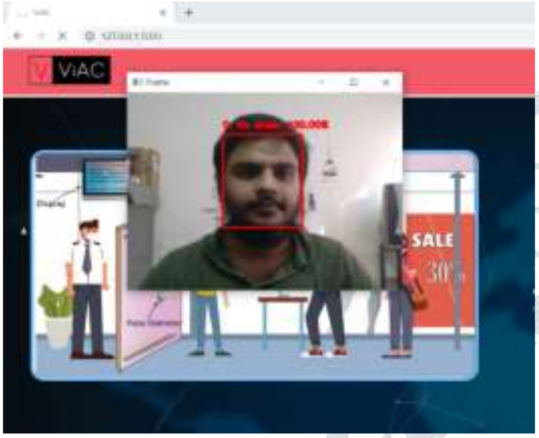

Fig 11: Case2 input

**Output:**

| TYPE | NAME | MASK | TEMPERATURE | SPO2 | TIME | ACCESS |
|---|---|---|---|---|---|---|
| Employee | Nehul | No | 98.7 | 97.5 | [illegible] | Access Denied |

Fig 12: Case2 Output

**Case 3:**
Visitor: Un-known (QR code)
Mask: Wore
Temperature and Oxygen level: Within safe limits
**Input:**

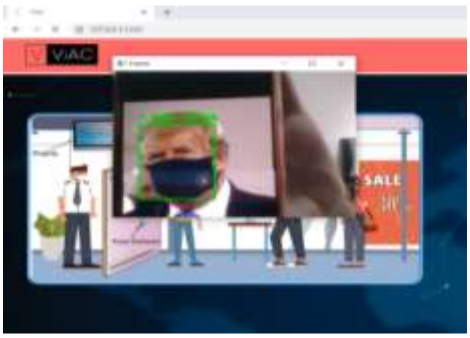

Fig 13: Case3 input

**Output** :

| TYPE | NAME | MASK | TEMPERATURE | SPO2 | TIME | ACCESS |
|---|---|---|---|---|---|---|
| Visitor | Donald | Yes | 97.0 | 97.5 | 11:26:17 | Access Granted |

Fig 14 : Case 3 Output

**Case 4:**

Visitor: Un-known (QR code)
Mask: Not Wore
Temperature and Oxygen level: Within safe limits
**Input**:

Fig 15: Case 4 input

**Output:**

| TYPE | NAME | MASK | TEMPERATURE | SPO2 | TIME | ACCESS |
|---|---|---|---|---|---|---|
| Visitor | Donald | No | 97.0 | 97.5 | 11:26:17 | Access Denied |

Fig 16: Case 4 output

## 5. CONCLUSION

As the technology are blooming with emerging trends the availability so we are trying to develop a novel visitor analyser which can possibly contribute to public healthcare. Face detection and picture or video recognition is a popular subject of research on biometrics. Face recognition in a real-time setting has an exciting area and a rapidly growing challenge. The proposed method is special in that it uses the MobilenetV2 image classifier to classify images, resulting in more accurate performance. Many previous studies had issues with their findings, although others were able to improve accuracy with their dataset.

Furthermore, the proposed method achieves state-of-the-art results on a public face mask dataset. By the development of face mask detection along with temperature and oxygen analyser we can detect if the person is wearing a face mask and is safe or not, and allow their entry would be of great help to the society.4. The solution has the potential to significantly reduce violations by real-time interventions, so the proposed system would improve public safety through saving time and helping to reduce the spread of coronavirus. This solution can be used in places like temples, shopping complex, metro stations, airports, etc.

**Future Scope**

For the future scope we can add more mask types with incorrect mask wear classification. We can also add Face-ID verification using computer vision, so that all the visitor data is extracted from his ID and thus making the visitor identification process easier and simpler.

Coughing and Sneezing Detection: Chronic coughing and sneezing is one of the key symptoms of COVID-19 infection as per WHO guidelines and also one of the major route of disease spread to non-infected public. Deep learning based approach can be proved handy here to detect & limit the disease spread by enhancing our proposed solution with body gesture analysis to understand if an individual is coughing and sneezing in public places while breaching facial mask and social distancing guidelines and based on outcome enforcement agencies can be alerted

**Applications**

1)Visitor monitoring

2) This proposed system can also be used for an unpredicted disease with symptoms similar to Covid-19 (Ebola, H1N1). The proposed system can be achieved by using Convolutional Neural Network, Naive Bayes Classifier (for Mask detection and Face-ID verification) and Internet of Things (for temperature and oxygen level check)

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