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Thermal Screening Enabled Face Mask Detection and Sanitization system

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***Abstract*- Even though vaccination is done and the spread of COVID is reduced in a considerable way, the threat of COVID-19 virus is still existing since the virus is not completely disappeared and vaccination is also not done fully. Hence, a low cost based Covid-19 safety measure approach of Thermal Screening Enabled Face Mask Detection and Sanitization system was proposed in the research paper. The Face Mask Detection is done using Face Recognition process through the usage of Raspberry pi and Web Camera. Then thermal screening is also performed for monitoring the temperatures of individuals through MLX9061 IR temperature sensor.**

Keywords: Thermal Screening Enabled Face Mask Detection and Sanitization system, Face Recognition, Thermal Screening, Raspberry pi, Web Camera, MLX9061 IR temperature sensor.

1. Introduction

The World Health Organization (WHO) released a safety advisory during the COVID-19 (Corona Virus) pandemic for preventing the spread of COVID-19. The WHO advised all the countries in the world to make it mandatory for all the citizens to wear masks in public places and gatherings. This is due to the fact that most of the COVID positive cases are identified only in public and heavy crowded areas. Hence scientists and doctors around the world recommend to wear masks in the public and crowded places for preventing the transmission of COVID virus. Moreover, sanitizing the hands regularly also helps in the prevention of COVID-19 spread.

Deep Convolutional Neural Networks (DCNNs) are mostly utilized for the process of deep face recognition [1]. It is a highly progressive technique and achieves good accuracy in terms of face recognition [2]. Some of the sample normal face images and masked face images are represented in the below fig. 1.

Fig. 1 Sample normal face and masked face images

The framework can recognize the presence or nonattendance of a facial covering in recordings utilizing a blend of picture order and video investigation. Coronavirus contaminated in excess of 5,000,000 individuals in 188 nations in under a half year. The infection spreads through personal contact, as well as in blocked and packed conditions. With the guidance of arising innovations like man-

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made reasoning, the Internet of Things, and AI, we can battle and expect new diseases.

Numerous countries have guidelines expecting individuals to wear facial coverings openly. These rules and regulation were made in light of the quick expansion in cases and passing's in a few areas. Out in the open spaces, in any case, checking huge social occasions of people is getting progressively testing. Thus, we'll computerize the face recognition technique. We give a PC vision and profound learning-based facemask discovery calculation in this paper. The proposed model might be utilized related to observation cameras to mitigate the COVID-19 transmission by distinguishing people who aren't wearing facial coverings. With OpenCV and python, the model methodologies are made.

1.1 Background

In the existing methodologies, there are some of the technologies are used to detect people and monitor their body temperatures. IR sensors are utilized for detecting presence of people and manual monitoring body temperature. Since these technologies are not much effective, when more people come to a common place. Temperature monitoring also becomes difficult if many people arrive.

Hence, Thermal Screening Enabled Face Mask Detection and Sanitization system was proposed in the research work. Here the combination of thermal screening, face mask detection and sanitizing were done as the low cost based Covid-19 safety measures.

1.2 Our Objectives

The major objectives of our work are listed below.

- To successfully distinguish between masked and non-masked person entering the considered area.
- To alert the person if they are found to be without mask.
- To measure their temperature for every masked person.
- To sanitize the entering person's hands if they are found to be within the normal temperature range.

1.3 Outline of the Paper

The remaining sections of this paper are arranged in the following way: Section 2 gives a review of some of the face detection techniques for the detailed understanding of face detection concept; Section 3 gives the overview of our Authorized covid-19 Entry system along with the block diagram, functional purposes of every utilized hardware, various specifications, and way in which the integration was achieved; Section 4 discusses in detail about the functions of all the hardware component involved along with its configurations; Section 5 gives the results obtained in terms of masked and non-masked person distinguishing; and Section 6 discusses about the concluding remarks for the carried out work along with the future work possibilities.

2. Literature Review

For the detailed understanding of face detection concept, a review of some of the face detection techniques has been provided in this section.

The study was performed for the purpose of reviewing about 5800 small business for exploring the influence of

ISSN: 2366-1313

coronavirus disease in the small scale businesses [3]. The survey was conducted between the duration of March 28 to April 4 2020. It was reported that most of the small businesses either feared the risk of closure due to the unknown length of lockdown due to the pandemic or already had done business closure. And some of the small-scale businesses are more fragile in terms of the financial stability. Few median-scale businesses which were having just above $ 10,000 monthly expenditures could maintain the cash for only 2 weeks. But most of the businesses had a proper planning for the funding of running the businesses through the CARES (Coronavirus Aid, Relief, and Economic Security) Act.

The primary objective of any technological, social and economic development is to enhance the well-being and health of human. [4] Due to the rising population and aging of people, the world has changed drastically and there is a need for developing the systems to handle the increasing demands of food supply and healthcare systems. The implementation of the emerging Internet of Things (IoT) acts as the solution to the above-mentioned issues. The research work concentrates on the implementation of IoT technologies in both the Food Supply Chain (FSC) & In-Home Healthcare (IHH) and referred to as Food IoT and Health IoT respectively. The work also focusses on developing the technologies for practical usage.

It was mandatory for every person in the world to wear mask during the coronavirus pandemic and was also advised to wear masks for the prevention of coronavirus. [5] The traditional face recognition systems will not be effective in performing actions like facial attendance, community access control, facial security checks and face access control at public places. Hence the advanced version of face recognition systems was developed recently based on deep learning and requires huge datasets or samples of face images. But currently are no such datasets containing the masked face images for face recognition. Therefore, three different kinds of datasets like MFDD, RMFRD and SMFRD were proposed in the work for face recognition. And RMFRD was concluded to be the world's largest dataset having images of numerous masked faces that aids in the face recognition.

The work discusses about the sterilization technique of N95 respirators through the usage of UV radiation in BSCs (Biosafety Cabinets) [6]. The results of the experimental study help various healthcare organizations that are looking for a substitute method for the reservation of Personal Protective Equipment (PPE). The proposed method can be employed for eliminating the shortage of PPE which can able to sterilize the PPE so that it can be re-used for multiple times.

An automated method of facial mask detection was proposed in the research work for limiting the spread of COVID-19 virus in smart city environment. [7] Here, the facial mask detection was done through the usage of Closed-Circuit Television (CCTV) cameras which are placed for monitoring in various public places. When a person was detected as not wearing the face mask, the concerned authorities and officers were given alert. The deep learning architecture was utilized for training the dataset which comprises of face images of numerous people who are wearing masks and also of those who are not wearing the masks. About

ISSN: 2366-1313

98.7% of accuracy was attained in the trained dataset. The proposed system successively distinguishes peoples among who are wearing the masks and not wearing masks.

3. Proposed System Methodology

In this work, we integrate various hardware like Raspberry Pi, MLX90614 IR Temperature Sensor, MIPI CSI Camera/ Image sensor, DC motor, Display device, DC Water Pump powered sanitizing system, and Relays along with the software tools like OpenCV, NOOBS, VNC, PYTHON3 IDE, and UVC streamers (Guvcview or GStreamer) to put froth our Thermal Screening Enabled Face Mask Detection and Sanitization system. The above said four objectives will be achieved through our novel methodology trying to restrict the spread of COVID-19.

Our novel Thermal Screening Enabled Face Mask Detection and Sanitization system will execute the following actions to restrict the COVID-19 pandemic and thereby be an Authorized covid-19 Entry system:

- All the non-masked persons will be intimated as “Please wear Mask” by using Camera/ Image sensor.
- All the masked persons will be intimated as “Thank you for wearing mask” by using Camera/ Image sensor.
- Then, the temperature screening will be done by the IR Temperature Sensor to identify whether the masked person is within the normal temperature range or not and it will display that “temperature is normal” if the person is within the normal temperature range.
- Then, the person whose bodily temperature is within the range will be sanitized with the help of DC pump operate via the DC motor.
- Finally, the person who has got sanitized will be allowed to enter the door operated via the DC motor to enter the intended area.

In our novel system, Raspberry Pi 4 serves a major processing element in which various hardware are integrated and operated via the above said software tools. The Raspberry Pi 4 will be connected to a 5 Volts power source for powering it. All the implementation parts of the proposed work are being carried out in the python programming language. Camera/ image sensor and IR Temperature sensor acts as input units, while the Relay, DC Pump, and DC motor acts as output units. A Display is used to alert the entering of all the intended messages like “Please wear Mask”; “Thank you for wearing mask”; and “temperature is normal”. Raspberry Pi 4 is not only the processing element in our proposed system methodology, but also it serves as a controlling unit in our system.

controlling unit in our system.

3.1 Block Diagram

The block diagram of our Thermal Screening Enabled Face Mask Detection and Sanitization system is shown in the below fig. 2.

ISSN: 2366-1313

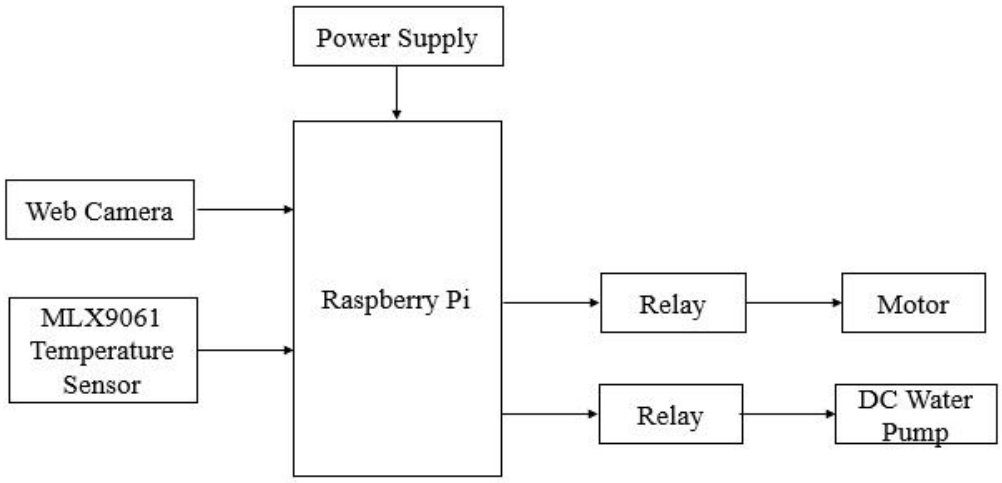

Fig. 2 Block diagram for the proposed Thermal Screening Enabled Face Mask Detection and Sanitization system

Each hardware connected to Raspberry Pi 4 has a specific purpose for it. The following are the purpose of those hardware:

- **Web camera or Image sensor-** The image of the person is captured through it and then fed to the controlling unit for processing.
- **Temperature sensor-** It measures the temperature and communicates to the controlling unit.
- **Relays-** The relays are used to connect the DC Motor and DC pump to the controlling unit for processing.
- **DC Motor-** It is used to power the DC pump and then deployed to actuate the entry door of the intended area. Two DC motors needs to be deployed for better results.
- **DC Pump-** It is used to sanitize the entering person with the help of DC motor.

3.2 Software and Hardware Specifications of Thermal Screening Enabled Face Mask Detection

The below table 1 shows the hardware and software specifications of our proposed system methodology.

Table 1 Software and Hardware Specifications of our Face Mask Detection and Sanitization system

CPU type	Quad core Cortex-A72 (64-bit) @ 1.5GHz
GPU support	H264 (1080p60 decode, 1080p30 encode) OpenGL ES 3.0 graphics, H.265 (4kp60 decode)
Software Utilized	NOOBS, VNC, PYTHON3 IDE, and UVC streamers (Guvcview

ISSN: 2366-1313

	or GStreamer)
Wi-Fi support	Yes, with 2.4 GHz and 5 GHz speeds
Bluetooth support	Yes, with version 5.0
RAM Ports support	1GB, 2GB, 4GB.
Operating Voltage range	5V with 3A minimum
GPIO Ports	28 I/O Pins
LAN interface support	Yes, with Gigabyte support
PoE	Enabled
SD Card support	Yes
HDMI	2- Ports with 4k Display (mini-HDMI)
Power Source	DC Power Jack, mini-USB-C Port
Expansion Connectors	40 Pins (SPI, I^2C, LCD, UART, PWM, SDIO)
USB ports	2×v 2.0, 2×v 3.0
Camera	CSI
Display	DSI
Operating Temperature	0 to 50 °C

3.3 Software and Hardware integration for the proposed methodology

Our Thermal Screening Enabled Face Mask Detection and Sanitization system captures the image of a person by using OpenCV for deciding whether a person can enter the intended area or not. We trained the Raspberry Pi powered system with the help of various images with and without mask. Then, we tested it by the achieving the successful integration of various hardware and software tools like NOOBS, VNC, PYTHON3 IDE, and UVC streamers (Guvcview or GStreamer).

3.4 Suitability for the proposed system

Our proposed system methodology is much suitable in any areas where lots of people gather in order to prevent or reduce the spread of COVID-19 diseases. The areas in which our system could be deployed are as follows:

ISSN: 2366-1313

- Temples
- Theatres
- Malls
- Parks
- Gyms
- Schools
- Colleges
- Governmental offices
- Bus stands
- Railway Stations
- Airports and many more

4. Hardware Components

Various hardware components will be detailed in the following sections.

4.1 Raspberry Pi and its Pin Configuration

Raspberry Pi is generally a smaller sized computing device that operates with Linux OS. We have used the Raspberry Pi 4, as it is more convenient to use in any embedded system. It has a total of forty pins in it, out of which 28 of the pins are GPIO pins and remaining of those pins are dedicated to power. A typical Raspberry Pi 4 has been depicted in the below fig. 3. Furthermore, all of these pins in the controlling unit have been indicated and shown in the below fig. 4.

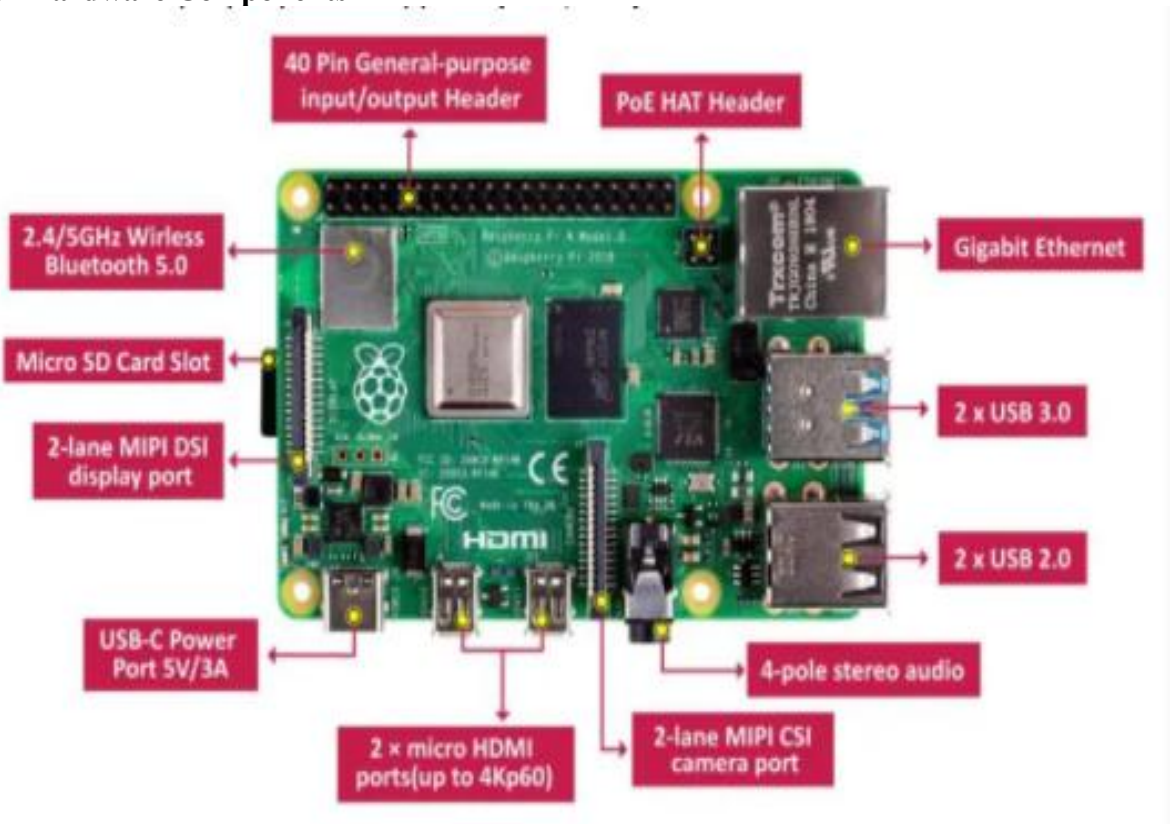

Fig. 3 Schema of a Raspberry pi 4 Board with reference to its support

ISSN: 2366-1313

Fig. 4 Depiction of various Pin configurations in a Raspberry pi 4 Board

4.2 MLX90614 IR Temperature Sensor

This MLX90614 IR Temperature Sensor is inbuilt with two functions like sensing and processing of the temperature measured (usually human's bodily temperature). The function of sensing is achieved through its embedded device MLX81101 and the function of processing of the measured temperature to determine the normal temperature through its embedded device MLX90302.

4.3 MIPI CSI Camera/ Image sensor

A simple web-camera or image sensor can be utilized for the purpose of capturing the images of all the persons entering into the intended area. This camera or sensor is capable of producing the output resolution not less than 1024×768 pixels. This is connected to the CSI port of Raspberry Pi 4.

4.4 DC motor

The DC Motors running with at least 300 rpm speed is integrated with Raspberry Pi 4 through the relays, one for operating the DC pump and the other for operating the door which allows the person to enter the intended area.

4.5 Display device

A monitor is used to display the above said alert messages by connecting it to the DSI interface of Raspberry Pi 4.

4.6 DC Water Pump powered sanitizing system

A minimum of 12 volts DC pump operatable via a DC motor is connected to the Raspberry Pi 4 through the relays for

ISSN: 2366-1313

spraying the sanitizer after the person being identified as temperature is normal".

4.7 Relays

The relays are utilized for connecting the DC motor and DC pump to the Raspberry Pi 4. It is deployed for providing the needed inputs to both the DC motor and DC pump as per the requirements.

4.8 Assembled Thermal Screening Enabled Face Mask Detection and Sanitization system

The above discussed hardware components have been integrated to form our Thermal Screening Enabled Face Mask Detection and Sanitization system. The assemblage of them is given in the below fig. 5.

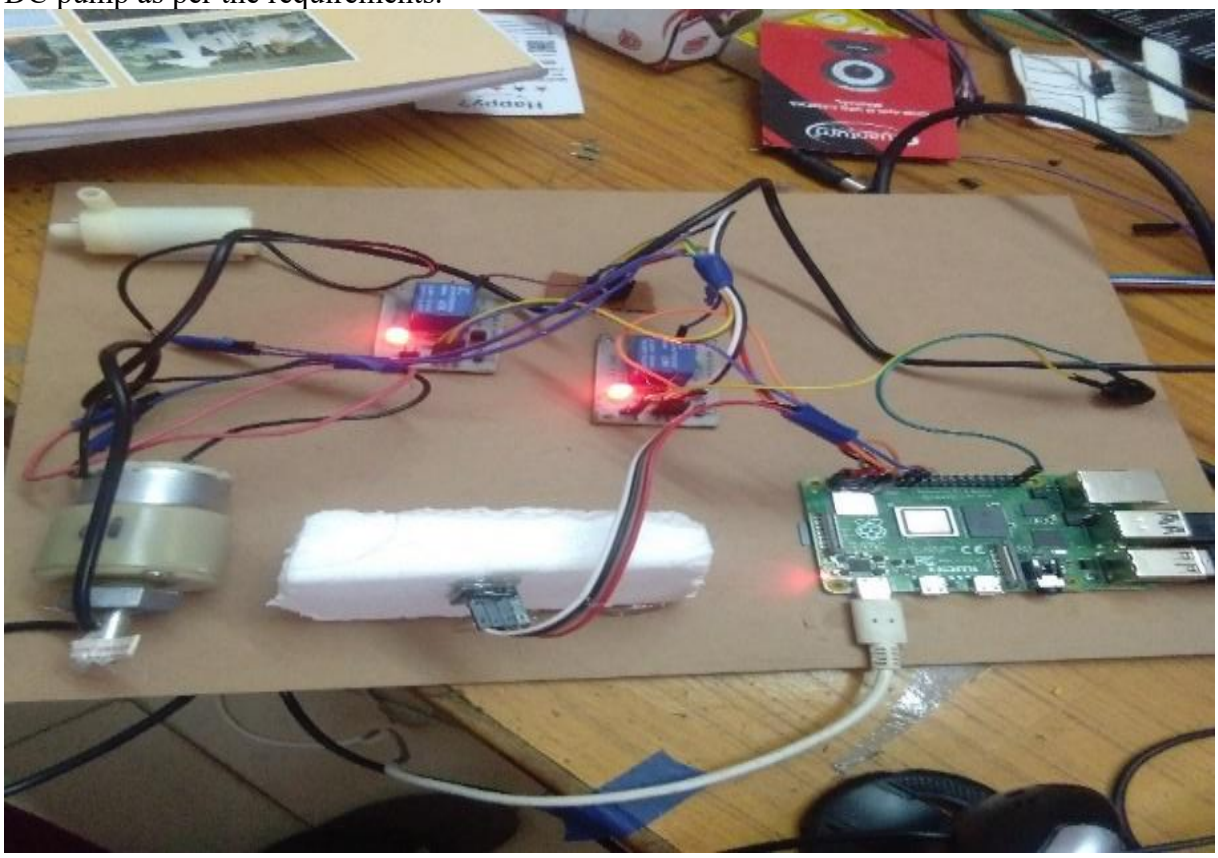

Fig. 5 Arrangement of authorized covid-19 entry using face mask detection and sanitization

5. Results and Discussion

We are considering only the mask distinguishing for evaluating the performance of our proposed system methodology. The below are the two cases considered for the evaluation of our mask detection functionality alone.

5.1 Case I- detecting non-masked persons

With the help of VNC Viewer, we were able to successfully identify the masked persons entering the intended area with the alert message "Please wear Mask" as shown in the below fig. 6.

ISSN: 2366-1313

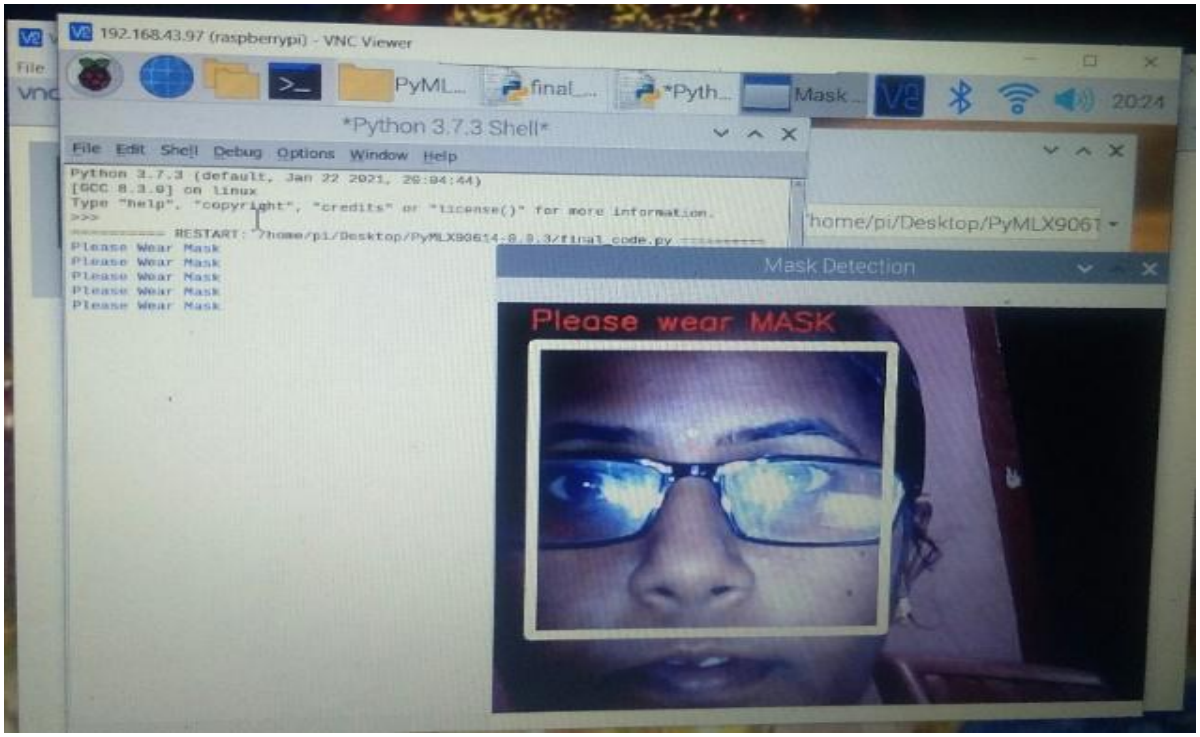

Fig. 6 Output obtained for a non-masked condition

5.2 Case II- detecting masked persons

With the help of VNC Viewer, we were able to successfully identify the masked persons entering the intended area with the alert message "Thank you for wearing mask" as shown in the below fig. 7.

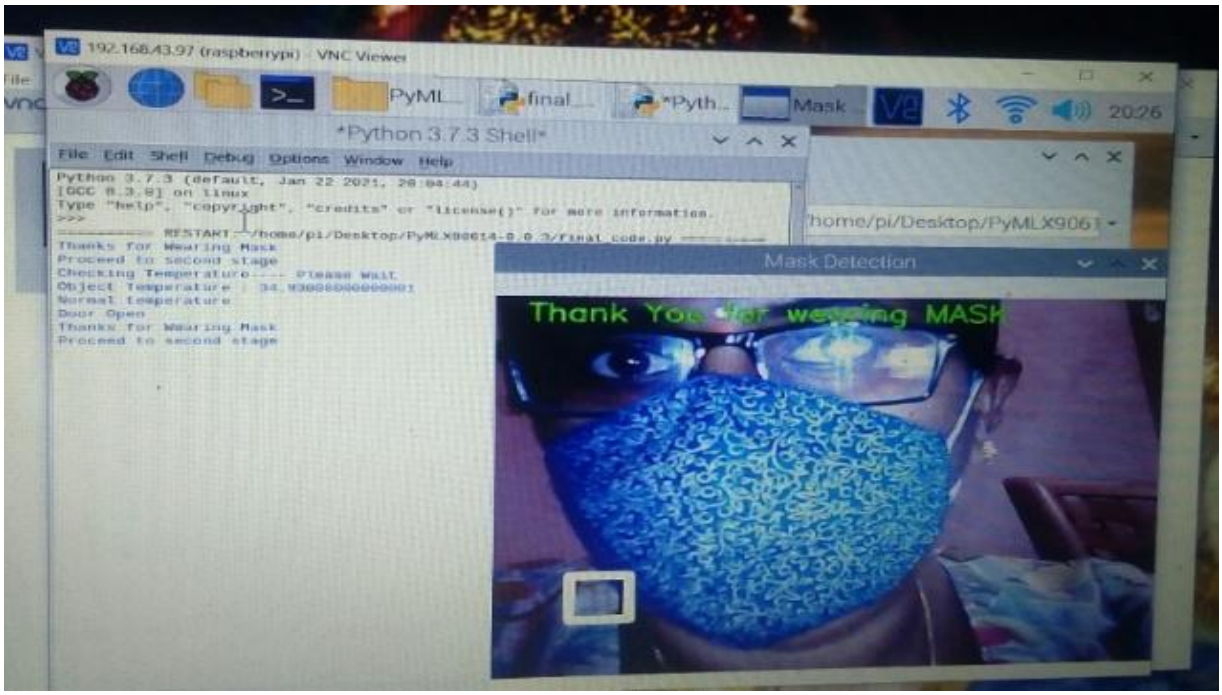

Fig. 7 Output obtained for a masked condition

ISSN: 2366-1313

6. Conclusion and Future Work

We were able to successfully propose the Thermal Screening Enabled Face Mask Detection and Sanitization system with the help of Raspberry Pi 4 as the controlling unit. We were able to claim our proposed system methodology to be "Authorized covid-19 Entry system" because of the obtained evaluation outcomes. Our proposed system was able to be robust in identifying both the masked and non-masked persons and thus it can be effective as an entry system in many places where a lot of people could possibly be gathering. However, our method is restricted only to entry level screening and thus the entire covering of the area might have been better.

We have only listed the suitable areas of our system methodology, but didn't take up any case study on that. So, we desire to take up several case studies in order to check the effectiveness of our system when being implemented. Furthermore, we also desire to check the accuracy levels of various measurements and alert messages so that our entry system is able to robust even for the far future applications.

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