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Intelligent Barrier for Face Mask and Body Temperature Detection

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Abstract*— Corona virus is the most recently discovered causing deadly disease COVID-19. Situations in present world is getting worst because of new variants evolving day by day. It affects economically as well as socially causing great threat to human lives to peril. COVID-19 pandemic caused the entire globe to force for lockdowns in sequence to forestall proliferation of corona virus. A proper face mask and monitoring body temperature can help the authorities to notice people who are at the high risk of infection and prevents security guards getting infected. Omicron virus contamination gives rise to a great threat in the society regardless of age. According to the survey conducted, wearing mask can avert the proliferation of covid-19. Wearing mask is made mandatory everywhere especially in public places. WHO declared that high temperature is one of the symptom of variant. Here we can avoid the person without mask and having high temperature. Face mask detection is achieved using CNN technology specifically MobilenetV2 and temperature of a person is detected using MLX90614 IR temperature sensor and by making use of servo motor barrier movement can take place. Generally, gate remains open, only when having high risk of temperature and not having mask it closes and buzzer. The main goal is to prevent the society from deadly virus infection and making life easier.

Keywords - Face mask detection, MobileNetV2, CNN, MLX90614, Raspberry Pi, Servo motor, OpenCV.

I. INTRODUCTION

The first virus which is causing an epidemic was first discovered in Wuhan, China. From there onwards was lay out all over the world. And also India was rolled out in the infection of corona virus. It not only affected the people's health but also affected the people's financial condition. By the WHO related review this deadly virus is considered as vicious [1] [2]. [3] Gives a significant note that many entities has made several endeavour. With the public of more than 134 billion reveals to be the second in the world [4] [5]. [3] government made various plan to prevent it in social gatherings like maintain 2 feet gap with each other and also tiring mask [6] [7] and also it was made compulsory of tiring mask whenever people talking with one another [8].This caused strain in adopting this habit [9]. So to overcome this situation various technologies evolved. One among them is developing automated face mask detection along with temperature detection [10] [11]. This method can put forward the spot of high body temperature and person not wearing mask by combining the deep learning and the internet of things automation. In this composition, we are constructing an inexpensive or cheap internet of things apparatus to assist the individuals to spread control of covid-19 by following the caution provided by the government [14] [15]. And therefore we can forestall the corona easily by installing our proposed system. Our main is to find whether the individual is tiring mask or not tiring the mask with individual's body temperature must be normal for consideration. From our proposed system the person who are checked with mask and body temperature are only sent inside the public places because of the barrier opening and closing technique. So our system is very quick and clever in nature which will stay alert all the time. So only the individual wearing the mask properly and having normal body temperature can enter into the public places without any problem causing. The last of method is structured to utilize of an infrared temperature measurement outcome which is of affordable cost and can be initialized by the numerous individual which will assure an elegance of in all probability measuring the contaminated people in early stage. At the opening of communal location examine for the face mask and body temperature is needed. It will become compulsory procedure to temperature check for the people without leaving anyone. By using deep learning and convolution neural network (CNN) techniques, it become possible to achieve high accuracy results in image classification and object detection applications. The foremost vision of this project is to design and develop a product of intelligent barrier for detecting body temperature and face mask. This system is built to put an end to the individual who are not tiring the mask [38]. The proposed product will determine the person is either the visor or not tiring the mask and the body temperature at the opening door or entrance of the public places. This system is constructed using internet of things and deep learning concepts. Where the python programming is used to take a difference between the person who are having face mask and the person who are not wearing the face mask [32]. As the CPU which acts as microcontroller the Raspberry Pi is required for the running the python program for distinguishing between the individual tiring the face mask and the individual not tiring the face mask. And the

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Raspberry Pi is attached with the Pi camera to capture the stream of video, and MLX90614 is used as a temperature sensor for measuring the temperature of the person. Servo motor is used lift the barrier up and down which acts as blockade for the corona virus [37]. For training the constructed model MobileNetV2 technique is implemented where it is a small and efficient convolution neural network. Face mask is detected using Mobile Net v2 technology and also OpenCV. Temperature of a person is detected using MLX90614 and object detection using IR sensor [36]. Raspberry Pi is used here as CPU. For Barrier movement Servomotor can be used.

II. TECHNOLOGIES USED

1. Face Mask Detection Technique

Deep learning is part of artificial intelligence and machine learning. Which is inspired by brain neurons, it proved to have higher pliability and construct high accurate system in comparison with the machine learning [31]. Deep learning has utilization in different fields like image classification, speech identification, robot learning, e-commerce, bioinformatics, advertising, natural language processing, digital marketing, computer vision, and many more [16]. Identification of mask during this study is developed with machine learning algorithm direct the image bracket system MobileNetv2. It is a system supported Convolutional Neural Network (CNN) that evolved by Google with bettered staging and improvement to be high effective [12]. MobileNetV2 is that the rearmost technology of mobile visual recognition, including bracket, object semantic segmentation discovery [13]. The classifier uses deep learning divisible complication, this purpose is to make less difficultly amount and the size of system with the network, so it is adaptable for mobile bias, or bias with the less computing power. The nonlinearity within the narrow sub caste is removed. Settle because the backbone of point birth, MobileNetV2 achieves the only performance in object discovery and semantic segmentation [40]. In MobileNetV2, another fashion module introduced is that the rear residual structure.

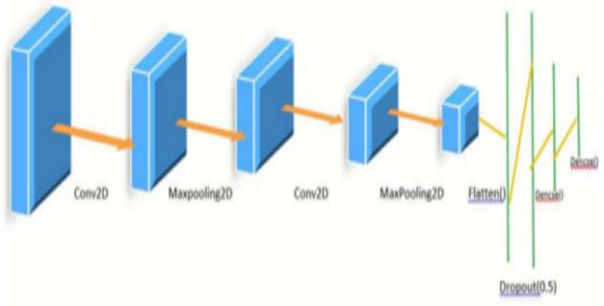

Figure: Face Mask Detection technique

1.1 Convolutional Layer

Figure depicts the CNVL, which is a crucial component of every convolutional network. CNVL's main purpose is to extract features from picture data (the input). A tiny portion of a large image is captured and traversed across all locations in the large image (the input). They are twisted within a single position at every point of passage (the output). Kernel or filter refers to each little portion that passes over the larger picture. In the output picture, this generates an activation map or a feature map. The activation maps are then maintained as input data for the next CNVL.

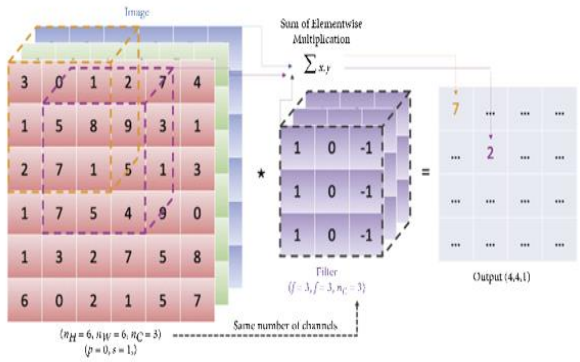

Figure: Convolution Layer's Operation

The typhical convolution operation, shown in the above figure, denotes the input image by X (n_H, n_W and n_C), where n_H, n_W and n_C are the height, the width size of the feature map, and the number of channels, respectively, while K(f, f, n_C) is the filter kernel, where f x f is the size of the convolution kernel. Thus, the CONV formula is denoted in equation, and the output dimension is given by equation, where s designates the stride parameter [27, 28]:

$$\mathrm{CONV}(X,K)_{x,y} = \sum_{i}^{n_H}\sum_{j}^{n_W}\sum_{k}^{n_C} K_{i,j,k} X_{x+i-1,y+j-1,k},$$

$$\mathrm{Dim}\left(\mathrm{CONV}(X,K)_{x,y}\right) = \left(\left[\frac{n_H + 2_p - f}{s} + 1\right], \left[\frac{n_W + 2_p - f}{s} + 1\right]\right); s > 0,$$

$$= \left(n_H + 2_p - f, n_W + 2_p - f\right); s = 0.$$

1.2 Pooling Layer

Figure shows a max-pooling procedure in action. Down sampling each picture is what the pooling layer or subsampling does. It minimises the size of each activation map while keeping the most important data. As a result, subsampling a tiny section of convolutional output yields a single output. Pooling strategies include maximum pooling, average pooling, and mean pooling. Max pooling uses the region's largest pixel value. The max pooling and average pooling are calculated using equations, respectively. This layer's key benefit is that it achieves faster convergence, greater generalisation, and is resistant to distortion and translation, and it's usually found in the centre of convolution layers:

$$\mathrm{Max}_i = \max_{1 \longrightarrow f \times s}(X),$$

$$\mathrm{Avg}_i = \frac{1}{f \times s}\sum_{1}^{f \times s} X.$$

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Vol 9, Issue 6, June 2022

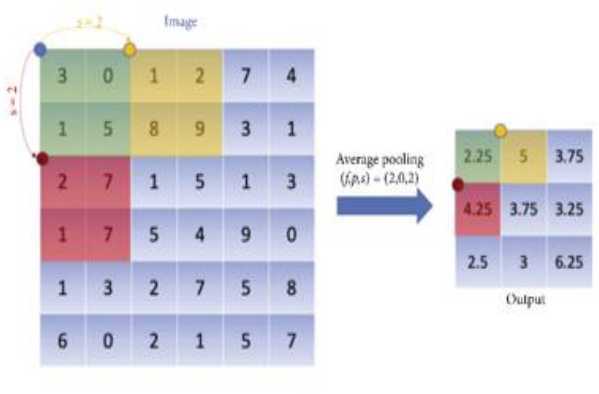

Figure: Max Pooling Operation

1.3 Fully Connected Layer

The FCL is depicted in Figure. However, the number of neurons that accept one vector as input and return another is limited. Consider the output of a layer node, which is specified as equation:

$$[i]_j^{[i]} = \sum_{l=1}^{n_{i-1}} W_{j,l}^{[i]} a_l^{[i-1]} + b_j^{[i]}.$$

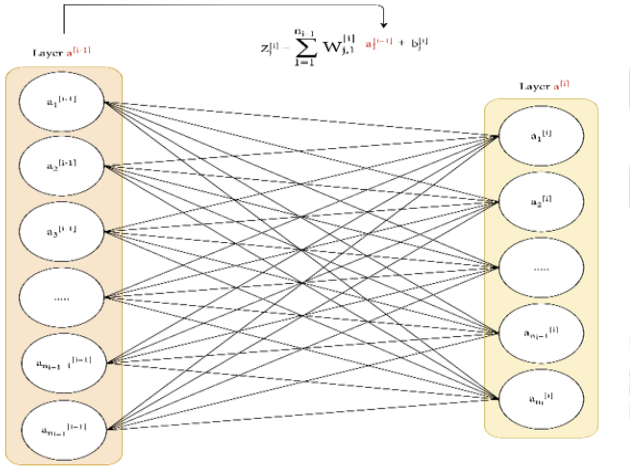

Figure: Fully Connected layer

1.4 Softmax and Classification Layer

In a CNN, the classification layer is usually the final layer. The Softmax function is commonly used in CNNs to match nonnormalized data from the preceding layer in order to distribute above-predicted class scores.

1.5 MobileNetV2 Results

MobileNet is one of the deep learning models which is used for in low-cost hardware devices. Classification, object identification and segmentation, can be carried out by operating the MobileNet model. The MobileNetV2 model is derived from the MobileNetV1. Figure a presents the MobileNetV2 training and validation loss. Also, Figure c shows the graphs of training and validation accuracy.

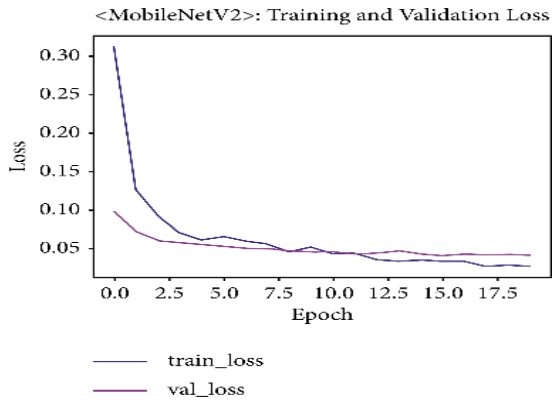

Figure a: MobileNetV2 Training and Validation Loss

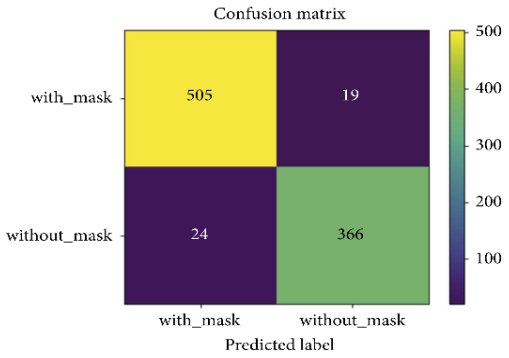

Figure b: Confusion Matrix of Predicted Label

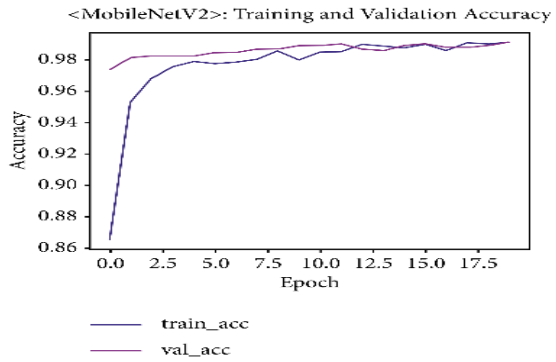

Figure c: Graphs of Training and Validation Accuracy

This model's total testing accuracy is 96.32 percent. When categorising COVID-19 data, the F1-score, sensitivity, specificity, precision, and accuracy achieved were 99.43 percent, 100 percent, 97.72 percent, 98.87 percent, and 99.24 percent, respectively. These measurements all had values of over 89 percent in the categorization of normal and affected patients. The MobileNetV2 model may clearly aid in the detection of faces with or without masks.

2. MLX90614 Temperature Sensor

It is an Infrared (IR) Temperature Sensor is used to estimate the temperature of any recipient begin with -70° C to 382.2°C without any contact. This sensor uses infrared rays to find the value of temperature of an object without physical touch and communicates to microcontroller by making use of the I2C protocol. And this has become

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Vol 9, Issue 6, June 2022

possible with a law called as Stefan-Boltzmann regulation, according to this law every object and the living beings give off infrared energy and the depth of its discharged IR power is proportional to the temperature of recipient emitting radiation. Therefore, this sensor will verify the temperature of the recipient by finding the total of infrared radiation being radiated from the body [14].

Figure: MLX90614 Temperature Sensor

3. Raspberry Pi

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, ac, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

Figure: Raspberry Pi

4. Infrared sensor

Infrared sensor is utilized for checking the unit of individual set foot in common area where this system is installed. The IR Sensor's calculates at the voltage of 5VDC, and the input/output pins are 5V and 3.3V well matched. This gives rise to a various kinds of choice. This portray infrared sensor that trait to builds encompassing light sensor and adaptable perceiving range till 20cm [15].

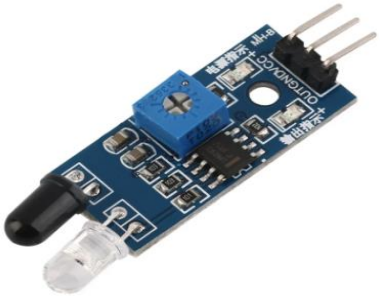

Figure: Infrared Sensor

5. Buzzer

A buzzer is an audio signal device that can be electro mechanical and mechanical.it can be used as alarms or timers. Which can be buzzer on the dumped program on the microcontroller. They can be various tune of the buzzer are present.

Figure: Buzzer

6. Pi Camera

Pi Camera module is a camera which can be used to take pictures and high definition video. Raspberry Pi Board has CSI (Camera Serial Interface) interface to which we can attach Pi Camera module directly. This Pi Camera module can attach to the Raspberry Pi's CSI port using 15-pin ribbon cable.

Figure: Pi Camera

7. I2C LCD Display

I2C LCD is an easy to use display model, it can make display easier. Using it can reduce the difficulty of make, so that makes can focus on the core of the work only 2 arduino pins are occupied (use I2C interface).supports standard I2C mode(100Kbit/s) and fast I2C mode (400Kbit/s). Compatible with multiple communication logic levels: 2.85 VDC arduino library supported, use a line of code to complete the display.integrate 7 sizes of ASCII fonts.5 graphic functions.

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International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)

Vol 9, Issue 6, June 2022

Figure: I2C LCD Display

III. RELATED WORK

The importance of assessing the body temperature of patients is often overstated [17] [18] [19]. Unfortunately, traditional methods are not very accurate and can take long time to measure correctly. A distributed monitor system was then developed to provide accurate body temperature readings. The system works by taking advantage of the multi-temperature sensors that are attached to the monitor. The system is powered by a USB adapter and a wireless transceiver chip. The readings are transmitted through a cable to a central station, and this ensures that the monitor is always up to date with the latest medical conditions. Real-time data collection in health care is challenging due to the huge amount of information that's needed to be collected [20]. This paper presents a method to monitor and detect a person's heartbeat using a distance. When the sensor is activated power consumption of the device decreases from receiving pc with remote-control command [21] [22] [23]. The applications in which the performance is increasing are seismic surveillance, weapon sensor ships, habitat monitoring, and application of medical was scrutinized [24] [25]. The concept of a wireless sensor network allows the user to control the device with a remote-control command. It was tested in various applications such as weapon ships and seismic surveillance. The goal of this project was to demonstrate the efficiency of the WSN models created by PIC. Through the study, it was discovered that the time setting plays a critical role in the output's efficiency. Measure took by controlling laboratory and some experiments curb the duration of tests and fidelity [26]. For instance, to track the impact of sleep deprivation on the human body's circadian rhythms, it needs to be able to measure skin temperature accurately. This paper describes a method to analyse the physiological factors that influence circadian rhythms in humans. They design and build a wireless non-contact sensor prototype. Intrusive monitor device that scale's the impose temperature of the recipient and offers actual feedback to the user doctor. By constructing, parameterizing, and calibrating an active measurement system, they were able to obtain a 0.02 degrees Celsius precision. Component that regulates body temperature between 16 and 42 degrees Celsius on average. Biometric systems are used for various security applications [27]. Although there are various methods and algorithms for recognizing a person's appearance, there is no known correlation between these systems and real-world applications. They discovered that individuals who are trying to extract a fingerprint from another person's profile are more likely to make mistakes than those who are not trying to do so. Evaluation have will also represent the fingerprints that is used to establish the mask on the face. The systems are still in their early stages, but the results are promising. The tasks are conducted such as analysis of post-event, tracking incident in real-time, improving video surveillance services video analytics [28]. People can utilize the amount of time in a more efficient way, while the effectiveness of surveillance systems improved. The paper describes the fundamentals underlying each of these techniques, as well as how to employ widely available people and face mask identification algorithm. Then the different outlook for complication yielded the figured answer with a simpler solution is then implemented in instantaneous time. The algorithm's performance upon the evaluated video sequence gives useful procedure for enhancing the performance of masked face detection. Face mask detection is considered as the notable advance in the sector face identification and computer vision. To develop a face recognition model a various algorithm and methods are implemented. The put forward the method OpenCV, Keras and Tensorflow is used for identification of face mask. The proposed system is implemented easily with the cheaper rate so it is much used in defensive purpose. For face detection of the inexpensive material Haar Cascase algorithm is used with the Raspberry Pi which is an Internet of Things concept. It appear a machine learning address for face identification and face mask detection uses the OpenCV library's hair cascade to finish the chore fast with having more remembrance value. Looking at a person's face identifying and detecting is a route for the face recognition. The python program is take to do the changes to the given framework. With the help of pro positive style the coloured images of a person's face is recognised. Low cost of the Internet of Things devices are used in this paper and machine learning techniques is used for qualitative examination.

IV. RESULT

The persons are not well trained on using temperature scanner devices. There is human error in reading values. Many times people are not barred from entry even after higher temperature readings or no masks. The scanning is skipped by the personnel if supervisors are not watching. Manual scanning system is not suitable for large crowds.

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International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)

Vol 9, Issue 6, June 2022

Figure: Model Setup

Figure: Model Setup

V. CONCLUSION

By the survey conducted by using mobilenetv2 as face mask classifier and also mlx90614 as auto body temperature detector is much better for achieving our goal. Intelligent barrier is made by using IoT to check the body temperature and capture the face mask to increase the safety of a public to decrease the spread of virus. A proper face mask and monitoring body temperature can help the authorities to notice people who are at the high risk of infection. Omicron virus contamination gives rise to a great threat in the society regardless of age. According to the survey conducted, wearing mask can avert the proliferation of covid-19. Wearing mask is made mandatory everywhere especially in public places. This product is used to decrease the man power in the public places. This product can be implemented in real time using deep learning concept by using Raspberry pi which is an IoT hardware to check face mask and body temperature. The product will detect the face mask and body temperature accurately. And the product will be trained to achieve 97 percent accuracy. The result of the test will be having high level accuracy for detection of wearing a face mask or not.

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