IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 4, April 2021

DOI 10.17148/IJARCCE.2021.10412

AUTOMATIC ENTRY CHECK USING IoT

Dr.Saranya.C.P[1], Akshay.B.M[2], Den Leo Sunil[3], Madhan.S[4], Vanaja.R [5]

Associate Professor, Computer Science and Engineering, Coimbatore Institute of Engineering and Technology, Coimbatore, India[1]

Student, Computer Science and Engineering,Coimbatore Institute of Engineering and Technology,Coimbatore, India[2-5]

Abstract: In the present scenario due to Covid-19, the need for face mask detection applications, temperature detection and hand sanitizing are now in high demand for Railway Entrance, Airport Entrance, Office Entrance, Museums and Amusement Parks, Other Public Places and enterprises to ensure safety. These steps are now done in manual way by which the personnel may get in contact with the other personnel while sanitizing and checking temperature might not be accurate. To mitigate the problem, this research work introduce an affordable IoT-based solution aiming to increase Covid-19 entrance safety, covering several relevant aspects: Contactless temperature sensing, Mask detection, Automatic hand sanitizing. Contactless temperature sensing subsystem relies on Raspberry Pi using temperature sensor, while mask detection performed by leveraging computer vision techniques on camera-equipped Raspberry Pi, then the automatic hand sanitizing is achieved by the DC motor connected with the PIR sensor and Raspberry Pi. Any person without temperature check, hand sanitizing and mask scan will not be provided entry. Only person having the conditions satisfied by the system is instantly allowed inside, else the buzzer will alert the security about the situation, if any violation of the condition is found. From the simulation results, it is clearly observed that the proposed method has high accuracy compare to the existing methods. Thus the system provides a 100% automated system to prevent the spread of Covid-19.

Keywords: Covid-19, Contactless temperature sensing, Mask detection, Automatic hand sanitizing, Raspberry Pi, DC motor, PIR sensor.

I. INTRODUCTION

Since the last days of the previous year, the occurrence of novel infectious flu-a like respiratory disease Covid-19 caused by SARS-Cov-2 virus (also known as coronavirus) has affected almost every aspect of people's lives globally [1]. Common symptoms of coronavirus disease include fever, tiredness, sore throat, nasal congestion, loss of taste and smell. In most cases, it is transmitted directly (person to person) through respiratory droplets, but also indirectly via surfaces. Therefore, the usage of face masks and sanitizers has shown positive results when it comes to disease spread reduction.

The first step to detect Covid-19 is by scanning for fever. Also, we need to monitor every person for a mask. We have temperature checking systems for every entrance for scanning but manual temperature scanning has lots of disadvantages and also the personnel are not well trained on using temperature scanner devices. There may be the human error that can occur while reading the values [2]. Many a times people are not barred from entry even after they are diagnosed with higher temperature readings and also, they will allow them to enter the building even if they have no masks. The scanning is skipped by the personnel if supervisors are not watching. Manual scanning system is not suitable for large crowds.

To solve this problem, we are going to propose a fully automated temperature scanner and entry provider system. It is a multipurpose system that has a wide range of applications [3]. The system makes use of a contactless temperature scanner and a mask monitor. The scanner is connected directly with a human barrier to restrict the entry if the personnel are diagnosed with high temperature or if the personnel is identified with no mask is detected with the help of the scanner. No person will be provided entry without temperature and mask scan. Only the person who satisfies both the conditions correctly they will be provided with the entry instantly to go inside [4]. The system uses temperature sensor and camera connected with a raspberry pi system to control the entire operation.
The camera is used to scan for mask and temperature sensor for forehead temperature. The raspberry processes the sensor inputs and decides whether the person is to be allowed. In this case the system operates a motor to open the barrier allowing the person to enter the premises [5]. If a person is flagged by system for high temperature or no Mask the system glows the red light and bars the person from entry. Also, the face and temperature of person is transmitted over IOT to server for authorities to take action and test the person for covid. Thus, the system provides a 100% automated system to prevent the spread of COVID.

The rest of the section is organized as follows, section 2 reviews the recent techniques for preventing the spread of corona virus. Section 3 explains the proposed methodology. section 4 elaborates the experimental results and its discussion. Section 5 deals with the conclusion and future work.

IJARCCE
ISSN (Online) 2278-1021
ISSN (Print) 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering
Vol. 10, Issue 4, April 2021
DOI 10.17148/IJARCCE.2021.10412

II. LITERATURE REVIEW

In this section discuss the some of the recent techniques for face mask detection techniques using machine learning methods.

Rehman et al [6] proposed a system that restrict the growth of COVID-19 by finding out people who are not wearing any facial mask in a smart city network where all the public places are monitored with Closed-Circuit Television (CCTV) cameras. While a person without a mask is detected, the corresponding authority is informed through the city network. A deep learning architecture is trained on a dataset that consists of images of people with and without masks collected from various sources. The trained architecture achieved 98.7% accuracy on distinguishing people with and without a facial mask for previously unseen test data. It is hoped that our study would be a useful tool to reduce the spread of this communicable disease for many countries in the world.

Toshanlal Meenpal et al [7] designed in such a way that it use a binary face classifier which can detect any face present in the frame irrespective of its alignment. We present a method to generate accurate face segmentation masks from any arbitrary size input image. Beginning from the RGB image of any size, the method uses Predefined Training Weights of VGG – 16 Architecture for feature extraction. Training is performed through Fully Convolutional Networks to semantically segment out the faces present in that image. Gradient Descent is used for training while Binomial Cross Entropy is used as a loss function. Further the output image from the FCN is processed to remove the unwanted noise and avoid the false predictions if any and make bounding box around the faces. Furthermore, proposed model has also shown great results in recognizing non-frontal faces. Along with this it is also able to detect multiple facial masks in a single frame. Experiments were performed on Multi Parsing Human Dataset obtaining mean pixel level accuracy of 93.884 % for the segmented face masks.

Hamidreza et al [8] presented an algorithm for processing infrared images and accomplishing automatic detection and path tracking of moving subjects with fever. The detection is based on two main features: the distinction between the geometry of a human face and other objects in the field of view of the camera and the temperature of the radiating object. These features are used for tracking the identified person with fever. The position of camera with respect to direction of motion the walkers appeared to be critical in this process. Infrared thermography is a remote sensing technique used to measure temperatures based on emitted infrared radiation. This application may be used for fever screening in major public places such as airports and hospitals.

Po-Wei Huang et al [9] developed a Neural Network Regression not only to reduce the error from 0.6 degree to 0.12 degree, which is close to the medical instrument level, but as well to lengthen the valid distance to the range between 50 cm and 100 cm. Furthermore, this study developed an embedded automatic body temperature estimation system which could continuously and unconsciously measure the human temperature in real-time. Integrated with face tracking and fuzzy-control of Pan-tilt unit, the system ensures that human face is focused while measuring. With wireless communication techniques, users can review their physiological Information via App and Web, which is beneficial to remote healthcare.

Nenad Petrović et al [10] proposed a IoT-based system aiming to help organizations respect the COVID-19 safety rules and guidelines in order to reduce the disease spread is presented. It focus on most common indoor measures - people with high body temperature should stay at home, wearing mask is obligatory and distance between persons should be at 11 least 1.5-2 meters. For the first scenario, Arduino Uno microcontroller board with contactless temperature sensor is used, while we rely on Raspberry Pi single-board computer equipped with camera making use of computer vision techniques for other two scenarios. Python version of OpenCV, open-source computer vision library was used for implementation of mask detection and social distance check algorithms.

Enerst Edozie et al [11] implemented a low-cost smart hand sanitizer dispenser with door controller based on ATMEGA328P (Microcontroller), electromagnetic lock and Ultrasonic sensor that can help to solve the challenges faced by security guards at different stations such as bank doors, school gates, hospital gates etc. in enforcing this hand sanitizing action before letting people in to where ever they intend to enter. That is to say, when a person(s) wants to access the entrance door, they must first sanitizer their hands or else the door will remain locked. With this smart hand sanitizer dispenser, an ultrasonic sensor is used to check the presence of hands below the outlet of the sanitizer machine. It will continuously calculate the distance between the sanitizer outlet and itself and tells the microcontroller to turn on the servo motor whenever the distance is less than 10cm to push the sanitizer out and immediately after the sanitizer outlet dropping some amount into your hands, the electromagnetic lock will de-energize (unlock the door) lighting up a green LED and display a word "The Entrance Door is Open" on the LCD display, then the second servo motor will open the entrance door. Otherwise, the door will neither unlock nor open but a red LED will continuously be on with the "Please Sanitize Here" words displayed on the LCD display.

From the above analysis it is observed that these methods have some limitations. It is a manual process which requires the man power. The person has to be trained to handle the temperature checking. Human error may happen. Scanning is skipped whenever no one is watching. Not suitable to handle large crowd.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 4, April 2021

DOI 10.17148/IJARCCE.2021.10412

III. PROPOSED METHODOLOGY

In this work introduced a automated system for covering several relevant aspects like Contactless temperature sensing, Mask detection, Automatic hand sanitizing aiming to increase Covid-19 entrance safety. It is a purely automated system. No one is allowed to enter if they didn't wear mask and has high temperature. Buzzer will alert the security of this situation if any fail-safe condition is found. Additionally, if they have high temperature the message will be sent to the Covid19 health canter.

Initially PIR sensor identify the person by the motion. Using temperature sensor, the temperature of the person is detected and if it exceeds temperature limit a alert message is send. The alert message send by WiFi module ESP8266. Parallelly the camera captures the image. The image processed using Viola Jones technique using OpenCV and tensor flow, the classification between the person wearing mask or not is verified. The proximity sensor detects the hand of a person places his/her hand under the sanitizer and it dispenses the sanitizer accordingly. Each process of the proposed work is explained in briefly in the following section.

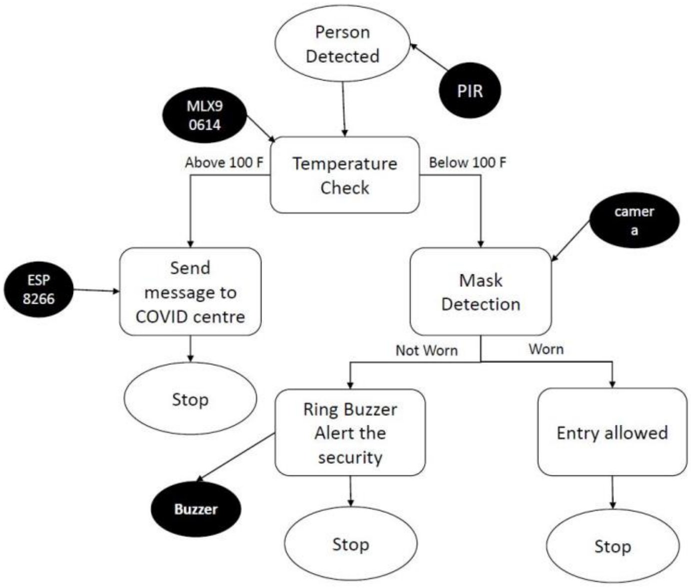

Fig.1 Flow Chart of the Proposed System

A. *PERSON DETECTION*

Person detection is the process of identifying a human's presence at the entrance. It is achieved using the Passive Infra Red sensor(PIR). When a person is detected the PIR sensor gives the output as 1. When a person is not detected it gives the output as 0.

B. *TEMPERATURE CHECK*

When a person is detected then the temperature of the person is checked using mlx90614 sensor. If the temperature is above 1000F then an alert message is sent to the COVID centre. If the temperature is below 1000F then the person is checked for face mask.

C. *ALERT TO COVID CENTRE*

ESP 8266 module is used to send the message to COVID centre.

D. *FACE MASK DETECTION*

When the temperature is below 1000F the facemask is detected using camera's input. For checking the facemask of a person, we use deep learning with image processing using python. The code is flashed inside the Raspberry Pi module.

E. *ALERTING SYSTEM*

If the facemask is not worn by the person then the buzzer supply is turned on by the Raspberry Pi. The buzzer will ring until the facemask is worn.

IV. IMAGE PROCESSING

Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. Nowadays, image processing is among rapidly growing technologies. It forms core research area within engineering and computer science disciplines too. Image processing basically includes the following three steps:

- Importing the image via image acquisition tools;
- Analysing and manipulating the image;

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering
Vol. 10, Issue 4, April 2021
DOI 10.17148/IJARCCE.2021.10412

- Output in which result can be altered image or report that is based on image analysis.

There are two types of methods used for image processing namely, analogue and digital image processing. Analogue image processing can be used for the hard copies like printouts and photographs. Image analysts use various fundamentals of interpretation while using these visual techniques. Digital image processing techniques help in manipulation of the digital images by using computers. The three 34 general phases that all types of data have to undergo while using digital technique are pre-processing, enhancement, and display, information extraction.

V. FACE RECOGNITION

Facial recognition is a way of recognizing a human face through technology. A facial recognition system uses biometrics to map facial features from a photograph or video. It compares the information with a database of known faces to find a match. Facial recognition can help verify personal identity.

- **Working process of facial recognition**

Step 1. A picture of face is captured from a photo or video. Face might appear alone or in a crowd. The image may show you looking straight ahead or nearly in profile.

Step 2. Facial recognition software reads the geometry of the face. Key factors include the distance between your eyes and the distance from forehead to chin. The software identifies facial landmarks —one system identifies 68 of them —that are key to distinguishing your face. The result: the facial signature.

Step 3. Facial signature —a mathematical formula —is compared to a database of known faces.

Step 4. A determination is made. The faceprint may match that of an image in a facial recognition system database.

VI. VIOLA–JONES OBJECT DETECTION FRAMEWORK

The Viola–Jones object detection framework is an object detection framework which was proposed in 2001 by Paul Viola and Michael Jones. Although it can be trained to detect a variety of object classes, it was motivated primarily by the problem of face detection. The algorithm has four stages:

1. Haar Feature Selection
2. Creating an Integral Image
3. Adaboost Training
4. Cascading Classifiers

The features sought by the detection framework universally involve the sums of image pixels within rectangular areas. As such, they bear some resemblance to Haar basis functions, which have been used previously in the realm of image-based object detection. However, since the features used by Viola and Jones all rely on more than one rectangular area, they are generally more complex. The figure on the right illustrates the four different types of features used in the framework. The value of any given feature is the sum of the pixels within clear rectangles subtracted from the sum of the pixels within shaded rectangles. Rectangular features of this sort are primitive when compared to alternatives such as steerable filters. Although they are sensitive to vertical and horizontal features, their feedback is considerably coarser.

A. Haar Features

All human faces share some similar properties. These regularities may be matched using Haar Features. A few properties common to human faces:

- The eye region is darker than the upper-cheeks.
- The nose bridge region is brighter than the eyes.

Composition of properties forming matchable facial features:

- Location and size: eyes, mouth, bridge of nose
- Value: oriented gradients of pixel intensities

The four features matched by this algorithm are then sought in the image of a face (shown at right).

B. Rectangle features

- Value = Σ (pixels in black area) -Σ (pixels in white area)
- Three types: two-, three-, four-rectangles, Viola & Jones used two-rectangle features
- For example: the difference in brightness between the white & black rectangles over a specific area
- Each feature is related to a special location in the sub-window

DOI 10.17148/IJARCCE.2021.10412

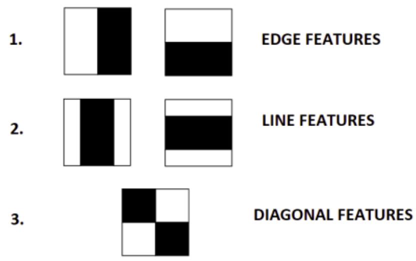

Fig 2. Haar Features

C. Summed area table

An image representation called the integral image evaluates rectangular features in *constant* time, which gives them a considerable speed advantage over more sophisticated alternative features. Because each feature's rectangular area is always adjacent to at least one other rectangle, it follows that any two-rectangle feature can be computed in six array references, any three-rectangle feature in eight, and any four-rectangle feature in nine.

1	3	7	5
12	4	8	2
0	14	16	9
5	11	6	10

Source Image

1	4	11	16
13	20	35	42
13	34	65	81
18	50	87	113

Integral Image

Fig 3. Summed Area Table

D. Learning algorithm

The speed with which features may be evaluated does not adequately compensate for their number, however. For example, in a standard 24x24 pixel sub-window, there are a total of M = 162,336 possible features, and it would be prohibitively expensive to evaluate them all when testing an image. Thus, the object detection framework employs a variant of the learning algorithm AdaBoost to both select the best features and to train classifiers that use them. This algorithm constructs a "strong" classifier as a linear combination of weighted simple "weak" classifiers.

Each weak classifier is a threshold function based on the feature. The threshold value and the polarity are determined in the training, as well as the coefficients. Here a simplified version of the learning algorithm is reported:

Input: Set of N positive and negative training images with their labels. If image i is a face, if not.

1. Initialization: assign a weight to each image i.
2. For each feature with 1. Renormalize the weights such that they sum to one.
3. Apply the feature to each image in the training set, then find the optimal threshold and polarity that minimizes the weighted classification error. That is were
4. Assign a weight to that is inversely proportional to the error rate. In this way best classifiers are considered more.
5. The weights for the next iteration, i.e., are reduced for the images i that were correctly classified.
6. Set the final classifier

E. Cascade architecture

On average only 0.01% of all sub-windows are positive (faces). Equal computation time is spent on all sub-windows. Must spend most time only on potentially positive sub-windows. A simple 2-feature classifier can achieve almost 100% detection rate with 50% FP rate. That classifier can act as a 1st layer of a series to filter out most negative windows. 2nd layer with 10 features can tackle "harder" negative-windows which survived the 1st layer, and so on...

A cascade of gradually more complex classifiers achieves even better detection rates. The evaluation of the strong classifiers generated by the learning process can be done quickly, but it isn't fast enough to run in real-time. For this reason, the strong classifiers are arranged in a cascade in order of complexity, where each successive classifier is trained only on those selected samples which pass through the preceding classifiers. If at any stage in the cascade a classifier rejects the sub-window under inspection, no further processing is performed and continue on searching the next sub-window. The cascade therefore has the form of a degenerate tree. In the case of faces, the first classifier in the

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 4, April 2021

DOI 10.17148/IJARCCE.2021.10412

cascade –called the attentional operator –uses only two features to achieve a false negative rate of approximately 0% and a false positive rate of 40%. The effect of this single classifier is to reduce by roughly half the number of times the entire cascade is evaluated.

In cascading, each stage consists of a strong classifier. So all the features are grouped into several stages where each stage has certain The job of each stage is to determine whether a given sub-window is definitely not a face or may be a face. A given sub-window is immediately discarded as not a face if it fails in any of the stages. A simple framework for cascade training is given below:

f = the maximum acceptable false positive rate per layer.
d = the minimum acceptable detection rate per layer.
Ftarget = target overall false positive rate.
P = set of positive examples.
N = set of negative examples.

The cascade architecture has interesting implications for the performance of the individual classifiers. Because the activation of each classifier depends entirely on the behaviour of its predecessor, the false positive rate for an entire cascade.

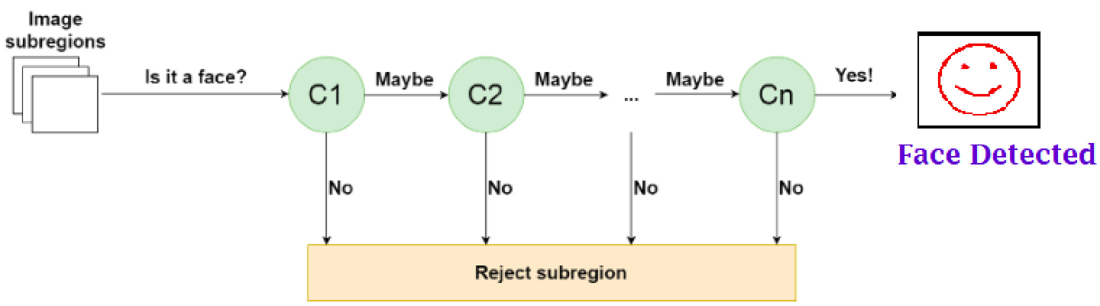

Fig. 4. Cascading Architecture

Similarly, the detection rate is:

Thus, to match the false positive rates typically achieved by other detectors, each classifier can get away with having surprisingly poor performance. For example, for a 32-stage cascade to achieve a false positive rate of 10−6, each classifier need only achieve a false positive rate of about 65%. At the same time, however, each classifier needs to be exceptionally capable if it is to achieve adequate detection rates. For example, to achieve a detection rate of about 90%, each classifier in the aforementioned cascade needs to achieve a detection rate of approximately 99.7%.

F. Adam

Adaptive Moment Estimation (Adam) is the next optimizer, and probably also the optimizer that performs the best on average. Taking a big step forward from the SGD algorithm to explain Adam does require some explanation of some clever techniques from other algorithms adopted in Adam, as well as the unique approaches Adam brings. Adam uses Momentum and Adaptive Learning Rates to converge faster. We have already explored what Momentum means, now we are going to explore what adaptive learning rates means.

G. Adaptive Learning Rate

An adaptive learning rate can be observed in AdaGrad, AdaDelta, RMSprop and Adam, but I will only go into AdaGrad and RMSprop, as they seem to be the relevant one's (although AdaDelta has the same update rule as RMSprop). The adaptive learning rate property is also known as Learning Rate Schedules. Part of the intuition for adaptive learning rates, is that we start off with big steps and finish with small steps –almost like mini-golf. We are then allowed to move faster initially. As the learning rate decays, we take smaller and smaller steps, allowing us to converge faster, since we don't overstep the local minimum with as big steps

VII. AUTOMATIC HAND SANITIZING

Using proximity sensor hand sanitizing is done. A proximity sensor is a non-contact sensor that detects the presence of an object (often referred to as the "target") when the target enters the sensor's field. Depending on the type of proximity sensor, sound, light, infrared radiation (IR), or electromagnetic fields may be utilized by the sensor to detect a target. When a person places his hand in the presence of the sensor the sensor sends signal to the Raspberry pi controller and the connected DC pump is activated and then sanitizer in the bottle is dispensed into the persons hand and until the absence of the persons hand the sanitizer is dispensed accordingly to the need. Then as the target is moved away the dispensing of the sanitizer is stopped and the sensor gives the negative signal.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 4, April 2021

DOI 10.17148/IJARCCE.2021.10412

VIII. DEEP NEURAL NETWORKS

A deep neural network (DNN) is an artificial neural network (ANN) with multiple layers between the input and output layers. There are different types of neural networks but they always consist of the same components: neurons, synapses, weights, biases, and functions. These components functioning similar to the human brains and can be trained like any other ML algorithm. DNNs can model complex non-linear relationships. DNN architectures generate compositional models where the object is expressed as a layered composition of primitives. The extra layers enable composition of features from lower layers, potentially modelling complex data with fewer units than a similarly performing shallow network. For instance, it was proved that sparse multivariate polynomials are exponentially easier to approximate with DNNs than with shallow networks. Deep architectures include many variants of a few basic approaches. Each architecture has found success in specific domains. It is not always possible to compare the performance of multiple architectures, unless they have been evaluated on the same data sets. DNNs are typically feedforward networks in which data flows from the input layer to the output layer without looping back. At first, the DNN creates a map of virtual neurons and assigns random numerical values, or "weights", to connections between them. The weights and inputs are multiplied and return an output between 0 and 1. If the network did not accurately recognize a particular pattern, an algorithm would adjust the weights. That way the algorithm can make certain parameters more influential, until it determines the correct mathematical manipulation to fully process the data. Recurrent neural networks (RNNs), in which data can flow in any direction, are used for applications such as language modelling. Long short-term memory is particularly effective for this use. Convolutional deep neural networks (CNNs) are used in computer vision.

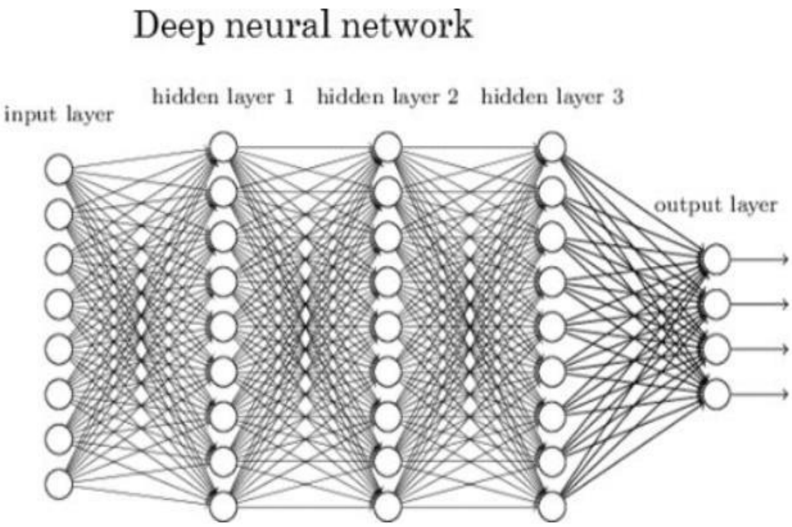

Fig 5. Deep Neural Network Layers

IX. RESULTS AND DISCUSSION

In this section illustrate the experimental results for evaluating the performance of the proposed system. Here PIR motion sensor uses element RE200B for infrared detection. The below figure 6.-12. shows the results for the object detection, temperature checking rate. From the results it is observed that the proposed automatic detection system has good accuracy results compare to the existing manual detection system.

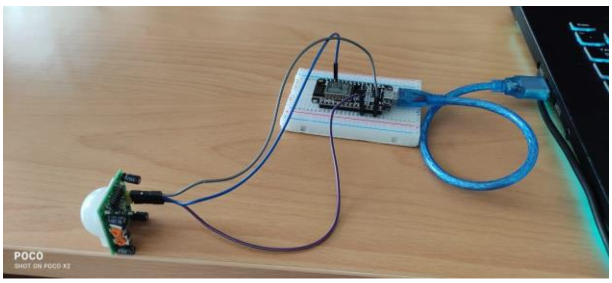

Fig 6. PIR in Idle Position

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 4, April 2021

DOI 10.17148/IJARCCE.2021.10412

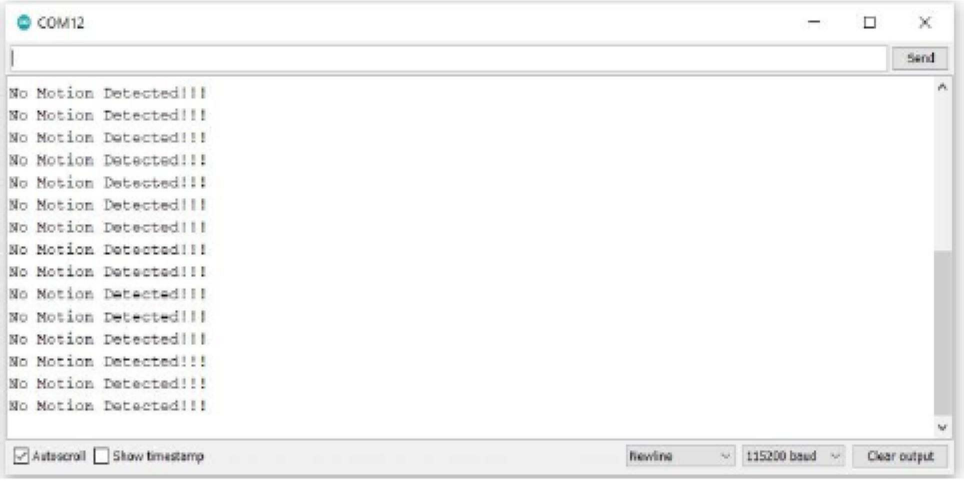

Fig 7. PIR sensor output

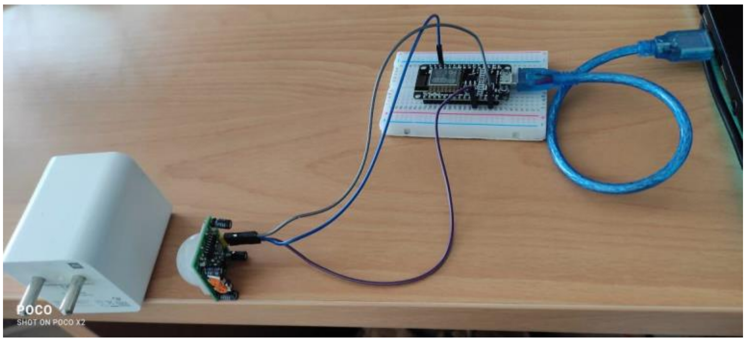

Fig 8. PIR Sensor with Object in Motion

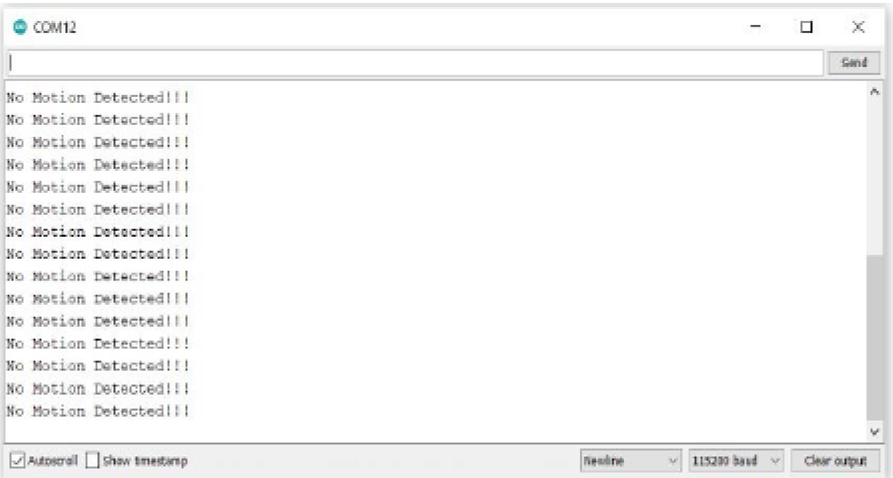

Fig 9. PIR sensor output for object recognition

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 4, April 2021

DOI 10.17148/IJARCCE.2021.10412

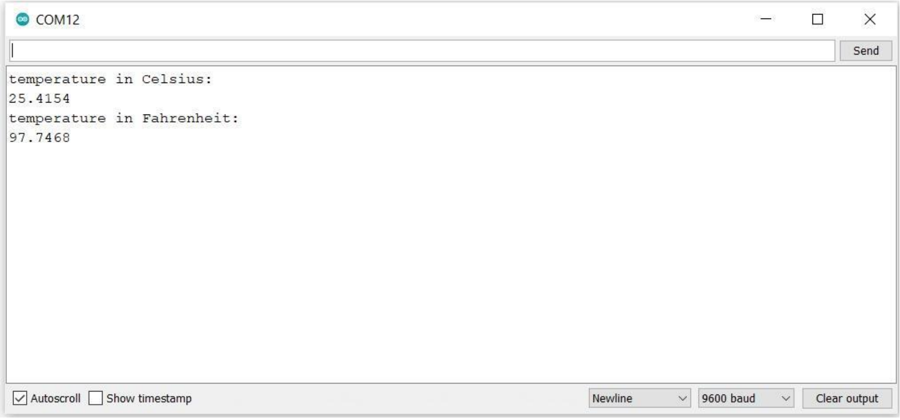

Fig 10. Temperature Sensor Output

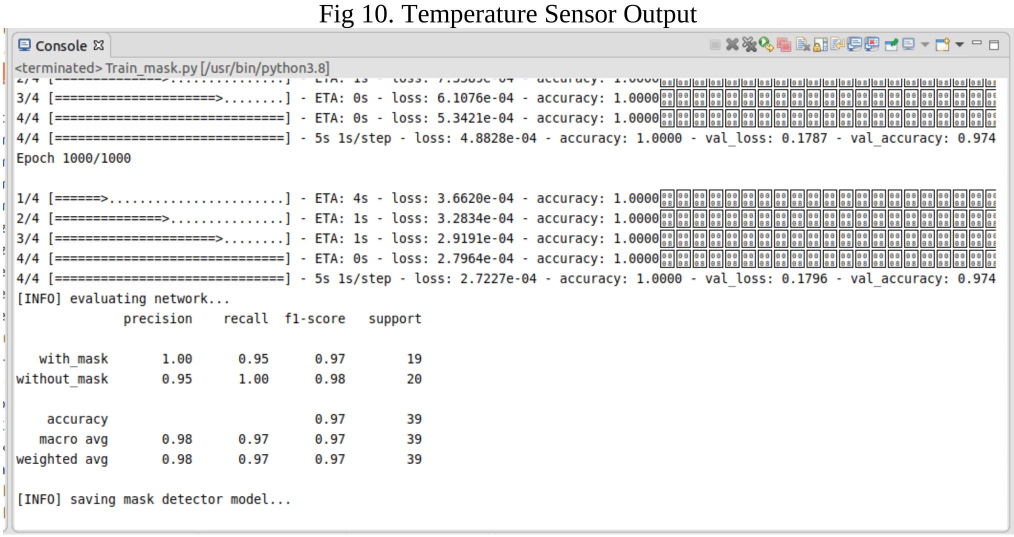

Fig 11. Training dataset

Fig 12. Training accuracy

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Vol. 10, Issue 4, April 2021

DOI 10.17148/IJARCCE.2021.10412

X. CONCLUSION

The main purpose of this project is to automate the manual work of the covid-19 protocols of sanitizing hands, checking the temperature and ensure if people wear mask or not. By this system the spread of the covid-19 virus can be controlled and the accuracy of the temperature checking increases than when it is manually done. The authority of certain management need not worry about the health and care concern of employees or students. Also lack of attention of the personal who checks the conditions can be resolved by this system. Further in future the accuracy of the mask detection can be increased and there is also scope for further development in our project to a great extent. A number of features can be added to this system in future like for security systems and any other outbreak preventing systems. By reporting the information to the government sectors, they can track prevent the spreading. By using these applications, the people can feel more secure and prevent the human generation from getting affected from the life-threatening situations.

REFERENCES

[1]. Karimpour, N., Karaduman, B., Ural, A., Challenger, M., & Dagdeviren, O. (2019, June). IoT based hand hygiene compliance monitoring. In *2019 International Symposium on Networks, Computers and Communications (ISNCC)* (pp. 1-6). IEEE.

[2]. Sorto, A., Marquez, T., Carrasco, A., & Ordoñez, J. (2020, November). Face Recognition and Temperature Data Acquisition for COVID-19 Patients in Honduras. In *Journal of Physics: Conference Series* (Vol. 1710, No. 1, p. 012009). IOP Publishing.

[3]. Huang, Z., Huang, J., Gu, Q., Du, P., Liang, H., & Dong, Q. (2020). Optimal temperature zone for the dispersal of COVID-19. *Science of The Total Environment*, *736*, 139487.

[4]. Bal, M., & Abrishambaf, R. (2017, March). A system for monitoring hand hygiene compliance based-on internet-of-things. In *2017 IEEE International Conference on Industrial Technology (ICIT)* (pp. 1348-1353). IEEE.

[5]. Eddy, Y., Mohammed, M. N., Daoodd, I. I., Bahrain, S. H. K., Al-Zubaidi, S., Al-Sanjary, O. I., & Sairah, A. K. (2020). 2019 Novel Coronavirus Disease (Covid-19): Smart Contactless Hand Sanitizer-Dispensing System Using IoT Based Robotics Technology. *Revista Argentina de Clínica Psicológica, 29*(5), 215.

[6]. Mohammad Marufur Rahman, Md. Motaleb Hossen Manik, Md. Milon Islam, Saifuddin Mahmud, Jong-Hoon Kim, "An Automated System to Limit COVID-19 Using Facial Mask Detection in Smart City Network", IEEE Xplore, 18 Octobre 2020.

[7]. Toshanlal Meenpal, Ashutosh Balakrishnan, Amit Verma, "Facial Mask Detection using Semantic Segmentation", 4th International Conference on Computing, Communications and Security (ICCCS) 2019.

[8]. Hamidreza Fallah-Haghmohammadi, Dan-Sorin Necsulecsu, "Fever Detection for Dynamic Human Environment Using Sensor Fusion"**,** IEEE 2017 .

[9]. Po-Wei Huang, Tzu-Hsuan Chang, Meng-Ju Lee1, Tzu-Min Lin2 , Meng-Liang Chung, Bing-Fei Wu, "An Embedded Non-Contact Body Temperature Measurement System with Automatic Face Tracking and Neural Network Regression", International Automatic Control Conference (CACS), 09 November 2016.

[10]. Nenad Petrović and Đorđe Kocić, "IoT-based System for COVID-19 Indoor SafetyMonitoring", Conference Paper, 20 September 2020.

[11]. Enerst Edozie, Wantimba Janat, Zaina Kalyankolo, "Design and Implementation of a Smart Hand Sanitizer Dispenser with Door Controller using ATMEGA328P", International Journal of Engineering and Information Systems (IJEAIS), Volume: 04 Issue: 6 June 2020.