ISSN: 2278-4632
Vol-12 Issue-01 No.01: 2022

FACE MASK DETECTION AND TEMPERATURE SCANNING MACHINE USING ARDUINO AND ESP-32 CAMERA.

G. Bhavya Sri, M. Tejaswi, K. Hema Reshma, K. Anjana, A. Nagajyothi

Mail id: aggala.jyothi@gmail.com

Department of Electronics and Communication, Vignan's Institute of Information Technology, Duvvada, Visakhapatnam. Andhra Pradesh, India.

Abstract:

Corona virus is responsible for many deaths in recent years. Effective approaches to restrain COVID-19 pandemic need high attention these days. Wearing face masks is one of the important measures for the personal protection to prevent the spread of corona virus. But most of the people are not wearing face mask in public places which increases the spread of many viruses. High temperature is one of the main symptoms of many viruses. So, face mask detection and temperature scanning is significant in public places. In this paper, a simple and effective model for monitoring face mask and temperature scanning with automated gate control is proposed. The model is implemented using Arduino Technology & ESP-32 Camera Module.

Keywords:

Face mask detection, Temperature Scanning, Arduino, ESP-32 Camera, Contactless temperature Sensor.

Introduction:

COVID-19 brought a drastic change in the lives of humankind. The corona virus disease originated at Wuhan city of China in December 2019, has spread to several countries including India. Due to the spread of this virus many people lost their lives across the world. According to World Health Organization (WHO) over 500 million COVID cases are confirmed and over 6 million deaths are reported globally. Only during a week in April, 2022 more than 5 million confirmed cases and over 18,000 deaths have been reported in the six WHO regions (i.e., Western Europe, Central and Eastern Europe, Asia, Africa, Mediterranean & Middle East, America) [18].

The corona virus in most cases is transmitted directly from person to person, but in some cases, it is indirectly spread via surfaces. Due to these reasons, many protectional safety measures were taken by World Health Organization (WHO) to reduce the spread of the virus like wearing face masks, maintaining social distance, quarantine for affected people, limiting citizens' movement within country borders as well as abroad.

One of the major symptoms of the virus is high temperature. So, temperature scanning must be deployed in public places to avoid the spread of virus to some extent. WHO has always given priority to ensure safety measures like face mask and respirators for the health care assistance. So, the importance of face mask is a crucial task in present situation. The proposed model will help the people in ensuring safety and health by implementing face mask detection and temperature scanning.

Copyright @ 2022 Author

ISSN: 2278-4632
Vol-12 Issue-01 No.01: 2022

Literature Review:

In this catastrophic pandemic, it is indispensable to protect ourselves and others around by taking appropriate precautions to avoid the spread of the virus. So, the significance of face mask detection and temperature scanning machine has increased. In numerous localities, temperature guns operated by humans are available, but are not an efficient way as the virus may spread to the person in charge of monitoring and the temperature measured may not be accurate also. To resolve this issue an automated face mask detection and temperature scanning machine is introduced. Earlier on, some projects using the concepts of Neural Networks and Deep Learning were enforced for this purpose.

In particular, face mask detection was implemented using Convolutional Neural Networks (CNN) that captures real time video using Closed- Circuit Television (CCTV) and report it to corresponding officials. In this model the CCTV captures the live images which are then processed using a Deep Learning architecture technique which is highly based on CNN and if the person without mask is detected then the picture of the person along with his location is sent to the corresponding authority via sms. It had an accuracy of face mask detection of 98.7%. But this model, couldn't identify a person without mask on a vehicle. In a very densely populated area also this model couldn't distinguish the face of each person. This model was tested using a dataset consisting of 1539 samples among which 80% were used for training the model and remaining 20% were used while testing the model [6].

An alternate model was realized using YOLO algorithm of Neural Networks along with the concepts of Machine Learning. This model was implemented with a two-stage detector. First stage detector had the input, backbone, neck and the dense prediction while the second stage detector had the sparse detection to identify and understand the object by the bounding boxes and the classes of object. It had a web cam and a speaker. The web cam continuously monitors and the speaker is used to alert the person if no mask is detected. The second stage predictor in this model applies the faster R-CNN as the prediction method. In this model even if they were some disturbances in the surrounding it was successfully able to determine the person [7].

A multi task Deep Learning method like F-DR Net is implemented for face mask detection. This model used Tensor Flow as a backend to operate the CNN architecture in the backend. All the layers of CNN architecture that were used in the model was implemented using Keras. The F-DR Net was used for object detection and recognition for this purpose. It had 2D convolutional layers connected to the layers of dense neutrons. It was trained and tested using two data sets. In one data set it had an accuracy about 95.77% and in the second one it had an accuracy about 94.58%. This model faced challenges due to the lack of clarity and the varying angles of the person [9].

A model based on Neural Networks is imposed along with Arduino to contrive face mask detection and temperature scanning machine. This model was first trained using some datasets and they trained by rotating and flipping the samples in the dataset. These are trained and tested on CNN architecture [15]. The CNN architecture was build using various layers such as Conv2D, Flatten, Dense etc. The model was built using the Keras library. The output was labelled with two probabilities based on which the output was determined [10].

Copyright @ 2022 Author

ISSN: 2278-4632
Vol-12 Issue-01 No.01: 2022

Different models were implemented on Deep Neural Networks using Yolov3 model & data sets like CLAHE data set [11].

Along with these concepts, a project for this purpose is also realized using Raspberry Pi Technology using Pi camera [12]. This model detects the people that pass through it and identifies the face mask usage. It also detects the thermal heat of people. It used the software like Anaconda Navigator, Python idle etc. An infrared thermopile sensor was used for temperature measurement in this project. Different algorithms like HMM, SVM, Adaboost learning was used while implementing this model [13].In this paper, a project for face mask detection and temperature scanning is proposed using Arduino, ESP-32 Camera Module and contactless temperature sensor as primary elements.

Methodology:

The ESP-32 Camera Module captures the real time images in this proposed project and the images are processed by the Tensilica Xtensa LX6 processor and given to Arduino for further processing. Similarly, the signal from temperature sensor is transmitted to Arduino. After further processing by the Arduino, it determines whether the person is wearing face mask and also if the temperature is below the threshold level or not. The entire model is programmed for face mask and temperature detection as shown in figure 1.

Step 1: Programming the ESP-32 Camera Module

The ESP-32 Camera is programmed such that it captures the images of real world and send the images to Arduino UNO.

Step 2: Programming the Arduino UNO for Face Mask Detection

The Arduino UNO is programmed such that it receives data from ESP-32 Camera Module and temperature sensor. The data received from ESP-32 is processed and if more than 80% of face mask is detected then the Arduino checks the signal from temperature sensor otherwise Arduino will send signal which rings the buzzer that is connected to it.

Step 3: Programming the Arduino UNO for Temperature Scanning

The Arduino UNO is programmed in such a manner that the threshold of the temperature sensor is set to 99ºF, which is the average human temperature. If the signal received from temperature sensor exceeds the threshold, then the Arduino will again send signal which rings the buzzer. If the temperature is below the threshold value, then the Arduino will send corresponding signals to Servo.

Step 4: Programming the Arduino UNO for Gate Controlling

If the face mask and normal temperature are detected then the Arduino will send signal to the Servo that makes the gate connected to it open for a predefined time limit. After the time limit exceeds, Arduino sends another signal to the Servo to close the gate [1].

Copyright @ 2022 Author

ISSN: 2278-4632
Vol-12 Issue-01 No.01: 2022

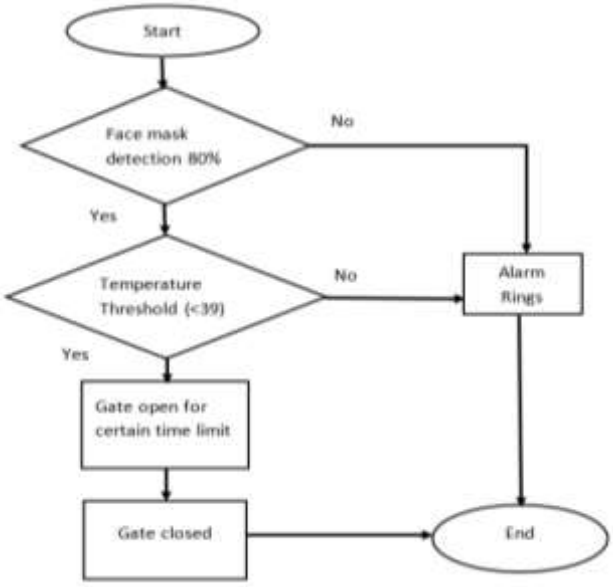

Fig. 1: Flowchart for Operation of the proposed model

Hardware Requirements:

1. **Arduino UNO:**

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc [2]. The board is having a provision of sets of digital and analog input/output (I/O) pins that can be interfaced to different expansion boards (shields) and also to the other circuits. The board has 14 digital Input/Output pins (six capable of PWM output), 6 analog Input/Output pins, and is programmable with the Arduino Integrated Development Environment (IDE), through a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, although it accepts voltages between 7 and 20 volts. It has an UART, I2C and also a SPI pin as shown in figure 2.

While the Arduino Uno communicates using the original STK500 protocol, it differs from all preceding boards in that it doesn't use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 programmed as a USB-to-serial converter. It has an SRAM (Static RAM) of 2 KB and an EEPROM (Electrically Erasable Programmable Read Only Memory) of 1 KB. It has a clock speed of 16 MHz. It has 14 digital pins and 6 analog pins on the Uno can be used as an input or output, under software control (using pinMode(), digitalWrite(), and digitalRead() functions). They operate at 5 volts.

Copyright @ 2022 Author

ISSN: 2278-4632
Vol-12 Issue-01 No.01: 2022

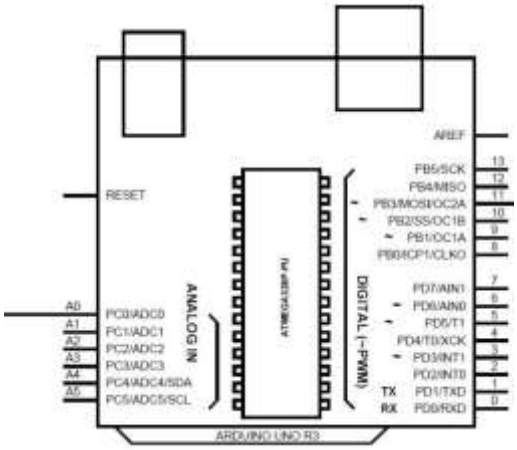

Fig. 2: Arduino UNO

The Arduino Uno has many facilities for communicating with a computer or another Arduino board and also with other microcontrollers. The ATmega328 has UART TTL (5V) that provides serial communication, which is present on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board provides this serial communication over USB and is to be seen as a virtual communication port to software that is present on the computer. The 16U2 firmware use the standard USB COM drivers, and it does not need any external driver [3].

Other than pressing the reset button before uploading, the Arduino UNO board is designed in a way that allows it to be reset by software running on the computer that is connected to it. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 through a 100 nano-farad capacitor. When this line is asserted, the reset line drops long enough to reset the chip.

ESP-32 Camera Module:

The ESP32-CAM is a small size, low power consumption camera module based on ESP32. It comes with an OV2640 camera and provides onboard TF card slot as shown in figure 3. The ESP32-CAM can be widely used in intelligent IoT applications such as wireless video monitoring, WiFi image upload, QR identification, and so on. It has an onboard ESP32-S module, supports WiFi + Bluetooth. It comprises of a OV2640 camera with flash. It supports onboard TF card slot, supports up to 4G TF card for data storage. It supports WiFi video monitoring and WiFi image upload. It also supports multi sleep modes, deep sleep current as low as 6mA.Its control interface is accessible through pinheader, easy to be integrated and embedded into user products. It also has an onboard antenna [14].

Copyright @ 2022 Author

ISSN: 2278-4632
Vol-12 Issue-01 No.01: 2022

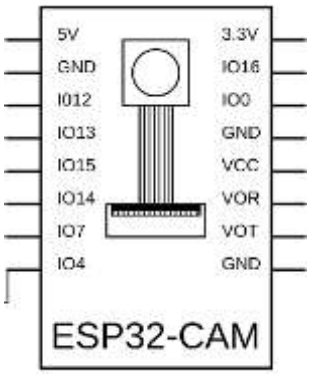

Fig. 3: ESP-32 Camera Module

It supports Bluetooth 4.2 BR/EDR and BLE. It supports IEEE 802.11 b/g/n/e/i Wi-Fi protocol.It supports security types of WPA/WPA2/WPA2-Enterprise/WPS. The ESP32-CAM suit for IOT applications such as Smart home devices image upload, Wireless monitoring, Intelligent agriculture, QR wireless identification, Facial recognition etc [17].

MLX90614 Contactless Temperature Sensor:

The MLX90614 is a Contactless Infrared (IR) Digital Temperature Sensor that can be used to measure the temperature of a particular object ranging from -70° C to 382.2°C. The sensor uses IR rays to measure the temperature of the object without any physical contact and communicates to the microcontroller using the I2C protocol [5].

The key feature of MLX90614 is that it is a contactless IR temperature sensor with high accuracy. So, it can be used in industries to measure the temperature of moving objects like a rotating motor shaft. Due to its high accuracy and precision, it is also used in a wide range of commercial, health care, and household applications like room temperature monitoring, body temperature measurement, etc. The MLX90614 sensor can measure the temperature of an object without any physical contact with it. This is made possible with a law called **Stefan-Boltzmann Law**, which states that all objects and living beings emit IR Energy and the intensity of this emitted IR energy will be directly proportional to the temperature of that object or living being. So the MLX90614 sensor calculates the temperature of an object by measuring the amount of IR energy emitted from it. The MLX90614 Temperature sensor is manufactured by a company called Melexis. The sensor is factory calibrated and hence it acts like a plug and play sensor module for speeding up development processes. The MLX90614 consists of two devices embedded as a single sensor, one device acts as a sensing unit and the other device acts as a processing unit. The sensing unit an Infrared Thermopile Detector called MLX81101 which senses the temperature and the processing unit is a Single Conditioning ASSP called MLX90302 which converts the signal from the sensor to digital value and communicates using I2C protocol. The MLX90302 has a low noise amplifier, 17-bit ADC and a powerful DSP which helps the sensor to have high accuracy and resolution[8].

Copyright @ 2022 Author

ISSN: 2278-4632
Vol-12 Issue-01 No.01: 2022

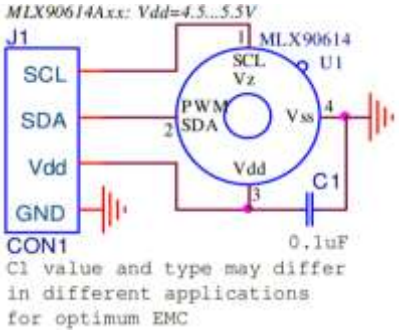

Fig. 4: MLX90614 Temperature Sensor Module

The sensor requires no external components and can be directly interfaced with a microcontroller like Arduino. As you can see above the power pins (Vdd and Gnd) can be directly used to power the sensor, typically 5V can be used, but there are other versions of this sensor which can operate on 3.3V and 7V as well. The capacitor C1 is optional and is used to filter noise and provide optimum EMC [16]. The signal pins (SCL and SDA) for used for I2C communication and can be connected directly to microcontroller operating on 5V logic as shown in figure 4.

Implementation:

This project consists of Arduino UNO to which the ESP-32 Camera Module and Contactless IR temperature sensor are connected as inputs. The LCD Display is used to display the scanning, input, output and any other status of the model.

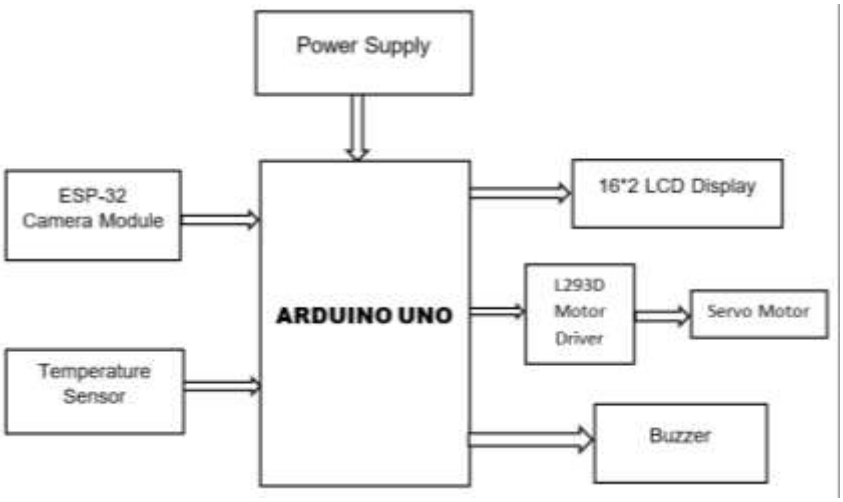

Fig. 5: Block Diagram

The SG-90 Servo motor is connected to the Arduino for gate controlling with the L293D Motor Driver[4]. A Buzzer also connected to Arduino for indicating the high temperature or person without face mask as shown in the figure 5.

Conclusion:

In this work, a face mask detection and temperature scanning machine is successfully implemented using the Arduino Technology. The entire model is programmed using Embedded C, Arduino, ESP-32 CAM and contactless temperature sensor (MLX90614) and

Copyright @ 2022 Author

ISSN: 2278-4632
Vol-12 Issue-01 No.01: 2022

all the modules controlled and which enhanced to control the gate and only allow the people with face mask and normal temperature.The proposed model is tested in different conditions by capturing different persons. It was able to detect the face mask in many conditions. It detects different types of masks and normal temperature. The model is also tested with people of different temperatures. It was able to detect accurately if the person has high temperature or not. Its performance is limited to the lightning conditions. It was not able to detect face mask accurately in poor lightning conditions.This project is mainly emphasized to use in schools, colleges and in public places at the main gate entrance.

References:

[1]. Moyeed Abrar, "Interfacing a Servo Motor with Arduino UNO Microcontroller", International Journal of Recent Scientific Research, Vol. 10, Issue 2, 2019.

[2]. Yusuf Abdullahi Badamasi, "The working principle of an Arduino", International Conference on Electronics, Computer and Computation (ICECCO), Issue: 2014 (IEEE).

[3]. Leo Louis, "Working Principle of Arduino and Using it as a Tool for Study and Research", International Journal of Control, Automation, Communication and Systems (IJCACS), Vol. 1, No.2, April 2016.

[4].Onyinye Florence IKPEZE, Emmanuel Chidiebere UWAEZUOKE, Bola-Matanmi SAMIAT, Kola Mikael KAREEM, "Design and Construction of an Automatic Gate", ABUAD Journal of Engineering Research and Development (AJERD), Vol. 2, Issue 2, 123-321, 2019.

[5]. Puput W. Rusimamto, Rina Harimurti, Endryansyah, Yeni Anistyasari, Lilik Anifah, "Design and Implementation of Thermal Body System Employing Thermal Sensor MLX90614 for Covid-19 Symptoms Early Detector", International Joint Conference on Science and Engineering (IJCSE), Issue: 2020.

[6]. Md. Marufur Rahman, Md. Motaleb Hossen Manik, Md. Milon Islam, Saifuddin Mahmud, Jong-Hoon Kim, "An Automated System to Limit COVID-19 Using Face Mask Detection in Smart City Network", Institute of Electrical and Electronics Engineers (IEEE), Issue:2020.

[7]. Susanto, Febri Alwan Putra, Riska Analia, Ika Karlina Laila Nur, "The Face Mask Detection For Preventing the Spread of COVID-19 at Politeknik Negeri Batam", 2020 3rd International Conference on Applied Engineering(ICAE), Issue: 2020(IEEE).

[8]. Asif Ahmed, Md. Noor Abdullah, Ishkrizat Taib, "Design of a Contactless body temperature measurement system using Arduino", Indonesian Journal of Electrical Engineering and Computer Science, Issue 2020.

[9]. A.A. Abd El-Aziz, Nesrine A. Azim, Mahmood A. Mahmood and Hamoud Alshammari, " A Deep Learning Model for Face Mask Detection", International Journal of Computer Science and Network Security, VOL,21 No.10, October, 2021.

[10]. Megha Warungase, Ruchita Wagh, Komal Jundre, Prof. S. G. Chordiya. "Face Mask and Body Temperature Detection System to Prevent COVID for Work Environment", International Journal of Advance Research and Innovative Ideas in Education (IJARIIE), Vol-7 Issue-3 2021.

Copyright @ 2022 Author

ISSN: 2278-4632
Vol-12 Issue-01 No.01: 2022

[11]. Natalia Glowacka, Jacek Ruminski, "Face with Mask Detection in Thermal Images Using Deep Neural Networks", Multidisciplinary Digital Publishing Institute (MDPI) Journals Sensors 2021.

[12]. D. Kavya Preethi, M. Mani Venkata Sai, K. Sowmya Sri, G. Krishna Sai, "Automatic Temperature Scanner and Face Mask Detection Using IoT", Journal of Emerging Technologies and Innovative Research (JETIR), Volume 8, Issue 7, 2021.

[13]. Bhuvan R, "Face Mask and Temperature Detection", International Journal of Innovative Science and Research Technology, Volume 6, Issue 8, 2021.

[14]. Vaibhav, Shubham, Anuj Kumar, " Advance Face Lock and Automation using ESP32 Cam", International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE), Vol 8, Issue 9, 2021.

[15]. Davang Sikand, Jaya Krishna Raguru, Vijay Kumar Sharma, "Alert System for Face Mask Detection using CNN", 5th International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud), Issue 2021.

[16]. Subandi, Agus Setiyo Budi Nugroho, Nurkamilia, Aulia Akhrian Syahidi, "Body Temperature Measurement Tool for Early Detection of COVID-19 Based on Interactive Augmented Reality Technology and Sensor MLX90614: Framework and Prototyping", Jurikom (Jurnal Riset Komputer), Vol.8 No. 5 , Issue: 2021.

[17]. Hemanth Kumar MS, "ESP-32 CAM for Face Mask Detection", International Journal of Advanced Research in Science, Communication and Technology (IJARSCT), Vol. 2, Issue 1, February 2022.

[18]. Weekly epidemiological update on COVID-19 – 20 April 2022, "www.who.int/publications/m/item/weekly-epidemiological-update-on-covid-19---20-april-2022".

Copyright @ 2022 Author