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AUTOMATIC COVID-19 FACE MASK AND BODY TEMPERATURE DETECTION WITH DEEP LEARNING AND COMPUTER VISION

[1]NaveenKumar K, [2]Surya.S, [3]Mohammed Nihaal. S. S, [4]Suranthar. S, [5]Manoj Kumar. A

[1]Assistant Professor, [2]Student, [3]Student, [4]Student, [5]Student
[1]Department of Mechanical and Automation Engineering,
[1]SNS College of Technology, Coimbatore, India

Abstract: The data obtained from different sources such as the World Health Organization, the Wikipedia, Government Health Ministries, The New York Times, and other sources show that COVID-19 has sickened more than 127 million people worldwide and has killed more than 2 million people. The two main protocols that need to be followed in public places in order to prevent the further spread of the virus is by wearing face masks and following safe social distancing. To create a safe, COVID-19 free environment, we propose a dynamic Computer Vision based automated solution system focused on the real-time face monitoring of people to detect both face masks and body temperature in public places by using Raspberry Pi 4 Model B to detect face mask protocol violations through an integrated Pi camera and to monitor body temperature with the help of MLX90614 sensor. A security clearance system is deployed that will allow that person to enter if they are wearing a face mask and their body temperature is in check with WHO guidelines. Thus, the above said system will help the society by saving time and also helps in contaminating the spread of coronavirus. This can be implemented in public places such as colleges, schools, offices, shopping malls, etc. to inspect people.

Index Terms **- Deep Learning, Open CV, Keras, Python, Tensor Flow, Computer Vision, Raspberry Pi, COVID-19.**

I. INTRODUCTION

Since the COVID-19 outbreak, it has been a great challenge to identify people who are affected by COVID-19, because so many people with COVID-19 showed no symptoms. COVID-19 ICMR antibody kits produced high rate of false negatives that incorrectly show a person isn't infected. One notable symptom of COVID-19 is high body temperature. So, WHO has advised for body temperature screening to identify COVID-19. It is also necessary to wear face mask in public places, as numerous researches show the effectiveness of wearing facemask that reduces the spread. There are many temperature guns available but they are not smart enough to check temperature and facemask at the same time and alert the respected authorities to take necessary actions if the protocol is not followed.

In many parts of the world many humans have been employed at public places of interest such as shops, cinemas, shopping malls, schools, colleges, railway stations etc. to ensure people wearing facemask and to screen body temperature. This could be one of the worst and risky jobs that anyone can land into, asking people to wear facemask and to check their body temperature. It could also lead to the transmission of COVID-19 from the common people to the concerned person who is in charge of monitoring facemask and body temperature.

The solution to this problem is to deploy an automated facemask and body temperature detection system powered by Raspberry Pi microcontroller. This setup has its own camera module through which it monitors facemask and it has a non-contact temperature sensor to read the body temperature and allows the person if they clear the COVID-19 protocols or it will alert the respected authorities.

II. DESIGN

2.1 Raspberry Pi

We have gone with the latest release from the Raspberry Pi Foundation, the Raspberry Pi 4B. It offers greater speed, multimedia performance, memory and connectivity compared to the previous generation. It is a credit card sized microcontroller

Fig.1

which hosts our software and collects data from the attached peripherals and it performs action based on the set condition given to the Raspberry Pi. It has a quad-core CPU that can run at speeds up to 1.5GHz and the new Video Core VI 3D unit now runs at up to 500 MHz. The on-board memory ranges from 1 GB to 8 GB RAM.

2.2 Camera Module

A 5MP Raspberry Pi Camera Module Rev 1.3 is used for this setup. Any USB webcam can be used with the Raspberry Pi 4. The 5MP camera module is perfect for small Raspberry Pi projects which have very little space allowance. The high-definition 5MP camera delivers outstanding photos but can also shoot video, ideal for drones or a CCTV project. The Raspberry Pi 4 continuously receives signal from the 5MP Camera module for further calculations.

2.3 TFT LCD Display for Raspberry Pi

This TFT LCD Display for Raspberry Pi has 5″ size which features 800×480-pixel resolution. It is used to display camera feed from the Raspberry Pi and to show body temperature readings. It is also used to navigate through the Raspberry Pi itself.

2.4 MLX90614 Non-Contact Infrared Temperature Sensor

The MLX90614 ESF is an Infra-Red thermometer for non-contact temperature measurements. We are using it here to detect body temperature. It has a range of -20 to 120 °C. It detects the body temperature of the person and sends the reading to the Raspberry Pi.

2.5 Servo Motor

A servo motor is a rotary actuator or a linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. We have used the servo motor for controlling the barrier arm that will allow the person to pass through or not.

2.6 LEDs

Here we have used two different LEDs that emit green and red light. If the person has a facemask and his body temperature is lower than the protocol value then the Green LED will turn on, if not the Red LED will turn on.

2.7 Buzzer

If the person has a facemask and the body temperature is below the protocol value then the buzzer will buzz for a single time, if not then it will buzz continuously for 5 times which will be helpful in alerting the respected authorities.

III. SOFTWARE & LIBRARIES

3.1. MACHINE LEARNING

Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. Machine learning focuses on the development of computer programs that can access data and use it to learn for themselves.

The process of learning begins with observations or data, such as examples, direct experience, or instruction, in order to look for patterns in data and make better decisions in the future based on the examples that we provide. The primary aim is to allow the computers learn automatically without human intervention or assistance and adjust actions accordingly.

But, using the classic algorithms of machine learning, text is considered as a sequence of keywords; instead, an approach based on semantic analysis mimics the human ability to understand the meaning of a text.

3.2 COMPUTER VISION

Computer vision is the field of study surrounding how computers see and understand digital images and videos. Computer vision spans all tasks performed by biological vision systems, including "seeing" or sensing a visual stimulus, understanding what is being seen, and extracting complex information into a form that can be used in other processes. This interdisciplinary field simulates and automates these elements of human vision systems using sensors, computers, and machine learning algorithms. Computer vision is the theory underlying artificial intelligence systems' ability to see and understand their surrounding environment.

3.3 DEEP LEARNING

Deep Learning Deep learning is an artificial intelligence function that imitates the workings of the human brain in processing data and creating patterns for use in decision making. Deep learning is a subset of machine learning in artificial intelligence that has networks capable of learning unsupervised from data that is unstructured or unlabeled. Also known as deep neural learning or deep neural network.

3.4 OPENCV

OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products. Being a BSD-licensed product, OpenCV makes it easy for businesses to utilize and modify the code. The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together to produce a high resolution image of an entire scene, find similar images from an image database, remove red eyes from images taken using flash, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc. We have used functions available in this library to implement our facial recognition part.

3.5 TENSORFLOW

TensorFlow is a free and open-source software library for dataflow and differentiable programming across a range of tasks. It is a symbolic math library, and is also used for machine learning applications such as neural networks. It is used for both research and production at Google, TensorFlow is Google Brain's second-generation system. Version 1.0.0 was released on February 11, While the reference implementation runs on single devices, TensorFlow can run on multiple CPUs and GPUs (with optional CUDA and SYCL extensions for general-purpose computing on graphics processing units).

3.6 KERAS

Keras is an API designed for human beings, not machines. Keras follows best practices for reducing cognitive load: it offers consistent & simple APIs, it minimizes the number of user actions required for common use cases, and it provides clear & actionable error messages. It also has extensive documentation and developer guides. Keras contains numerous implementations of commonly used neural-network building blocks such as layers, objectives, activation functions, optimizers, and a host of tools to make working with image and text data easier to simplify the coding necessary for writing deep neural network code.

3.7 PYTHON

Python is an interpreter, high-level, general-purpose programming language. Python's design philosophy emphasizes code readability with its notable use of significant whitespace. Its language constructs and object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects. We have used this software to write our facial detection program and all the necessary above said libraries are installed here.

IV. PROPOSED SYSTEM

4.1 FACEMASK DETECTION

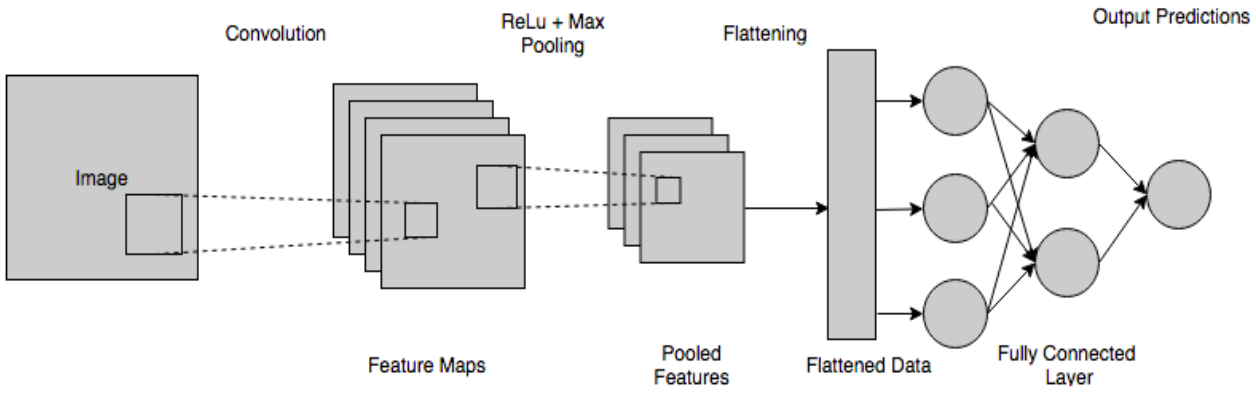

Fig.2

This system will help identify people on image/ video stream wearing a facemask with the help of Deep Learning and Computer Vision algorithms by using various libraries such as OpenCV, Keras, TensorFlow etc. The images are downloaded from various open source websites and are differentiated as “mask” and “no mask”. The images that we downloaded were of different sizes and different resolutions.

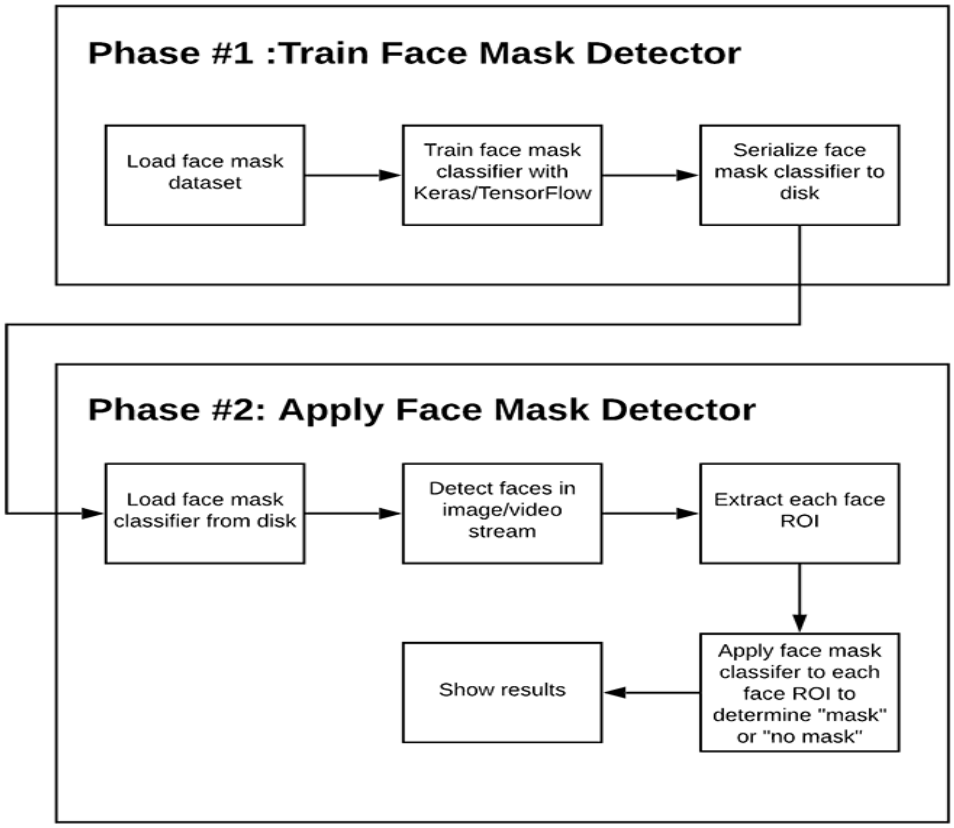

Fig.3

- Resizing the input image (256 x 256)
- Applying the color filtering (RGB) over the channels (Our model MobileNetV2 supports 2D 3 channel image)
- Scaling / Normalizing images using the standard mean of PyTorch build in weights
- Center cropping the image with the pixel value of 224x224x3
- Finally Converting them into tensors (Similar to NumPy array)

We trained the model using tensor-flow retrain which captures the essential differentiating features between the classes of images. The differentiating features are saved in the form of a graph. It is trained once and reused to classify the input images into categories for which it is trained. Later, this trained graph is used by the Image classification algorithm for authentication.

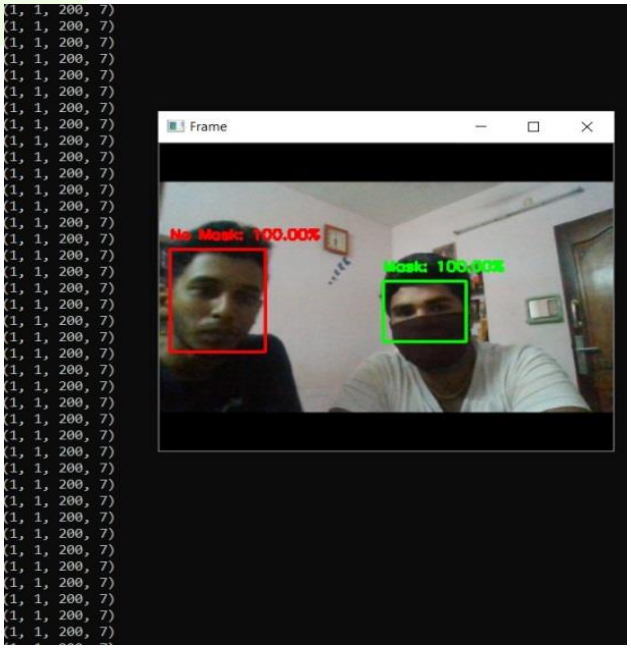

Fig.4

4.2 CONTACTLESS TEMPERATURE DETECTION

The MLX90614 sensor is a non-contact infrared temperature sensor which detects temperature varying from -20 to 120 °C. It can communicate with the microcontroller through I2C interface. Being an I2C device you simply need to connect to the SDA, SCL and choose a suitable GND and Vin, either 3.3V or 5V.

4.3 SYSTEM FLOW

To identify the faces a pre-trained model provided by the OpenCV framework was used. The model was trained using web images. This facemask data detected by the Raspberry Pi camera is sent to the Raspberry Pi 4 for processing. Now the temperature will be checked with the help of MLX90614 sensor. Now the data will be processed on the Raspberry Pi and, if the concerned person has worn the mask and the body temperature is below the threshold then the green light will turn on along with the buzzer buzzing for a single time and the door will be unlocked. On the other hand, if the concerned person has failed to wear facemask or the temperature is higher then, the red light will be turned on. Now the buzzer will buzz for 5 times to alert the respected authorities.

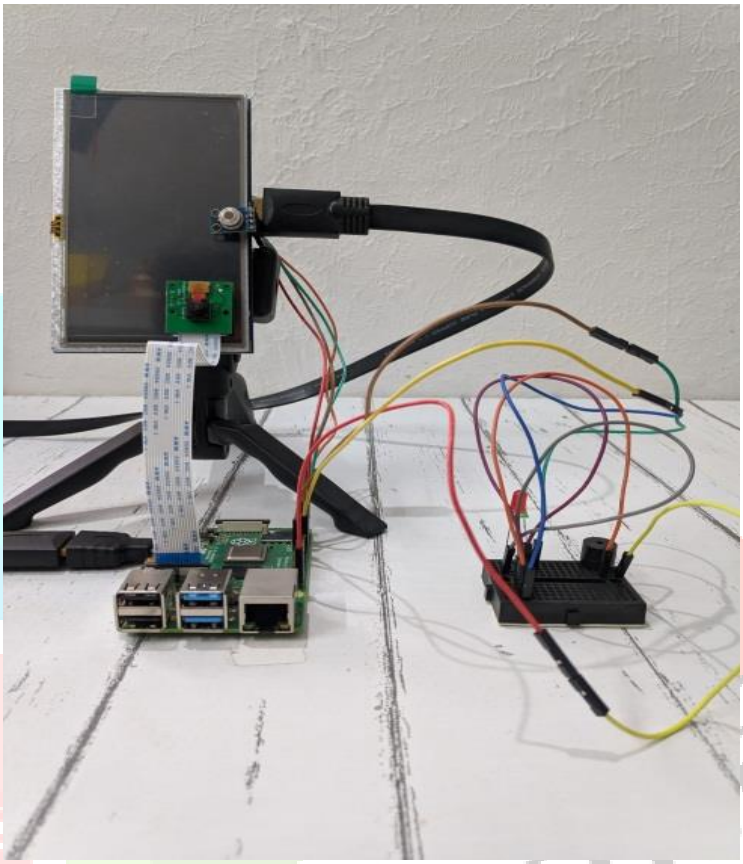

Fig. 5

V. CONCLUSION

In this project we have successfully implemented a working prototype of Face Mask and Body Temperature detection system. This project can be used in places with large gatherings such as schools, colleges, offices, shopping malls etc. The system first detects whether the person is wearing a facemask and sends the data to the microcontroller. The non-contact temperature sensor reads the person's body temperature and upon checking it opens the barrier arm and allows the person inside. With the help of this project an automized solution is achieved hence there's no need for any human to monitor COVID-19 protocols. The accuracy of facemask detection can be achieved by training the module with a larger image dataset. Raspberry Pi 4B has almost the necessary computational power for detecting facemask from image/video stream but with future Raspberry Pi releases, the process can be done with ease.

In conclusion, Face Mask and body temperature detection can help us to reduce the large gathering of people in one place without masks, reducing the risk of getting infected.

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