OpenCV-based Smart Face Mask Recognition System

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Abstract -Covid 19 has been spreading like wildfire over the globe. It has infected a large number of people, and because it was a novel virus, there were no previous medicines or vaccines available to combat it. It took a year for scientists to discover the vaccine and distribute it; it will take another year or two for everyone to get vaccinated; until then, the most basic and effective approach to protect ourselves from disease is to maintain good hygiene andwear a face mask. However, because the casual attitude of not wearing a face mask in public places has increased the number of corona virus cases, it is difficult for government bodies to monitor these places. As a result, we need a valid system that will monitor these places with maximum social distance and precision—a face mask detection system.The technology will distinguish between persons wearing masks and those who are not wearing masks, and will accept the person who is wearing a mask. For example Malls, schools, colleges, hospitals, government, public meetings, and bus terminals are examples of places where monitoring is required. This can be accomplished by using OpenCV on Raspberry pi. Growth can be defined as the utilization of technology in a more intelligent manner.

Key Words:Deep Learning, OpenCV, Raspberry Pi, Camera Module, TenserflowKeras, Relay Module, Electromagnetic Lock

1.INTRODUCTION

The year 2020 has thrown mankind a mind-boggling succession of catastrophes, the most life-changing of which is the COVID-19 epidemic, which has shocked the world since the year began. COVID-19 has urged for severe measures to be followed in order to avoid the spread of disease, which has an impact on the health and life of many people.In order to prevent the transmission of disease, COVID-19 has called for severe procedures to be implemented. People are doing everything they can to ensure their own and society's safety, from the most basic hygiene standards to medical treatments; face masks are one of the personal protection equipment.A strategy should be devised to ensure that people obey this essential safety guideline. To check this, a face mask detection system can be used. Face mask detection refers to determining whether someone is wearing a mask or not.

Essentially, while some individuals dislike being compelled to do anything, especially by the government, scientists have demonstrated that taking this extra precaution (together with social distance) tends to dramatically reduce coronavirus spread.

This research article discusses advancement in method of face mask recognition using OpenCV which mainly aim to process real-time computer vision on Raspberry Pi. The camera module will capture the image and send it to the processor, who will compare it to the data set provided. If the person in the image is wearing a mask, the processor will send commands to the relay, which will turn on the electromagnetic door lock, and the door will be open.

If the camera takes an image of a person who is not wearing a mask, the image is sent to the processor, who compares it to the dataset and sends commands to turn off the relay. The door will remain closed if the relay does not switch on.

2. LITERATURE SURVEY

The information age is quickly revolutionizing the way transactions are completed. There is a need for a faster and accurate user identification and authentication method. Face recognition has become one of the most important user identification methods.Face recognition research is in a growing era, according to literature survey figures, and research in this field has expanded tremendously in the last forty years.Face recognition software imitates the ability of human eyes to recognise faces.

This is accomplished by smart computing, which generates a "facial bunch" of 70 nodal points. The face's features are retrieved and preserved as templates. The face detected is compared to these templates.

We connected an LCD, a camera, and a motor to the Raspberry Pi board for this experiment. We created a real-time programme that compares the scans to records saved on the Raspberry Pi, which is then utilised as a gate pass, with the motor rotating to indicate when the gate opens and closes.Deep learning is a technology that can be used to analyse large amounts of data and has applications in computer vision, pattern recognition, and speech recognition, among other things. The focus of the research is on some of the most regularly used deep learning architectures and their applications. The auto encoder, convolutional neural networks, Boltzmann machines, and deep belief networks are all detailed

networks.To process unlabeled data, deep learning can be employed in unsupervised learning methods. Li et al. proposed a CNN model for fast face detection that examines low resolution input images, discards non-facial parts, and accurately processes the regions with higher resolution for exact detection. To stimulate detection, calibration nets are utilised.

3. DESCRIPTION OF COMPONENTS

3.1 RASPBERRY PI

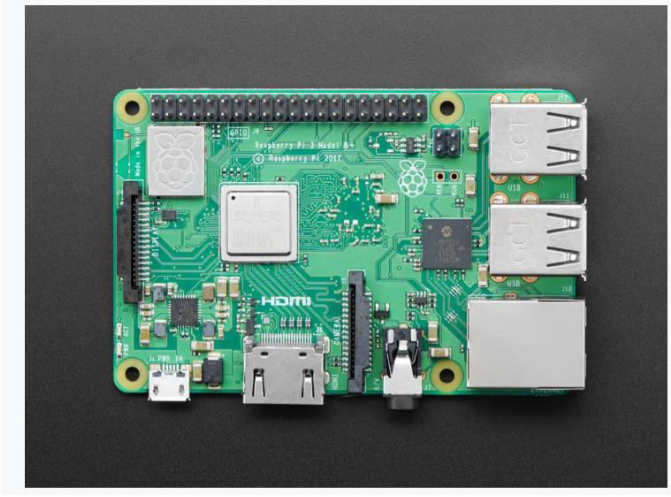

Fig 1: Raspberry Pi

The Raspberry Pi 4 Model B (Pi4B) is the first of a new generation of Raspberry Pi computers that features additional RAM and significantly improved CPU, GPU, and I/O performance while maintaining the same form factor, power envelope, and cost as the previous generation Raspberry Pi 3B+. The Pi4B comes with one, two, or four gigabytes of LPDDR4 SDRAM.

3.2 RASPBERRY PI CAMERA MODULE V1.3

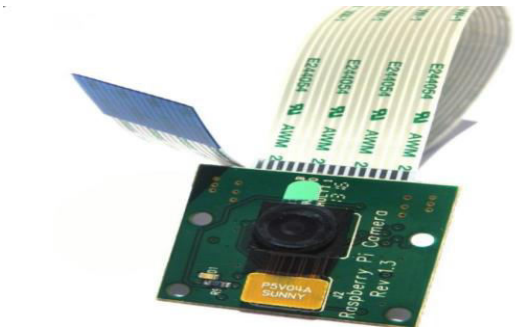

Fig 2: Raspberry Pi Camera Model

In order to keep up with the growing demand for Raspberry Pi camera modules. The ArduCAM team has finally produced a Raspberry Pi revision C add-on camera module that is entirely compatible with the official one. It improves optical performance over prior Pi cameras, resulting in a considerably clearer and sharper image for the user.

It also includes the FREX and STROBE signals, which can be used to synchronise many cameras with the right camera driver firmware. One of the two little connections on the board's upper surface connects it to the Raspberry Pi. This interface employs the CSI interface, which was created specifically for connecting to cameras.

The CSI bus can handle exceptionally high data rates and is only used to transport pixel data. The camera is compatible with Raspbian, the Raspberry Pi's chosen operating system. The board is little, measuring roughly 36mm by 36mm.

3.3 ARDUINO UNO

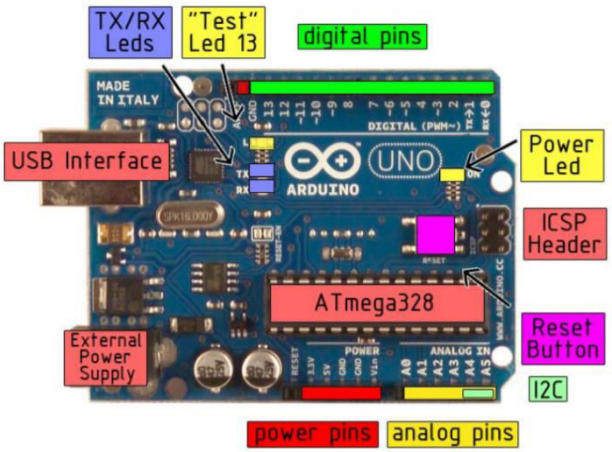

Fig 3: Arduino Uno

The Arduino Uno is a microcontroller board that uses the ATmega328 microcontroller (datasheet). There are 14 digital input/output pins (six of which can be used as PWM outputs), six analogue inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button on the board.

It comes with everything you'll need to get started with the microcontroller; simply plug it into a computer with a USB cable or power it with an AC-to-DC adapter or battery. The Uno is unique in that it does not employ the FTDI USB-to-serial driver chip found on previous boards.Instead, it uses a USB-to-serial converter based on the Atmega16U2 (Atmega8U2 up to version R2).

The name "Uno" comes from the Italian word "uno," which means "one." It was chosen to commemorate the imminent release of Arduino 1.0. Moving forward, the Uno and version 1.0 will be the reference versions of Arduino. The Uno is the most recent of a series of USB Arduino boards, and the platform's reference model; see the index of Arduino boards for a comparison with

previous generations.The Arduino Uno can be fueled either by USB or an external power supply. The power source is automatically selected. An AC-to-DC adapter (wall-wart) or a battery can provide external (non-USB) power.

3.4 RELAY

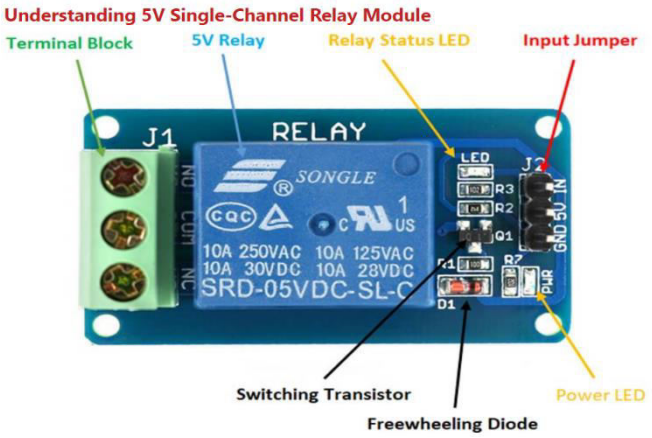

Fig 4 : Relay

Using the pinMode(), digitalWrite(), and digitalRead() routines, each of the Uno's 14 digital pins can be 3tilized as an input or output. They are powered by 5 volts. Each pin includes a 20-50 kOhm internal pull-up resistor (disconnected by default) and can deliver or receive a maximum of 40 mA. Furthermore, several pins have unique functionality**.**

5V Single Channel Relay Module Pin Description

Pin Number	Pin Name	Description
1	Relay Trigger	Input to activate the relay
2	Ground	0V reference
3	VCC	Supply input for powering the relay coil
4	Normally Open	Normally open terminal of the relay
5	Common	Common terminal of the relay
6	Normally Closed	Normally closed contact of the relay

The single-channel relay module is more than just a relay; it also includes components that make switching and connecting easier, as well as indicators that signal if the module is powered and whether the relay is operational. The screw terminal block comes first. Because this is the section of the module that makes contact with the power supply, a secure connection is required.

Adding screw terminals makes it easier to connect thick mains cables, which might be difficult to solder directly.The three terminal block connections are connected to the relay's normally open, normally closed, and common terminals.

The second component is the relay itself, which is a blue plastic case in this case. The marks on the relay itself can provide a wealth of information. The relay's part number on the underside indicates "05VDC," which means the relay coil is triggered at a voltage of at least 5V; any voltage lower than this will not successfully close the relay's contacts.

There are also voltage and current indications on the relay, which indicate the maximum voltage and current it can switch. For example, the top left label on the relay reads "10A 250VAC," which means that when connected to a 250V mains circuit, the relay can switch a maximum load of 10A. The "10A 30VDC" rating on the bottom left indicates that the relay can switch a maximum current of 10A DC before the contacts are destroyed.

3.5 ELECTROMAGNET LOCK

Fig 5 : Electromagnetic Lock

EM locks were created to meet fire/life safety requirements by including an auxiliary locking mechanism with no moving parts that can bind or wear out, ensuring trouble-free operation.

This will ensure that they are not released at any point where they have become very common in applications other than fire/life safety. For re-inforced grip, choose a double screw type. Access regulated and secure zones within buildings are ideal.

4. SOFTWARE REQUIREMENTS

4.1 SETTING UP RASPBIAN PI:

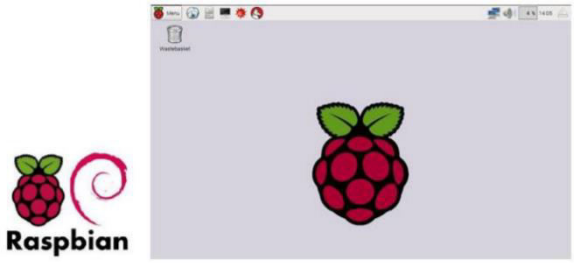

Fig 6 : Raspbian OS

Download the Raspbian's most recent adaption .A image author was required to compose the download OS onto the little scale SD card. So, get the "win32 circle imager" programme. Run the picture essayist after inserting the SD card into the tablet/computer. Peruse and select the downloaded Raspbian picture document once it has opened.

4.2 INSTALLING OPENCV ON RASPBERRY PI

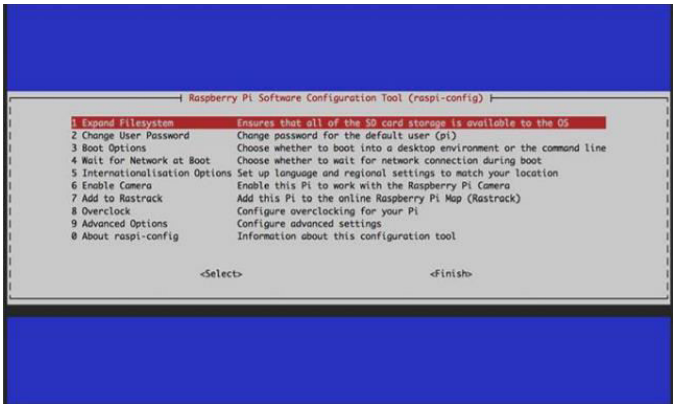

Fig 7: OpenCV Liabrary

OpenCV is licenced under the BSD licence, making it free for both personal and commercial usage. It supports Windows, Linux, Mac OS, iOS, and Android and offers C++, C, Python, and Java interfaces. OpenCV was created with a major focus on continuous applications and processing capacity.

The library, which is written in enhanced C/C++, may take advantage of multi-focus management. It can take use of the hardware acceleration of the fundamental heterogeneous process organise when OpenCL is enabled. OpenCV has more than 47 thousand customers from all around the world, with a total of 9 million downloads.The applications span from instinctive artistry to mine exploration, web-sewing maps, and cutting-edge robotics.

OpenCV, an open source PC vision library, began as a research project at Intel in 1998. It has been available under the BSD open sourcelicence since 2000. OpenCV is no longer available for devices that are anticipated to address PC vision concerns. It combines low-level image processing capabilities with abnormal state computations.

For instance, confronting a location, identifying a person on foot, coordinating, and following. The GPU module in OpenCV has a slew of options, many of which have been updated in various ways, such as picture types (scorch, short, drift), channel count, and outskirt extrapolation modes.

As a result, it's more difficult to report accurate execution numbers. The overhead of syncing and transferring information is another source of difficulty in reducing execution numbers. This means that the best performance is obtained for large images where a lot of preparation should be feasible while the data is stored on the GPU.

The most important step is to expand your file system to include all of the available space on your small-scale SD card.

4.3 FACE RECOGNITION ALGORITHM

Fig 8 : Face Recognition Algorithm

A Haar-like component evaluates adjacent rectangular regions in a given region of an area window, adds up the pixel controls in each locality, and estimates the difference between these totals.

This refinement is then used to request photo subsections. The disclosure of human appearances is an example of this. The areas around the eyes are generally darker than the areas surrounding the cheeks. A design of two nearby rectangular localities spanning the eye and cheek ranges is one example of a Haar-like component for face recognition.

The eigenface technique is one of the simplest and most effective PCA algorithms used in face recognition systems. Faces are converted into a small collection of basic properties called eigenfaces, which are the core components of the underlying learning image arrangement (preparing set).

The individual is then grouped by contrasting its position in eigenface space with the position of known

people, which is completed by predicting another picture in the eigenface subspace. The advantages of this methodology over other facial recognition frameworks include its ease of use, speed, and severity toward little or gradual changes in the face.

5. WORKING PRINCIPLE

5.1 BLOCK DIAGRAM

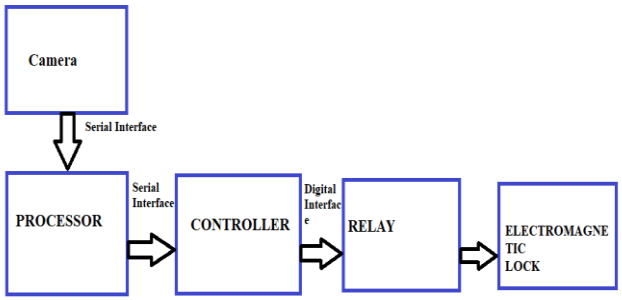

Fig 9 : Block Diagram

When a user approaches your webcam, the Python code will determine if they are wearing a face mask or not using TensorFlow, OpenCV, and imutils libraries. Users who are not wearing a face mask will have a red box around their face, while those who are wearing one will have a green box around their face with the word "Thank you mask On"If the user isn't wearing a face mask, a red box will appear around their face with the words "No Face Mask Detected," and the relay will switch off, indicating the door is locked.

Because this system will be linked to CCTV cameras or any other form of surveillance system, it will be linked to the entrances of those locations, and the system will decide whether or not to let the individual enter, based on the image captured.

5.2 ALGORITHM

The following algorithm shows how does the face mask detection system works:

1. Start
2. Load the face mask dataset in the code
3. Train those face mask classifier with Keras/TensorFlow
4. Serialize the face mask classifier to the disk
5. Load Face Mask classifier from disk
6. Capture and detect the images
7. Extract the ROI of each face
8. Compare the face mask classifier to each face ROI to determine whether the mask is on or mask is off
9. If the mask is on the door opens, else the door remain closed.
10. Stop

Hence this is how the OpenCV-based Smart Face Mask Recognition System. It only allows people wearing mask to enter the public places.

5.3 FLOWCHART

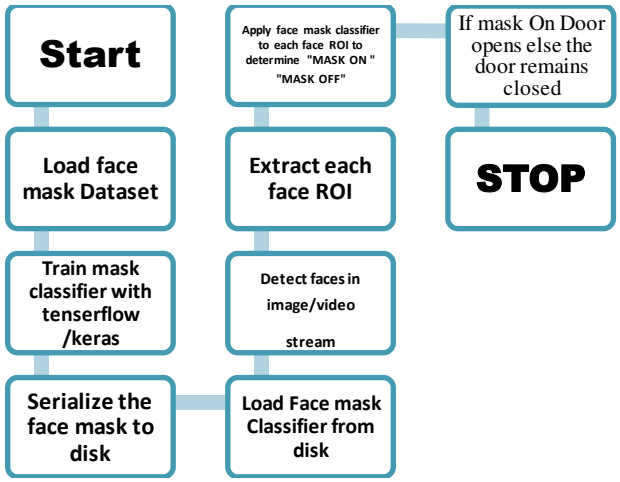

Fig 10 : Flow Chart

6. CONCLUSIONS

In a nutshell, the system is based on the Raspberry Pi, which serves as the system's brain. Because of its open source library capabilities, Python is used in this system. We used the OpenCV open source package, which is designed to handle real-time computer vision. Python stores the still image from the video as a two-dimensional array.The system includes a storage management system for storing the data of persons of interest. For data administration, SQLite, a popular database management system, is employed.The database provides information about the person who needs to be reviewed. Because there is no background impact for detecting the person, the technique is extremely useful and efficient.Even if the environment and background change, it can recognise a person. It also performs well in a variety of lighting situations. The recognition process is unaffected by minor changes in a person's face, such as make-up or spectacles. Furthermore, the system is capable of processing four frames per second.As a result, it may be linked with any system to improve its automation, efficacy, and user-friendliness.
In today's circumstance, protecting the globe from the spread of the corona virus is more important than ever. This Advancesystem will allow us to monitor circumstances with zero physical touch and maximum security. It will provide a secure environment for both government personnel and the general public. These systems can also be altered in the future to accommodate new solutions.

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