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IoT based Health Monitoring System and Face Mask Detection for COVID Prevention

Prof. V. M. Bonal [1], Mr. Sharanabasavaraj R. Meti [2]

[1] Department of Computer Science, Basaveshwar Engineering college Vidyagiri, Bagalkot

[2] Department of Computer Science, Basaveshwar Engineering college Vidyagiri, Bagalkot

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. In this paper, a dynamic Computer Vision based automated solution system has been proposed and focused on the real-time face monitoring of people and to detect Palm print for authentication of a person by using Raspberry Pi 3 Model B through an integrated Pi camera and with the help of MLX90614 temperature sensor. An IoT based e-mail alert system is deployed that will check the persons if they are wearing a face mask and their body temperature is in check with WHO guidelines. This can be implemented in public places such as colleges, schools, offices, shopping malls, etc. to inspect people.

Keywords*: Raspberry pi, MLX90614, IoT, MIPI camera, MobileNetV2.*

1. 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 [1]. 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 theprotocol 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. It couldalso 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 [2].

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, palm print base person identification and it has a non-contact temperaturesensor to read the body temperature and allows the person if they clear the COVID-19 protocols or it will alert the respected authorities [3].

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. it focuses on the development of computer programs that can access data and use it to learn for themselves. The primary aim is to allow the computers learn automatically without human intervention or assistance and adjust actions accordingly. 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.

MobileNetV2 builds on ideas from MobileNetV1, using intelligent split depths as active building blocks. However, V2 introduced two new features in architecture:

- Bottle Direct barriers between layers, too
- Connections Shortcut connections between issues. The basic structure is shown below.

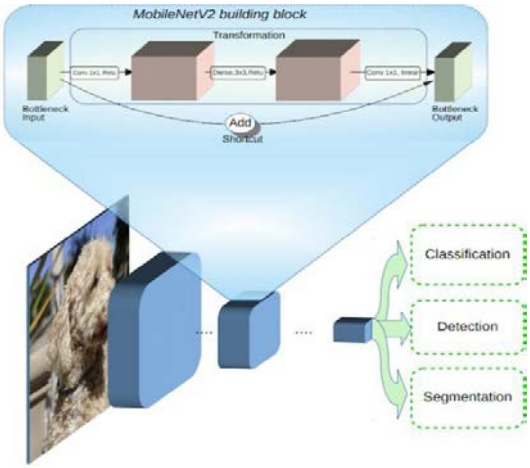

Fig 5.8: Structure of MobileNetV1

The standard configuration of MobilenetV2 has many layers listed below, at Pytorch we can use the TorchVision model library to build a MobileNetV2 model instead of defining / constructing our model. The weights of each layer in the model are defined based on the Image Net database. Weights indicate folding, steps, kernel size, input channels and output channels. A fully integrated layer consisting of four consecutive layers above the MobileNetV2 model has been created.

2. Existing System

- To avoid infection or spread, it is important to wear a face mask when leaving home especially in public places such as markets or hospitals.
- To check a person is affected from Covid-19 a common symptom is a temperature, If a person is having a temperature then he is affected by Covid-19, and we need to check the temperature without contacting the person is the challenge for conventional ways of checking the temperature.
- Most of the institutes, offices, workspace etc normally attendances are taken from finger print module in which a person need to place a finger on the sensor, but this will lead to another complication of spreading Covid-19 from one to other.

To recognize the faces and palm print a pre-trained model provided by the Open CV framework were used. The model were trained using web and real time images taken from camera. This facemask and palm print data detected by the Raspberry Pi camera is sent to the Raspberry Pi 3 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 is authorized and is wearing the mask and the body temperature is below the threshold then no action will be taken ,otherwise if he is not wearing the mask or temperature is higher than the thresh hold value an intimation e-mail will be sent to admin to take the further action.

3. Proposed Methodology And Discussion.

3.1 Facemask Detection

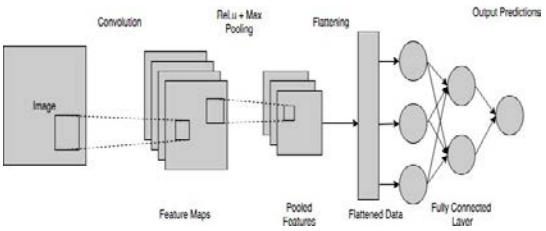

Fig 3.1(a): Phase 1 Face Mask Detection.

This system will help to identify people on their face image for 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”.

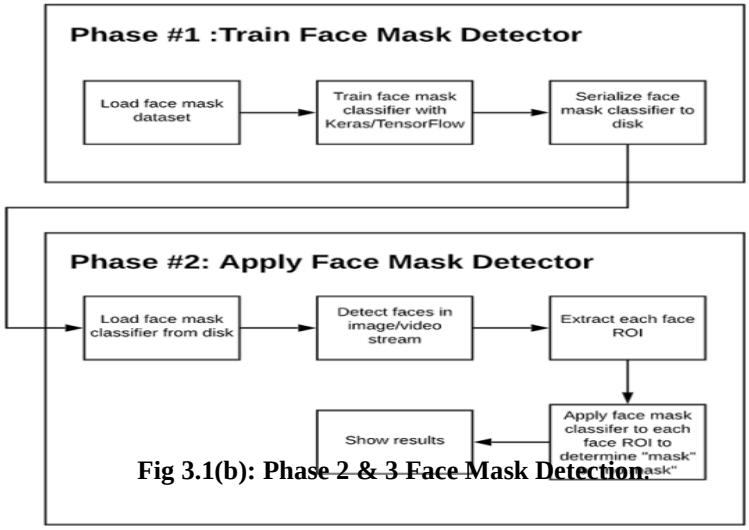

Fig 3.1(b): Phase 2 & 3 Face Mask Detection.

The images we downloaded were of different size and resolution.

- Resizes input image size (300 x 300).
- Inserting colour filtering (RGB) over channels (Our MobileNetV2 model supports 2D 3 channel image).
- Scale / zoom images using the standard definition of PyTorch architecture at weights.
- Center captures image with 224x224x3 pixel value.
- Eventually it transforms them into managers (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 trained module. It is trained once and reused to classify the input images into categories for which it is trained. Later, this trained data is used by the Image classification function function detects and predict for authentication and results [4].

3.2 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.

In this project, we design and develop the Temperature Monitoring device using Raspberry Pi, MLX90614, and Pi Camera. This project is divided into two parts.

- Understanding & Interfacing of MLX90614 with Raspberry pi.
- Getting started with MLX90614.

3.2.1 Raspberry Pi

Raspberry Pi is a credit card size computer designed for educational purposes. The price and specifications such as wifi, Bluetooth, and a well-designed GPIO theme, as well as the number of options you can make use to create an application.

3.2.2 MLX90614 IR Temperature Sensor.

There are many sensors available in a market that can provide us with heat and moisture. What makes this sensor different from all the other senses that it can give us the heat of the object and so on. The nerves provide the heat that is present. We have DHT11 and LM35 sensors have been used extensively of many applications in space humidity or temperature should be constant measured. But here's how to make a file for unnecessary firearms physical contact and you can measure an object temperature instead of ambient temperature, we use IR based MLX90614. To learn more about the Infrared and IR sensor circuits, follow the link. MLX90614 sensor is made by Melexis Integrated Microelectronics systems, it applies to the Infra-Red policy thermopile sensor for temperature measure. The MLX90614 sensor contains two units embedded within to provide output heat. The first unit is an infrared sensor unit followed by the second unit namely perform data counts with Digital signal processing (DSP). This the sensor works on Stefan-Boltzmann's law which describes the power exerted by a black person body by its heat. It's easy terms, anything that emits IR energy and the intensity of that will be direct in proportion to the temperature of that thing. MLX90614 sensor converts file to value rating was 17-bit ADC and that can be achieved using I2C communication.

These sensors measure the ambient temperature as well as object temperature with the resolution calibration of 0.02°C.

3.3 Palm Print Detection (Creating datasets).

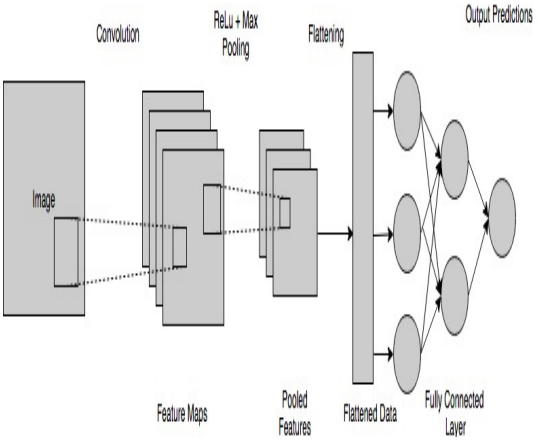

Fig 3.3: Structure of Palm Print Detection.

In order to train a custom Palm print detector, we need to break our project into two distinct phases, each with its own respective sub-steps :

- Training: Here we'll focus on loading our Palm print of authorized user dataset from disk, training a model on this dataset contains user information and then serializing the Palm print detector to disk.
- Classification: Once the Palm print detector is trained, we can then move on to loading the palm print of current user by pi camera, performing palm pattern detection, and then classifying each palm as Authorized or un authorized. If authorized then system will check for temperature and mask.

To create this dataset,

- Taking normal images of palm
- Then creating a custom computer vision Python script to add information of the user, thereby creating an authorized (but still real-world applicable) dataset.

From there, we apply face detection to compute the bounding box location of the face in the image:

- Once we know *where* in the image the palm is, we can extract the Region of Interest (ROI):
- And from there, we apply palm prints, allowing us to localize the thick lines, thin lines, patterns, etc..
- Next, we need an information of the person belonging to that palm print
- This information will be automatically applied to the Palm Print by using script and id will store as id.
- The image is then resized and rotated
- We can then repeat this process for all of our input images, thereby creating our artificial Palm print dataset.

3.4. Block Diagram

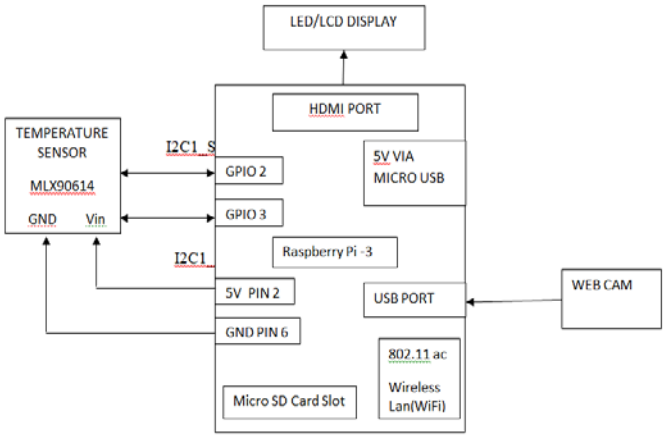

Fig 3.4: Block diagram.

The above block diagram is made as an automatic temperature scanning system and an entry access provider system. It is a multi-purpose system with a wide variety of applications. The system uses a

temperature scanner that cannot communicate with the mask monitor. The scanner is directly connected to the human barrier to the bar entry when high temperature is detected or no surface.

No person will be allowed to enter without heating and scanning the mask. Only a person with both conditions is allowed to enter immediately. The system uses a temperature sensor and a camera connected to the raspberry pi system to control all operations.

The camera is used to scan the mask and temperature sensor to check the body temperature on the forehead. The raspberry examines the input sensor and determines whether the person is allowed. In this case the system uses the car to open a barrier that allows one to enter the premises. When a person is flagged with a high temperature system or without a Mask the system lights up a red light and prevents the person from entering. And the person's face and temperature are transferred over the IoT server so that authorities can take action and test the person with covid. The system therefore provides a 100% coverage plan to prevent the spread of COVID. This proposed system introduces a hand-based contactless communication system to get a palm print.

Palm printing refers to a smooth flow pattern created by alternating cracks and crevices in the surface of the hand. Three types of line patterns are clearly visible in the palm of the hand. These line patterns are known as main lines, wrinkles, and ridges. The main lines are the longest, strongest and widest lines in the palm of the hand. The main lines show the distinctive features in the palm of the hand. Most people have three main lines, called the heart line, head line, and life line in Fig. 4.1 (b). Wrinkles are considered thin and irregular line patterns. Wrinkles, especially wrinkles around the main lines, can also contribute to the imprint of palm print. The hills, on the other hand, are fine lines of fabric spread all over the palm surface. The ridge feature is less useful for discriminating individual as they cannot be perceived under poor imaging source.

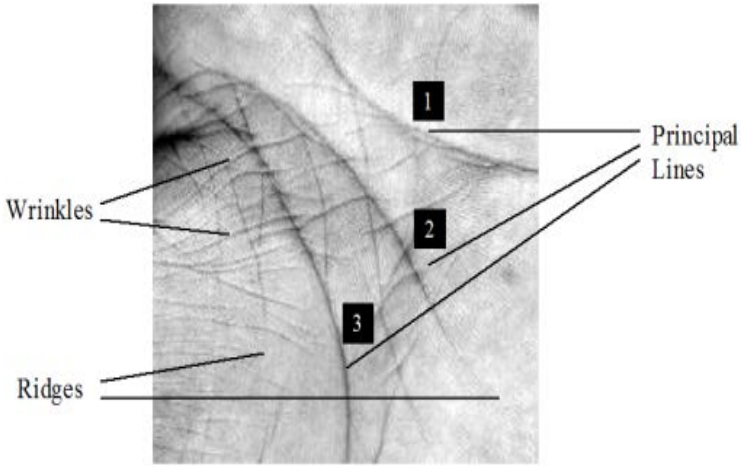

Fig 4.1(b): Palm Patterns.

The Line Patterns on the Palm Print. The Three Principal Lines on a Palm: 1–heart line, 2–head line and 3–life line. In this research, we develop an online acquisition device which can capture hand images in a contactless environment. Specifically, we want to find different hand methods, namely palm printing. Users do not have to touch or hold on to any peripheral of their hand-drawn images. When their hand photos are taken, the regions of interest (ROI) of the palm will be followed. ROIs contain important hand information used for recognition. The ROIs are analyzed in advance so that the text and print of the veve is separated in the background. Thereafter, the dividing factors in the ROI are extracted using a proposed process called derationing coding. Hand features are made mostly of line-like texture. The pointing coding process incorporates hand-discriminatory details depending on the precision of the first line symbols. Palm printing features and palm vein features are then integrated at the point level to provide better recognition accuracy. We have also installed an image quality monitoring system to check image quality. We spread a lot of weight on the image of the best quality when the integration is done.

4. Results

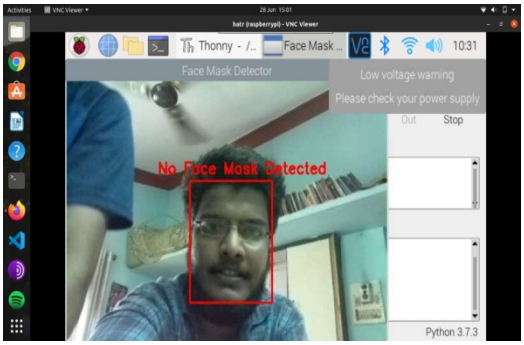

Fig 4a: No Face Mask Detected.

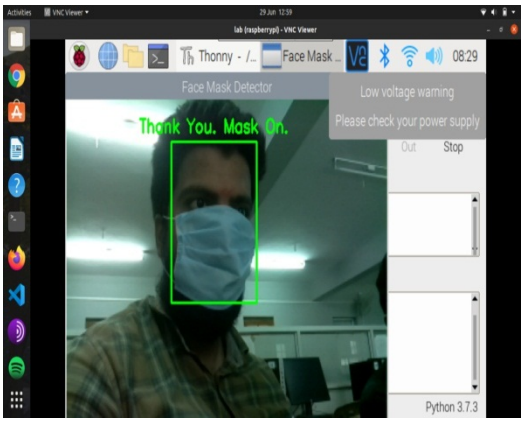

Fig 4b: Face Mask Detected.

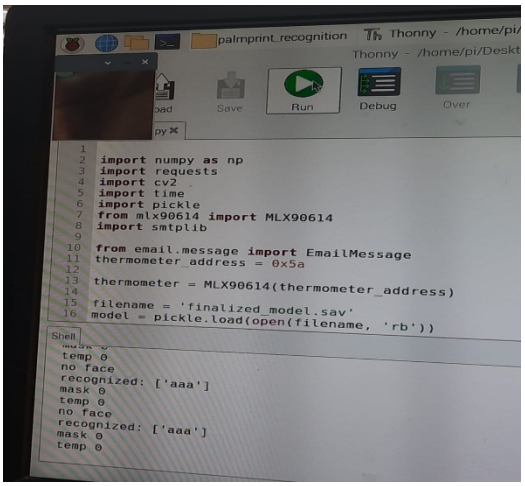

Fig 4c: Simulation.

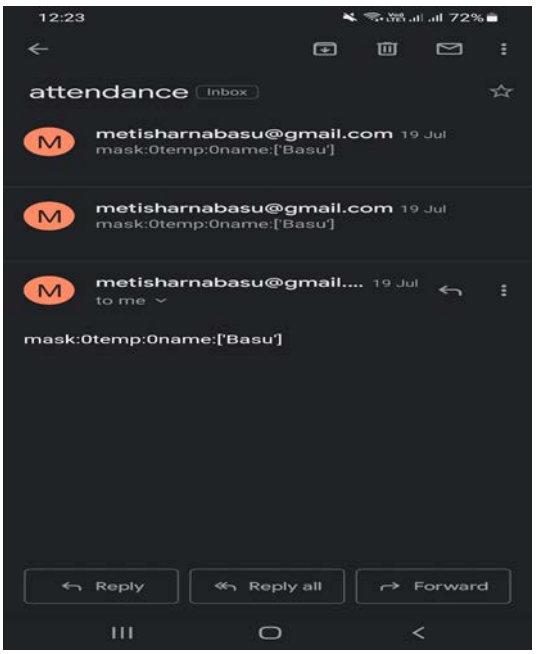

Fig 4a: Intimation Mail.

To identify the faces and palm print a pre-trained model provided by the Open CV framework was used. The model was trained using web and real time images taken from camera. This facemask and palm print data detected by the Raspberry Pi camera is sent to the Raspberry Pi 3 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 is authorized and is wearing the mask and the body temperature is below the threshold then no action will be taken ,otherwise if he is not wearing the mask or temperature is higher than the thresh hold value an intimation e-mail will be sent to admin to take the further action.

5. Conclusion

In this project we have successfully implemented a working prototype of Palm print based person identification, 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 authorized or by using palm print detector module then it detects weather person 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 if a person wearing mask and his temperature is normal then no action will be taken otherwise an alert mail is sent to admin. With the help of this project an atomized solution is achieved hence there's no need for any human to monitor COVID-19 protocols. The accuracy of facemask detection and palm print detection can be achieved by training the module with a larger image dataset. Raspberry Pi 3B 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, Palm print based identification 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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