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Smart Intrusion Detection System

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Abstract - In recent times there is an increase in thefts. This creates an unpleasant environment for people to live. The problem with home security in the modern world is a cause for concern. The concerns found with former systems were that they can only identify the intruder after the theft. The proposed methodology aims to design an implementable surveillance and detection tool for providing a home owner/member with the immediate notification of unauthorized access to their premises. The fundamental idea was to design a cost-effective and efficient system for an individual to be able to detect any kind of intrusion in real-time and provide instant notification to the house owner. The images that were acquired through live video feed and analysed through frame comparisons and then process to detect an intruder.

Keywords: Image Processing, IoT, Intrusion Detection, Raspberry Pi Zero, Python

1. INTRODUCTION

In the modern era, security and surveillance are important issues. Recent acts of theft/terrorism have highlighted the urgent need for efficient video surveillance and on-the-spot notification of ongoing thefts to house owners and other household members. A number of surveillance solutions are currently available on the market, such as CCTV cameras that can record the unauthorized activities of a trespasser, but are not able to provide on-the-spot information to the owner.[1] The major flaw of this arrangement is that it demands the continuous availability of a house owner or member, or manual video surveillance, which is almost impossible. In addition, it is a tedious task to go through all the recorded video clips after a possible theft has become known. It might be that the storage server contains a large amount of pointless footage, which is of no use in identifying trespassers. By using this system, we can reduce intrusion and respond quickly such that no harm takes place in our home.[3] In the designed system, the camera is kept outside the house and the continuous video is captured by the camera. We designed our system in such a way that as soon as a person is detected the system check if the person is registered or not. If a registered person is not present a notification is sent at the mobile device of the owner/members by giving information of the time and date when intruder enters.

2. NECESSITY OF DEVICE

In the modern era, security and surveillance are important issues. Recent acts of theft/terrorism have highlighted the urgent need for efficient video surveillance and on-the-spot notification of ongoing thefts to house owners and other household members. A number of surveillance solutions are currently available on the market, such as CCTV cameras that can record the unauthorized activities of a trespasser, but are not able to provide on-the-spot information to the owner.[4] The major flaw of this arrangement is that it demands the continuous availability of a house owner or member, or manual video surveillance, which is almost impossible. In addition, it is a tedious task to go through all the recorded video clips after a possible theft has become known.[7] It might be that the storage server contains a large amount of pointless footage, which is of no use in identifying trespassers. By using this system, we can reduce intrusion and respond quickly such that no harm takes place in our home. In the designed system, the camera is kept outside the house and the continuous video is captured by the camera. We designed our system in such a way that as soon as a person is detected the system check if the person is registered or

not. If a registered person is not present a message is sent at the mobile device of the owner/members by giving information of the time and date when intruder enters.[1]

3. DESIGN AND EXPERIMENTAL SETUP

In the given figure, a Raspberry Pi camera module (Pi Cam), a Wi-Fi enabled hardware with a memory card i.e., Raspberry Pi Zero, supporting LEDs for indicating the intrusion, and a client-side mobile device is used for receiving notification.[2] The camera is placed at the door for capturing the image of approaching person. The customized hardware used in the system has Bluetooth and Wi-Fi capability, which allows placing the proposed system anywhere inside the smart home

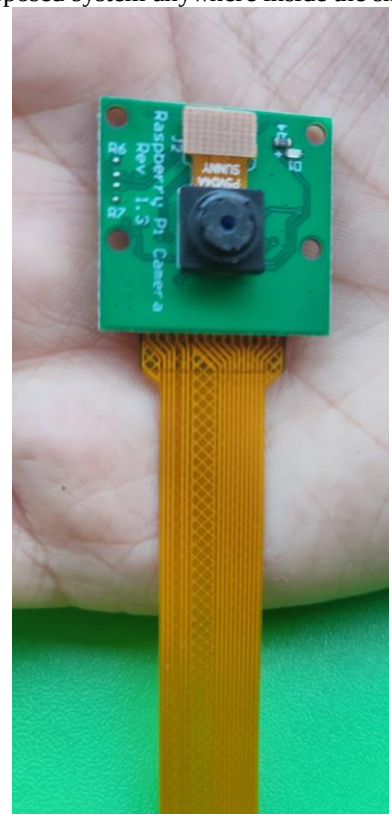

Fig. 1 Raspberry Pi Camera Module

where Wi-Fi is available. Even in the case of power failure, the proposed system can still function if it is connected to a hotspot internet connection. Also, the hardware is covered by a plastic casing to protect it from the water inside the electricity conceal lines. As shown in Figure, the proposed system starts detecting when an intruder comes into the monitored area. The movement of an intruder is captured by a face detection module, as shown in Figure.[4]

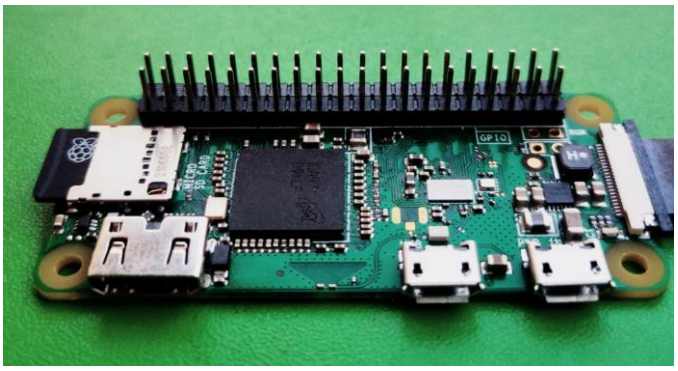

Fig. 2 Raspberry Pi Zero W

The main function of the face detection module is to differentiate the registered persons and the intruders. When any human face is detected, the camera is activated and start capturing frames. After the initial frame has been captured, it is immediately sent to the house owner on a mobile application. This step allows the house owners to make a rapid decision accordingly.[8]

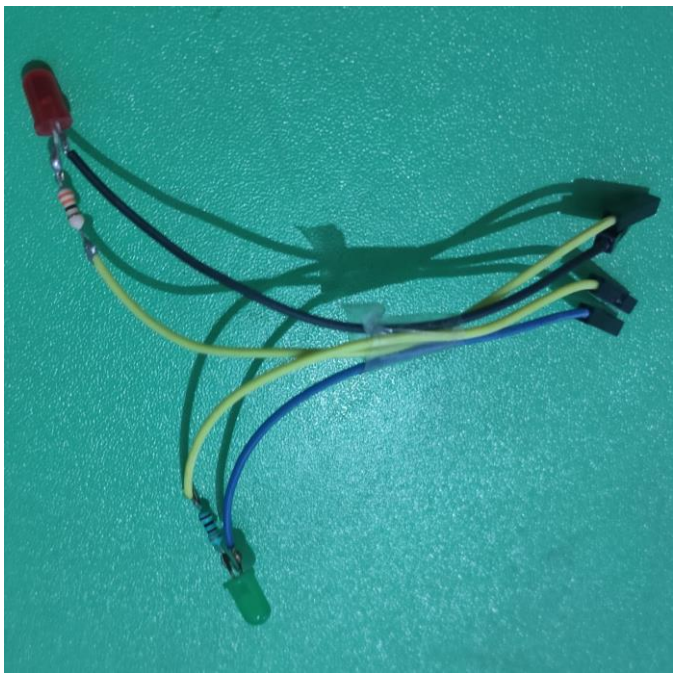

Fig. 3 LED Indicators

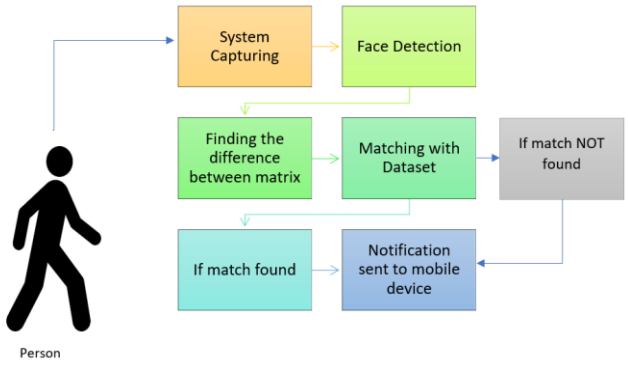

Fig. 4 Block Diagram

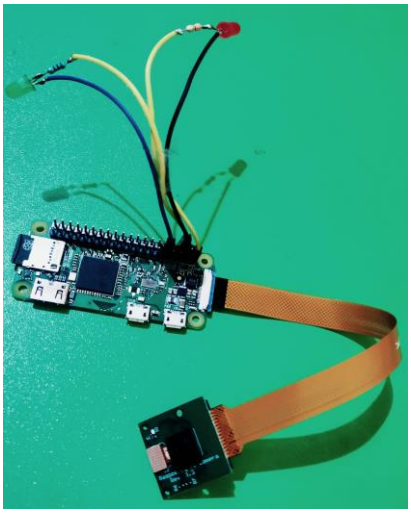

Fig. 5 Raw Experimental Setup

4. WORKING

The system consists of a Raspberry Pi, to which a Raspberry Pi Camera is interfaced, for the purpose of capturing video continuously and two LED indicators for indicating whether a registered person has been detected or not. The system consists of two parts a server and a client. The inbuilt python script that is designed to run at boot time is the server that is entrusted with capturing continuous video and extract human face image frames from it in the form of "img_name.jpg" files. The image file is then passed onto the server side where the image is compared with the existing datasets to check if the detected image exists by matching with existing datasets. If match is found by the predetermined parameters, the Green LED is blinked, and a message is sent through the registered MQTT client on the owner's mobile informing the name of the user detected along with the date and time and the processing stops.

If match is not found then the Red LED is blinked, and a message is sent to the owner's phone informing that a "Unknown Person" is detected along with the timestamp.[10]

In, our designed system the Raspberry Pi is used as a microcontroller. The newer version of Raspberry Pi Zero W v1.3 is a 6.5cm x 3cm sized mini-computer that can have a standard monitor display unit plugged into it and uses a standard sized keyboard and mouse that is connected through a USB hub connected with it. The Raspberry Pi then turns out to become a CPU unit which is both small in size and can be easily designed to carry-out standalone applications after programming it. This Raspberry Pi system uses the Linux operating system which is required to be flashed into it. The storge unit of this system is a microSD card that is flashed with the version of Raspbian OS flashed using an image flasher from the PC. The board is a lighter version of the advanced Raspberry Pi 4 Series which is suitable for light-weight low-power applications. This board comes with a direct port to plug in the Raspberry Pi Camera Module and comes with a integrated 2.4GHz Wi-Fi module and a Bluetooth v4.1 support. Other input sensors and output devices can be connected using the GPIO pins available. It is powered by a micro-USB port.[8]

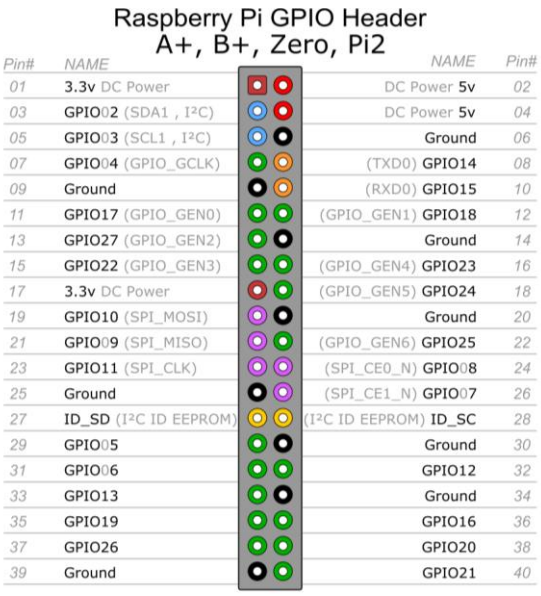

Fig. 6 Raspberry Pi Pin Diagram

Python v3.9 is then installed in the Raspberry Pi storage as it forms the base of our software setup. After installing of Python, "dlib" library is then installed along with the "face_recognition" library is installed. These libraries are used for detection of the face image that is captured by the Pi Camera. Python uses the "picamera" library for the purpose of capturing the video and extract image files from it. For the purpose of sending the

message to the owner's mobile device a package "paho.mqtt.client" is used which is a package used for IOT based operations. As a part of output, to show the LED beacons the GPIO pins are also required to be configured using "RPi.GPIO" library.[2]

The image is captured when a human face is detected in the video and is then encoded into a "numpy array" format. Then the program compares the encoded image file with the pre-existing datasets of registered images using a method called the Euclidean distance formula. In Euclidean Distance method both the arrays are compared and the distance between each array element is found out. If the distance is closer to zero then it is assumed to be matching, otherwise if the distance is greater than a required threshold limit then is it assumed to be not matching and then the results for all the elements of the given array is compiled to give a compiled result.

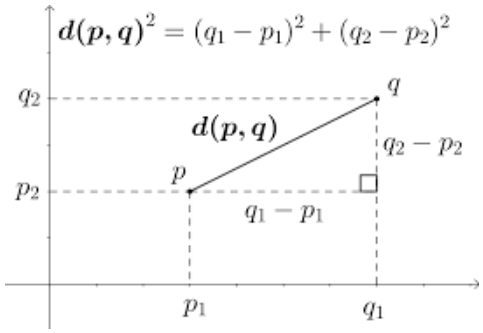

Fig. 8 Euclidean Distance

that is used to estimate a match. If the match is found the Green LED on Pin 26 is flashed otherwise the Red LED on Pin 6 is flashed. Then the program connects to the MQTT client server and publishes the result (Name if person is matching otherwise publish Unknown person) along with the timestamp. After, sleep period of 1second the LEDs are switched OFF and the program initiates again. The python script is design to be run continually and it is initiated right during the booting process so that the application may be deployed as a standalone application without manual intervention.[4]

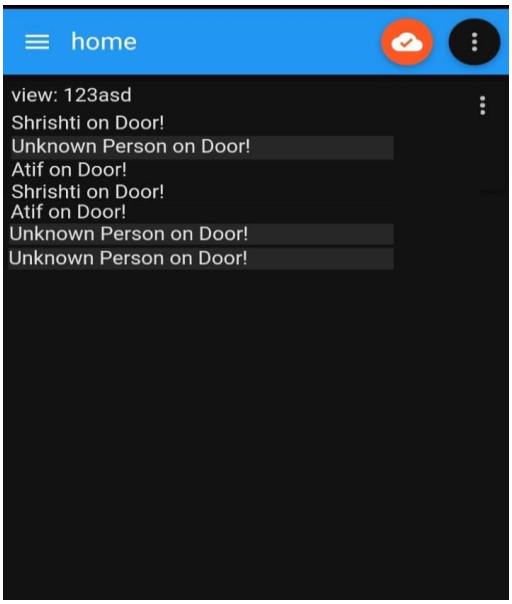

Fig. 7 Message Received on Mobile Device

5. CONCLUSIONS

People nowadays use CCTV cameras to secure their homes or offices, but they have a few drawbacks, such as the inability to notify the owner of a theft and the inability to capture evidence or any visual proof outside of the surveillance area. As a result, we are implementing this project to address the disadvantage of existing systems. To prevent theft, we are developing a Raspberry Pi-based Smart Intrusion Detection System programmed in Python and integrated with "dlib" and "face recognition." We can now keep a constant eye on the house thanks to our Human Intrusion Detection System. When the system detects any intervention, an alert message is sent to the owner. We will not need any memory storage because we are not working like a CCTV camera This system is inexpensive and can be used anywhere security is required. This system can be improved to include more sophisticated features.

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