Advanced Surveillance System Using OpenCV

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Abstract: Surveillance is the monitoring of behavior, activities or other change information for the purpose of influencing, managing, directing, or protecting people. Surveillance is used by governments for intelligence gathering, prevention of crime, the protection of a process, person, group or object, or the investigation of crime. In this project we design an embedded surveillance system which consists of small PIR (Pyroelectric Infrared) sensor built around a microcontroller. The system senses the signal generated by PIR sensor detecting the presence of individuals. Detecting the presence of any unauthorized person in any specific time interval, it triggers an alarm & sends a short video of the unauthorized person to the admin, asking what action to be taken. The system is also trained to recognize the admin for easy access to the admin. In case of a person wearing mask, the system would detect motion and send the picture since it can't find a face in the frame. In this way system avoids any type of security breaches. Such a system and the algorithm is prepared with the help of raspberry pi and software's such as python, OpenCV and smtp protocol. After the real time response from the trained system, the admin is provided with mobile app for immediate reactions for any situation. This concept can be used in many applications in our society, thus creating a secure and safe society.

Index Terms **- Pyroelectric Infrared, Python, OpenCV, Raspberry PI, SMTP protocol.**

I. INTRODUCTION

Usage of security video cameras is considered as best way of preventing the intruders from causing damage to you or your home (even when you are thousands of miles away from your place), keeping away trespassers and even for inspecting activities of your kids. Most of the security cameras are linked to computers (electronic camera network security software). A cost-efficient and breach proof security video camera network can be produced with the help of PC, security and cam electronic camera software application.

The concept of usage of CCTV security electronic cameras is in existence since several years. With the development of innovation, the equipment utilized in the latest security camera CCTV system have changed significantly. Nowadays, the security cameras have become much more advanced, reasonable, smaller and straight forward. And we can notice CC televisions almost at any place you visit, from a small store to homes and holy places. As a result, they guarantee greater public security at a fraction of the cost. In our busy life we don't have much time to monitor and to keep a watch on everything. From every family most of the members are working, or even in malls and hospital to monitor each and every space is not possible.

There is continuous growth in network surveillance because of the instability incidents that are happening all around the world. Therefore, there is a need of a smart surveillance system for intelligent monitoring that captures data in real time, transmits, processes and understands the information related to those monitored. The video data can be used as a forensic tool for after-crime inspection. Hence, these systems ensure high level of security at public places which is usually an extremely complex challenge.

In the past times, the events captured on video were used to expose important information and work as proof after the event happened. But we need a system that let users to check and reply to alarms immediately. Using a number of video cameras, a large amount of visual data is captured that is to be monitored and screened for intrusion detection. Presently, the surveillance systems used requires constant human vigilance. However, the humans have limited abilities to perform in real-time which reduce the actual usability of such surveillance systems.

A. Hardware design:

- Raspberry Pi:

The Raspberry Pi is a series of small single-board computers. Processor speed ranges from 700 MHz to 1.4 GHz for the Pi 3 Model B+, on-board memory ranges from 256 MB to 1 GB RAM. Secure Digital (SD) cards in MicroSDHC form factor (SDHC on early models) are used to store the operating system and program memory.The boards have one to four USB ports. For video output, HDMI and composite video are supported, with a standard 3.5 mm tip-ring-sleeve jack for audio output. Lower-level output is provided by a number of GPIO pins, which support common protocols like I²C.t, confirm that you have the correct template for your paper size.

- Node MCU:

Node MCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC, and hardware which is based on the ESP-12 module. There are a total of 8pins, which include a TXD pin, RXD pin, VCC, and GND.Technical specifications includes, 32-bit RISC CPU: Ten silica Xtensa LX106 running at 80 MHz , 64 KiB of instruction RAM, 96 KiB of data RAM, External QSPI flash – 512 KB to 4 MB,IEEE 802.11 b/g/n Wi-Fi,Integrated TR switch, balun, LNA, power amplifier and matching network,WEP or WPA/WPA2 authentication, or open networks,16 GPIO pins,SPI, I²C,1 10-bit ADC.

- Servo motor:

A servomotor is a rotary actuator or 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. Servomotors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system. Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing. A servomotor is a closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is a signal (either analogue or digital) representing the position commanded for the output shaft.

- PIR sensor:

PIR sensor is used in security system to detect the motion of human. Humans produce infrared radiation; the infrared Radiation of human body are sensed by PIR sensors. Hence PIR sensors are passive electronic devices which detect motion by sensing infrared fluctuations. After it has detected IR radiation difference, a high is sent to the signal pin.This change in radiation striking the crystalline surface gives to change in charge. The sensor elements are sensitive to radiation of wide range but due to the use of filter window that limits the sensitiveness to the range which is most suitable to human body radiation.

B. Software design:

- Python:

Python is an interpreted, high-level, general-purpose programming language. It provides constructs that enable clear programming on both small and large scales. Python features a dynamic type system and automatic memory management. It supports multiple programming paradigms, including object-oriented, imperative, functional and procedural, and has a large and comprehensive standard library.

- Open CV:

Computer vision is an interdisciplinary scientific field that deals with how computers can be made to gain high-level understanding from digital images or videos. From the perspective of engineering, it seeks to automate tasks that the human visual system can do. Computer vision tasks include methods for acquiring, processing, analysing and understanding digital images, and extraction of high-dimensional data from the real world in order to produce numerical or symbolic information, e.g., in the forms of decisions.

As a scientific discipline, computer vision is concerned with the theory behind artificial systems that extract information from images. The image data can take many forms, such as video sequences, views from multiple cameras, or multi-dimensional data from a medical scanner. As a technological discipline, computer vision seeks to apply its theories and models for the construction of computer vision systems.

- Blynk:

App Inventor for Android is an open-source web application. It allows to create software applications for the Android operating system (OS). It uses a graphical interface, very similar to Scratch and the Star Logo TNG user interface, which allows users to drag-and-drop visual objects to create an application that can run on Android devices.

- SMTP:

Simple Mail Transfer Protocol is an Internet standard for email transmission. Mail servers and other mail transfer agents use SMTP to send and receive mail messages on TCP port 25. Although proprietary systems such as Microsoft Exchange and IBM Notes and webmail systems such as Outlook.com, Gmail may use their own non-standard protocols internally, all use SMTP when sending or receiving email from outside their own systems.

II. SYSTEM OVERVIEW AND ARCHITECTURE

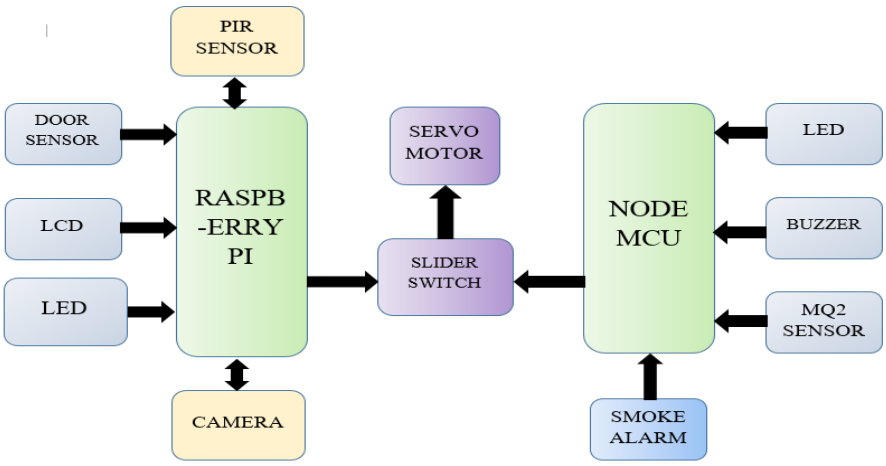

Figure 1: Overall block diagram of the system

The whole system can be viewed into two stages for a better understanding. The first stage deals with security system designed using raspberry pi and the second stage deals with the user end application and the devices connected to it with the help of Wi-Fi module (node MCU).

The PIR sensors are placed where an intruder must pass through. When an intruder enters the sensing area, motion is detected by the PIR sensors. Once the motion is detected raspberry pi activates the sleeping camera to perform face recognition algorithm to recognize the person who caused the motion. Facial recognition program is written with the help of OpenCV library in Python language. The system will already be trained with the facial data of admin and will not find any difficulty in recognizing the admin. If the recognized face is admin then the system opens the door letting him inside the facility. Servo motor is used to represent the door lock in our paper. Slider switch is used to control a single servo motor by raspberry pi and node MCU. Also raspberry pi is interfaced with LCD and DOOR sensor. Door sensor is used to detect if the door is closed or openand the same is printed in LCD module. This is done in order to indicate about the entry of a person in the facility for the people who are already in the facility. In case if the system does not recognize the person, a short video is taken of the unknown person and is sent immediately to the admin through mail with the help of SMTP protocol.

Coming to the second stage of our project the admin is provided with an application where he can react to the mails received. Once the admin finish watching the video and the unknown person is in the video is trying to break in the facility, admin can turn on alarms', buzzers from anywhere with the help of node MCU. If he finds that the person in the video is his friend or a relative, he can directly let the person in the facility by opening the door. The system is also fixed with smoke sensor and smoke alarm system for emergencies. The admin can also turn on led with the help of app which is placed near the camera to make the camera function properly in the night.

Architecture and working of user end application:

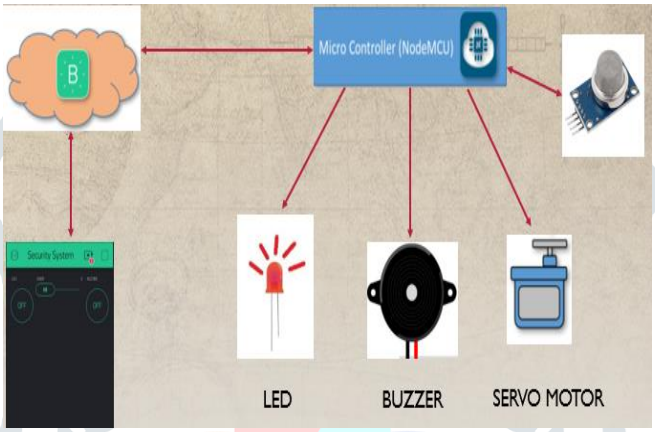

Figure 2:Block diagram of user end system

After the real time response from the system, now the admin can also react to the situations immediately. Depending on the response by the owner/admin, further actions take place. positive reaction gives approval or access to the particular location. The system is provided with night vision, where the user can turn ON LED whenever there is less intensity of light for accurate face recognition by the system. The user can trigger alarms for intrusion by unknown and also can control the action of door lock in case a person who he knows comes to the facility to let him inside the facility.

All these can be achieved with the help of an application, cloud service, Wi-Fi module, led, buzzer and servo motor. In our project we are using Blynk cloud and application in order to control these hardware components. Like all other IoT projects, the data from the application is sent to cloud and the data in the cloud is read by NodeMCU and depending on the data sent and read the hardware is functioned which is shown in fig2.

III. METHODOLOGY

The PIR sensors are placed where an intruder must pass through. When an intruder enters the sensing area, the sensors wake up the sleeping MPU (Microprocessor Unit). Raspberry pi activates the camera and performs face recognition algorithm. If the recognized face is admin then the system opens the door. If the face is not recognized it captures a small video of the intruder and mails it to the admin immediately. If the motion is detected and there is no face in front of the camera, the system will take a picture and sends it to the admin through mail. After the real time response from the system, now the admin can also react to the situations immediately. This is clearly shown in fig3.

Depending on the response by the owner/admin, further actions take place. positive reaction gives approval or access to the particular location. The system is provided with night vision, where the LED is turned ON whenever there is less intensity of light for accurate face recognition by the system. The system gives awareness to the members present in the house by putting a message, indicating that some is going to enter the house. The system is also put with emergency switch and a smoke sensor. The emergency switch is used when there is any danger to the members inside the house. When the switch is pressed the admin will immediately be notified about the emergency switch. These are shown in figure 4.

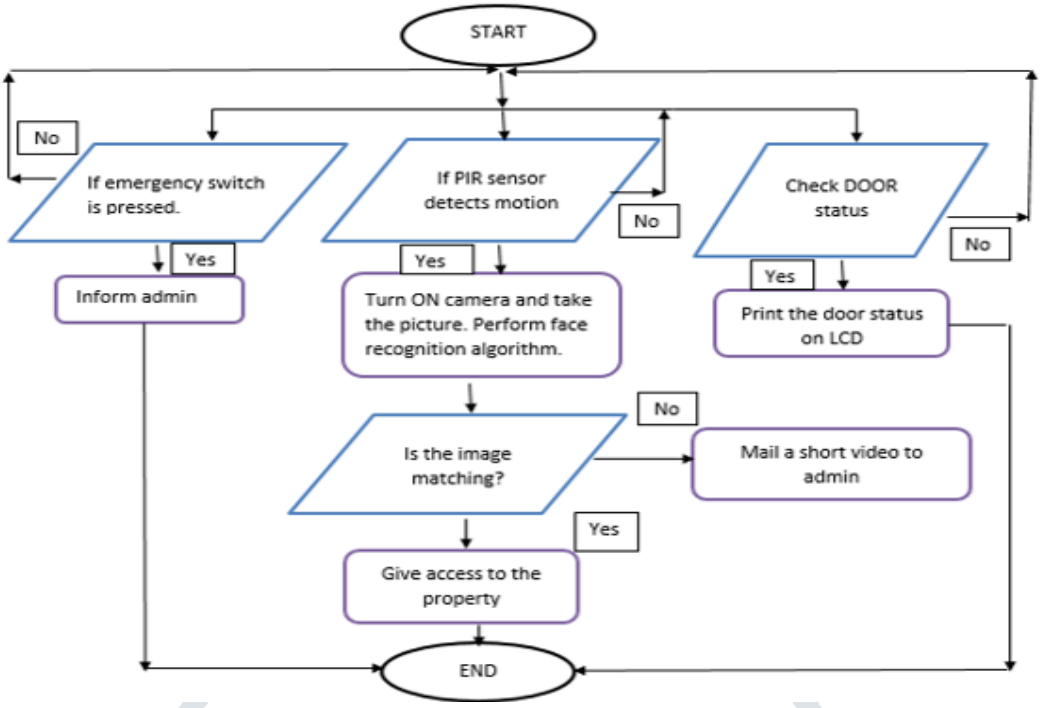

Figure 3: First stage flow

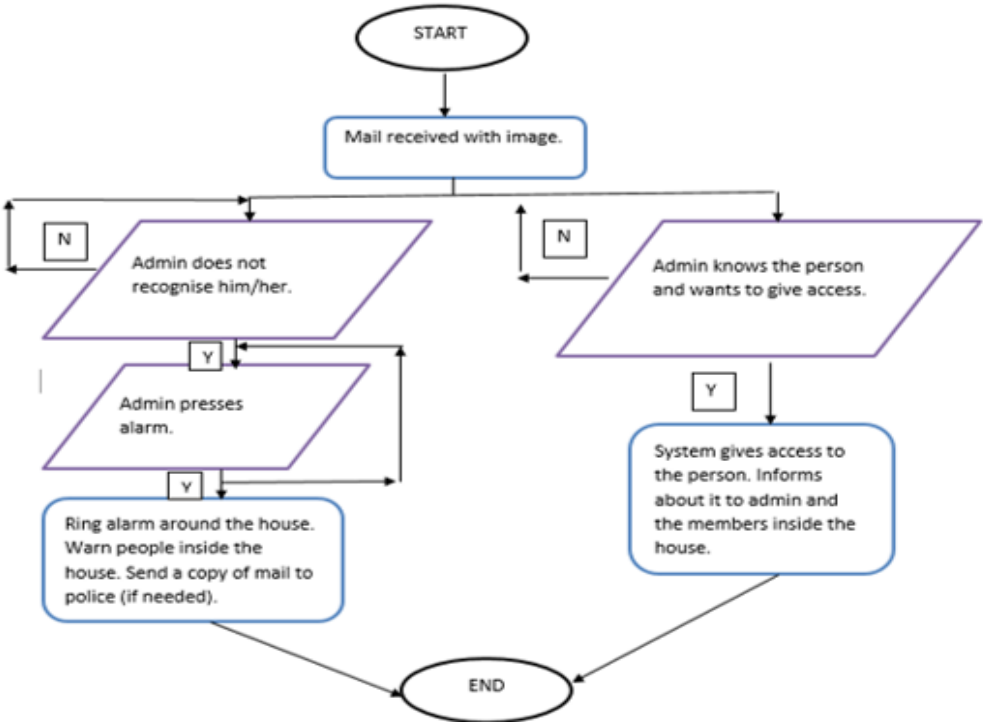

Figure 4: Second stage flow.

IV. IMPLEMENTATION AND RESULT

Figure 5 shows the screen shot of the window, where the system has recognized the person in front of it as admin.
Figure 6 shows the screen shot of the window, where the system has recognized the person in front of it as unknown.
Once the system recognizes the person as unknown it sends a mail to the admin, which can be seen in figure 7.

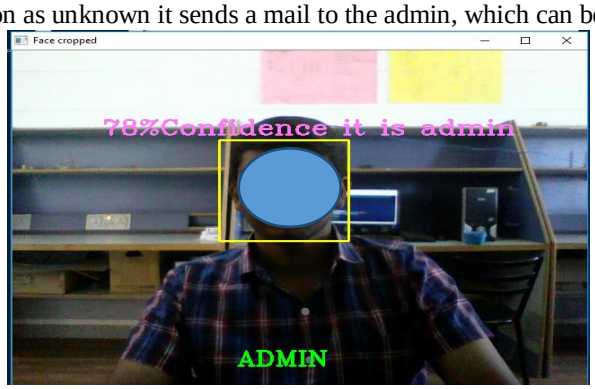

Figure 5: Screen shot of the window with admin in front of the system

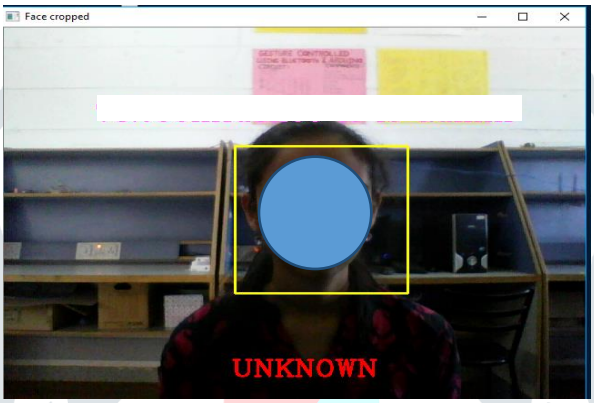

Figure 6: screen shot of the window with unknown in front of the system

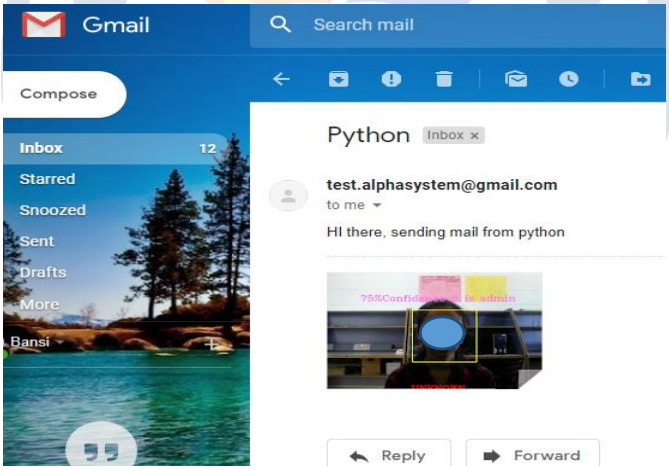

Figure 7: snapshot of the mail received to the admin

IV.CONCLUSION

By using this surveillance system, we can reduce the video storage system for a huge extent since it will store the video only if it detects any motion and also it reduces the cost of the entire system. It does not need any manpower to monitor the entire video continuously and hence it also reduces the man power required for surveillance system. It detects motion and capture image, sends out e-mail notification attached together with the image file via SMTP server as alert, making it a real-time system. Further the admin can react to any situation immediately, where as in other systems he will just know about the theft happening but could not react to it.

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