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SMART SURVEILLANCE CAMERA USING RASPBERRY PI 2 AND OPENCV

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Abstract— **Nowadays the need for a safe and secure system is desired by each and every individual in the society. The most commonly used system, Closed Circuit TeleVision (CCTV) is being implemented everywhere such as in hospitals, warehouses, parking lots, buildings etc... However this very system though effective has its downside when it comes to cost. Thus the need for a cost effective system is required. The existing system for surveillance is a security camera with the night vision capabilities using raspberry pi and openCV. This is a cost effective method that uses a credit card sized chip RPI. The image is captured and each frame is processed. The image is stored and an email is sent if human is detected. The existing system has accuracy of about 83 %. In this project we propose to use an enhanced recent model- raspberry pi 2 which has operating speed 900MHz. Also we use a pi camera. So the image is captured via the pi camera and it is send to the raspberry pi 2 for processing for face and human detection with the help of openCV. Then, the face detected is compared with the database, if the human detected is known (visitor) or not (stranger) and based on the output, an audio output is produced and a message is sent to the user. Thus, one can provide a low cost security system.**

Keywords—Raspberry Pi2; Pi Camera; openCV; Face detection; Haar Cascade classifier

I. INTRODUCTION

Nowadays, people want one sole thing that is to make them feel safe and secure. The most commonly used security system is the CCTV (closed circuitTelevision). The cost of implementation of CCTV varies depending upon the size and use of the system. It is usually installed in hospitals, malls, parking lots etc… However, with the help of CCTV one can monitor the area 24/7, or the footage if stored in a location can beretrieved when required. Although, it can be used to deter crime and allows the authorities to identify and solve a crime, it doesn't detectneither recognize the person who is involved.

We have implemented a system which provides both face detection and face recognition with the help of Raspberry pi 2 which is a credit card sized minicomputer and a Pi camera which is made especially for the raspberry pi2. Thus, when dealing with the real-time image processing, Open source computer vision (openCV) software, a powerful library of image processing tools, is a good choice. With the help of a smart surveillance system, we have achieved a system that can record the event, detect and recognize the person. A GSM module is used to send a message stating whether the person is an intruder or a visitor. If it is a visitor, then a command is sent by the user to perform some operation like- open the door (any type of automation is implemented) however if it is a stranger an alarm is generated to indicate that there is an intruder.

II. LOW COST SMART CAMERA WITH NIGHT VISION CAPABILITY USING RASPBERRY PI AND OPENCV

[1] In order to further maintain peace and provide security to people now-a-days,closed-circuit television(CCTV) surveillance system is being utilized. This study focused on the design and implementation of a low cost smart security camera with night vision capability using Raspberry Pi (RPI) and OpenCV The system was designed to be used inside a warehouse facility.It has human detection and smoke detection capability that can provide precaution to potential crimes and potential fire. The CREDIT CARD size Raspberry Pi (RPI) with open source computer vision (openCV) software handles the image processing, control algorithms for the alarms and sends captured pictures to user's email via Wi-Fi. As part of its alarm system, it will play the recorded sounds:"intruder" or "smoke detected" when there is detection. The system uses ordinary webcam but its IR filter was removed in order to have night vision capability.

III. SMART SURVEILLANCE CAMERA

Weare providing an integrated system which is capable of performing face detection and face recognition of the human being. This is being implemented in the normal household to provide security. Few modifications from the [1]existing system is done by replacing the RPI with Raspberry pi 2 with has 900MHz and with 1GB RAM. Also, instead of using a normal webcam, we are using a Pi camera which is

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compatiblewith the raspberry pi and it is connected to the pi via a 15 pin ribbon cable.The image is captured and with the help of haar like feature cascade classifier the face is detected. Now this is compared with a database to recognize the face.

A. BLOCK DIAGRAM

The block diagram of the paper is quite simple which has a few basic components but it is quite efficient in producing the result as required.

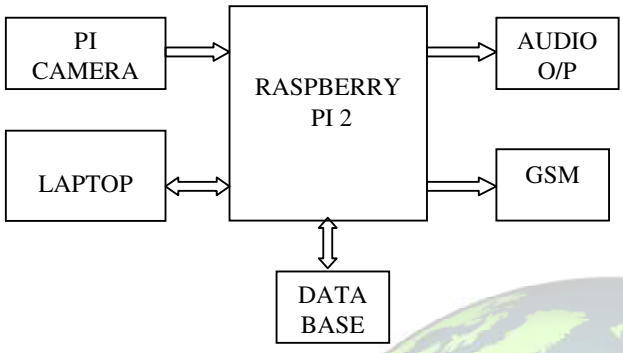

Fig. 1 Block diagram of the system

The input is the pi camera, which is used to capture the image and the captured image is sent to the processor which checks for the faces. If any faces are detected then it is further processed to check if the face is familiar or not. Finally the output is produced.

1) RASPBERRY PI 2: The raspberry pi 2 is a credit card size computer which is a 900MHz quad-core ARM Cortex-A7 CPU. It has a 1GB RAM and an additional memory is provided by using a micro SD card. It has 4 USB ports, 40 GPIO pins. A Full HDMI port is used to connect to a display and and an Ethernet port is used to interface the raspberry pi with the laptop. A combined 3.5mm audio jack and composite video jack is available. There are two types of interfaces available on the raspberry pi, Camera interface (CSI) for the pi camera and a display interface (DSI)

Fig.2. Raspberry pi 2 with the micro SD card

2) PI CAMERA: The camera consists of a small (25mm by 20mm by 9mm) circuit board, which connects to the Raspberry Pi's Camera Serial Interface (CSI) bus connector via a flexible ribbon cable. Christo Ananth et al. [5] proposed a system in which the cross-diamond search algorithm employs two diamond search patterns (a large and small) and a halfway-stop technique. It finds small motion vectors with fewer search points than the DS algorithm while maintaining similar or even better search quality. The efficient Three Step Search (E3SS) algorithm requires less computation and performs better in terms of PSNR. Modified objected block-base vector search algorithm (MOBS) fully utilizes the correlations existing in motion vectors to reduce the computations. Fast Objected - Base Efficient (FOBE) Three Step Search algorithm combines E3SS and MOBS. By combining these two existing algorithms CDS and MOBS, a new algorithm is proposed with reduced computational complexity without degradation in quality.

Fig. 3. Pi Camera

3) GSM MODULE: The GSM module is used to send amessage to the user if a face is detected and recognized in the surveillance camera.

B. SOFTWARE:

1) RASPBIAN WHEEZY: A Raspbian image is a file that you can download onto an SD card which in turn can be used to boot your Raspberry Pi into the Raspbian operating system. Using a Raspbian image is the easiest way for a new user to get started with Raspberry pi.

2) PUTTY: It is a protocol used to provide the intial connection with the raspberry pi using the ethernet cable to communicate with the laptop for remote connection. By providing the IP address of the raspberry pi one can provide a secure shell connection with the raspberry pi

3) XRDP- It is a protocol used to establish the remote desktop connection with the GUI of the raspberry pi 2 such that we can obtain the raspberry pi 2 desktop in our laptop . In windows, by selecting the remote desktop connection and providing the IP address of the raspberry pi 2, we can connect to the raspberry pi 2 and thus obtain the remote access with the raspberry pi.

4) OPENCV: OpenCV is written in C++ and its primary interface is in C++, but it still retains a lesser comprehensive though extensive older C interface. The API for these interfaces can be found in the online documentation. We have used the openCV for the face detection and recognition.

IV. WORKING PRINCIPLE

The overall working of the camera can be explained with the help of a flowchart. The image is captured by the picamera which has 5MP pixel resolution with 30 FPS, this image is then sent to the face detection module, which checks the frame obtained for any faces that can be found with the help of the Haar like features, if the face is detected then it is cropped out

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Once the face is compared with the well trained database, it is checked if the face is recognized.

- If the image matches with the database, then the person is a visitor and a message is sent to the user via a GSM module indicating that someone who is known has come home.
- However, if the face doesn't match with the database, then the person is identified as a stranger, and SMS is sent alerting the user, and an audio output is produced to warn and alarm the intruder.

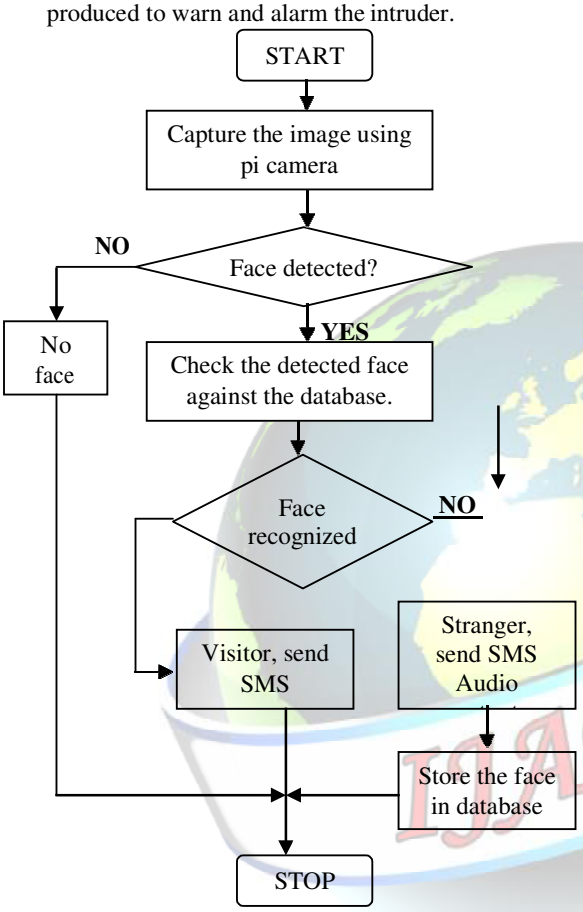

Fig.4. Flow chart of the smart surveillance system.

A) FACE DETECTION

We are providing a secure system, whose input I,0captured from the pi camera is sent to processor for face detection. The algorithm used for face detection is Haar like feature cascade classifier.

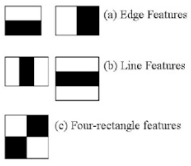

Fig.5. Haar like feature cascade classifier

Haar-like features are digital image features used in object recognition. They owe their name to their intuitive similarity with Haar wavelets and were used in the first real-time face detector.[2] Viola and Jones adapted the idea of using Haar wavelets and developed the so-called Haar-like features. A Haar-like feature considers adjacent rectangular regions at a specific location in a detection window, sums up the pixel intensities in each region and calculates the difference between these sums. This difference is then used to categorize sub-sections of an image. Therefore a common haar feature for face detection is a set of two adjacent rectangles that lie above the eye and the cheek region. The position of these rectangles is defined relative to a detection window that acts like a bounding box to the target face.

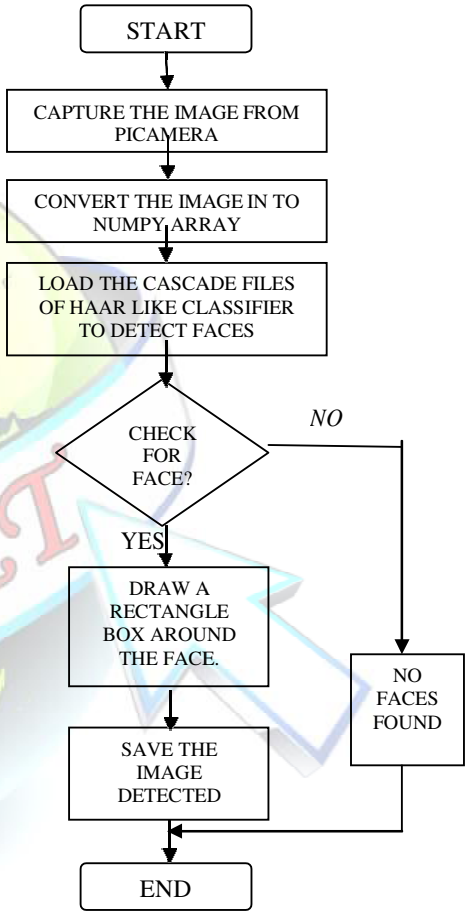

Fig.6. Flow diagram for the face detection

The captured image is first converted into the numpy which is a multidimensional array supported by the openCV. Now this image is converted to gray scale, with the help of the loaded haar cascade file from the openCV documentation, the feature is compared with the image, if any face is found based upon the haar like feature, [3]a rectangle box is drawn to indicatethat a face is detected.

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B) FACE RECOGNITION SYSTEM:

Recognition is the main part of any security system. Usually for a best recognition system, we require a well-trained database, which can provide the base for our recognition. So to obtain the database, first collect the images of the subject individual for the recognition. Once we obtain and train our system, we can provide face recognition.

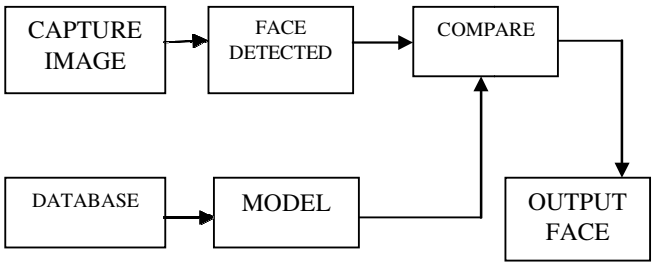
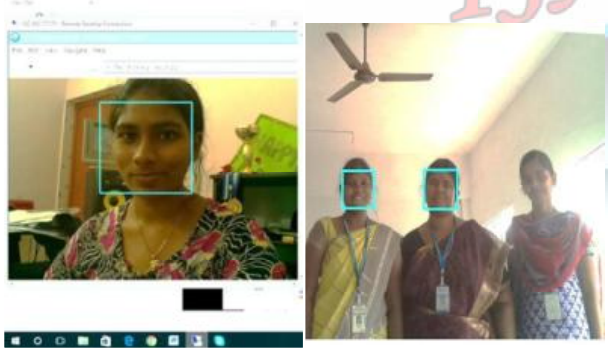


Fig.7. Overview of face recognition

We use the local binary pattern histogram (LBPH) for providing face recognition. This method helps us to provide a recognition model. The image is converted into a gray scale image. Then, the image pixels are compared with the neighboring pixels in a clock-wise or anti-clock-wise manner. Histogram is performed and normalization is done and a feature vector is generated for every image. These feature vectors can now be processed with some algorithms to classify images which is used to identify the texture. Once the face is recognized, it is checked to see if the detected face is familiar or not. Thus we integrate the face detection and recognition to provide a smart surveillance system for the domestic purposes in our everyday life.

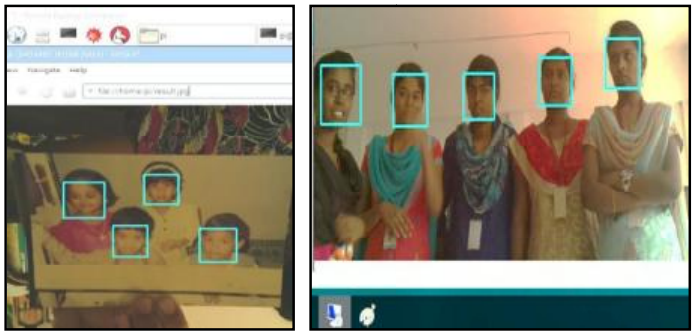
V. RESULT

The smart surveillance camera is very effective in a way that it provides security by reducing the alarming raise of crime at home. The Face of the human being is detected easily withthe help of the implemented algorithm – Haar like cascade classifier.

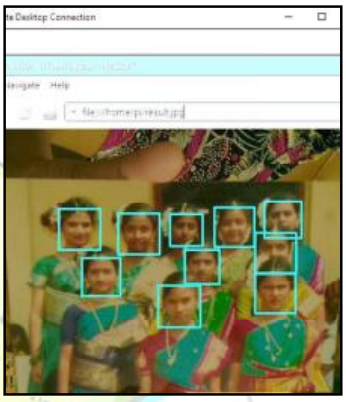


(a) (b)

Fig.8. (a) Found and detected one face correctly, (b) Out of the three faces in the image only two face is detected correctly.



(a) (b)



(c)

Fig.9. (a) Four faces are correctly detected, (b) all the faces are correctly detected and (c) All the 10 faces are detected in the image.

The accuracy of the face detection is calculated with the help of taking about 10 samples. Each sample consists of many numbers of faces. Thus, each frame is detected to identify the faces in that frame. There are two possibilities, either the face is correctly detected or it is not detected. Based on the observed result, the calculation is done with the help of mathematical formula.

SAMPLE	NO OF HUMANS IN THE IMAGE	CORRECT DETECTION	FALSE DETECTION
1	1	1	-
2	2	2	-
3	3	1	2
4	3	2	1
5	4	4	-
6	5	5	-
7	6	5	1
8	7	7	-
9	10	10	-
10	13	11	2

Table 1. Face detection done on 10 sample of frame.

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Formula used to find the accuracy of the face detection of the smart surveillance system is,

No of correct face detection = 48

Total no of faces in the samples = 54

$$\text{Face detection accuracy} = \frac{\text{no of correct face detection}}{\text{total no of faces in the samples}} \times 100$$

$$= (48 / 54) * 100$$

$$= 88.9\ \%$$

VI. CONCLUSION

Thus, we have developed a smart surveillance camera which is capable of providing both face detection and face recognition, rather than using different modules for performing the respective operations. Also the camera system is compact and can be implemented with low cost. The implemented face detection algorithm (Haar like cascade classifier) is very effective, with an accuracy of 88.9 % which can be increased further by effectively improving the illumination of the area. However, this system is connected with the help of a Ethernet cable to the laptop to communicate with the raspberry pi. This can be overcome by making the system wireless.

VII. FUTURE SCOPE

This system has a wide range of uses in various fields, such as banking, forensic department, etc… The reason this system is quiet useful is due to the fact that it is highly compact and it provides face detection and recognition at once.

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