Smart Security System Based on Raspberry Pi

Nurulhasan S. Mulla[1], Miss. S. U. Patil[2]
[1]Dept of Electronic Engineering
[2]Assistant Professor, Dept of Electronic Engineering
[1,2] Walchand College of Engg. Sangli , Maharashtra, India

Abstract- *The Smart security system has become indispensable in modern daily life It is much needed thing in all fields. As security is becoming the primary concern of society and hence having a security system is becoming a big requirement. Video surveillance plays a vital role in security systems. The proposed security system has been developed to prevent robbery in highly secure areas like home and industrial environment with lesser power consumption. With the help of smart security system, we can keep hawk's eye around the house or office. The system can be used for both Intruder detection and for automatic door access control. The ability of tracking and recognition of the visual device was implemented using Open CV library implemented on Raspberry pi. Intruder detection system achieved using absolute difference motion detection technique. The door access control is implemented by using face recognition technology, which grants access to only authorized people to enter that area*

Keywords- open source computer vision, smart security, raspberry pi, Intruder detection, face detection, face recognition, PCA.

I. INTRODUCTION

In recent days, Security system provides CCTV, Fire alarm, Gas leak detector intruder detector and Automatic door access. CCTV captures video continuously and store it for some days. It does not have any provision of alert signal. In Fire alarm sensor senses temperature , if temperature increases above the threshold value then it gives alert signal. Gas leak detector works same as temp sensor If it finds harmful gases above certain value then it gives indication. Intruder detection system is used to detect presence of any person in the restricted area. Such all things can be implemented using raspberry pi and Open cv.Main purpose behind choosing Raspberry pi is to reduce power consumption and to make efficient low cost system. Intruder detection system is used to detect any movement in Area. If any movement is detected then face detection algorithm based on the Haar features is started to detect the presence of any person the given area. Automatic door access control system implanted using face recognition. Face recognition is achieved using Principal component analysis.

II. LITERATURE REVIEW

Hteik Htar Lwin and et al. have proposed an door lock access system which consist of three subsystems: face detection, face recognition and automatic door access control[3]. The system is completely based on MATLAB Platform. Face recognition is implemented by using the Principal Component Analysis (PCA). When any person enters in the area face recognition done on PC, if it is known person then signal is given to microcontroller to open the door, if person is unknown then microcontroller will give alert signal. Drawback of this system is input images are taken through a web camera continuously which requires more memory space. To take further action about unknown person someone is required at the location. Personal computer (PC) is connected with the microcontroller, The whole system will not work if PC is crashed or Non-Function.

Jayashri Bangali and et al. Have proposed an system security of Home against Intruders and Fire[6]. The proposed system is controlled by an Atmega644p microcontroller. It collects information continuously from the sensors such as temperature and gas; If it finds any interruption in its sensors takes decision and sends SMS to a corresponding number by using a GSM modem. Working of system is such that if the temperature is increased above certain point or gas sensor sensors is ON, a SMS will be sent to the home owner 'Fire at home' giving the indication of fire. Intruder detection is achieved using software in PC. Drawback of system is it sends alert signal only as message using GSM modem.

Sadeque Reza Khan and et al. Have proposed a system contains sensors to detect obstacle, touch, heat, smoke, sound[4]. The whole system is controlled by a PIC microcontroller 16F76. It collects information from the sensors, makes a decision and sends SMS to a corresponding number by using a GSM modem. If it finds any interruption in its sensors like if the IR is interrupted then PIC will send a SMS to the home owner and another SMS to the Police Station. In the same way for fire interruption a SMS will be sent to the fire brigade and another to the home owner. In this system require extra hardware components like Sensors, GSM Modem. Alerts are sent through only SMS**.**

B. Udaya Kumar and et al. presents the implementation of a low cost wireless home security system using ZigBee protocol and remote access through internet[5]. Intruder detection and video surveillance is achieved using PIR sensor and camera. PIC, and MBED microcontroller are used for different purposes such as gas leak detection and home appliances control. All controllers are connected with each other in form of Zigbee star node. Problem is here multiple micro controllers are used, usage of ZigBee based network to communicate with the base station is limited to 100-150 meters long distance only. Base station is dependent on only Ethernet for internet connectivity.

Karan Maheshwari and et al. presents Facial recognition enabled smart door using Microsoft face API[2]. This uses raspberry pi with windows 10 IOT. When a person wants to open the door he needs to press push button then face recognition process is started. Face recognition is done on the visual studio. If person is authorized then door will automatically open if person is unauthorized then door bell will rang. The drawback of this system is the algorithms used in this work are implemented in neural networks and neural networks have few limitations in real time. These are enlisted as: Process is slow. Result is not so accurate. The methodology is complex. Also the time after successful detection of face is indefinite. This time should be set according to user needs. This system has only one admin and this may propose a problem if that person is not available to add any other user in case of emergency.

III. PROBLEM DEFINITION

To design and implement smart security system based on the raspberry pi. Which provide automatic door access using face recognition and same time provide security from fire and gas leakage

IV. PROPOSED SYSTEM

In order to implement the smart security system based on raspberry pi, we need a list of materials which is briefly mentioned below:

Hardware: Raspberry Pi 3 Model B, Logitech C310 Camera, Solenoid lock, Different color LED as indicators.

Software: Open CV, VNC server and Viewer, SQ lite, Python 2.7.

The proposed Smart security system is divided into four blocks Input unit, Processing Unit, Application Specific Unit and Communication Unit.

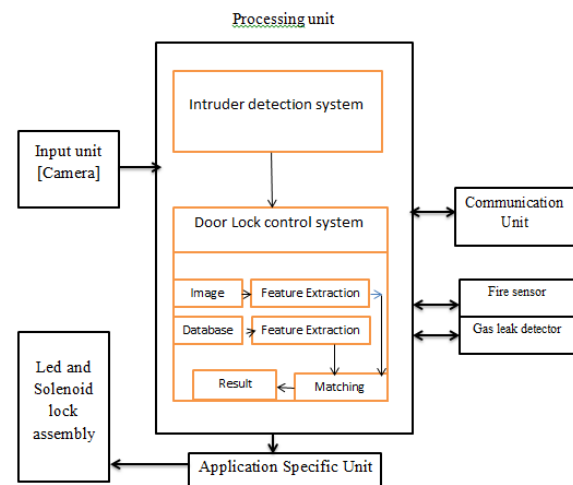Following figure shows the complete block diagram of proposed system

Figure 1 – System Architecture

A. Input Unit

In input unit the USB camera is used for both Face Recognition and intruder detection .Camera captures video continuously but storing is not require.

B. Processing Unit

Processing Unit divided into two blocks Intruder detector and Automatic door lock control access. Input is given to intruder detector block. It detects any movement in the area to be observed. If any movement is occurred the Face detection algorithm starts. It detect presence of any person Face detection is achieved by using the Haar cascaded detector .If any person is present then face recognition process is started. This compares the faces stored in database. Depend on the matching result obtained Application specific unit will works.

C. Application Specific Unit

Application specific unit also consist of two parts. Solenoid lock unit is used for opening the door for known person and Alert system will gives alert signal to the main user about unknown person.

D. Communication Unit

Raspberry pi gives support three types of communication interface: Bluetooth, Ethernet port, Wi-Fi. Out of which Wi-Fi is used in the system.

V. IMPLEMENTATION

A. Accessing Raspberry pi from anywhere

As smart security system consist of intruder detection and automatic door access control system we need to access raspberry pi from remote location. Following task can be achieved by accessing raspberry pi from remote location Accessing database, Adding or removing user from database, seeing previous alerts, seeing current status of system. All this can be achived using VNC server.
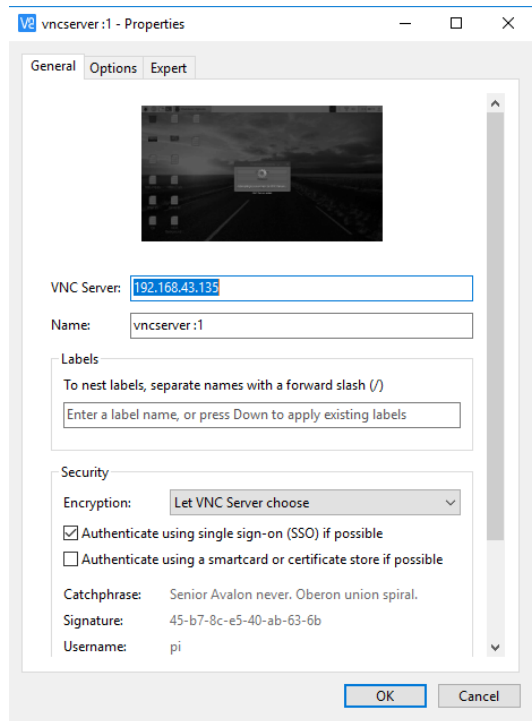
Figure-2- VNC server configuration

VNC has long been the best way to access any computer remotely on the same network. Recently, VNC Connect came out to make it easy to access your Raspberry Pi from anywhere using a cloud connection and port forwarding. Once it"s set up, we can access our Raspberry Pi"s graphic interface from any other computer or smartphone using the VNC Viewer app

B. Intruder Detection System

The first part of smart security system is intruder detection system. It works as visual surveillance system. This system uses an absolute differencing technique to detect the motion of an object in the motion required area. Fixed USB camera used for surveillance purpose

1) Video Capture:

Live video stream needs to be processed, using a USB camera connected externally to the system. The system processes every frame to track the motion.

2) Gaussian filter:

It removes specious movements as it does not exceed to a step function input while minimizing the rise and fall time. Gaussian filter is applied to smoothen the patchy image.

3) Threshold:

Binary thresholding is used for segmentation purpose to reduce the noise. Binary threshold is applied to the image, to identify the motion as a group of pixels called blob. It separates out regions in an image corresponding to object of interest that is important to analyze. Then based on the variation of intensity between the object pixels and the background pixels, separation is done. This thresholding operation can be expressed as:

Dst (x, y) = 255 ; if src (x, y)
Dst (x, y) = 0 ; otherwise

So, if the intensity of the pixel src (x, y) is higher than threshold, then the new pixel intensity is set to a 255 else that are set to 0. The foreground pixels with positive value become 255, and background pixels are reduced to zero. Threshold value is kept very lower, so that all the pixels causing motion are identified. Hence system will be motion sensitive. The user can select threshold value, so that it suits the need of different surveillance areas and illumination changes. The binary output is then provided to next block for detection of a boundary of an object.

4) Contour Detection:

A contour is boundary of object pixels above the threshold value that is set. Contour Analysis outputs a linked list which contains detected blobs. Here the boundary of the blobs causing motion is detected and highlighted using a red color boundary.

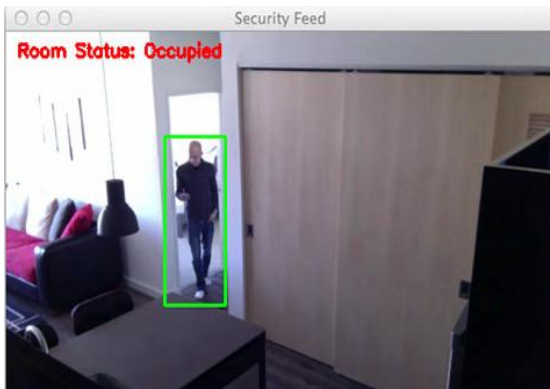### 5) Results obtained for intruder detection—

Figure4-Main Window
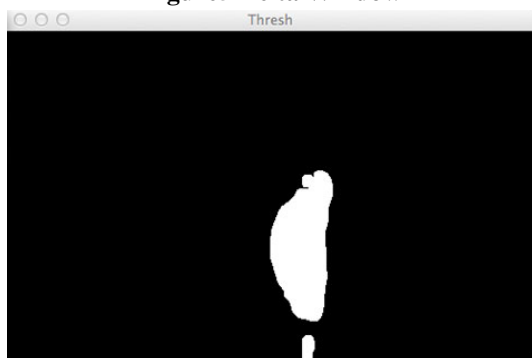

Figure5 Delta Window

Figure-6-Threshold Window

C. Face Detection

Haar cascade is explained by two things haar like features and cascade classifiers. Haar-like feature considers adjacent rectangular regions at a specific location in a detection window, sums up the pixel intensities in each of the regions and then calculates the difference between these sums. Due to its intuitive similarity with haar-wavelets these features get their name as haar-features These features are used for object detection. In the detection phase the window is moved over the input image and for each-subsection, haar-like features are calculated .This difference is then compared with a learned threshold value to detect the presence of an object. But for accurately detecting an object, a large number vof haar-like features are required. To implement this algorithm, we need a large number of positive and

negative samples where positive samples indicate the presence of a object and negative samples indicate the absence of the same object to train the classifier. For this, we need to apply each and every feature on all the training images and for each feature calculate the best threshold value which will classify the images as positive or negative. We select the features with minimum error rate, and this process is continued until required accuracy or required numbers of features are found. These features cannot detect the object on their own but when used together they form a strong classifier. So let's consider a scenario in which the task is to detect a face. Major part of the image is a non-face region. For this, the concept of cascade of classifiers was introduced. Instead of applying all the features on a window at once, group the features into different stages and apply them one-by-one. So if a region fails in the first stage itself, we don't need to apply the remaining classifiers. Only on those regions which pass the first stage, we apply the second stage and so on. Thus, the region which passes all these stages contains the object or in this case a face.

Result Obtained from Face detection using Haar Features
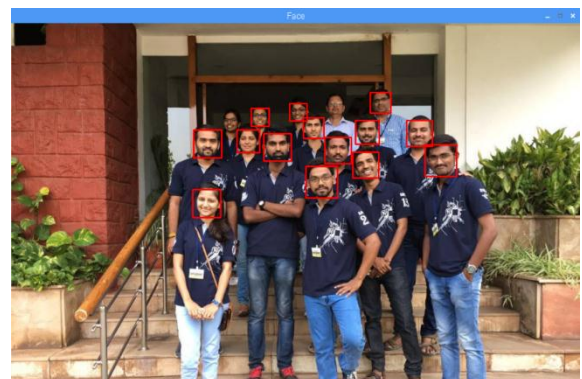

Figure-7-Face Detection

D. Face recognition:

A face recognition is achieved using principal component analysis. PCA is a technique that effectively and efficiently represents pictures of faces into its Eigen face components. It reduces data dimensionality by performing a covariance

analysis between the factors. Before applying PCA, it require Dataset With same object (database) and images in the database must be same dimension
Steps involved in PCA

1. Conversion to matrix form

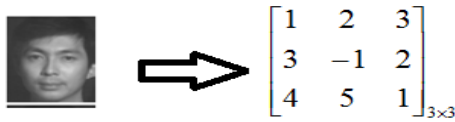To apply mathematical procedure image need to be convert into matrix form as bellow

Figure-8-Face converted into matrix form

2. Convert matrix into column vector

Image matrix may be of multiple dimensions So we require to convert it into unidimension.means matrix is converted to vector form

3. Normalize to face vector form

It remove common feature from each vector so each vector has unique feature. To calculate unique feature first need to calculate average vector.

Average vector= $\varphi = (1/M) \sum_{i=0}^{M} Ri$

Normalize face vector $\emptyset i = Ri - \varphi$.

4. Covariance Matrix
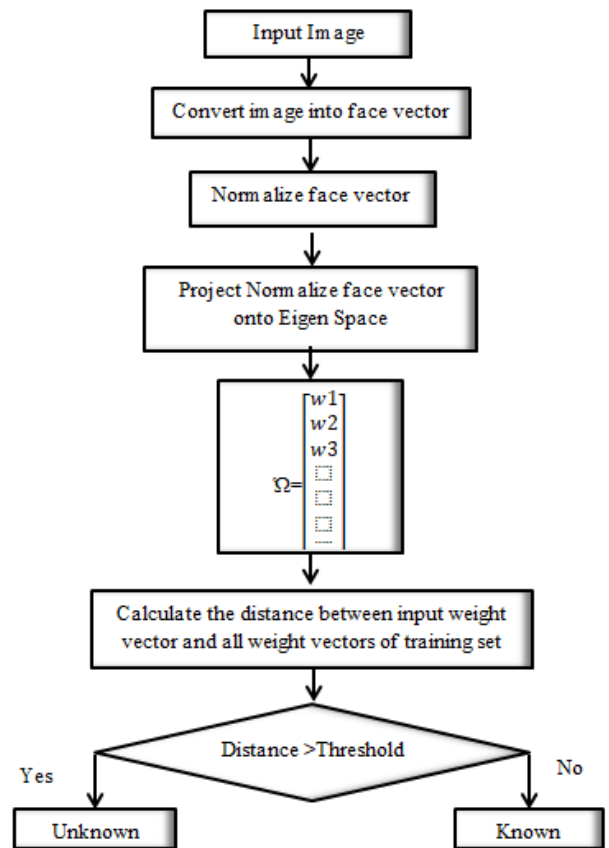
Covariance matrix can be calculated as

$$C = A.A^T$$

Where A=$[\emptyset_1 \emptyset_2 \emptyset_3 \emptyset_4 \emptyset_5 \emptyset_6 \emptyset_7 \emptyset_8 \ldots \emptyset_i]$

If the image is of NXN size then vector is of $N^2 X 1$ size. Dimension of covariance matrix is $N^2 X N^2$. As the dimensions are grater much difficult to calculate. So here we use

$$C = A^T.A$$

Therefore the dimension of the Covariance matrix becomes MXM .

Eigen face matrix Select 'K' eigen face such that K<M and can be able to represent whole training set. And make weighted matrix for each image.

5. Recognition of unknown face

Flowchart- Recognition of unknown faces
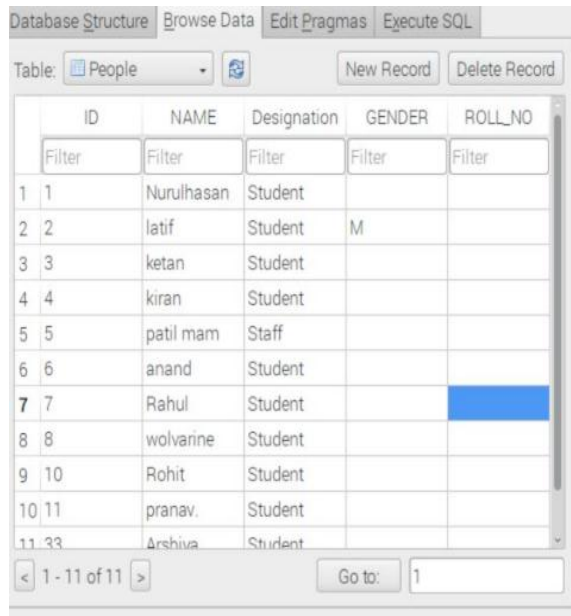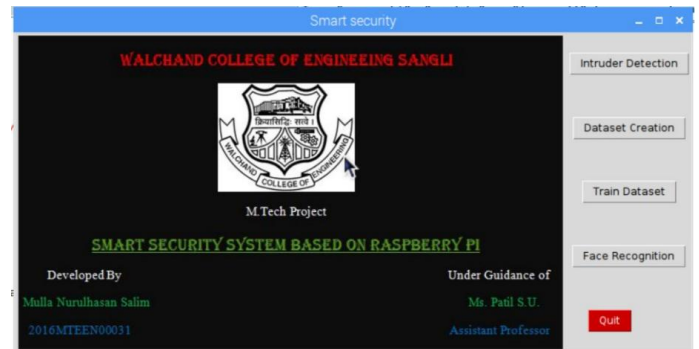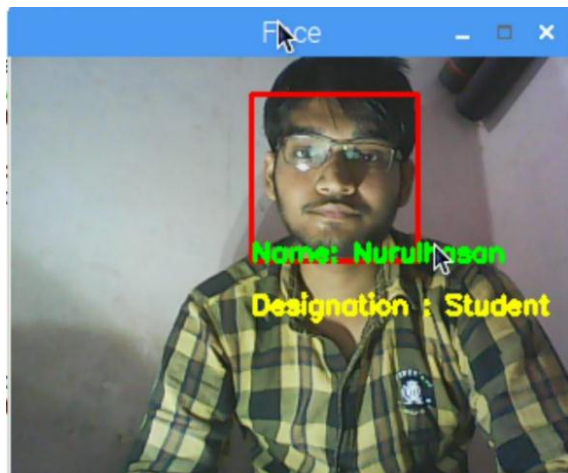
E. Final Results Obtained-

Figure-9- Main Window

Figure-10- Database

Figure-11- Recognized face

VI. CONCLUSION

In this proposed system door access system by using face recognition and along with the Intruder detection system has been presented. This system has been tested successfully with home door lock access control based on face recognition method by verifying enrolled facial images.

This proposed system can be enhanced by using the infrared image scanner camera to find concealed weapon detection under the clothes of the human body. We can also use this security system by making required modification to the system in an area like banking sector to provide more security to the lockers, based on their facial authentication and keep track of account holders record of information when and who is accessed the lockers. In this way we can enhance the proposed system effectively by making some modifications according to requirements.

REFERENCES

[1] R.Manjunatha1 ,Dr.R. Nagaraja "Home Security System and Door Access Control Based on Face Recognition", International Research Journal of Engineering and Technology (IRJET) Mar -2017

[2] Karan Maheshwari, Nalini N "Facial Recognition Enabled Smart Door Using Microsoft Face API" International Journal of Engineering Trends and Applications (IJETA), May-Jun 2017

[3] Hteik Htar Lwin, Aung Soe Khaing, Hla Myo Tun "Automatic Door Access System Using Face Recognition", International Journal of Scientific & Technology Research, June 2015

[4] Sadeque Reza Khan, Ahmed Al Mansur, Alvir Kabir, Shahid Jaman, Nahian Chowdhury, "Design and Implementation of Low Cost Home Security System using GSM Network", International Journal of Scientific & Engineering Research, March 2012.

[5] Udaya Kumar, D. S. Murty, Ch. R. Phani Kumar, "Implementation of Low Cost Ethernet Based Home Security Using Wireless Sensor Network", Journal published at Algorithms Research, March 2013.

[6] Jayashri Bangali, Arvind Shaligram, "Design and Implementation of Security Systems for Smart Home based on GSM technology", International Journal of Smart Home, August 2013.

[7] https://www.raspberrypi.org/products/model-3b