Automatic Door Lock System by Face Recognition

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Abstract. In this paper we have proposed face recognition door lock system using raspberry pi for security purpose. Implementation of the system is for monitoring whether any unknown person is entering in to the door. We have established communication with electronic devices through face detection with the help of Pi camera Raspberry Pi platform. For software coding Python and Open CV libraries are used. In order to get accurate and clear picture of an intruder we have proposed Haar classifier method for face detection. As soon as the person enters near the door, pi camera captures the image and face detection process is done then if it matches with database images then the door is unlocked otherwise a message with the picture of a person will be sent to the registered mobile through GSM and LAN network.

1. Introduction

Nowadays, as the technology is increasing, facilities for human beings are increasing. In day to day activities, life of people has become very easier with the incorporation of many technologies. On the other hand, it also creates security issues [1]. The traditional door locks have a problem that almost anyone can break and enter into your house. Hence it is a great challenge to overcome these problems. In general, in order to secure home, people make use of CCTV. Images will store in the database, so that the action can be taken when any suspicious incident happens. This type of approach is a passive [2]. But there is a need for an active approach. This type of approach is nothing but where actions can be taken immediately as soon as a security threat occurs [1].

Hence a smart IOT based face recognition system is the idea to develop, which recognizes the face of the person near by the door and compares with the uploaded faces stored in the database [3]. If person is detected then the door would open and welcomes them. If an unknown person enters, the owner would be alerted by message and mail with an intruder image. To develop this system, we have used Raspberry Pi, Pi camera which will be installed near the door for recognition of face of an intruder, DC motor to open the door through relay, LED’s to indicate whether the door is opened or not, GSM module is used in order to send messages to the registered mobile number.

2. Literature survey
From decades, for science society using of smart home is not a new term. As there is an advance in technology there is a fast increase in the field of home security automation. The control of smart systems for automatic door lock system is done through Bluetooth, internet etc. Most of the laptops, tablets, mobiles have built-in adapters which in turn reduce the cost of the system, but it controls within the Bluetooth range.

The system which is based on SMS technology have only two components [4] i.e. GSM and micro controller. Here micro controller is acting like bridge between the user, sensors and actuators. The author D Aishwarya et al [5] proposed a method for face detection by using algorithm known as viola-jones and recognition of face is done by the revised Gabor filter and multi key point. Using Neural Networks, Nandini M et al [6] proposed a facial recognition system. For training and to extract the local features like nose, eyes, shoulder and mouth they have used back propagation algorithm.

Using MATLAB PCA (Principal component analysis) is implemented by M Mulla et al [7] for face recognition. By using PCA, Eigen faces are generated by changing the faces in the dataset. Distance of the person is calculated by Euclidean distance method. If the distance is less, then it is a recognized face. After that by using GSM module the system generates an alert message to the owner.

3. Proposed system architecture

The main aim of the proposed system is to design cost effective, great flexibility by connecting all modules to system database and open source home automation system using python for various home and outdoor environments.

![Figure 1. The proposed system block diagram](image)

Figure 1 show the block diagram, which contains Raspberry Pi 3, Pi camera, Relay, LED’s, and DC motor. This proposed system is connected to the door. As the intruder approaches the door, the Pi camera captures the images. After that the Haar cascade algorithm is used to detect the face which was captured [8]. Firstly this algorithm needs to train whether it is positive or negative images. The faces which are clear are nothing but positive images and without faces are negative images [9]. Haar cascades are the same as convolution kernels which are shown in figure 2. Haar like features are digital image features used in object recognition for real time face detector [10]. The important feature of this is its calculation speed and the other key feature is accuracy. Adaboost machine learning
algorithm is used to avoid the complexity of calculations, which is inbuilt in Open CV library [10]. Raspberry Pi processes the captured image coordinates with the existing coordinates in the database. If it matches then it sends the signals to relay switch through GPIO pins. DC motor drives a miniature door which is being used for a door locking system. If the intruder's face doesn’t match then the LED’s are on and the door remains closed.

![Image](image.png)

a.) Edge Features  
b.) Line Features  
c.) Special Diagonal Line Features  

**Figure 2. Types of features in Haar Cascade classifier algorithm**

The main blocks of the proposed system are:

**3.1 Raspberry Pi**  
The version of the model (A or B) doesn’t really matter. But we have used Raspberry Pi model B with Wi-Fi. With the intention of promoting the teaching of basic computer UK has developed Raspberry Pi as a credit card sized single board. It has a Broad com system on a chip (BCM2835). It also includes an ARM11 700 MHz, video core IV GPU, with originally 256 MB of RAM, now upgraded to 512 MB. It uses SD card for long term storage purpose. It uses a 5V power supply to run [11].

**3.2 Pi Camera**  
It comes with a flex cable. This is inserted into the connector located in between the Ethernet and HDMI port. When there is someone next to the door, by using face recognition software it can capture the image and store it in the database using python and then it can be send to the owner through android application, this can help in providing security to home. The camera is capable of 2592 x 1944- pixel static images, and supports 1080p30, 720p60 and 640x480p60/90 video.

**3.3 Relay**  
In our system we have used two channel relay for device control. A relay is an electrically operated switch to operate a suitable pull in and a holding current should be passed through its coil. It is designed to operate from 5V to 12V. Relay would be ON, When a LOGIC 1 is written on the port PIN. It is turned OFF by writing LOGIC 0 on the port pin. The main advantage of this is it very low cost and expandable, and it is noise free system.

**3.4 DC Motor**  
A DC motor is rotary electrical equipment which converts electrical energy into mechanical energy. A current running through a coil of wire generates an electromagnetic field aligned with the center of the
coil. Changing of the direction and the magnitude of the magnetic field can be done by changing the current flow through it. It is connected to the relay where it drives the miniature door after successful recognition process.

4. Proposed method for face detection
After preprocessing like resizing and cropped images, Haar cascade classifier is used to detect whether there is a single face detected or not. Figure 3 demonstrates the flow chart for the proposed system. Edge, line, and center surround are the features of Haar which are acting as inputs. By these cascade features the test of the image is done. The features of Haar are divided into various different stages [9]. Stage by stage the window will be tested. Usually initial stages will have less Haar-like features. If the first stage window fails, then it is to be discarded and the next stages will not be tested. If all the stages successfully passes then it is considered to be face is detected and checks with the images already stored in database of raspberry Pi [9, 12, 13, and 14]. The advantage of Haar cascade classifiers is fast detection speed compared to other classifiers.

5. Experimental results
When any motion is detected the Pi camera effectively captures the pictures. The real time face detection is done by cascade classifier. The system starts running once the picture is captured. The
figure 4 shows that the face is detected. The figure 5 shows the received notifications and the captured image on the smartphone. The overall execution time is capturing of images, detecting of faces through cascade classifier and for sending the message with the image of unknown person to the owner.

![Figure 4: Face is detected](image1.png)

![Figure 5: Received notification in mobile.](image2.png)

6. Conclusion

In this paper we have implemented a face recognition door lock system. Recognizing of faces is done by using cascade classifiers, which gets a high accuracy and will store in the database. For this testing, we have used 40 images only. Computer vision is used in the IOT. For security purpose, we have implemented real time face detection by Haar classifier. Thus this system can useful for senior citizens living alone and for immobilized people. Hence the proposed system is practically easy to construct and easy to track the path.

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