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Face Recognition Door Lock System

A Raghu Prasath[1], Aditya Kumar[2], Akanksha Yadav[3], Bhuvishri Acharya[4], Md Tauseef[5]

[1]*Student, School of ECE, REVA University, Karnataka, India*
[2]*Student, School of ECE, REVA University, Karnataka, India*
[3]*Student, School of ECE, REVA University, Karnataka, India*
[4]*Student, School of ECE, REVA University, Karnataka, India*
[5]*Asst. Professor, School of ECE, REVA University, Karnataka, India*

Abstract – *Nowadays, we are facing security issues in every aspect. So we have to resolve these issues by using updated technology. In this project, we are using the Face recognition module to capture human images and to compare with stored database images. The most important of feature of any home security system is to detect the people who enter or leave the house. Instead of monitoring that through passwords or pins, unique faces can be made use of as they are one's biometric trait. We aim to create a smart door, which secures the gateway on the basis of who we are. We want to develop this system based on Raspberry-pi 3, to make the house only accessible when your face is recognized by the recognition algorithms from Open CV library and meanwhile you are allowed in by the house owner, who could monitor entrance remotely. Whenever the person comes in front of the door, it recognizes the face and if it is registered then it unlocks the door, if the face is not registered it will raise an alarm in the mobile and clicks a picture and send it on the registered number. This is how the system works.*

Key Words: Raspberry -pi 3, Open CV, GSM Module, Python

1. INTRODUCTION

Biometrics is unique to an individual and is used in many systems that involve security. In the face recognition approach, a given face is compared with the faces stored in the database in order to identify the person. The aim is to search out a face in the database, which has the highest similarity with the given face. This paper deals with the idea of secure locking automation utilizing RPi for door unlocking system to provide essential security to our homes, bank lockers and related control operations and security caution through the GSM module .It uses an image capturing technique in an embedded system based on raspberry pi server system. RPi (Raspberry pi) controls the video camera for catching it for turning on a relay for door unlocking. The module contains a secured face recognizer for automatic door unlocking. The camera catches the facial picture and compares it with the image which is stored in the database. If the picture is found in the database then the door lock opens otherwise it will produce a SMS that an unknown person is trying to gain access. Most of the face recognition systems available today work under controlled environment. Variation in lighting, pose, facial expression, occlusion, ageing etc., are some of the key factors that greatly influence the accuracy and efficiency of face detection and recognition. The system consists of face detection, face recognition, a password custom, a GSM module and a door lock. Face detection is the process of detecting the region of face in an image. The face is detected using Haar-like feature and face recognition is implemented using Local binary pattern histogram (LBPH). Now-a-days door locks can be accessed using systems that are incorporated with fingerprint sensors, passwords, RFIDs, face recognition etc. The system comprises a webcam to detect the faces and a solenoid door lock for unlocking the door. Every users detected by the webcam will be checked for compatibility with the database in the system. If the face is recognized, the password box will appear. The user will enter the password. If the password is correct, the door will open automatically. On the other hand, GSM module will send the notification to the owner for the unknown person. The main control circuit on this system is Raspberry Pi. The software used is OpenCV Library & Python.

2. LITERATURE SURVEY

We have discovered various papers identified with the security framework. The author in [1] proposed a novel approach of face recognition which based on Gabor filtering and supervised classification. The 2D filter bank are used and then produces 3D robust face for vector average distance used in supervised classifier and threshold based face verification method used by using this technique a high facial recognition rate is obtained. The author in [2] proposed an efficient face detection algorithm. This paper introduces the concepts of integral image, efficient AdaBoost classifier and cascading of classifiers thus reducing the computations and resulting in an efficient and fast detection algorithm. The author in [3] proposed a system to ensure security for automobiles. The system is based on Arduino and captures the image of the person trying to start the vehicle. The algorithm used for face recognition is PCA. The authors in [4] They were used an Embedded platform which was very unique and easy to implement. They proposed an image capturing technique in an embedded system based on Raspberry Pi board. The author in [5] he project was "Raspberry Pi Face Recognition in Treasure Box" a great example of how to use the Raspberry Pi and Pi camera with Open CV's computer vision algorithms. By compiling the latest version of Open CV, it can get access to the latest and

most interesting computer vision algorithms like face recognition. The author in [6] He developed a system with an advanced surveillance camera capable of face detection and at the same time recognizing the face detected using OPEN-CV library, Eigen face methodology and these all processing has been done on Raspbian OS on Raspberry Pi. The authors in [7] They proposed there work on Raspberry pi 2 B+ model with camera interface to capture an image and convert this capture image into gray image with digital processing image algorithm. The author in [8] He proposed that real time application of Face Recognition concept by generating a MATLAB code using image acquisition tool box on the basic approach used is PCA using Eigen faces. The authors in [9] had implemented security system where if any person came at the door it was notified to the home owner via e-mail and twitter then the user could see the person standing at the door using camera from remote location.

3. PROPOSED WORK

In this system, we are using Local Binary Pattern Histogram (LBPH) for face recognition. Open CV is an open source computer vision library that has three built-in face recognition algorithms, (i) Eigenfaces, (ii) Fishersface, (iii) Local Binary Pattern Histogram (LBPH). Compared with the two algorithms, the LBPH can not only recognize the front face, but also recognize the side face, which is more flexible. Therefore, the face recognition algorithms used here is **Local Binary Pattern Histogram (LBPH)**. It is a simple yet very efficient texture operator which labels the pixels of an image by thresholding the neighbourhood of each pixel and considers the result as a binary number. And then it converts the binary number into a decimal number, and that decimal number is the new value of the centre pixel.

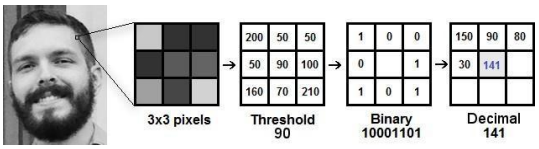

Fig.1 Conversion of grayscale image to decimal

At first, we have to save images by using data sets and after that, we will train that faces to LBPH algorithm then it stores into the database. At first, it converts colour images to gray scale images and then it converts into pixels for detecting this will divide the image into various pieces then it stores the values of each pixel. If pixels are less than it will be represented as 0 and pixels which are high will be 1 then it will be arranged in 3 × 3 matrix format for recognizing the images on screen compared to database stored images.
The proposed works are as follows:

- Interfacing of camera to capture live face images.
- Create a database of authorized person if they exist.
- Capturing current image, save it and compare with the database image.
- Interface GSM module to send alert to authorized person while unlocking the locked door in the form of SMS and CALL.
- The project can also be used for surveillance. For instance, it can capture the images of unidentified individuals and store it which can later be used to determine the impostors who tried to gain illegitimate access.
- Interface relay as an output.

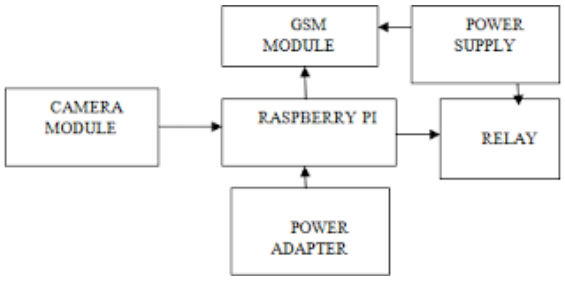

Fig. 2 Block diagram of "Raspberry pi based face recognition system for door unlocking"

3.1. FLOWCHART

The system will works in two different parts. The first part is for capturing and creating a database by storing the image. And the second one is to compare the image with the stored images in the database. For feature extraction we will use Eigen faces methodology and Euclidian distances will used for recognition of the face.

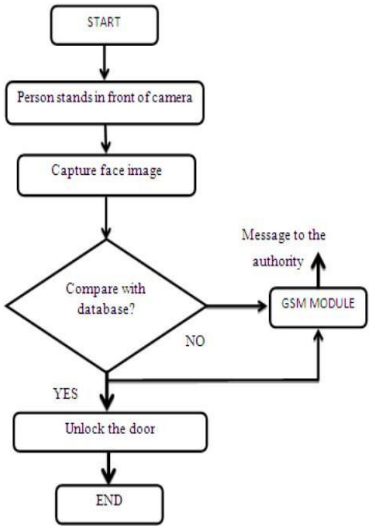

Fig 3. Flowchart of Image capturing and database comparison

Camera Module: Camera module is pi camera interfacing to the raspberry pi module. It is used to capture images and send the clicked images to the raspberry pi module. Camera contains LEDs and flashes to handle that light condition that is not explicitly supplied by the

environment and these light conditions are known as ambient light conditions.

Raspberry Pi Module: Raspberry pi 3 module is a small computer board. When an image is taken by raspberry pi it is compared with database image. For the first time when we capture an image to Create a database raspberry pi module captures many images to create a database in the system and this database is compared with the live captured images. After comparing the two images, based on whether the output is positive or negative it gives commands to GSM module.

GSM Module: GSM module is used to send a message to the authorized people based on the output. If the output is positive "Information matched Access granted" message will be sent to the authorized people, otherwise in case of unauthorized access it will send an "Access denied. Some unknown person is trying to unlock the door". Message to the certified users of the system.

4. RESULT ANALYSIS

In this system, we designed a Secured Door Lock System with the help of Face Recognition. In this, we are using Raspberry Pi which has many features that make the user modify use in different smart applications. The experiment was performed to implement the face recognition using OpenCV library installed in Raspberry Pi. We used Python in Python IDLE 3.6.5 and the database that used was SQLite studio.

The face detection procedure was first implemented which was done by the help of face detection algorithm that we used. Firstly, we used the web camera to capture the images. We registered five users as authorized user and their images are stored in the database. For these users, we took 10 facial images with different poses and expressions.

Here below are the different facial images in the database in fig 1. Below

Fig 4. Different Facial Images with different expression

In the experiment we trained the face images in the database. That the facial images are successfully trained. Based on the LBPH algorithm, the input face images are compared with database facial images for identification. If the face is recognized, the password box will appear.

The user will enter the password. If the password is correct, the door will open automatically. On the other hand, the password is wrong in three times, GSM module will send the notification to the owner for the unknown person.

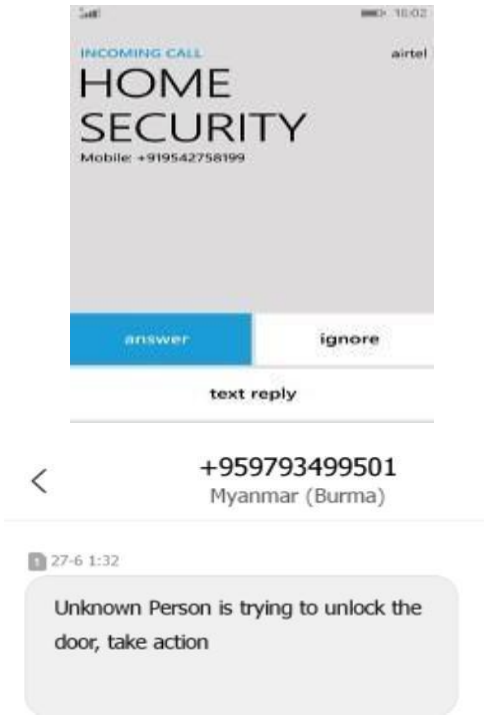

Fig 5. Call or SMS from GSM Module

Some important notes to look up to in this project are as follows:

- The system is tested using same person and different people including the authorized person and unauthorized person and the results show that the system recognizes the users 9 times out of 10.
- Therefore, it has an efficiency of 90% with a 10% tolerance. However, this only happened when the user changed some of the facial expressions.
- But when it comes to measure the recognition time required, the system is evaluated ten times and the average was taken. It was found that the average recognition time was 15 seconds.
- The experiment was done using a brightly lit room with enough space between the user and the Pi camera. The best distance the user should stand to get the best accuracy is about 0.5m from the camera. Taking the picture from a closer distance will not get a good recognition as the whole face should be able to be seen inside the picture.
- When the captured image resolution is low, the accuracy seemed to drop because the image captures has not enough data to be processed. By using a hierarchical approach to this problem is reduced.

- The user image is captured in high resolution then shrunk to a smaller size before comparing to the training image. This produced a good recognition rate as well.
- Using a training image of high resolution can also be used to get better accuracy but the Raspberry Pi's limited processing power causes the system to hang if the image above 720p is used for training. Therefore, a smaller image is the best way to get the results.
- One of the limitation of the system is that the user must appear exactly as the training image captured by them. For example, if the intended user does not wears a spectacle when taking sample image then he cannot wear them during authorization. Sometimes, it is also sensitive when the user smiles wider than usual due to the size of mouth changing differently than the training image.
- The Raspberry Pi has a good power management system but the internal power supply is enough to the board itself but it is inefficient to provide power to external sources.
- Unlike the GPIO pins in the Arduino, the raspberry Pi has limited power to supply to these pins by making developers rely on different alternatives such as combining two boards together.
- A low power relay was used to replace a normal relay but this can only be used for small voltage load. This is one of the limitation in the current Raspberry Pi board.
- In this project the GPIO pins are the only source used to power up all the hardware to keep its simplicity and it is was insufficient to provide power to all the components.

5. APPLICATIONS

- **Offices**: Physical access to workspace facilities
- **Government**: Transfer important document safely
- **Banking and Telecom**: Help to know the current process to the customer, allow authentication of credit/debit cards
- **Education**: Allow attendance tracking of the students and entry to labs
- **Construction**: Control access to specific point at a site
- **Real Estate Commercial**: Offers access to campus facilities like residence halls, common area, cafeteria, etc.
- **Manufacturing**: Control and record access to specific locations for employees, visitors, vendors and maintenance staff.
- **Aviation**: Paperless travel at airports
- **Warehouse**: Control process to provision entry and exit of vehicles
- **Entertainment**: Access to multiplex cinema
- **Hotels**: Entrance and Exit after reservation in Hotels

6. CONCLUSION

In this project, a Secured Door Lock System Based on Face Recognition using Raspberry Pi and GSM module is presented. We designed the system which provides security locks for door, comfort, connivance security and energy efficiency for user.

In this system, we have been implemented with a combination of webcam, Raspberry Pi, relay, solenoid door lock and GSM module. And we used Local Binary Pattern Histogram (LBPH) for recognize the face. The arrangement of a facial recognition system using raspberry pi can make the system littler, lighter and work successfully utilizing lower control use, so it is more convenient than the pc-based face recognition system. Also, send a security alert message to the authorized person utilities. We are also providing power backup for the smooth and continuous functioning of the system in case of power failure. The power bank is used to charge the Raspberry Pi so there is less chance to slow down the system. As a conclusion, security system by using face recognition combined with IoT is successfully done. The face recognition is able to recognize the face and able to send notification to a user when an unknown being has been detected through IoT.

7. FUTURE SCOPE

A real time speaking assistant can be deployed to make the system more user -friendly and efficient. Highly secure protocols such as TLS can be deployed to ensure there is no security breach. Using raspberry pi the current project can be modified by an Infrared camera interfacing it can be used in Smart Surveillance Monitoring security system which any type of public security is using Living body detection or spying.

Also it can be used in Attendance system of the class, also some profound applications can be implemented using interfacing of Raspberry pi and Arduino UNO board like sensor application of smartcard swapping, finger detection, alcohol detection, agriculture humidity sensing, Temperature sensing using web server, and many more.

New studies are being made to allow images to be processed on the GPU of the Raspberry Pi, achieving better results with the use of specific libraries.

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