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Intelligent Door Lock Using Raspberry Pi and Android Application

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***Abstract*: Home automation place a major role in today's lifestyle. Using home automation, we can provide a secure, energy efficient devices, remotely controllable home devices. We focus on securing homes using intelligent door lock, which captures the image of the person standing before the door to get access to enter the house. Using image recognition, the captured image is tested and if it is the image of an authorized person the door opens automatically and if it is of an unknown person the captured image is sent to the owner of the house to get access. If the owner recognizes the person, he/she can give access through his mobile using an android application. If the owner finds the person to be a stranger, then he/she can deny the access. Existing Intelligent door lock requires all the devices to be connected in the same network including mobile phones. An attempt is made to improve this technology by controlling the door lock from anywhere. This can be done by connecting the mobile phone and the door lock to a cloud network. Firebase is a suitable option for this operation because connection of firebase with android application is simple. Using firebase, we can change the status of the door using an android application and using this status we can control the door opening and closing operation.**

***Keywords*: Cloud network, Door lock, Firebase, Home automation, Image recognition.**

1. Introduction

The aim is to implement a door lock which can recognize a person standing in front of the door and can give access if he/she is a known person. If the person is unknown to the system then the system captures image of the person and sends the image to the owner of the house through mail and waits until the owner gives access. If the owner recognizes the person, he/she can give access from anywhere. This system achieves the technology of connecting the door lock and mobile phone to the same network to gain access.

2. Literature Summary

A. Advanced Home Automation System using Raspberry-Pi and Arduino

All the devices of the system are connected to Raspberry Pi. The System also provides a facility to control all home appliances locally without the internet via a local network. Raspberry Pi runs a web server to host a web -based control interface and a SQL database to maintain the current status of appliances. The interface can be accessed through the internet or locally without the internet. The rapid advancement of the internet of things (IoT), life is getting easier and simpler in all aspects. At present world, automatic systems are being favored over the manual system. Today's world automation has become an inseparable part of ordinary households and subjects to constant evolution. IoT is a growing network of conventional object- from industry to consumer that can share information and complete jobs while you are involved with other activities.

B. IoT Based Real Time Face Recognition Door Lock System using Neural Network

Face recognition is one of the most popular and challenging topics in the fields of pattern recognition and computer vision. In this system, Raspberry Pi is used for face recognition. Firstly, the Pi camera will capture the face image and will give to the Raspberry Pi/ computer for recognition of the images. Face recognition systems can be divided into two groups: dynamic (video) and static matching. In this system, dynamic matching can be used when a video sequence is available. The video images tend to be of low quality, the background is cluttered and more than one face present in the picture. There are many sources of variability in the face recognition problem. They are (a) variation in the image plane, (b) pose variation, (c) lighting and texture variation, (d) background variation and (e) shape variation and so on. In this system, histogram equalization, principal component analysis and back propagation network are used to solve this face recognition problems.

C. Smart Home Automation using IOT based Sensing and Monitoring Platform

Smart home technology is collaboration of technology and currently being implemented for entire house in services through a network for better quality living. A smart home allows the entire home to be home facilitates users with security, comfortable automated living and energy management features as well as and therefore provide ease and convenience to everyday activities in the home. A smart device is a common

through cable broadband, DSL, Bluetooth and wireless ZigBee modules due to their low power and cost technologies provide a way to have a home efficiency. GSM Based Home Automation System wired or wireless control electric appliances through SMS request. Home smart phone, PIC16F887 microcontroller interfaced with a GSM Arduino board and Bluetooth technology are secured modem and it is used to read and decode the received and low cost.

D. Lighting Control Using Raspberry Pi and Oblo Living Home Automation System

Home Automation systems are bringing comfort and safety into the life of a modern human. OBLO Living is a home automation system presents one successful binding of the Raspberry Pi computer and the OBLO living system. Its low price, compact dimensions and yet mighty hardware has made it a controller of choice in countless systems A home automating system is a set of subsystems used to control security, surveillance, energy management, climate, lighting and other segments of residential space. Home automation systems mostly have a connection to the Internet and allow remote access and control of the devices in the house. Using a home automation system, the user should be able to set the air conditioning temperature hours before coming home, check if the stove was left turned on or if the door is locked. Oblo Living Home Automation System From an engineer's point of view, is a control system consisted of a vast number of sensors, numerous actuators, a central control unit and supervisory controls.

E. Fire Detection by Pattern matching by using Camera and Raspberry Pi

The main objective of image processing-based fire detection system is the early warning benefit. This system captures images of surroundings, the system will process these images and filter it with specific set of patterns. These images will then be processed by the various modules for checking of patterns of fire. The complete Image Processing module mainly consisting of Raspberry Pi 16 Camera with RPI and how to use it with OpenCV. In this paper the author has explained in depth regarding motion detection using OpenCV. This paper uses OpenCV and raspberry PI to handle image processing and control algorithms for intrusion detection and alarm. The authors have developed fire flame color feature model based on the HSI color space by analyzing 70 training flame images. The proposed system will use images, image processing to detect if there is a fire and will then generate warnings. The proposed system will capture images of the surroundings, the system will process these images and filter it with specific set of patterns.

F. Research of Intelligent Home Security Surveillance System based on Zigbee

Intelligent home security surveillance system is becoming a hotspot due to its flexibility. To implement wireless communication technologies mainly include: real-time surveillance of the home security, the IrDA infrared technology, Bluetooth and ZigBee intelligent remote monitoring system was developed technology, and so on for home security based on ZigBee technology and for the half-duplex point-to-point communication. The system can send abnormal Besides, it's inconvenient and of high error rate, images and warning messages through MMS and which make IrDA not applicable to the family SMS, receive remote instruction, and remote monitor network communication. ZigBee monitoring system can be responsible for home technology has the moderate transmission range and security. The system motherboard core controller is can also meet the transmission requirements through S3C44B0X-32 microcontroller and mainly.

G. FaceNet: A Unified Embedding for Face Recognition and Clustering

Despite significant recent advances in the field of face recognition, implementing face verification and recognition efficiently at scale presents serious challenges to current approaches. Here the system uses FaceNet, that directly learns a mapping from face images to a compact Euclidean space where distances directly correspond to a measure of face similarity. Once this space has been produced, tasks such as face recognition, verification and clustering can be easily implemented using standard techniques with Face Net embeddings as feature vectors. Our method uses a deep convolutional network trained to directly optimize the embedding itself, rather than an intermediate bottleneck layer as in previous deep learning approaches. To train, we use triplets of roughly aligned matching / non-matching face patches generated using a novel online triplet mining method. The benefit of our approach is much greater representational efficiency: we achieve state of the art face recognition performance using only 128-bytes per face.

H. Face Recognition using Content Based Image Retrieval for Intelligent Security

Here, the system tries to construct an intelligent security system based on face recognition. The data used in this research are frontal face images and without obstacles, and facial images with obstacles. In this research, the system used Content Based Image Retrieval or CBIR method. Approximately 10,000 images used in this work which is collected from internet, police department office, and shooting directly as primary data. Facial image data are stored in the database object-based files through process of identification and facial recognition. Consequently, facial images are retrieved using facial similarity techniques. All face image stored in database and indexed based on image retrieving. Retrieval process was delivered by matching query image and image in database. Face images are stored in the database and images facing frontal forward without obstacles. This work deployed recognition method by matching similar face image used previously. When similarity result exactly the same or fully 100 percent recognize by

system, otherwise face image not recognizable. In this stage of identification, an application can specify shape of the front face, performs feature extraction, and running intelligent Similarity (matching face data) which open the door automatically. This system can be used to minimize the occurrence of criminality occurs nowadays. This system can be used such as for house door security, office doors, and airport gates.

I. A Conceptual Model for Automated Attendance Marking system using Facial Recognition

The main purpose of the research is to analyze the solutions given by others and considering the shortcomings of their proposed systems, bring out a better solution. One is face database that contains the picture of the students and the other is the attendance database. Attendance database is used to mark attendance of the student when camera takes a picture of the class and then removes the background and noise from the image. Afterwards the skin is classified and the detected face is matched with it the image stored in the face database. After matching and recognition of the image, attendance is marked in the attendance database. The basic approach taken to tackle the hindrances of attendance marking through facial recognition is to match the images taken recently with those images deliberately captured and placed in the central database. They proposed a system that continuously observes the attendance although video service streaming was also available in many systems but they used face detection technique and capturing images for continuous observation.

J. Going Deeper with Convolution

The most straightforward way of improving the performance of deep neural networks is by increasing their size. This includes both increasing the depth–the number of network levels – as well as its width: the number of units at each level. This is an easy and safe way of training higher quality models, especially given the availability of a large amount of labeled training data. However, this simple solution comes with two major drawbacks. The uniformly increased network size is the dramatically increased use of computational resources. For example, in a deep vision network, if two convolutional layers are chained, any uniform increase in the number of their filters results in a quadratic increase of computation. As the computational budget is always finite, an efficient distribution of computing resources is preferred to an indiscriminate increase of size, even when the main objective is to increase the quality of performance. Bigger size typically means a larger number of parameters, which makes the enlarged network more prone to over fitting, especially if the number of labeled examples in the training set is limited.

K. Review of Face Recognition Techniques

Knowledge based methods are encoding our knowledge of human faces. These are rule-based methods. They try to capture our knowledge of faces, and translate them into a set of rules. It's easy to guess some simple rules. For example, a face usually has two symmetric eyes, and the eye area is darker than the cheeks. Facial features could be the distance between eyes or the color intensity difference between the eye area and the lower zone. The big problem with these methods is the difficulty in building an appropriate set of rules. There could be many false positives if the rules were too general. On the other hand, there could be many false negatives if the rules were too detailed. A solution is to build hierarchical knowledge-based methods to overcome these problems. These methods show themselves efficient with simple inputs. But, what happens if a man is wearing glasses? There are other features that can deal with that problem. For example, there are algorithms that detect face-like textures or the color of human skin. These algorithms compare input images with stored patterns of faces or features. Template matching methods try to define a face as a function.

L. Algorithm for efficient attendance management: Face recognition-based approach

First step in every biometric system is the enrollment of persons using general data and their unique biometric features as templates. This work uses the enrollment algorithm as shown in the Image is captured from the camera and then it is enhanced using histogram equalization and noise filtering. In the second step face is detected in the image and features are extracted from it. These unique features are then stored in the face database with certain id of that person. The system consists of a camera that captures the images of the classroom and sends it to the image enhancement module. After enhancement the image comes in the Face Detection and Recognition modules and then the attendance is marked on the database server. At the time of enrollment templates of face images of individual students are stored in the Face database. Here all the faces are detected from the input image and the algorithm compares them one by one with the face database. If any face is recognized the attendance is marked on the server from where anyone can access and use it for different purposes. This system uses a protocol for attendance. A time table module is also attached with the system which automatically gets the subject, class, date and time. Teachers come in the class and just press a button to start the attendance process and the system automatically gets the attendance without even the intensions of students and teacher. In this way a lot of time is saved and this is highly secure process no one can mark the attendance of other. Attendance is maintained on the server so anyone can access it for it purposes like administration, parents and students themselves.

3. Proposed Method

When a person presses the calling bell the event is called and started. The image of the person is captured using pi camera and the image is recognized, if it is a known person the door opens automatically and if it is a stranger the captured image is sent to the owner. If the owner recognizes then he can give access to the door. All these operations are done with firebase as cloud.

Figure 1 shows the overall block diagram of the system. User rings the bell and the door system starts working by capturing the person image using camera module, then the image is processed and then if it is a known person then the door opens automatically and if it an unknown person then the system sends mail to the user and if the user authorizes then the door opens otherwise the access is denied.

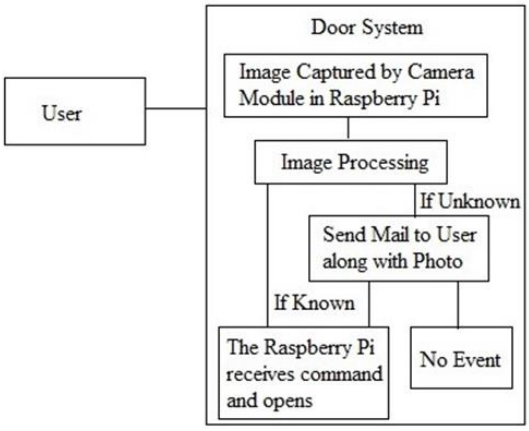

Fig. 1. Block diagram of door lock system

A. Getting Input data

The input data is in the form of images. The pi camera captures the image and stores it in the raspberry pi internal storage. Every time the camera captures an image and assigns different image name by using a variable. For example, we can capture the images with name like image0, image1, image2 etc. This can be camera. capture('pi/desktop/image%s.jpg',%i). Here 'i' is the variable and %s changes the name. So, using this method we can change the image name when a new photo gets captured.

B. Image Recognition Process

The captured image from raspberry pi is sent to google drive and the program which does face recognition is uploaded to the google colab. The program is called using http request using flask server and the image is also taken from drive and then the process takes place by comparing the face with the known face which is already stored. The image of face is cut out and taken using OpenCV. If the person is known then the door opens automatically by sending a signal to raspberry pi and if it is an unknown person then the next module starts working.

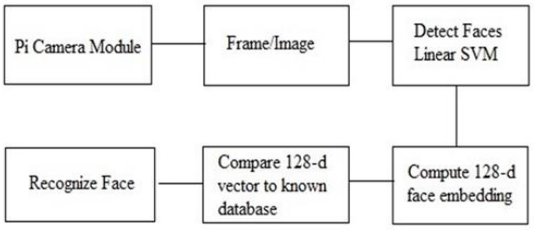

Fig. 2. Python face recognition package block diagram

Figure 2 shows the block diagram of how raspberry pi sends the image and recognizes the person. First the image is obtained by cutting out and detection of faces takes place. Finally, the result comes out as known/unknown.

C. Sending Mail to User

After the image recognition process if the system didn't recognize the user then this module starts working by running a python code which creates a SMTP mail server and gets the system mail details i.e. email id and password and gets the port number and also gets the owners mail address to which the image has to be sent. The image is converted to bit format and before it can be sent.

Figure 3 shows the overall process of sending mail to the owner. The users terminal code will be executed at first and then user agent sets the photo to the mail queue and then the client's connection to the server is set and finally the owner receives the mail.

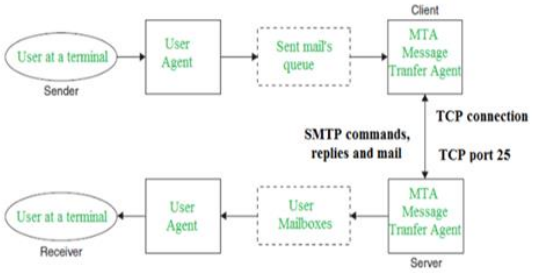

Fig. 3. Sending mail to the owner block diagram

D. Setting Up Firebase and Importing Status to Door

A Firebase account has been established to change and view the status of the door by creating a real time database. Using python programming we can do create, remove update and delete data of firebase. Using adding function the recent status of the door is updated in the table. And when the status of the door changes we can update the database using functions and can also delete data if we need.

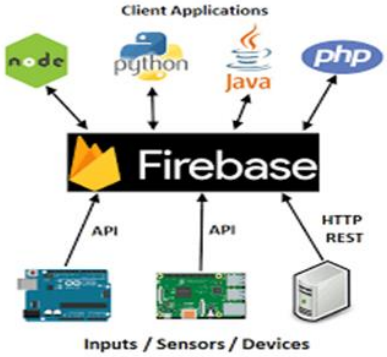

Fig. 4. Firebase input and output diagram

E. Controlling Door using Mobile Application

This module becomes the most important part of the system as controlling door using mobile application connected to the same network is changed to controlling door from anywhere

around the world. The firebase database is changed using android mobile application. The raspberry pi waits for 10 minutes to receive signal. If the owner changes the state of the door then the door opens otherwise the door remains closed. Figure 5 shows the actual working of Raspberry pi controlled using mobile phone. The cloud is accessed by raspberry pi through WIFI network connected with our home. And using Internet we can control raspberry pi with the help of mobile phone.

Fig. 5. Controlling raspberry pi using mobile phone

4. Results

A. Evaluation Metrices

The evaluation for the system includes the distance between mobile and raspberry pi which is the controlling device. Comparing to the existing system the distance has been increased. The time is also compared to previous system and the new system depends on network speed as the cloud comes as an intermediate. The image recognition time is little faster because the program runs as a cloud application and raspberry pi's memory stays free.

B. Experiments & Results

The GPIO event is called correctly when a bell button is pressed and all the process starts correctly after this event. The time taken for bell event to be called is less than 2 seconds and the works starts automatically. The cloud program is called and the photos are sent to the google drive and the image recognition process starts successfully. Due to network speed and System speed, sometimes the process may become slow and the results come little late. After capturing the image and if the person does not get recognized then this module works and if the network speed is better than the email of sending image to the owner takes place within 10 seconds. Data are saved successfully when it is added from firebase as well as when it is added from mobile application. The updation of data and retrieval of data are successful in both ways with the display of status of door is successful. And in the mobile application the display of status of door and the saved data of who entered to the house is also displayed.

C. Summary of Result

From the evaluation we can conclude that the time has been increased for the door to process but the distance of controlling has also been increased. The image recognition process takes place without taking much memory. The GPIO process also starts well as soon as the bell button is pressed.

5. Conclusion

This paper presented an overview on intelligent door lock using raspberry pi and android application.

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