Home Automation System with Security using Raspberry-Pi

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Abstract - *Internet of Things (IoT) offers new and exciting opportunities to increase the connectivity of gadgets inside the home for the cause of domestic automation. Smart phones are perfect in providing a consumer interface in a home automation system, due to their portability and their wide range of capabilities. The most crucial goal is to design and implement an efficient domestic automation system with safety. We use IOT primarily based home automation device to build a home security device that gives the character full manage over all his or her home remotely controllable factors and is also able to tracking and automating the residence entrance through a without problem on hand interface and using cloud as the data. The task is composed of the home safety with actual time access and manage via mobile smartphone and Raspberry Pi because the manage unit. A security gadget which includes a webcam is deployed at the entrance of the home, that is connected to the Raspberry Pi. In our proposed system, the get proper access to the door can be automated which includes Face Detection and Face Recognition feature and simultaneously signals the message in the form of the photograph is sent to the registered e-mail id.*

***Key Words*: Internet of Things, Raspberry Pi, GSM Module, Webcam, Sensors, Face Recognition System.**

1. INTRODUCTION

In the existing situation the crimes are growing exponentially, arising a requirement of security. Security can be described as a condition if you want to increase and development freely and with a religion that no harm may also be done. Hence we are introducing an automated door lock security system and residential automation for the safety purpose. Camera is now surprisingly being used and with the occasion of its content it truly is utilized in various applications. One among such is computerized door lock security gadget the use of camera

Door Lock Security is of top significance because its miles the primary step toward ensuring the protection of valuable belongings and folks. Such a big amount of authors has provided you with different styles of door lock system which incorporates automatic password-primarily based lock entry, software-primarily based door lock that's being employed in various places of labor and houses. The varied door lock systems are categorized on the concept of technology used like password based totally, RFID based

totally, charge account credit card based totally, biometric-primarily based, GSM-based totally, Bluetooth based, social networking websites based totally and OTP based. Consistent with our survey, maximum obligations existing till now don't provide an at once alert just in case of any unauthorized entry. It requires guide paintings to reveal so as to guarantee safety.
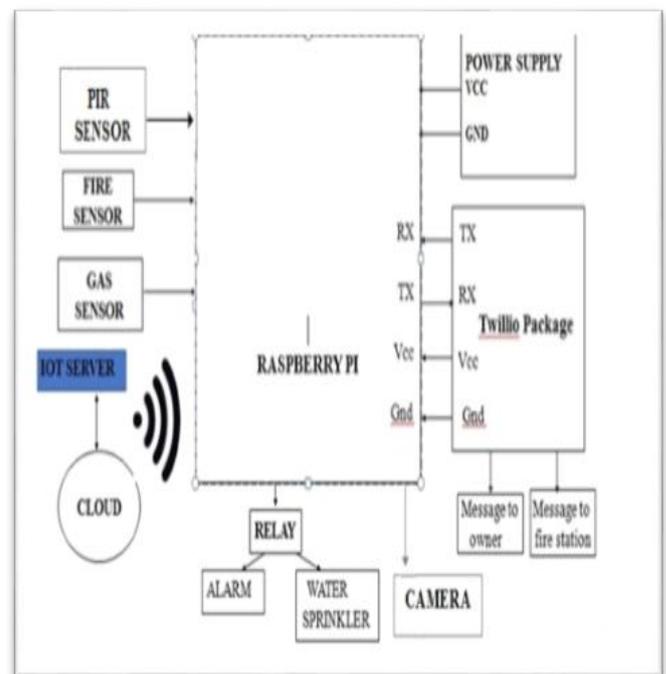
2. SYSTEM ARCHITECTURE

Fig-1: System Architecture.

A system architecture is a computational version that describes a system's configuration, behavior, and greater outlook. A description of a structure is a scientific description and interpretation of a system, dependent in a way that helps inference about system mechanisms and behaviors. Fig.1 shows the overall system architecture is proven in the form of block diagram.

2.1. Raspberry Pi 3 Model B+

Based on the same Broadcom BCM2837 64-bit quad core processor as its predecessor, but now clocked at 1.4 GHz instead of 1.2 GHz, the new Raspberry Pi board runs

only moderately faster- around fifteen percent- and come with the same 1 GB of LPDDR2 SDRAM as its predecessor. This single board computer provides2.4 GHz and 5 GHz dual-band Wireless LAN and Bluetooth 4.2 / BLE. The Raspberry Pi 3 Model B+ offers faster Ethernet (Gigabit Ethernet over USB 2.0) and Power-over Ethernet (PoE) capabilities via separate PoE HAT. This single board computer also provides enhanced network Preboot Execution Environment (PXE), USB mass storage booting, and enhanced thermal management [6].

(a)

(b)

Fig-2: (a) Raspberry Pi 3 Model B+
(b) Pin Description of Raspberry Pi 3.

2.2.   PIR (Passive Infrared) Sensor

A Passive detector of infrared motion with 360-degree field of view [2]. The Motion detector includes an integrated infra-red sensor circuit package that contains one or more infra-red sensor elements. The device work by detecting heat within the sort of infrared radiation that emanates from a personal or similarly warm object as because the person or object enters or moves within the field of view of the device. Fig. 3 shows the Working of PIR Sensor.
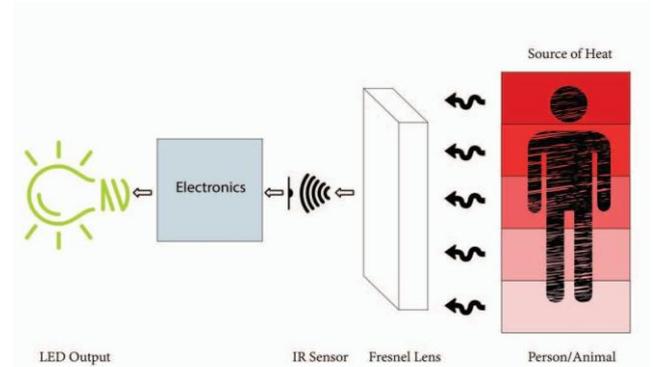

Fig-3: Working of PIR Sensor.

PIR sensor contains two slots, each with special material that is sensitive to the IR. Such slots measure equal amount of IR when no motion is detected. Generates a positive difference between these two slots when a warm body passes through it like a human or animal. When the motion is detected the camera is turned on and the image is captured.

2.3.   LPG GAS Sensor

The module MQ-3 Gas sensor detects gas leakage in both the home and industry. Inside the MQ-3 sensor is a heater that needs some heat to heat up and it is high sensitivity to alcohol and small sensitivity to Benzene, stable, long life and fast response. Fig.4 shows the LPG Gas Sensor.

Fig-4: LPG Gas Sensor.

2.4.   GSM Module

A GSM module is a device used by mobile network to determine communication. GSM or GPRS module requires a SIM card to register a network operator or service provider link to it. After comparing the captured images with stored images, GSM module is used to send a message to authorities based on whether the output is positive or negative. The GSM module does not operate in this device if the result is positive. If the unknown person attempts to open the door, the GSM module sends a message to the authority person "Unknown person is trying to unlock the door, take action". Fig.5 shows the GSM Module.

Fig-5: GSM Module

2.5. Relay

An electrical switch is a relay consisting of multiple signals. Relax equipment that allows communication outside of the home network. Our system will use four relay channel which are directly interface with the main controller and the smart home network can be monitored and operated remotely. Fig.6 shows the four relay channels,
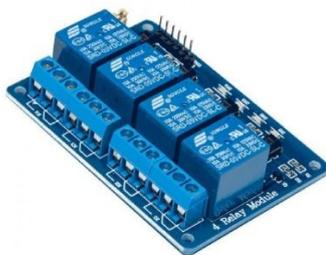

Fig-6: Relay

2.6. Web Camera

Web Camera [7] is a video camera recording photograph and video in a real time from personal computers and laptops and various lenses are used to focus and capture the real time movement. Camera monitoring is used as the security services and installed in sensitive locations such as hospitals, malls, airports, temples and traffic signals, etc for identifying the movement of with the help of webcam anyone can access anywhere from the globe. That makes video streaming easily for the telecommunication and that allows the mode of video conference. [1]

Fig-7: Web Camera

In this system we use a webcam that is connected to the raspberry pi that has 8MP interpolated resolution with plug and play USB interface. It captures the image in real-time streaming and sends the notification to the user. Fig.7 shows the Web camera.

2.7. Software

The system is basically based on Python programming from detecting the face to spotting the face. Python is used to seize and procedure images. The capture image is then processed using OpenCV library that integrates with python. The face detection and recognition factor is achieved by the Harr and LBPH algorithm. OpenCV stands for Open Source laptop vision. It is written in C++. There are bindings in languages such as Python, Java and MATLAB/OCTAVA. Here the OpenCV is used for processing the given picture and for evaluating the picture. Fig.8 shows the OpenCV.
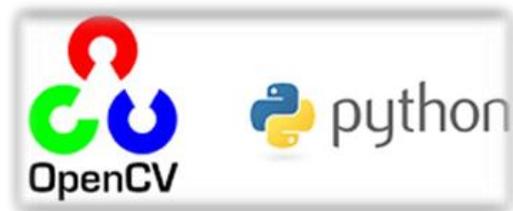

Fig-8: OpenCV

The Raspbian or Raspberry Pi operating device is closer to the mac than windows. Raspbian is hardly ever any exceptional to the use of windows (barring windows eight of course). There's a menu bar, an internet browser, a file supervisor and no scarcity of laptop shortcuts of pre-set up applications. Raspberry Pi operating system is raspbian primarily based debian operating device and the multiple version of raspbian are buster and stretch. Raspbian makes use of 35000 precompiled package deal and distinctive languages including a java, python and so forth and it could access to the linux terminal Raspberry Pi OS is excessive optimized for low overall performance ARMCRU Raspberry Pi. Fig.9 shows the Raspbian OS.
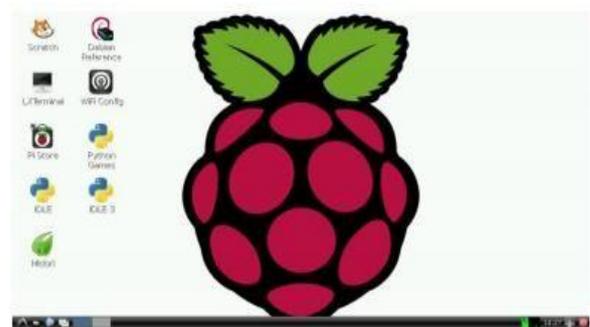

Fig-9: Raspbian OS

3. METHODOLOGY

3.1. System Flowchart

First, the session starts and works as follows when motion is detected, the web camera captures the image and sends it to the central Raspberry pi device. And this image is compared to the image which is stored in the database in order to recognize. The Haar Cascade Classifier Algorithm and the Local Binary Pattern Histogram (LBPH) are two algorithms used for face detection and face recognition process. If the result obtained through these algorithms is correct, the door will automatically open. Otherwise an SMS will be created automatically with the aid of the GSM module and sent to the owner that "Warning – Unknown individual is trying to unlock the door, take action," and the door remains locked. Now, by sending an SMS, the owner may take further action either by allowing an unknown person inside or by informing the nearest police station. Fig.10 shows the flowchart of a "Door lock system based on Face Recognition using Raspberry Pi and GSM module".
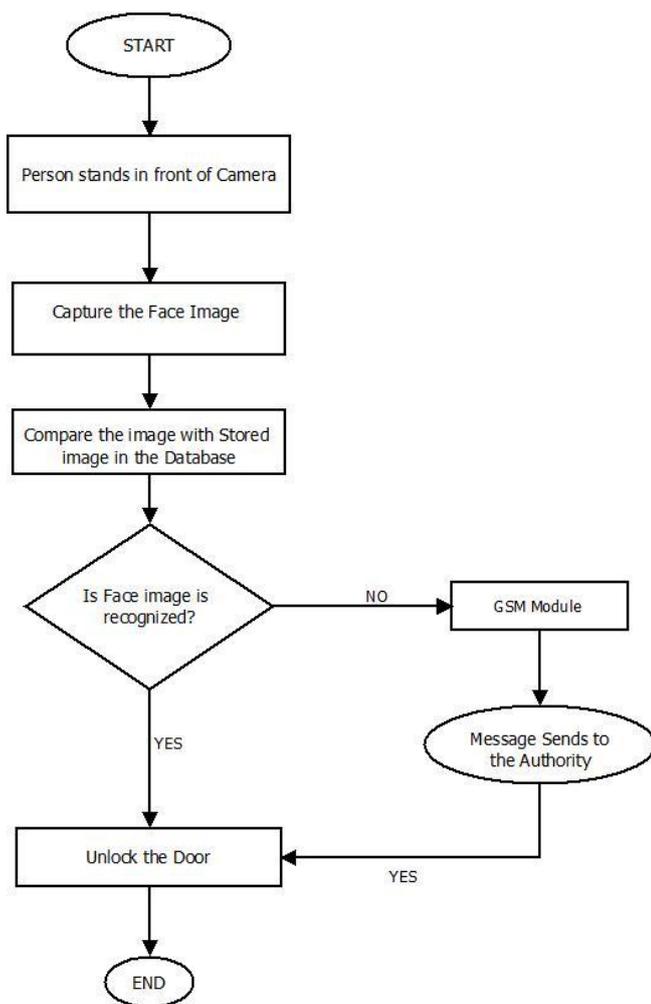

Figure.10: Flowchart of working of the System.

3.2. Face Detection

One of the elemental programs employed in the face recognition era is Face Detection. OpenCV is that the software library for machine learning, together with over 2500 based algorithms of which one of them is the Haar Cascade Classifier. In the Face Detection process, Haar Cascade Classifier are selected to this system. The reason for using the Haar Cascade Classifier is due to its speed, high accuracy in detection low false positive rate. Paul Viola and Michael Jones are the computer vision researchers who have created a Haar cascade classifier algorithm, which is trained from both positive images (with faces) and negative (faceless) images [3]. This algorithm has multiple features but few are taken. Each feature is a value derived from the sum of the pixels on the white area that is subtracted from the sum of the pixels in the dark area. The fig.11 shows the three types of features.
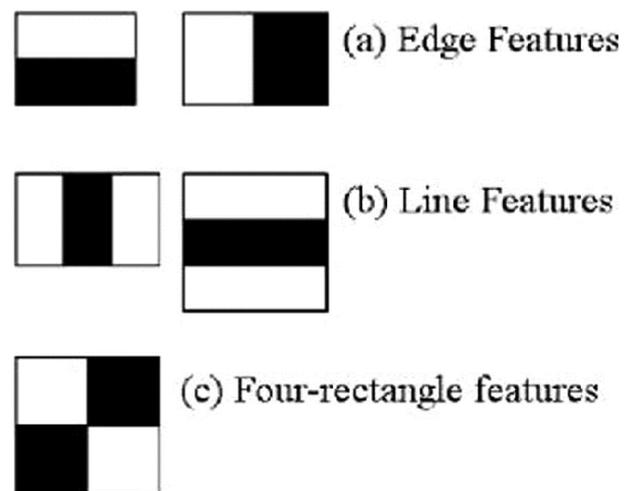

Fig-11: (a) Edge Features, (b) Line Features, (c) Four-rectangle Features.

3.3. Face Recognition

The detected faces are stored in the database and the LBPH values are computed, then match the currently recognized database and faces. We use Local Binary Pattern Histogram (LBPH) for face-recognition in our system. OpenCV is an open source machine vision learning library that has three built-in face recognition algorithms, (i) Egienfaces, (ii) Fisherfaces, and (iii) Local Binary Pattern Histogram (LBPH). LBPH algorithm is more robust as compared to two other algorithms because LBPH recognizes not only the front but also the side face [4]. Therefore, here the Local Binary Pattern Histogram (LBPH) algorithm is used for face recognition.
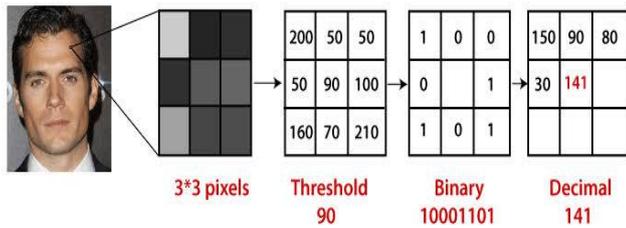
Fig-12: Conversion of Grayscale Image to Decimal.

At first, we train the images that are stored in the LBPH algorithm datasets and then store them in the database. LBPH algorithm initially converts color images into gray images and gets part of this image as a 3x3 pixels intensity window (0-255). The value obtained in the central pixel can be taken as threshold value. We set 0 for values lower than the threshold and 1 for values equal or higher than the threshold. Now, we will have a new binary matrix with a value taken in clockwise direction (eg.10001101). Then the binary value is converted to decimal value and set it to the central value of the matrix. Finally, the new image is obtained and it is compared with the image stored in the database for recognition [5].

4. RESULTS AND DISCUSSION

In this system, we designed a door lock system with the assistance of face recognition and a home automation system. In this, we are using raspberry pi which has many capabilities that make the user adjust use in different smart applications. Fig.13 shows the Assembly of Security System using Raspberry Pi.

The webcam is implemented in this system for surveillance for limited time (human activity occurs) and no need of storage requirement. When any unauthorized person occurs it will capture the image and sends the notification to the users. The PIR sensor is used to detect the motion in 360 degrees and sends for processing. Fig.14 shows the screenshot of Twillio received by the owner

The MQ-3 sensor is implemented for gas leakage detection if any gas accident occurs buzzer turns ON and fame sensor is used for detecting the fire accident in the home. The home automation system will provide the security surveillance for the home and we can monitor and control the home appliance anywhere at any time. Fig.15 shows the screenshot of e-mail received by the owner.
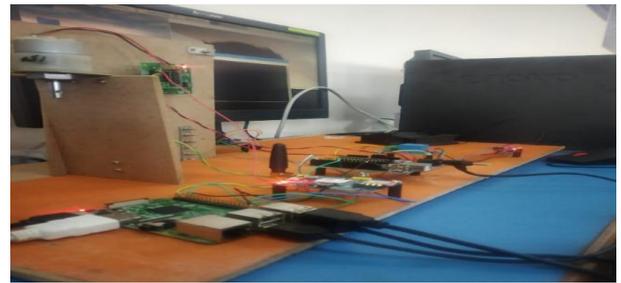

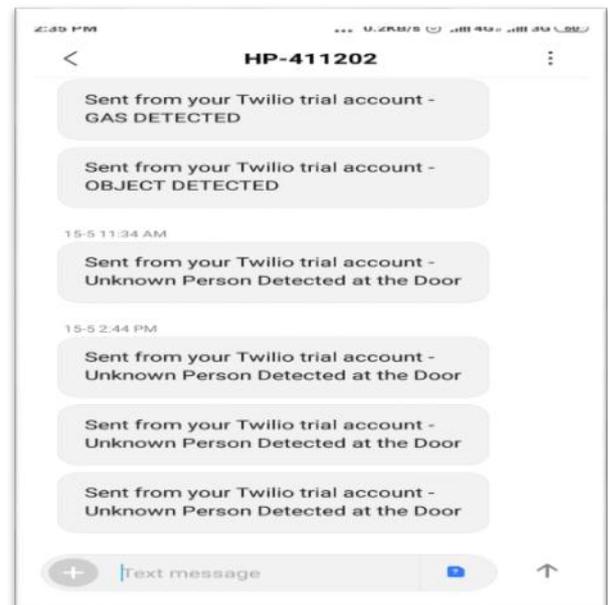**Fig-13:** A Prototype of Home Automation system and a Door Lock System.

Fig-14: Screenshot of Alert messages received by Owner.
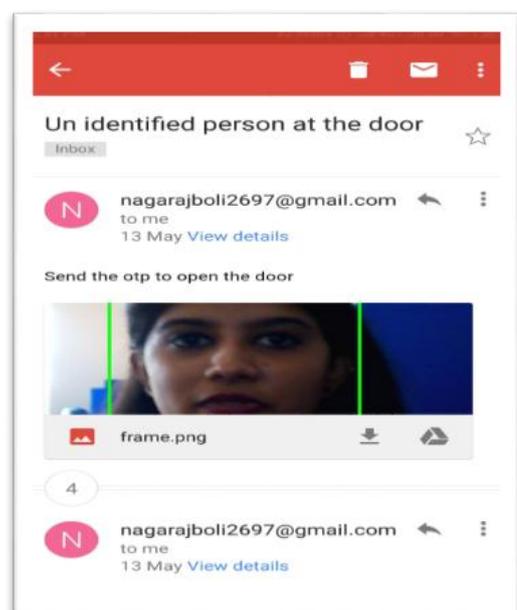

Fig-15: Screenshot of e-mail with a photograph of an Intruder.

5. CONCLUSION

In this paper, Face recognition is one of the several approach for recognizing people. There are several strategies that can be used for the purpose. In this gadget door access device by the usage of face reputation and at the side of the e-mail alert gadget has been presented. The Haar set of rules technique is used to detect the face and LBPH algorithm is used for the face reputation. With the help of various sensors, we will monitor the house gadgets via far off access. As a result of provision of the home equipment monitoring and standing control function customers can easily verify the repute of the house.

6. FUTURE WORK

Since the proposed system could be versatile. It can be implemented in sensitive location such as home, hospital, farmhouse and apartment etc, for providing security. This system has one step authentication mechanism i.e. if any unauthorized person occurs it will notify to the admin and it will send the OTP to the system but it can also implement multi step authentication process method by insulting biometric or RFID cards.

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