Home Surveillance and Security using IoT Application

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Abstract—In the present age, The Internet of things (IoT) has entered a brilliant time of quick development. The Internet of things is an idea that plans to extend the advantages of the standard Internet-data sharing, remote control, and monitor ability, constant connectivity etc-to products in the physical world. Regular things are getting connected with the Internet. This idea can be utilized to deal with the security concerned issues in a cost-effective way. In this paperwork, a system is being developed to interface any door with the Internet so the entrance control system can be controlled from anywhere in the world. For a situation that one is not at home and a guest is at his doorsteps then the user or authorized person will be notified about the guest/visitor via Android application and the user can see the guest/visitor from the web through the camera from anywhere and the system will take a picture of the visitor/guest and keep a record by sending a captured image and notification to the user's mobile application. If the guest/visitor wants to open the door it can be sent request easily to the user through the matrix keypad and it will appear on the user's android application with the request message. The door lock can be controlled through the Android application through the Internet. With the help of the system, proof of the guest/visitor can be kept as a record if any emergency case or circumstance happens.

Keywords—Internet of Things (IOT), Raspberry Pi, ATmega32 microcontroller, IR Sensor, USB Web Camera, Matrix Keypad, LCD, Door Lock

I. INTRODUCTION

Security system is characterized as to identify intrusion, unauthorized entry into a building or a secured zone or deny such unauthorized access to ensure work force and property from harm and mischief. Security system are for the most part utilized in residential, commercial, industrial and military properties for protection against robbery or property harm, as well as personal protection against intruders. Car alarms moreover secure vehicles and their contents. Detainment facilities additionally utilize security system for control of inmates. Among home security in private is generally prominent. Presently days, Home security and surveillance system is an fundamental part of any advanced automated system. The essential structure of security system starts with analyzing requirements of the occupants, studying existing innovations and equipments, reviewing system costs, considering monitoring decisions lastly arranging the establishment. As per the European Institute for Crime Prevention and Control International insights on wrongdoing and control 2011, to dissect the no. of robberies in a year we encountered that Bangladesh got 2.2 focuses and ranked 53rd position and in addition 0.7 focuses and ranked 71st position for auto robbery on the world [1]. Now if we look the worlds one of rich country USA we see that they positioned 6th in auto theft and 9th in burglary [2]. Their surveying also demonstrates that most of the theft occurred in residential area, office and in addition bank. Non-automated security system were discovered non-solid. Entryways were fitted with lock and key system which can be opened effortlessly. Indeed, even the human presence of security monitor may not be totally reliable. Every system from the past has been observed to be especially defenseless. Home is where security is must, to guard every one of the assets and apparatuses. The proprietor ought to have the certainty to venture out of the house with the feel that nothing can happen to the Home. This feel will possibly emerge when the house is outfitted with a dependable security framework. Subsequently, in this paper, it has focused on the maintenance of home security.

The proposed methodology for planning this system is to implement the microcontroller based control module that receives its instructions and order from a Mobile Application over the mobile network. The microcontroller at that point will complete the issued Commands.

The main purpose of this system is to lock and unlock a door by a android app and matrix keypad, using a unique code entered through the matrix keypad and android app. Opening and closing of doors includes human to be physically engaged with the undertaking. The authorized person can open the door through mobile app using the door motor by entering correct password. This technique is exceptionally helpful as one doesn't need to get down of his door post to open the door physically. The system will control the door form anywhere, anyplace and anytime, this will eliminate the need of being physically present in any location for tasks involving the opening of door within a household and is power reliable because the power source is upheld up with battery in case of mains failure. the office, I can open the door of my house from my office for them by sending the authentic code and the door will be open consequently, I can do the likewise in the event that I need to lock it.

The Paper is divided into different sections: section II described the Literature Review, while section III gives the Components used in designing, sections IV described the System Architecture, section V described the Block Diagram.
of proposed system, section VI and VII gives the Hardware and Software Design and Implementation of Proposed system, section VIII and IX described the Methodology and Programming Explanation of Proposed system, Result and Discussion were carried out in section X and the Conclusion drawn was presented in section XI.

II. RELATED WORK

The design and implementation of smart home security system was developed by [3]. With the help of NFC tag, Password and PIR motion sensor provides three level of security system. To open the door a person should give NFC tag and secret key. In the event that one of them absence the door won’t open. To close the door the authorized person need to show the tag in the reader. So NFC card reader, PIC 16F877A, Arduino Uno, PIR sensor was used to provide maximum security. This security can be connected home as well as where an imperative report, a document is saved likewise the bank vault.

The research done by team [4] has proposed a Arduino Based Door Access Control System. The important role of the processing unit plays the Arduino in electronic locking system. The System consist Arduino Uno board, ATMega 328, Servomotor, 4x4 matrix keypad, solenoid lock etc. This project shows a keyless system for locking and unlocking purpose utilizing a pre defined Password. If the entered password matches then door will be opened automatically otherwise a message showing incorrect password will be displayed on the LCD.

The furthermost valuable research in Smart home security system by using Bluetooth device and Microcontroller was done by [5]. The system was consist Microcontroller Atmega16, stepper motor, Bluetooth device HC-05 etc. By using an enlisted secret key in this framework, open the entryway by which it builds the security level to keep an unauthorized opening and furthermore this framework gives the adaptability to the to the user to change or reset the password. The security measure is very high as given in two different ways. First we have to enter password for blue-tooth association and second is for opening the door in application. This system gave user more secure and low cost way of locking-unlocking system.

Automated Door Control System Using Android Phone and GSM Modem was developed by [6]. The proposed system consist of three parts of server, where the web service was hosted. Second part was hardware interface module which provide appropriate interface to the actuator, IP camera, server, and GSM modem. And the third part is of mobile having android application which encourages opening and shutting of entryway and survey video of the guest. The proposed system utilizes Wi-Fi technology as a network infrastructure connecting different parts.

With the use of Arduino UNO, Android Smart Phone, Bluetooth Module (HC-05) reference [7] have developed smart home to control the opening and closing of the door located at some distance from the user. The app uses the Bluetooth of the android phone to send a serial command of either open or close message to the external Bluetooth module that is connected to the Arduino UNO. It has made use of android app to monitor and control the hardware section installed on a door that controls the locking and unlocking the door where it is installed.

III. COMPONENTS USED IN DESIGNING

Relevant details ought to be given including experimental design and the procedure (s) utilized alongside proper factual techniques utilized clearly alongside the year of experimentation (field and lab). We will give a point by point depiction of each part utilized in planning this secret password protected locking system:

A. Raspberry Pi 3

The Raspberry Pi board [8] is a miniature marvel, packing considerable computing power into a footprint no larger than a credit card. The processor at the core of the Raspberry Pi system is a Broadcom BCM2835 system on-chip (SoC) multimedia processor. This means that the vast majority of the system’s components, including its central and graphics processing units alongside the audio and correspondence equipment, are constructed onto that solitary segment is covered up underneath the 512 MB memory chip at the focal point of the board. It’s not simply this SoC structure that makes the BCM2835 different to the processor found in our desktop or PC, be that as it may. It additionally utilizes a different instruction set engineering (ISA), known as ARM. The Raspberry Pi, by contrast, is designed to run an operating system called GNU/Linux Raspbian. Hereafter referred to simply as Linux. In contrast to Windows or OS X, Linux is open source: it’s possible to download the source code for the whole working system and make whatever improvements you want.

Features of the Raspberry Pi [9]

- Model B+ Raspberry Pi with Mounting Points and 512MB RAM.
- Broadcom BCM2835 ARM11 700 MHz
- Integrated Video core 4 Graphics GPU capable of playing
- Full 1080p HD Video.
- 4 x USB Ports (Max Output 1.2A).
- Board Power Draw: 600mA.
- HDMI Video Output.
- 10/100Mb Ethernet Port for Internet Access.
- Micro SD Flash Memory Card Slot.
- 40-pin 2.54mm Header Expansion Slot (Which allow for peripherals and expansion boards)
- Dimensions 85 x 56 x 17mm.
- The Raspberry Pi is boot by external memory card with Raspbian Jessie images
B. ATmega32 Microcontroller

Title ATmega328 [10] is an eight (8) bit Microcontroller. It can deal with the data sized of up to eight (8) bits. It is an AVR based microcontroller. Its implicit internal memory is around 32KB. It operates ranging from 1.8V to 5V. It can store the information notwithstanding when the electrical supply is expelled from its biasing terminals. Its excellent features include the cost efficiency, low power dissipation, programming lock for security purposes, real timer counter with the different oscillator. It’s normally utilized in Embedded Systems applications. ATmega-328 has appeared in the figure given below [10].

C. LCD

No LCD (Liquid Crystal Display) [11] screen is an electronic presentation module and finds a wide scope of utilization. A 16x2 LCD display is an extremely essential module and is generally utilized in different gadgets and circuits. This display comprises 16 columns and 2 rows. The library that is utilized is <liquidcrystal.h>.

Pin description of 16*LCD

1. Pin 1: VSS.
2. Pin 2: To VDD 5V input.
3. Pin 3: VL to adjust LCD contrast with the help of 10K potentiometer. Low VL indicates light contrast and high VL indicates dark contrast.
4. Pin 4: RS for register select. Data registers used for high RS. Similarly, instruction register for low RS.
5. Pin 5: R/W signal stands for read/write. When R/W bit is high, it indicates a read operation. If R/W bit is low, it indicates write operation.
6. Pin 6: Clock Enable- Edge triggering.
7. Pin 7 to 14: Represents from Bit 0 to Bit 7.

D. Membrane Keypad

Figures In our project we used 4X3 matrix membrane keypad. This 12 button keypad provides user interface component for project. This is programmed using the library <keypad.h>.

It has the following features:
1. Easy interface to Arduino.
2. Ultra-thin design.
3. Cheap and economical

E. IR Sensor

Figures The Multipurpose Infrared Sensor is an add-on our entryway and that have the ability to detect nearby objects. The sensor works by identifying reflected light originating from its very own infrared LED. By estimating the measure of reflected infrared light, it can detect light or dark (lines) or even objects directly in front of it. An onboard RED LED is utilized to demonstrate the nearness of an object. Detecting range is adjustable with inbuilt variable resistor.

F. USB Web Camera

Tables In the Raspberry Pi 3, there is certain zone available for interfacing USB Web Camera. The USB Web Camera is interfaced to the USB ports provided on the Raspberry pi. The
Raspberry Pi 3 integrated with the webcam serves efficiently in the field of security applications.

### 1) WEB Camera Specification

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Resolution hardware</td>
<td>500K pixels</td>
</tr>
<tr>
<td>Image Quality</td>
<td>RGB24 or I420</td>
</tr>
<tr>
<td>Exposure</td>
<td>Auto or manual, Angle of View 58°</td>
</tr>
<tr>
<td>Frame Rate</td>
<td>30 fps (MAX)</td>
</tr>
<tr>
<td>Lens</td>
<td>f=6.0 F=2.0</td>
</tr>
<tr>
<td>Focus Range</td>
<td>4cm to infinity</td>
</tr>
<tr>
<td>Image Resolution</td>
<td>14 Mega Pixels</td>
</tr>
<tr>
<td>Interface</td>
<td>USB2.0</td>
</tr>
</tbody>
</table>

G. Solenoid lock

The solenoid lock actuator is designed in a normally closed mode this means when there is no supply it is mechanically closed hence a door cannot be opened when in the closed position. When a voltage is supplied the plunger is pulled inside for a second duration hence allowing pushing or pulling of the door to an open position. On return of the door to the closed position a sliding ramp on the plunger allows the plunger to slide back in to closed position. Operates at 9-12VDC draws a maximum of 500mA due to this the solenoid lock actuator is connected to the ATmega32 microcontroller via L293D motor driver.

### IV. SYSTEM ARCHITECTURE

Smart home security system consists of two components, Embedded Control Unit (ECU) is part of Smart home where security system implemented and Remote Control Unit (RCU) is a framework implemented on Users smart phone.

A. **Embedded Control Unit (ECU)**

ECU is an effective, low power utilization and low cost embedded access control system for Smart home security and enables user to remote monitoring and controlling. ECU consists of Raspberry Pi set up with Raspbian Operating System on installed SD card. IR motion sensor and USB Web Camera interfaced with Raspberry Pi to detect visitor’s motion at door and capture image respectively. Captured images with date and time are saved on SD card. 4*3 matrix keypad and 16*2 LCD is interfaced with ATmega32 microcontroller. Utilizing this circuit, one can make any electrical appliance password protected. ECU is also consist of L293D motor driver to control the Electromagnetic door lock.

B. **Remote Control Unit (RCU)**

Android Application is an Remote Control Unit on Users Smart Phone. RCU is implemented on Android platform using Android studio. Android is the first complete, open, and free mobile platform. Android studio is used for implementing android application.

### V. BLOCK DIAGRAM

The System architecture of Smart Home Security System is shown in Figure 8. Raspberry Pi, ATmega32 microcontroller, USB Web Camera, IR sensor, Membrane keypad, and Power supply forms the entire security system to be installed at the required place.

![Block Diagram](image)

IR motion detection sensor is connected to GPIO pins of Raspberry Pi 3. We can use 4*3 matrix keypad and LCD interfaced with ATmega32 microcontroller which is used to make any electrical appliance password protected. Relay driver Circuit with IC L293D is interfaced to ATmega32 microcontroller to control the Solenoid door lock. The image captured can save with date and time on SD card connected on raspberry Pi 3.

### VI. HARDWARE DESIGN AND IMPLEMENTATION

A. **Hardware Design**

Hardware implementation includes interfacing ATMega32 microcontroller with matrix(4*3) keypad, a L293d motor driver...
driver (which actuates the door lock), LCD(16*2), also incorporates a power supply. And the ATmega32 microcontroller is interfaced with Raspberry Pi3 board. The Hardware implementation also includes interfacing Raspberry Pi3 with IR motion detection sensor and USB Web Camera. Software implementation means loading instructions into the microcontroller, which allows the microcontroller to verify the input from keypad with the stored password, to interface with peripheral devices and to change the current password. The complete project work is divided into the several parts.

The design of the complete project was first simulated in Proteus as given in Figure 9.

1) Circuit Description

Circuit of this Raspberry Pi based door lock system is very simple which contains Raspberry Pi 3, ATmega32 microcontroller, IR Sensor, 4*3 matrix keypad module, LCD. Here Raspberry Pi 3 controls the whole process like taking password from the matrix keypad module, comparing passwords, opening/ closing the gate and sending the status of LCD display to the Raspberry Pi 3. Also the IR motion detection sensor used to detect the object and capture the image using the USB Web Camera and send to the user on the Android application. Keypad is used for entering password. LCD is used for displaying the status or message on it.

Keypad module's column pin are directly connected to the pin 37, 38, 39, 40 and Row pins are connected to 34, 35, 36 of ATmega32 microcontroller pins. A 16*2 LCD is connected with Atmega32 microcontroller in 8-bit mode. LCD's control pin R5, RW and En are directly connected to Pin14, 15, 16. Data Pins D4-D7 are connected to pin5, 6, 7, 8. Motor driver L293D is connected at pin of Atmega32 microcontroller. IR sensor's data pin connected to GPIO 4 of Raspberry Pi 3. And Motor Driver L293D is connected at pin 22 and 23 of ATmega32 microcontroller. A 12-volt battery is associated at pin 8 of L293D as for ground.

A. Hardware Implementation

Figure 10: Hardware Implementation of Lock System

VII. SOFTWARE DESIGN AND IMPLEMENTATION

A. Software Design

Software implementation includes three components: the client application, the server and database, and the application on the device. Figure 11 shows the overall flow of communication between the components. This section will describe the communication between the different components, how the components are built, show the database structure and show what the application looks like.

The Raspberry Pi reads real-time data of home by using different sensors in the security system. The collected data will be sent to the server. the data will be stored in the database of the server. Data from the server can be accessed by using an android application with the internet connection (figure 11). An android application is developed by using the android studio. The system is portable and low-cost Smart Home Security system which allows collection, storage and transmission of data.
VIII. METHODOLOGY

Working of this project is simple. When user runs the code in Raspberry Pi 3, LCD shows some message and after it shows Enter Password. If user wants to open the door then the system will ask for the password. Default password is "1234". Presently the user needs to include the password and after this system will check the password, regardless of whether it is valid or not.

If user enters the correct password then the LCD shows some Password OK massage and then the system will open the door. At the same time the system will also capture the image and send the captured image and notification like "Authorized Person" to the user.

And if the user enters the wrong password then the LCD shows some Wrong Password message. And again the system will send the captured image and notification like "Unauthorized person" to the user.

Now suppose Unauthorized person wants to open the door, then that person send the request by entering "0000" using matrix keypad. And after the system will send the request with captured image and notification like "Access Request" to the user, then the user will check the notification. And if the user will knew the unauthorized person, then the user can open the door from the Mobile Application.

Basically opening and closing the door is nothing but to rotate a motor clockwise and anticlockwise to open and close the door. We can use motor driver L293D, but we need to change the code accordingly.

Further we can use a proper Electronic Door Lock. It have an Electro magnet which keeps the Door locked when there is no current passed through the Lock (open circuit), and at the point when some current went through it, the lock gets unlocked and the entryway can be opened.

Flow Chart

IX. PROGRAMMING EXPLANATION

Smart home security system consists of two components, Embedded Control Unit (ECU) is part of Smart home where security system implemented and Remote Control Unit (RCU) is a framework implemented on Users smart phone.

A. Python Programme for ECU

The python program of this project plays important role to perform all the operations. First of all, we include required libraries, initialize variables and define pins for IR and other components. The following library module files are imported on python script:

```python
import RPi.GPIO as GPIO
import os
import time
import urllib2
import requests
GPIO.setwarnings(False)
GPIO.setmode(GPIO.BCM)
GPIO.setup(4, GPIO.IN)
GPIO.setup(26, GPIO.IN)
GPIO.setup(19, GPIO.IN)
GPIO.setup(13, GPIO.IN)
GPIO.setup(6, GPIO.OUT)
```

After we need to define GPIO pins for IR sensor and define camera function to capture image when IR sensor tiger input. fswebcam is used to take the webcam snapshots by the USB Web Camera. Also this camera is accessible from anywhere for a live view of the visitor.
Now, we need to define the GPIO pins for input that is to detect the unauthorized user, Authorized user and Requesting to user and also define the notification for alert.

```python
s1=GPIO.input(4)
if s1 ==True:
    print ('ir')
    os.system('sudo omxplayer a.mp3')
time.sleep(1)
    os.system('sudo fswebcam -r 640x480 --top-banner --title SomeoneIsEntering ir.jpg')
time.sleep(1)
    os.system('sudo mpack -s PIR ir.jpg anujadamkonde20@gmail.com')
    url = 'http://krescendo.co.in/ordersys/anuja/uploadtoserver.php'
    files = {'image' : open('/home/pi/ir.jpg', 'rb')}
    response = requests.post(url, files=files)
    time.sleep(1)

s2=GPIO.input(13)
if s2 ==True:
    print ('UnAuthorised')
time.sleep(1)
    os.system('sudo fswebcam -r 640x480 --top-banner --title UnAuthorisedDetected UnAuthorised.jpg')
time.sleep(1)
    os.system('sudo mpack -s Biometric UnAuthorised.jpg anujadamkonde20@gmail.com')
    url = 'http://krescendo.co.in/ordersys/anuja/uploadtoserver.php'
    files = {'image' : open('/home/pi/UnAuthorised.jpg', 'rb')}
    response = requests.post(url, files=files)
    time.sleep(1)

s3=GPIO.input(26)
if s3 ==True:
    print ('Authorised')
time.sleep(1)
    os.system('sudo fswebcam -r 640x480 --top-banner --title AuthorisedDetected Authorised.jpg')
time.sleep(1)
    os.system('sudo mpack -s Biometric Authorised.jpg anujadamkonde20@gmail.com')
    url = 'http://krescendo.co.in/ordersys/anuja/uploadtoserver.php'
    files = {'image' : open('/home/pi/Authorised.jpg', 'rb')}
    response = requests.post(url, files=files)
    time.sleep(1)

GPIO.output(6,True)
time.sleep(2)
rec=GPIO.input(19)
if rec ==True:
    print ('Requesting...')
time.sleep(1)
    os.system('sudo fswebcam -r 640x480 --top-banner --title AccessRequest Request.jpg')
time.sleep(1)
    os.system('sudo mpack -s Biometric Request.jpg anujadamkonde20@gmail.com')
    url = 'http://krescendo.co.in/ordersys/anuja/uploadtoserver.php'
    files = {'image' : open('/home/pi/Request.jpg', 'rb')}
    response = requests.post(url, files=files)
    time.sleep(1)
```

The Electronic door lock which use motor driver to lock or unlock. It is done by running simple python script.

X. RESULT AND DISCUSSION

The Smart Home Security System used IR sensor, USB Web Camera interfaced with Raspberry Pi 3 are kept inside the box. Matrix keypad and LCD interfaced with ATmega32 microcontroller are placed outside the box for testing as shown in Figure 14.

As we can see the practical implementation of this project is given in above fig. Now let us discuss about the results or how the system works when we are using it. When the Power button is switched ON, Raspberry Pi 3, microcontroller, Solenoid lock, LCD gets power. Now to OPEN the lock enter password when LCD displays "Enter Password" as shown in Figure 15.
is shown in Figure 17. And also captured image with notification send to the user.

Figure 16: Password OK in the LCD display

Figure 17: Lock is Opened

On the other hand, if Password is Wrong, "Wrong Password" will be displayed (Figure 19), captured image with notification send to the user and the Lock will remain closed as shown in Figure 20.

Figure 18: Entered code in LCD display

Figure 19: Wrong Password in the LCD Display

Figure 20: Lock is Closed

Now this system also gives us an extra benefit to send a request to the user. If Unauthorized person wants to open the door then that person will send a request by entering code "0000" to open the door (Figure 21). "Requesting Password" will be displayed (Figure 22) and also captured image with "Access Request" notification send to the user.

Figure 21: Entered code in LCD display

Figure 22: Requesting Password in the LCD display

The status of the Door getting from the proposed system are stored in server's database along with the date and time is as shown in figure 23 and can be viewed and accessed on the android application named as "Home Security".

Figure 23: Database of Home Security Status

Users can access all the current and historical status of the home by using Smart Home Security Android Application (Figure 24).

Figure 24: Smart Home Security App

The Home Security app has six important menus. The first menu is New user. In this menu, a user can view Name, Mobile, Address, Email and Password for creating new user as shown in Figure 25.
The Second Menu is See User. It is used for viewing all the users as shown in Figure 26.

The third and Fourth menu are Open and Close (Figure 27). A user can open and close the door using Open button and Close button from anywhere, anyplace and anytime.

The fifth menu is View Images. This menu can view the historical records of the door that is Images, Image Name, Time and Date etc. as shown in Figure 28.
XI. CONCLUSIONS

In this highly developing era, where directly or indirectly, everything is dependent on computation and information technology, Raspberry Pi proves to be a smart, economic and efficient platform for implementing the Home security. This paper provides the low-cost and reliable Smart Home Security System using Raspberry Pi which can be easily implemented and used efficiently. And an Android application is developed to control and monitor the status of the home. This system mainly used in high security applications such as museums, bank lockers, home applications, libraries, ATM’s, shopping malls, laboratories etc. Remote operating can be done using Android application. In addition to this, sensors will give the current status of the system using IoT, thus enhance the security and eliminates the human monitoring near the system.

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