Smart Door Locking System in Hotels

Submitted to

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FINAL REVIEW

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Abstract:

Smart cities aren't new to us. Already few cities are called Smart cities. As our technology and IOT devices around us are getting advanced, In cities hotels ranging from 3 to 7 stars are providing so many convenient facilities to the customers to gain more attraction and justifying prices with their facilities. Smart applications are becoming central to the hotel guest experiences as soft pillows, extra towels and a competitive price. Most consumers want to make use of their devices for conducting all the core functions with hotels such as checking in, making reservations, ordering room service and keyless entry. As mobile usage becomes increasing, for guests and to meet the challenges of growing customer expectations, the hospitality industry is turning to technology. They are providing modern card locks which are RFID based, but the security of it is still compromised. So, our main objective is to develop an IOT product which will be used for modern and smart door lock systems in hotel rooms which is way more secure than existing methods. Our system will be easy to use and secured enough for hotels.

Literature Survey:

[1] Android Based Smart Door Locking System:
In this model Android Based Smart Door Locking System is developed using the advancement in technology in efficient way for security. It is basically designed for normal mode and multi-mode operations. Such system is very much required in Bank and Business organization. The system also gives functionalities for general user, where single user is authorized to operate the lock. The cost-effective implementation with advanced functionality and easy to use interface makes the system very useful. Android Based Smart door locking system is designed to prevent unauthorized access, trespassing and intrusion. Banks, corporate offices, financial organization, jewellery shops, and government organization are some of the common targets where unauthorized access, trespassing and intrusion take place. The purpose of Android Based Smart door locking system is to provide a smart solution to overcome these challenges and provide a feasible solution. The system works using keypad to enter a password to the system. If entered password is correct then door is open by motor which is used to rotate the handle of the door lock. System also includes extra features like adding new users and changing passwords. It uses Arduino, Bluetooth Module HC- 05, GSM SIM 800 and Android Smartphone.
Limitations:
The main drawback of this device is without power supply it doesn't work. As it isn't connected to normal lock it has to be opened for opening of the door. So it would cause a problem in absence of power back up. It might get issues for the people who are not familiar with this and make them uncomfortable.

[2] Using A Smartphone Application as A Digital Key for Hotel Guest Room and Its Other App Features:

The author developed this smartphone application for the security of hotel guests considering the large usage of smartphones in the service industry particularly the hotel business. Smartphone applications are becoming central to the hotel guest experiences as soft pillows, extra towels and a competitive price. Most consumers want to make use of their Smartphones for conducting all the core functions with hotels such as checking in, making reservations, ordering room service and keyless entry. As mobile usage becomes increasingly ubiquitous for guests and to meet the challenges of growing customer expectations, the hospitality industry is turning to technology. Innovation enable hotel operators to stand out from the competition, full-fill guests' expectations and entice more customers. This introduces a novel design and development of a digital key for guestroom entry using a smartphone application. It will speed up and efficiently undergo the check-in and check-out procedure. Long queuing lines to check-in are common in hotels during peak time due to an exceeded amount of guest's demand. For instance, hotel guests may encounter a full lobby when checking-in during holidays. The lengthy queuing time to check-in would result to negative perceptions on hotel's service quality and reduce guest's satisfaction. Therefore, hoteliers should find ways to accommodate guest check-in with speed and efficiency. Hotels can enable a guest to use their smartphone application developed here in place of a traditional key card to lock and unlock the guest room door. In addition, it will have other features that can served as a communication tool between guest and the hotel services and facilities such as room check in and out; reservation booking; rewards program login; general hotel information; digital guest feedback and comment cards and hotel promos. It works on the Radio-Frequency Identification (RFID) technology which is a key component in the Internet of Things (IoT) as a means of tagging, or identifying, physical objects on the IoT network. The door lock maybe equipped also with Bluetooth Low Energy compatible locks.

Limitations:

Limitations of this application include expensive cost of hotel doors and RFID enabled locks will be additional cost to them. Small hotels will find costly to install the technology. Another is when the phone is left somewhere. A lot of personal information is available on the phone so if a thief was able to get guest's name and somehow rustle up with the guest's room number, thief can access it.

[3] A Study on the IoT Based Smart Door Lock System:
The proposed method in this study uses the IoT technology and the application of smartphone communication technology to conventional device (door lock) to open or close a door remotely through authentication. Application services based on information and communication technology has been actively investigated in the knowledge information society. In particular, the most rapid growth can be observed in convergence services which combines more than two elements for the same purpose. Convergence services prove to represent Internet of Things (IoT) technology, as it enables all objects to provide intelligent service and interactive communication through wired or wireless networks. IoT provides convenient and effective services in any place at any time, beyond the technical and economical restrictions, as well as the temporal and spatial limits by providing services required in various kinds of fields. It also aids the distribution of intelligent terminals which includes smart phones, in conjunction with the advancement of information and communication technology. Based on the IoT technology, the authentication based central control system controls door lock as a thing in wired and wireless communication ways (USB, audio channel, and Bluetooth) by achieving connection between smartphone as a device and security authentication server in mobile communication network. Door lock is controlled in the way of binary-coding Dual Tone Multiple Frequency (DTMF) generated in mobile device and sending it to the module on the transmission side. If it interacts with mobile communication network, the state of door lock can be checked remotely in mobile device. DTMF signals are created in the combination of 4 types of low frequency signals (69Hz, 770Hz, 852Hz, and 941Hz) and 3 types of high frequency signals (1209Hz, 1336Hz, and 1477Hz) and have 12 types of signals. The connection between door lock and security authentication server is made with the use of mobile phone over USB, audio, and Bluetooth communications. Smartphone is connected with the server through HTTP communication. Mobile app functions the communication connection between door lock and security authentication server. Smart Door Lock system uses personal smartphone. As a result, the digital door lock system and the Smart Door Lock system have higher convenience. Regarding scalability, the Smart Door Lock system has scalability to USB, Audio Jack, Bluetooth, and OPT ways.
Limitations:
Sometimes there will be disturbances in the frequency of binary-coding Dual Tone Multiple Frequency generated in mobile device due to external factor which may cause problems in the proper working of smart door lock. It is vulnerable in case of physical damage. It has no encryption of data.

[4] Intelligent Lock Applied for Smart Door:
In this paper, the author built a smart door security system to increase the public safety from intruders. The system provides a set of easy and more secure options for the owner to unlock his door; the lock can detect your recorded fingerprint and unlock the door. It can also unlock the door through a set of knocks, the owner can record a specific pattern and once the owner knock on the door the system than will unlock the door if it matches the recorded knock pattern, it also can unlock it through smart phone Bluetooth, this option come in handy if the owner forgets the knock pattern. It gives the owner's guests the ability to record a voice message and leave it if he is not at home. In this paper, intelligent lock is presented, where door user can assign specific knocking Pattern to the door lock so only the person who knows the pattern and who can knock that pattern in certain accuracy can open the door. The user can change the pattern and add new one at any time. Door security system is considered as intelligent system applied for a smart home. There are many smart systems proposed for doors to provide safety and security at home and offices as the traditional door lock needs a key, identification (ID) card or password to be opened which can be simply lost or taken. Seismic-vibration information was analysed to implement a home-security system. Users defined knocking sequence in specific locations on the door, the security system is able to analyse the vibration signals of the knocks, and the pattern-recognition algorithm is used to identify the knocking locations. The door is opened if both knocking locations and sequence were matching. The unlocking of the door through a mobile phone using the Bluetooth module is also included. The system is designed using Arduino and piezo sensor. An approach for face recognition, based on the discrete cosine transform (DCT) and Euclidean distance classifier is used along with Raspberry Pi, Arduino Uno, HC06 Bluetooth. The owner can access his house with a special knock or use his fingerprint and also open the door through Bluetooth if he ever forgets the special knock. The next feature in the model could include improving the android app and connect it to a live camera. When someone knocks the door, the app will notify the owner. The owner can see the outside through the live camera and take the desired action.
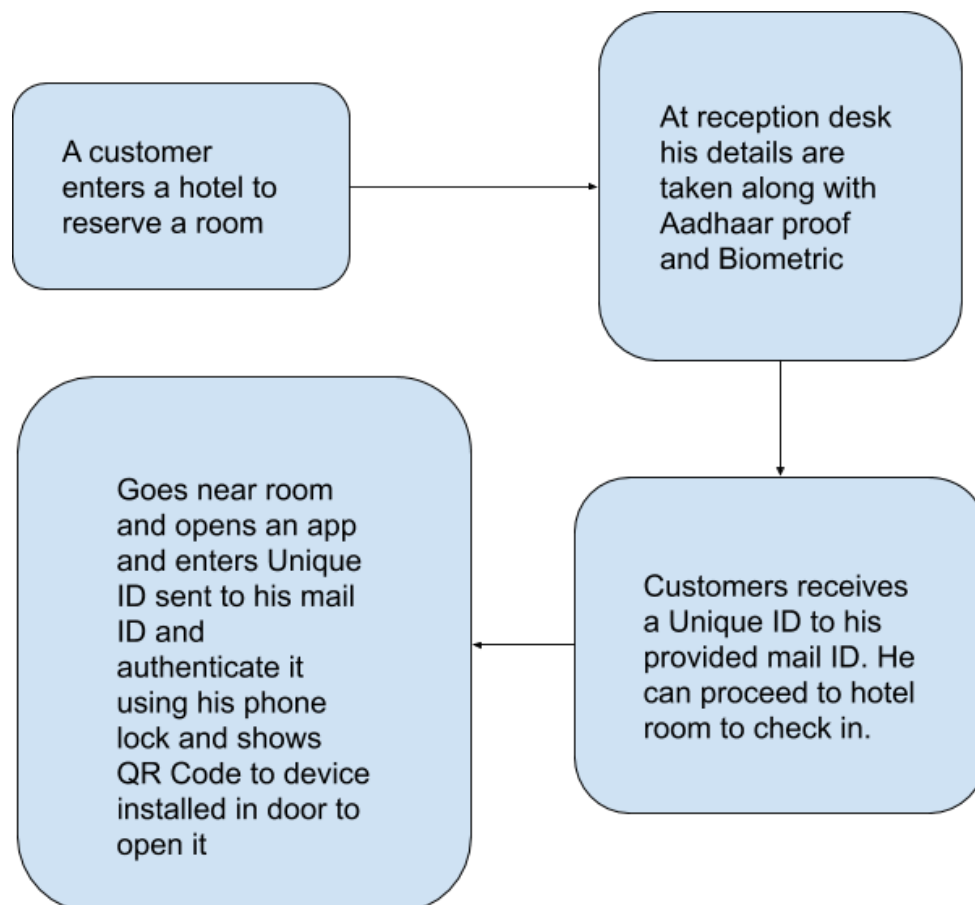Limitations:
The disadvantages of this system are that it is more complicated and it does not consider the intensity of the knocks, this may lead to reduce the accuracy of the system. It is vulnerable in case of physical damage. The fingerprint sensors and face scanner are sensitive and has to be maintained with extra caution as they are attached to doors.

[5] IoT Based Door Lock Surveillance System Using Cryptographic Algorithms: The main focus in this project is IoT which is revolutionizing the world. We know one of its renowned applications is a smart door lock system to protect the valuables and secrets behind the door. In IoT based system the user is transmitting his confidential data over the network which may contain passwords and other information, which are as crucial as the secrets or valuables behind the door. To resolve the valuables security and information security issues, we uniquely propose a password based and cryptographically shielded highly secure door lock system. We designed and developed a complete system including an Android smartphone app, using cryptographic algorithms for secure communication and programmable hardware with sensors and actuators in order to control unauthorized access. This cryptolock not only protects our valuables behind the door but also it protects our data which is being transmitted over the network. It gives easy remote access, controls unauthorized access and gives a complete sense of security. Door lock system has always been an appealing topic in places like smart homes, offices, military, and banks. Behind the doors are our valuable assets to whom we need to protect from unauthorized person. The recent advancement in IoT has brought sensational revolutions in the history of door locks, where we can now control and monitor the unauthorized access to our smart homes, offices or labs while sitting anywhere in the world by using smartphones. These IoT based door locks are more secure, provide easy and remote access and control unauthorized access. Most of the currently existing door locks use bio-metric, RFID, OTP, etc. However, none of them provide a complete solution in terms of complete physical security, easy remote access and securing information over the network. But in this paper a highly secure door lock system named as cyrptoLock which is using three emerging fields of the modern era, i.e., embedded system, IoT, and information security. The user login to the Android app using a unique username and password. Then the Log In is authenticated by the server. After Log In authentication the user exchange information over the network using secure cryptographic algorithms. In this a low power microcontroller Atemega2560. It takes the input from the keypad. The system is powered up with a 9V power supply. The user after configuration set the initial password and a servo motor locks the door and system security is activated. The user can now lock the door, unlock the door, reset the password also in case of emergencies (unauthorized access) the user will receive an emergency notification from our cryptoLock. The cryptoLock performs hashing on the above-mentioned string of data using SHA512 algorithm and encrypt this hashed data using AES-128 encryption algorithm in order to maintain the integrity and confidentiality of the data. Servo Motor, Android SDK, LCD 16x2, Keypad, PIR, Ethernet Shield, Micro-controller, Security Alarm are the mainly used devices.
Limitations:

This highly complexed model comparing to any other smart door lock systems and requires risky process for instalment. We have to be cautious while using this device and with the sensors. Mismatch of hashes while performing the process can cause problems and open without proper authorization.

Methodology:

```
┌─────────────────┐                    ┌─────────────────┐
│ A customer      │                    │ At reception    │
│ enters a hotel  │ ─────────────────► │ desk his details│
│ to reserve a    │                    │ are taken along │
│ room            │                    │ with Aadhaar    │
│                 │                    │ proof and       │
│                 │                    │ Biometric       │
└─────────────────┘                    └─────────────────┘
                                               │
                                               ▼
┌─────────────────┐                    ┌─────────────────┐
│ Goes near room  │                    │ Customers       │
│ and opens an app│                    │ receives a      │
│ and enters      │                    │ Unique ID to his│
│ Unique ID sent  │ ◄───────────────── │ provided mail   │
│ to his mail ID  │                    │ ID. He can      │
│ and authenticate│                    │ proceed to hotel│
│ it using his    │                    │ room to check   │
│ phone lock and  │                    │ in.             │
│ shows QR Code to│                    └─────────────────┘
│ device installed│
│ in door to open │
│ it              │
└─────────────────┘
```

This demonstrates basic working of the device in user point of view. A detailed explanation of the device and its working is mentioned below which will cover all the details about this system.

Pin Diagram:
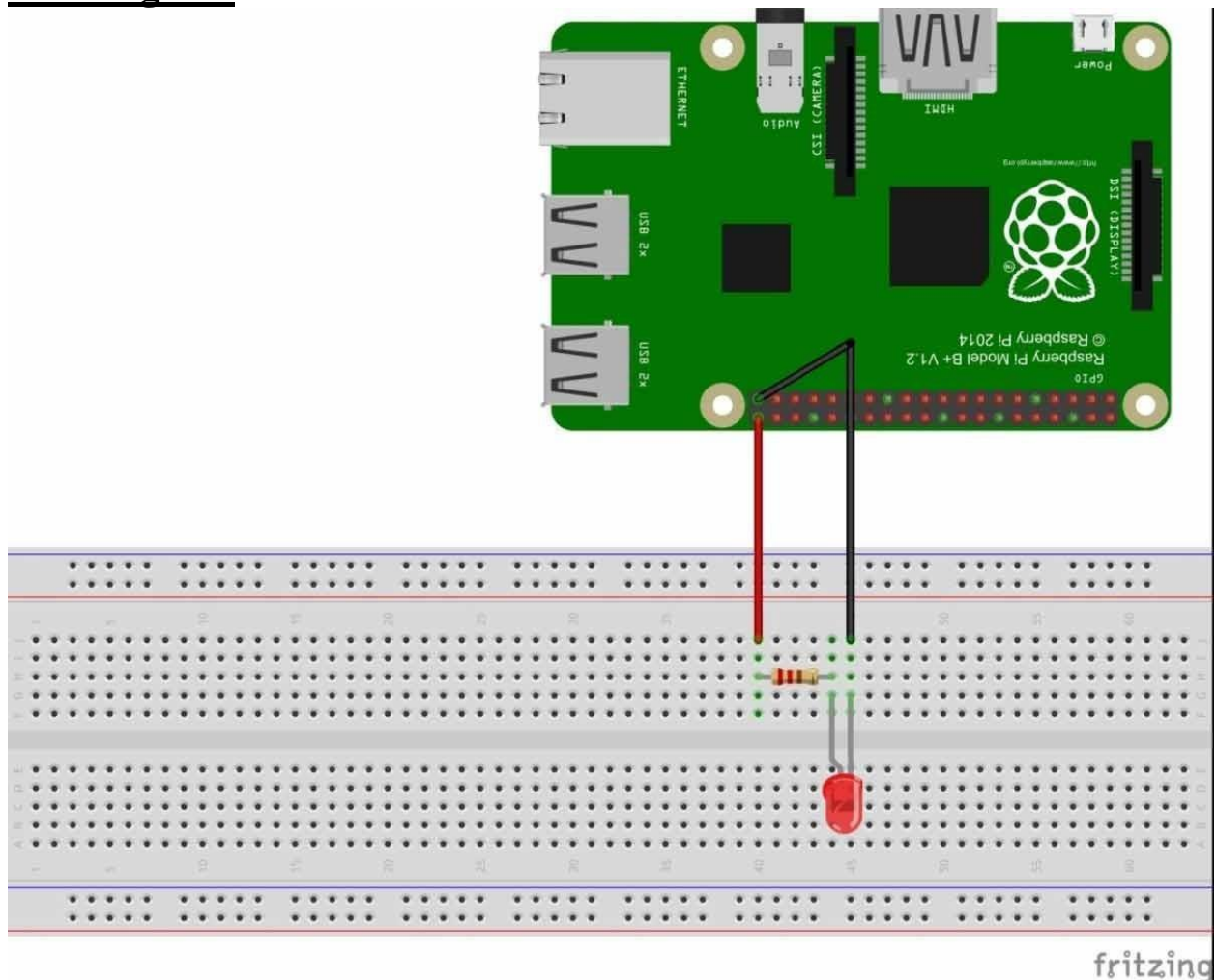
We use General-Purpose input/output (GPIO) pins to establish the connection in the Raspberry Pi and the device. In this device GPIO 6 and GPIO 7 pins for the output generation. Using relay node we will connect door lock solenoid to the device.

Sensor Used:

We use camera to scan the QR code

Software Used:

Python
Pyrebase
Firebase
Pyzbar
PuTTY & VM Viewer (connection purpose)
cv2(library for video purpose
GPIO6 and GPIO7(output)

Hardware Used:

Raspberry Pi
Door Lock Solenoid
Breadboard
Wires

Working Procedure:

In this device, system is connected with door lock raspberry pi and solenoid which are the main components of this device. We use python for coding and we have to install cv2 library for the working of this device. We can process raspberry pi in a while loop to scan the user information and QR codes. It can access data from firebase, which is the cloud in which data of users and respective QR code can be stored. Firebase is the best choice in cloud database related to these type of IoT projects.

Firebase:

We use Pyre base which acts as a medium between firebase and raspberry pi. It can process access to raspberry pi using an API Key. Pyzbar is used to scan the barcodes and QR codes. We install and initialize the required software and use them accordingly.

```
#===========Initialization==============#
firebaseConfig={
        "apiKey":"AIzaSyBSJZEo0E43edh48x7u190FytL8LcbsoRo",
        "authDomain": "qr-authentication.firebaseapp.com",
        "databaseURL":"https://qr-authentication.firebaseio.com/",
        "projectId":"qr-authentication",
        "storageBucket":"qr-authentication.appspot.com"
}
firebase = pyrebase.initialize_app(firebaseConfig)
auth =firebase.auth()
```

```
from imutils.video import VideoStream
from pyzbar import pyzbar
import pyrebase
from firebase import firebase
import argparse
import datetime
import imutils
import time
import cv2
import json
import RPi.GPIO as GPIO
```

We use GPIO pins for the output. Raspberry pi accesses the QR code and opens the door lock if it matches with the QR code in the firebase using pyrebase. But here it requires authentication which can be made by API Key. We use time lapse in providing output for blinking with an interval which indicates the output.

```
if barcodeData == value:
    GPIO.setmode(GPIO.BCM)
    GPIO.setup(4,GPIO.OUT)
    for i in range(0,10):
        GPIO.output(4,True)
        time.sleep(1)
        GPIO.output(4,False)
        time.sleep(1)
```

Demonstration of the Project:

First we start Raspberry Pi using putty software. Putty is a very useful application that can be used to connect to serial ports and Secure Shell(SSH) to Raspberry Pi's.
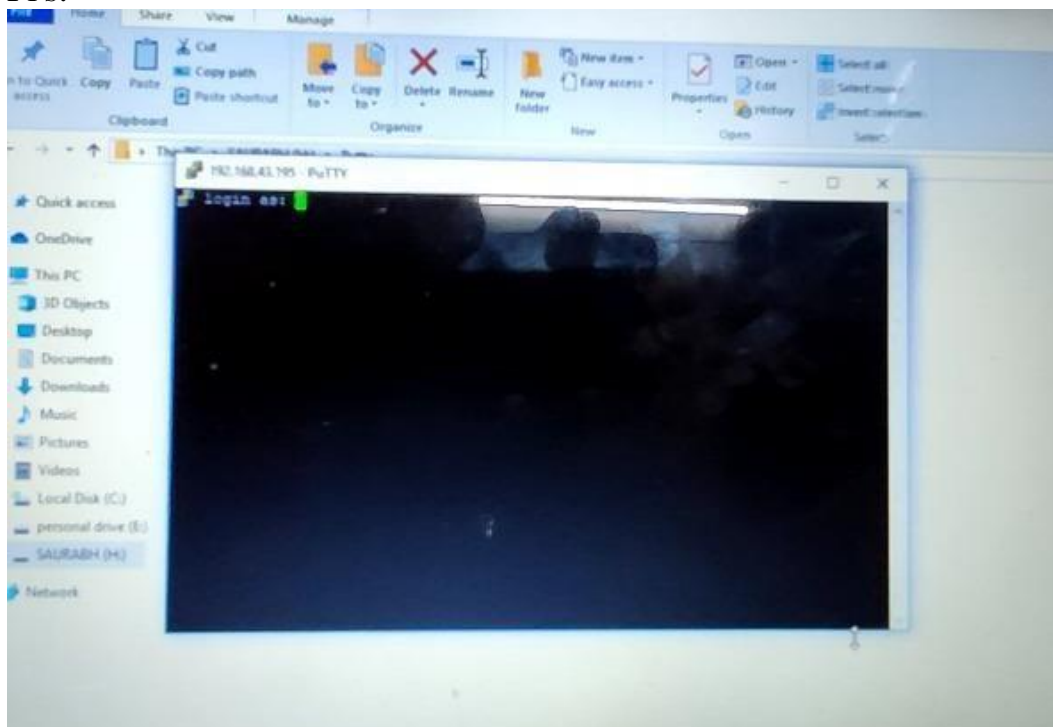
We use VMware to view inside the Raspberry Pi and its working. VMware Workstation Pro works by creating fully isolated, secure virtual machines that encapsulate an operating system and its applications. It enables users to set up virtual machines (VMs) on a single physical machine, and use them simultaneously along with the actual machine. So it can useful in viewing the process of how Raspberry Pi is working.
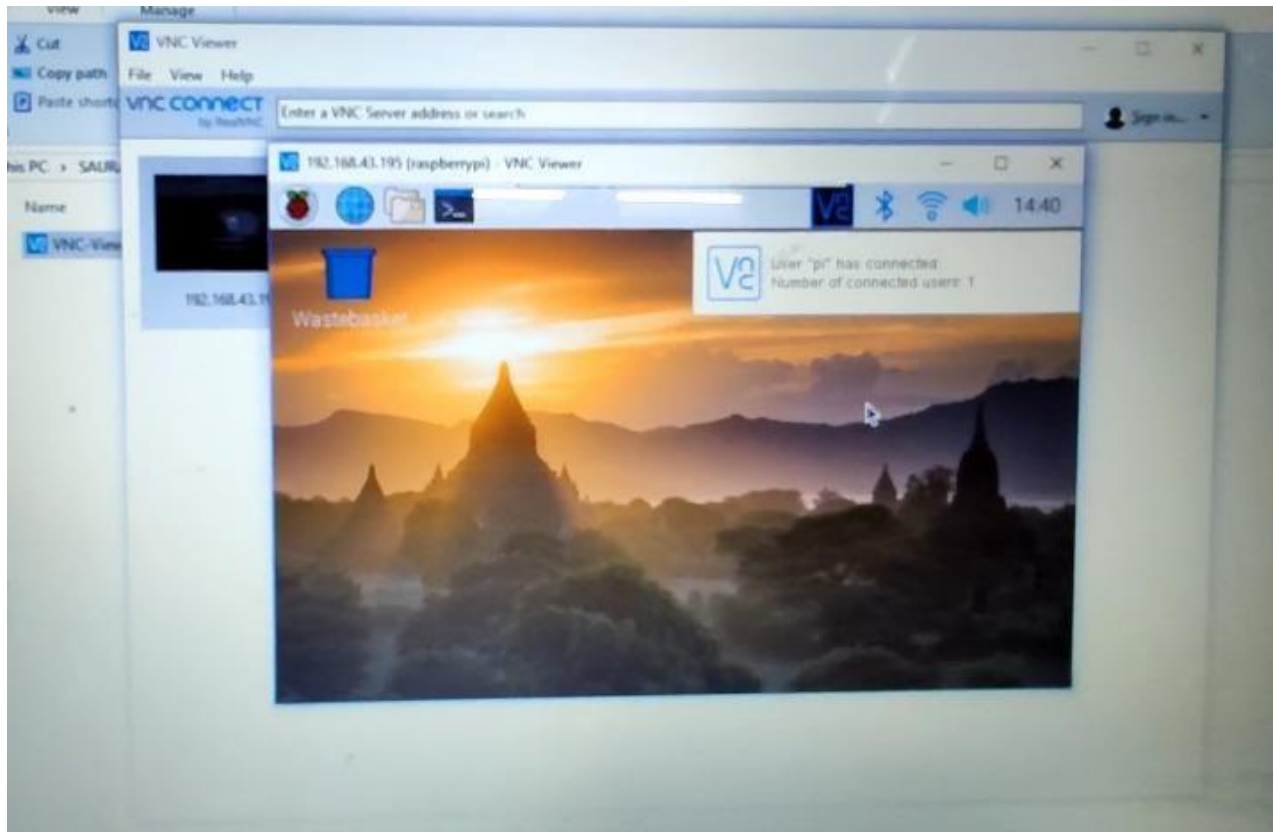
Camera sensor can be started by the below command. It is used to scan QR Code.
camera:python video_scanner.py
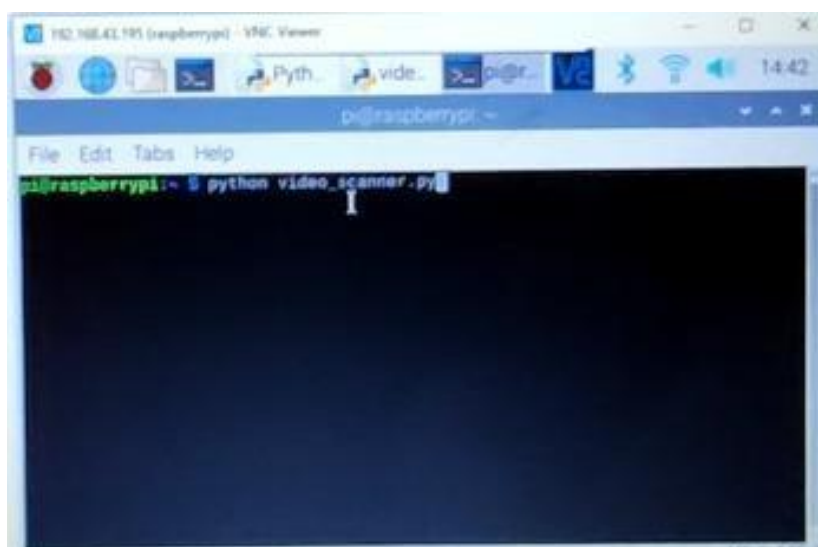
The scanning part by camera can be seen below
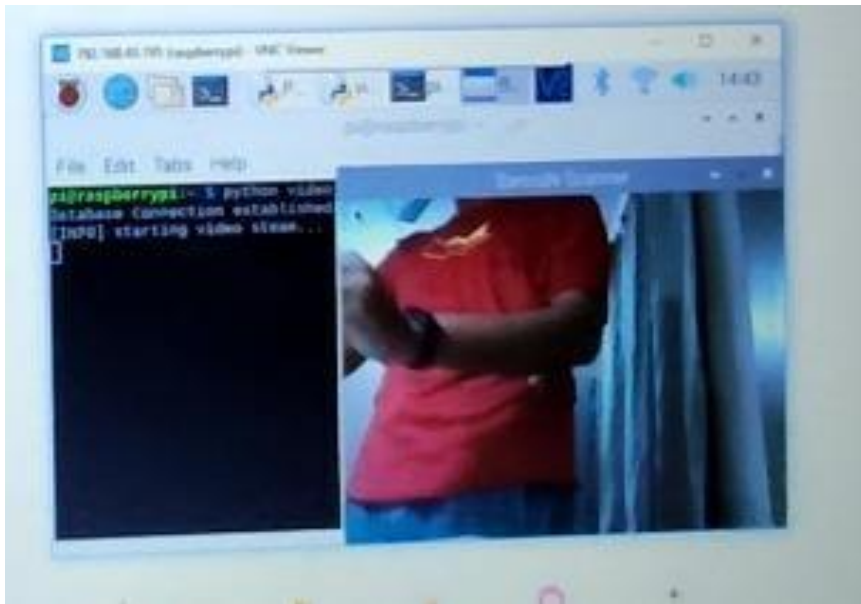
Camera is started to scan. In the figure below we can that along with Raspberry Pi and the setup of the lock.
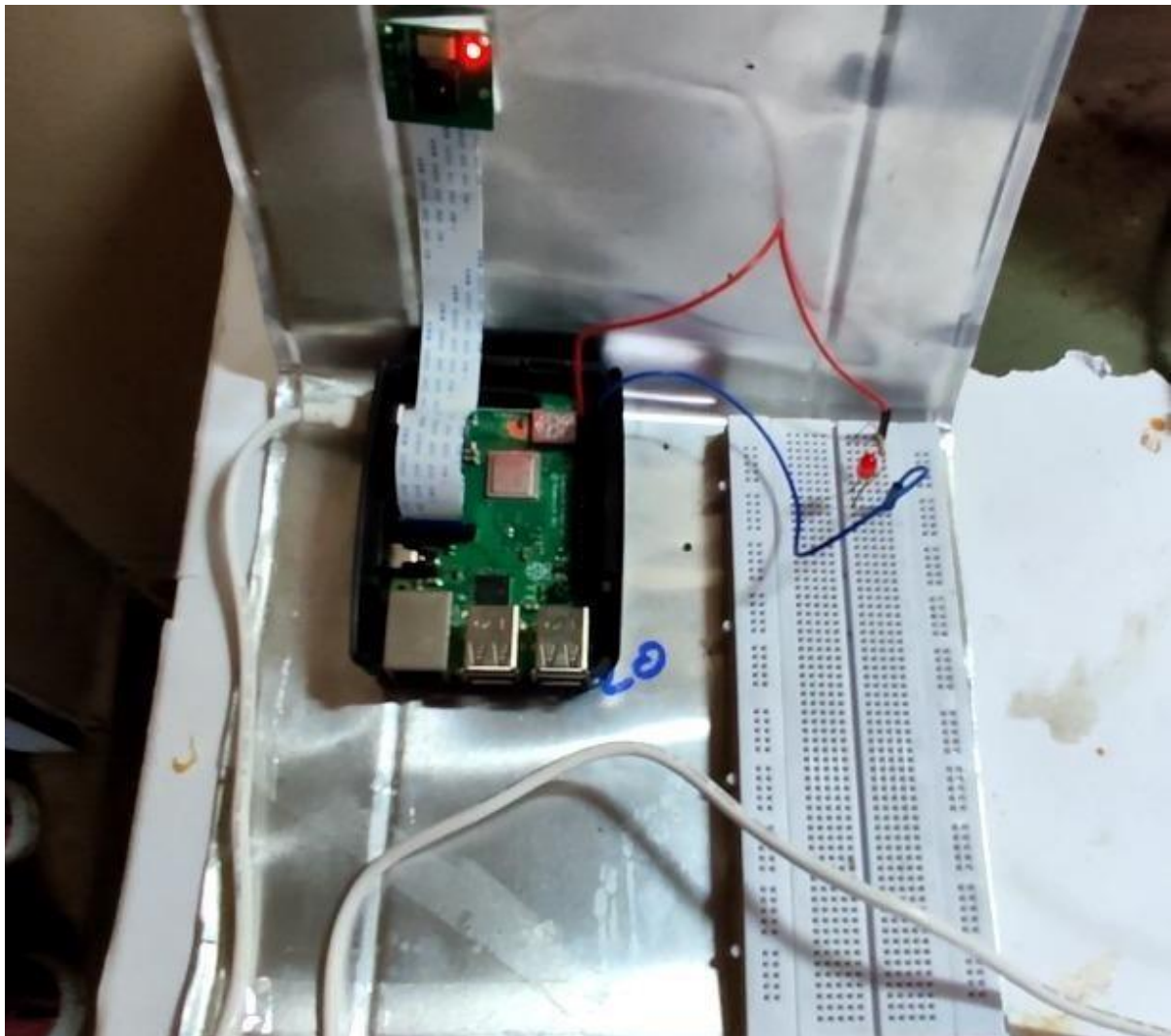
As mentioned before we use firebase as the database which is used while authenticating the QR Code. We use Pyrebase, a cloud platform, as the medium between firebase and Raspberry Pi. Pyrebase manages the QR code generation by Raspberry Pi between it and firebase.
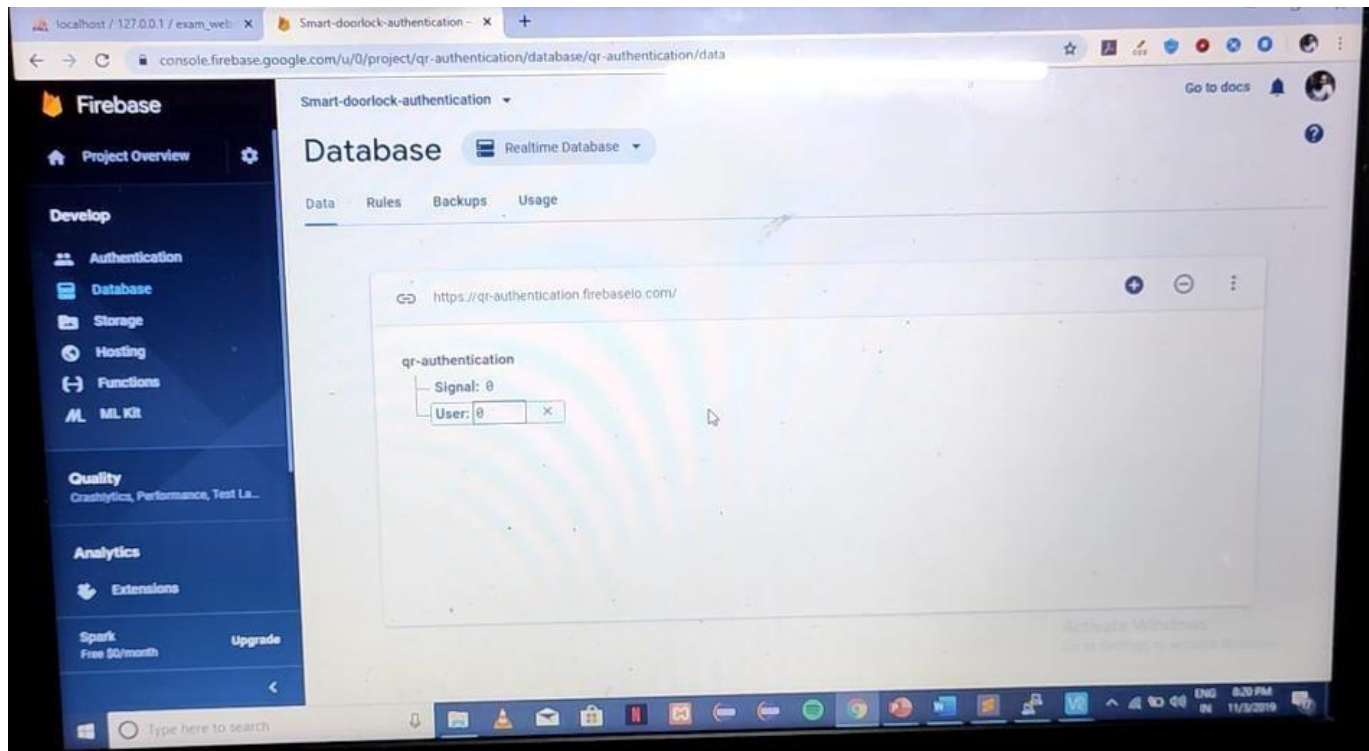
We use firebase as medium between user interface and Raspberry Pi. It is the one which imports the data of scanned QR Code and send for the verification of the QR code and then Raspberry Pi authenticates it. As of now no user has logged in, so there is no QR Code in the Firebase.

A guest can signup in the hotel website.

Give Your Personal Infromation Here.

First Name

Last Name

Your Email Address
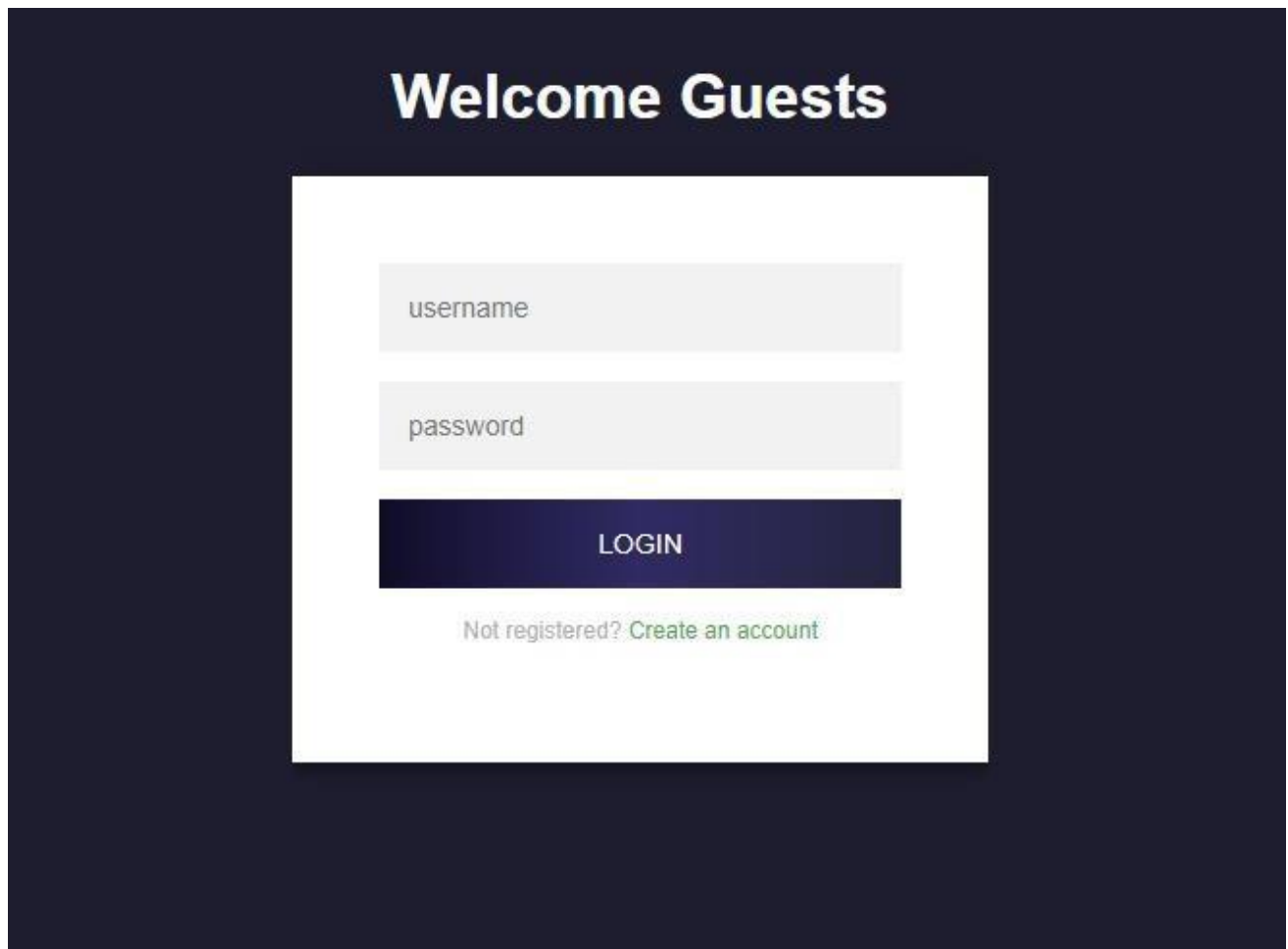
Password

Your Phone Number

Submit

Designed by Saurabh
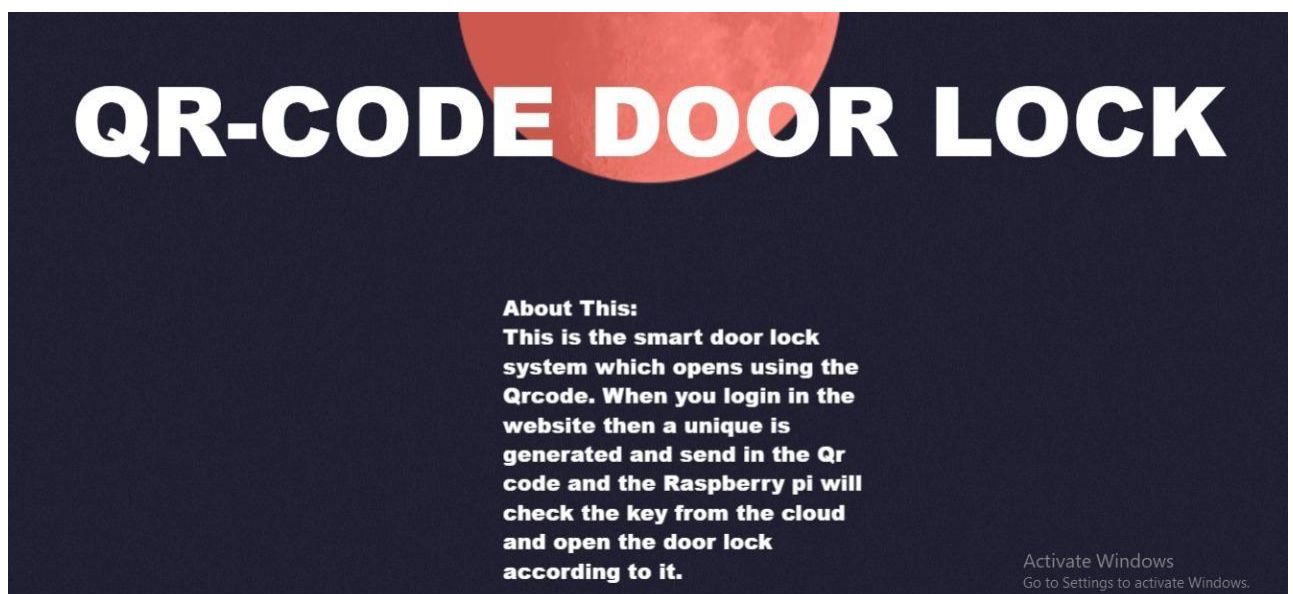
Guest has to log in into the website after signing up. After completing formalities of booking room, paying bill and verifying bill and mail, QR Code is generated to the guest's mail in a secured way using md5.

It is webpage after opening the website of the hotel's door lock part.

As of now no QR code is generated to the quest's mail
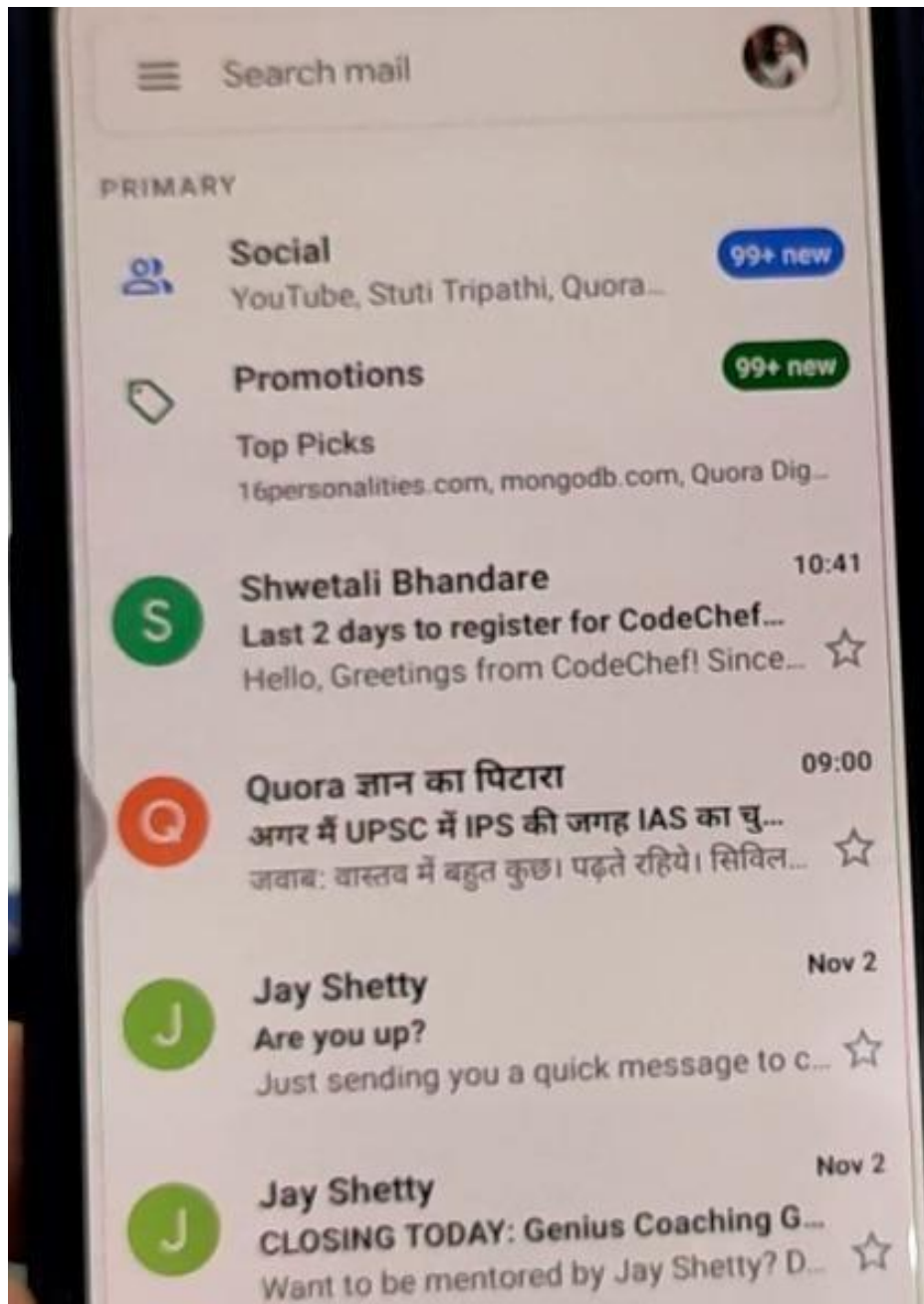
After refreshing the guest got the QR Code through mail. He can download it and scan it to open the smart door lock.
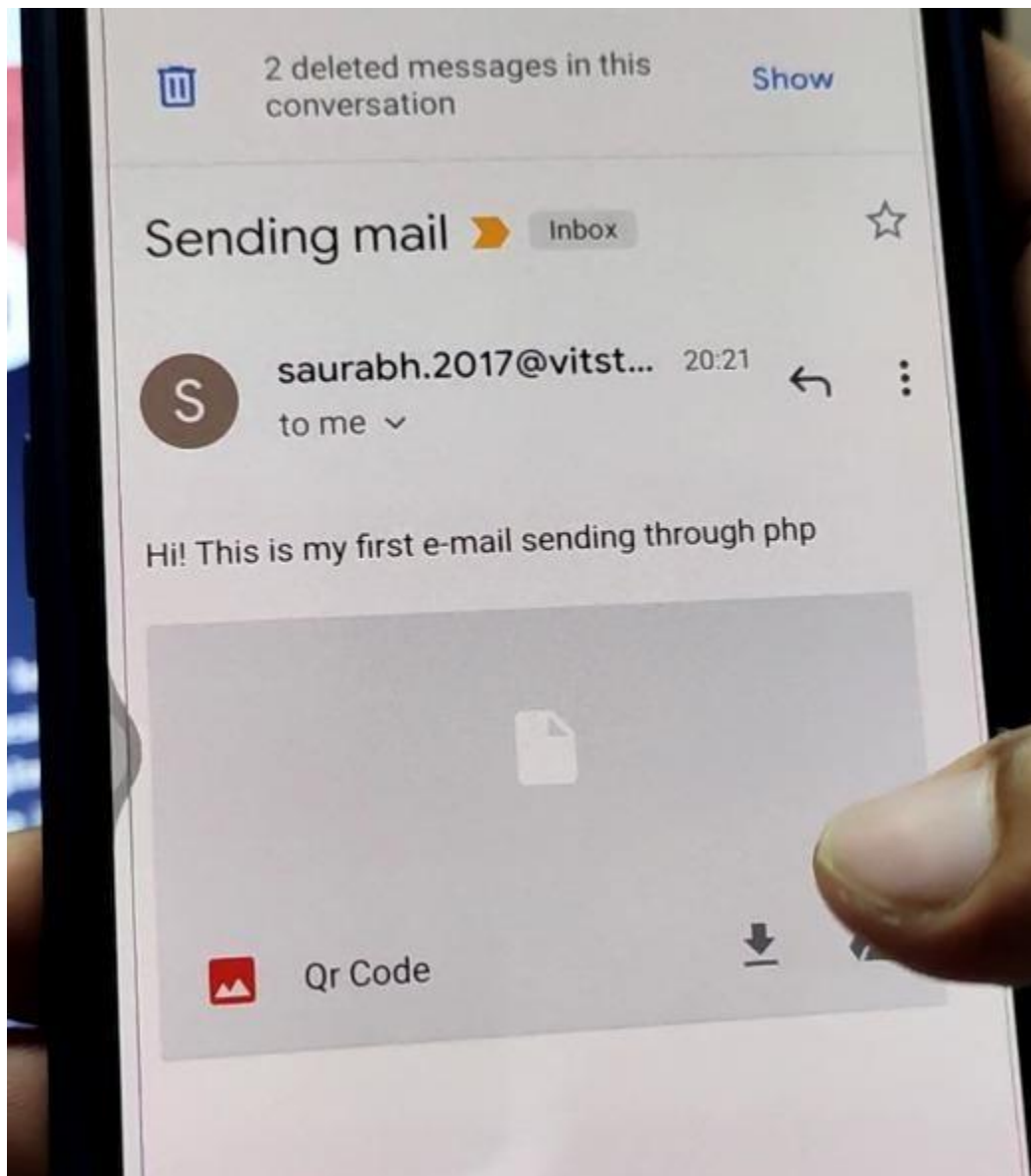

Downloaded QR code

Meanwhile the same QR code details are generated into the Fireabase after scanning. Using Pyrebase this data is transmitted to Raspberry Pi which authenticates the QR Code after scanning with the original QR details. We can see the updated data of QR Code in the firebase in below image. If the QR Code is matched with details in the original database then the lock will be opened otherwise it will show as wrong QR Code.
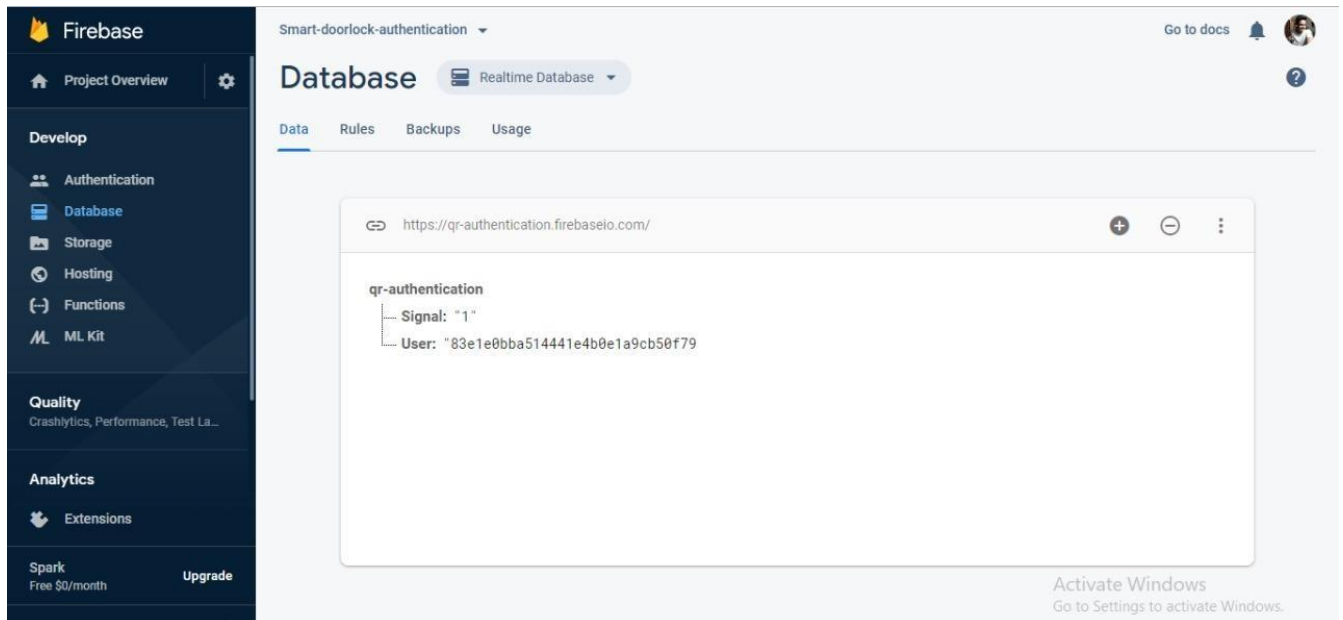

In the below image we can see the QR Code is scanning in front of the camera sensor attached to the door.

The QR Code details in firebase is matched by Raspberry Pi, so the authentication is completed. Finally, the lock is opened which is indicated by the lightening of LED (which can be replaced by door lock solenoid in real time).
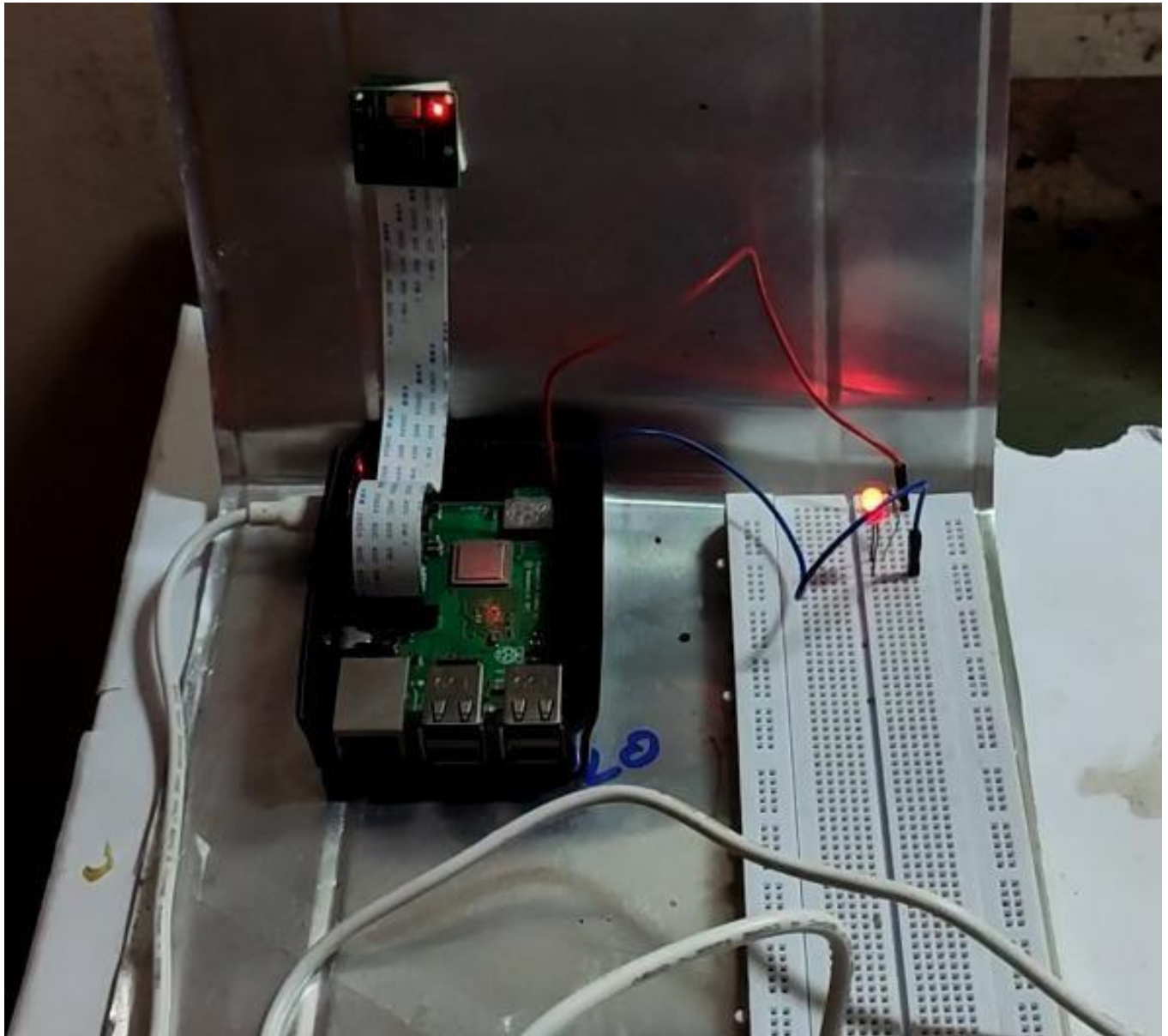
Now on other day a new user has signed up and logging into the hotel's website.
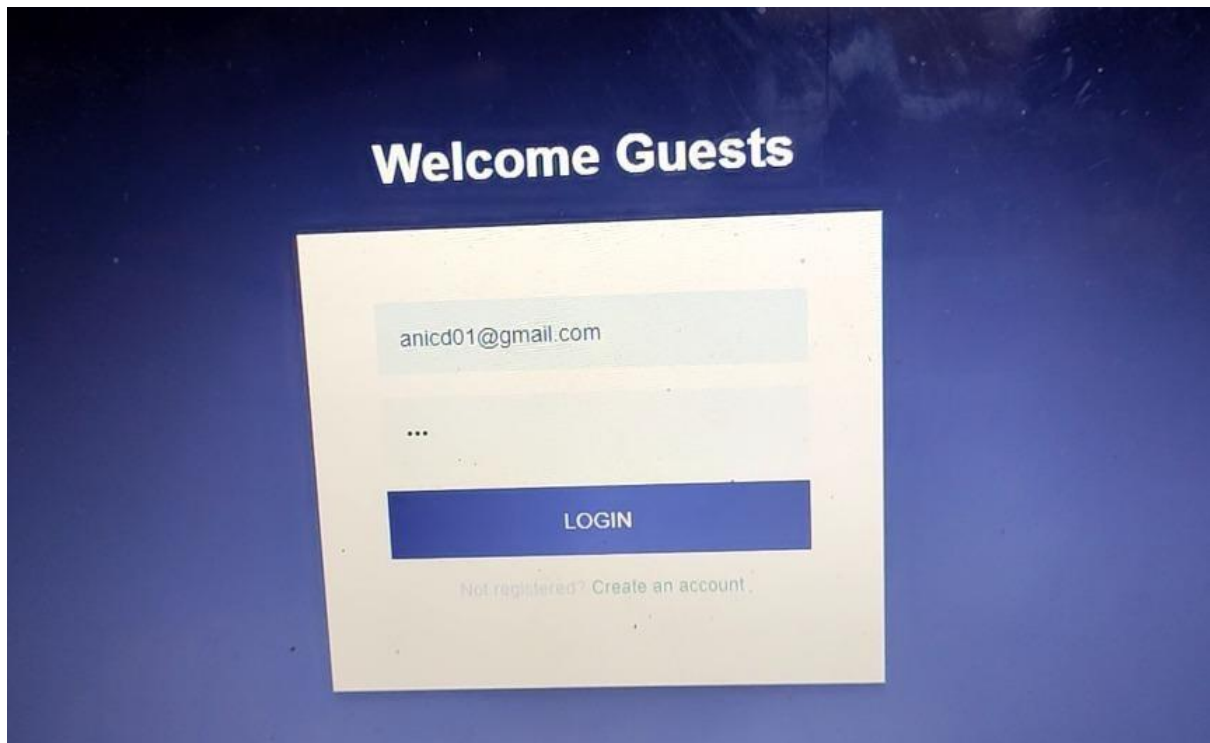
We used the same QR Code of previous user. But it is error because of the wrong QR Code which is expired on that day itself. We can see the error in VNC Viewer.
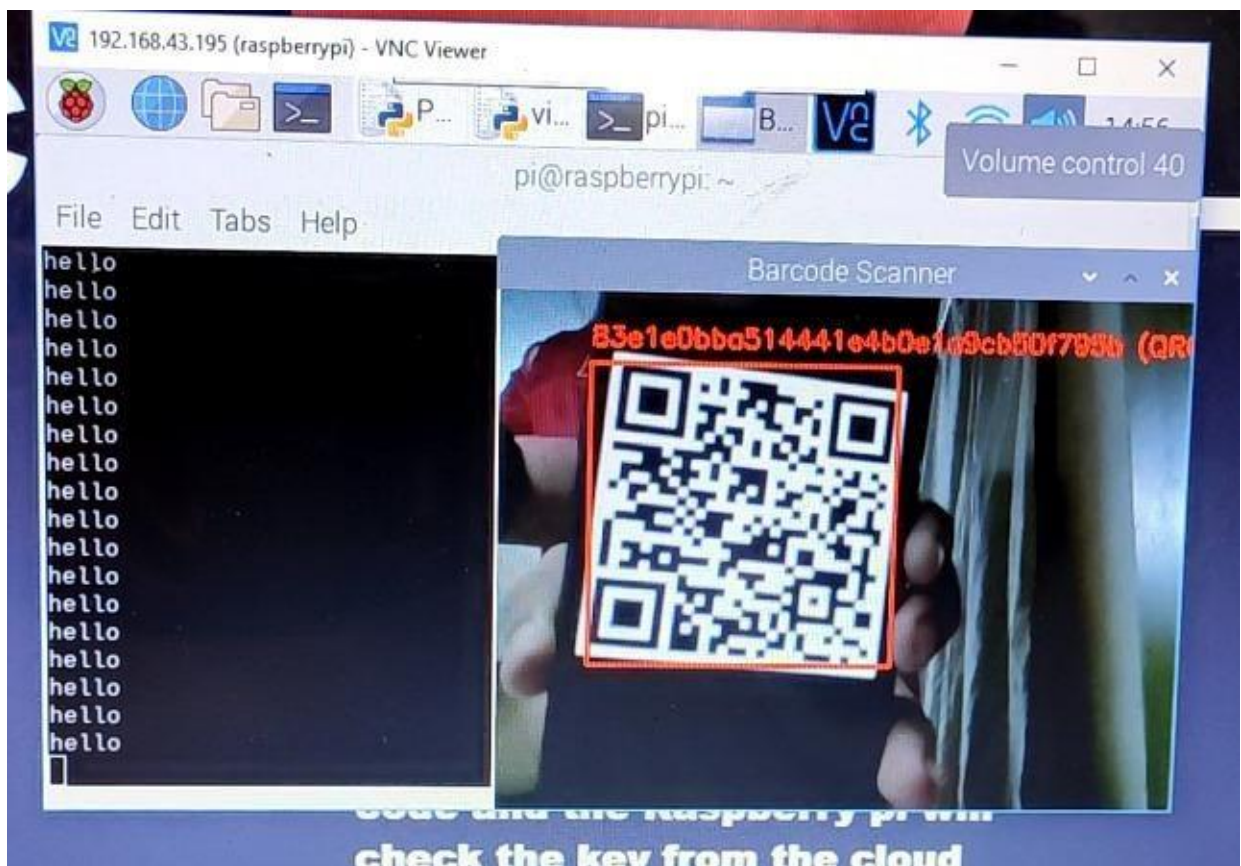
We can see the wrong QR Code data in the firebase which is send into it after scanning will be used for authentication. So, the lock doesn't open because of no matching of QR Code data by Raspberry Pi while authenticating it.
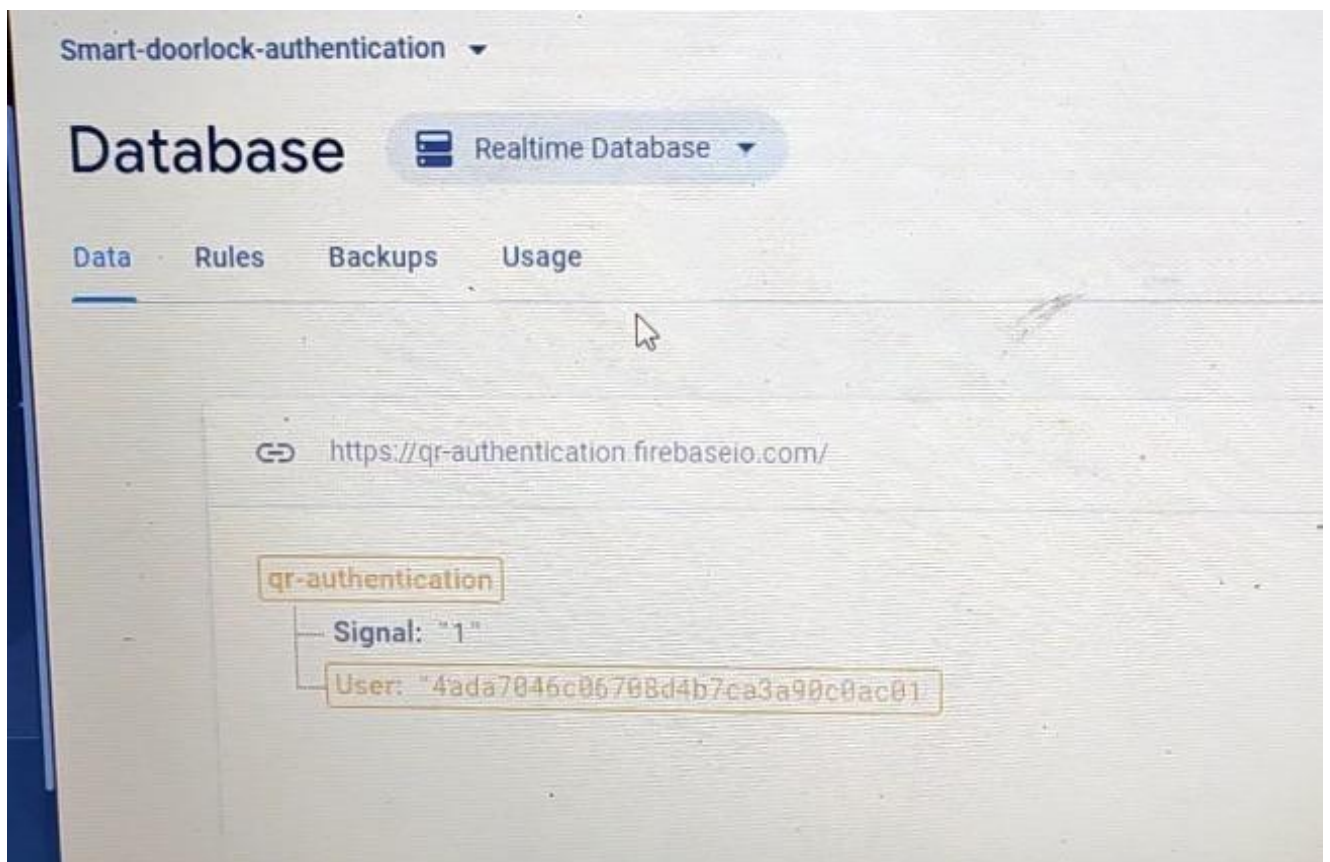
It will direct a error message to the user

It is database of the registered guests in the hotel website.

Code:

We used php for backend connection and fetching of details from the database. In the below code we fetched details like email details, Qr Code, Sending details to firebase.
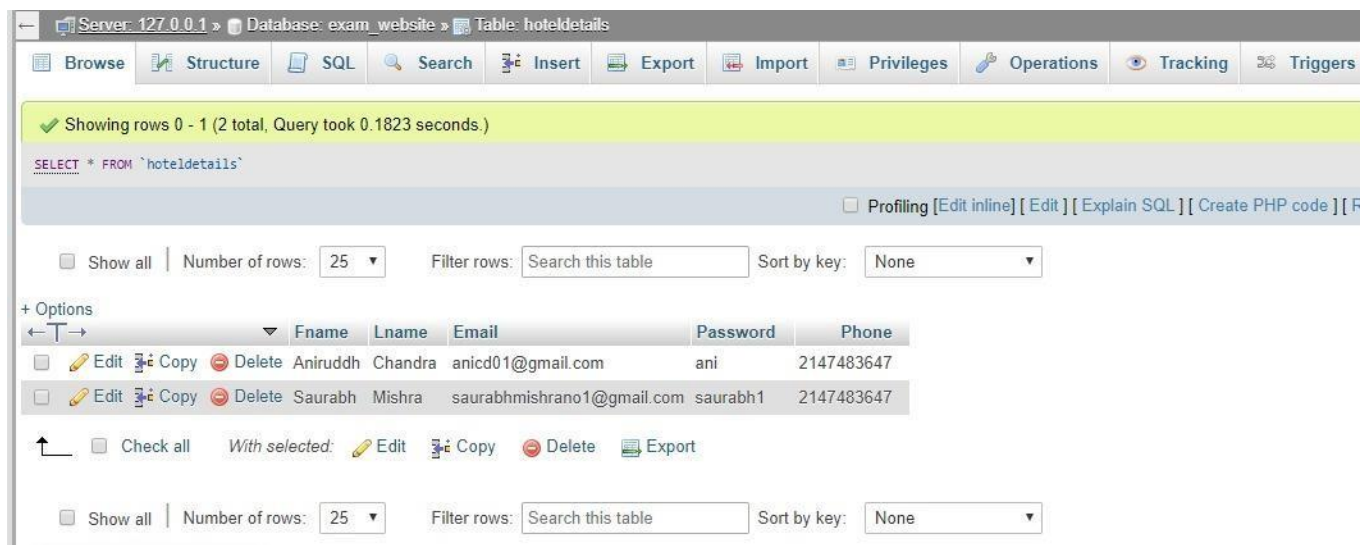
```php
<?php
        header("Content-Type: image/png");
        require "vendor/autoload.php";
        use vendor\Endroid\QrCode\ErrorCorrectionLevel;
        use Endroid\QrCode\LabelAlignment;
        use Endroid\QrCode\QrCode;
        use Endroid\QrCode\Response\QrCodeResponse;
        require('PHPMailer-master/src/PHPMailer.php');
        require('PHPMailer-master/src/SMTP.php');
        require('PHPMailer-master/src/Exception.php');
        include('index.php');

        $email=$_POST["login"];
        $password=$_POST["password"];
        global $conn;
        global $pass;
        $date=date("d-m-y");
        $day=date("l");
        $time=("H:i:sa");
        $enc=$date." ".$day." ".$time."Email-".$email;
        $value=md5($email);
```

```php
if(isset($_POST['submit']))
{
        $stmt=$conn->prepare("SELECT Password from
hoteldetails where Email=?");
        $stmt->bind_param("s",$email);
        $stmt->execute();
        $stmt->store_result();
        $stmt->bind_result($Password);
        $stmt->fetch();
        $pass=$Password;
}
else
{
        echo "Data connection failed.";
}
if($pass==$password)
{
        echo "Welcome";
        $qrCode = new QrCode($value);
        $qrCode->setSize(300);
        $qrCode->writeFile(__DIR__.'/qrcode.png');

        $mail = new PHPMailer\PHPMailer\PHPMailer();
        $mail -> IsSMTP();
        $mail->SMTPDebug = 4;
        $mail->SMTPAuth = true;
        $mail ->SMTPSecure='tls';
        $mail ->Host='smtp.gmail.com';
        $mail ->Port='587';
        $mail-> isHTML();
        $mail->Username='saurabh.2017@vitstudent.ac.in';
        $mail->Password='saurabh12345';
        $mail-> SetFrom('saurabh.2017@vitstudent.ac.in');
        $mail->addAddress($email);
        $mail->Subject='Sending mail';
        $mail->Body='Hi! This is my first e-mail sending through
php';
        $file_to_attach = 'qrcode.png';
        $mail->AddAttachment( $file_to_attach , 'Qr Code');
        $mail->SMTPDebug = 0;
        $mail->send();
        header("Location:../html/secondHotelLogin.html");
```

```
            }
            else
                   header("Location:../html/oops.html");

            ?>
```

For the Raspberry Pi processing we used python programming with installing carious packages in the putty IDE. Below code process the starting of the camera sensor and working the camera sensor. It also processes the extraction of data from the firebase. It checks the QR Code data and verifies it and finally lights the LED as a sign of opening the door.

```
#import the necessary packages
from imutils.video import VideoStream
from pyzbar import pyzbar
import pyrebase
from firebase import firebase
import argparse
import datetime
import imutils
import time
import cv2
import json
import RPi.GPIO as GPIO

#==========Initialization==============#
firebaseConfig={
    "apiKey":"AIzaSyBSJZEo0E43edh48x7u190FytL8LcbsoRo",
    "authDomain": "qr-authentication.firebaseapp.com",
    "databaseURL":"https://qr-authentication.firebaseio.com/",
    "projectId":"qr-authentication",
    "storageBucket":"qr-authentication.appspot.com"
}
firebase = pyrebase.initialize_app(firebaseConfig)
auth =firebase.auth()

user =
auth.sign_in_with_email_and_password("saurabhmishrano1@gmail.com",
"saurabh12345")
print("Database Connection established.")
```

```python
#construct the argument parser and parse the arguments
ap=argparse.ArgumentParser()
ap.add_argument("-o","--output",type=str,default="barcodes.csv",help="path to
output CSV file containing barcodes")
args=vars(ap.parse_args())
#initialize the video stream and allow the camera sensor to warm up
print("[INFO] starting video steam...")
vs=VideoStream(usePiCamera=True).start()
time.sleep(2.0)

#open the output CSV file for writing and initialize the set of
#barcodes found thus for
csv=open(args["output"],"w")
found=set()
#loop over the frames from the video stream
while True:
        #grab the frame from the threaded video stream and resize to it
        frame=vs.read()
        frame=imutils.resize(frame,width=400)
        #frame the barcodes in the frame and decode each of the barcodes
        barcodes=pyzbar.decode(frame)
        #loop over the detected barcodes
        for barcode in barcodes:
          #extract the bounding box location of the barcode and draw
          #the bounding box surronding the barcodes on the image
          (x,y,w,h)=barcode.rect
          cv2.rectangle(frame,(x,y),(x+w,y+h),(0,0,255),2)

          #the barcodes data is a bytes object so if we want to draw it
          #on our output image we need to convert it to a string first

          barcodeData=barcode.data.decode("utf-8")
          barcodeType=barcode.type

          #draw the barcode data and barcode type on the image
          text="{} ({})".format(barcodeData,barcodeType)
          cv2.putText(frame,text,(x,y-
10),cv2.FONT_HERSHEY_SIMPLEX,0.5,(0,0,255),2)
        db= firebase.database()
        result=db.child().get()
        value=[]
        for user in result.each():
            value.append(user.val())
```

```python
        if barcodeData == value[1]:
            GPIO.setmode(GPIO.BCM)
            GPIO.setup(4,GPIO.OUT)
            for i in range(0,10):
                print("hello")
                GPIO.output(4,True)
                time.sleep(1)
                GPIO.output(4,False)
                time.sleep(1)
        #if the barcode text is currently not in our CSV file,write
        #the timestamp+barcodes to disk and update the set
        if barcodeData not in found:
            csv.write("{},{}\n".format(datetime.datetime.now(),barcodeData))
            csv.flush()
            found.add(barcodeData)
    #show the output frame
    cv2.imshow("Barcode Scanner", frame)
    key=cv2.waitKey(1) & 0xFF

    #if the 'q' key was pressed,break from the loop
    if key ==ord("q"):
            break

#close the output CSV file do a bit of cleanup
print("[INFO] cleaning up.... ")
csv.close()
cv2.destroyAllWindows()
vs.stop()
```

Video Demonstration of the Project:

We clearly demonstrated the complete working of our project in three videos which can be accessed through the drive link given below.

https://drive.google.com/drive/folders/1_VEPlIc3Qvv9LHzSOeu-_NBl4xBBaOta

Conclusion:

In this project, we created a smart system for hotels to open doors using QR Code. The main outcome of this project is simple and secure to make guests in the hotel comfortable and secure enough about their safety and privacy. The guest's comfort and security is a big difference compared other similar projects. In this QR Code is generated to the registered mail itself which is simple and direct. It also makes the hotels smart and upgrade them into brand new level. Our project is one of the best applications of Internet of Things which is necessary in order to make our society smart as hotels are key place for tourism, business, functions, meetings, etc. This application of Internet of Things can be used for many purpose in order to keep more security of public places like these.

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