Smart Door System for Home Security

Adesh Sangoi - 16IT102
Department of Informationation Technology
National Institute of Technology
Karnataka, India
adeshsangoi25@gmail.com

Abhishek Kamal - 16IT202
Department of Informationation Technology
National Institute of Technology
Karnataka, India
kamalabhishek20@gmail.com

Arjun Kumar - 16IT108
Department of Informationation Technology
National Institute of Technology
Karnataka, India
karjun344@gmail.com

Dashan Jot Singh - 16IT216
Department of Informationation Technology
National Institute of Technology
Karnataka, India
dashanjotsingh961999@gmail.com

***Abstract*—Nowadays the use of Internet of Things (IoT) technology has developed that almost all aspects in human's life utilize IoT technology to increase the quality of life. Internet of Things (IoT) conceptualizes the idea of remotely connecting and monitoring real world objects (things) through the Internet. With the exponential growth of IoT devices, IoT security is becoming important. Nowadays, providing a security system for houses has become a vital research in which the latest technologies are being adopted to serve this purpose. Wireless network is one of the technologies that have been used to provide remote monitor and control for the home appliances. We aim to propose a security door lock system based on IoT technology and mobile communication technology where cameras, IR sensor are being utilized to provide an alarming system that has the ability to notify the owner, as well as, recognizing guests by giving them a user-id. In this vein, the authorized individuals are only the ones who will get the permission to access the doors. The system works by taking snaps for the guest through a code and camera positioned in the doors then, such snaps will be sent to the owner. The proposed system can be extended to be used for different properties and facilities such as banks and office.**

***Index Terms*—Smart Lock System, Mobile Technology, IR Sensor, Internet of Things**

I. Introduction

Nowadays, technology plays an essential role in our life in which different domain of interests are taking advantage of technology. Recently, computers and smart phones have significantly contributed our daily life where numerous computations and adjustments are being accomplished by such technologies.

Securing homes has become one of the concerning issues that facing many people. With the expanded duration of leaving the home due to work, study and other duties, homes are being more vulnerable for several threats especially being burgled. For this manner, smart door security has been introduced. An efficient, low power consumption and low cost embedded access control system for Smart home security and remote monitoring[1] based on motion detection is very important for wide range of commercial and security application. Many countries are gradually adopting smart home security control system. Today most of the home and office appliances that we interact with contain microprocessors. All of these appliances have some user interface, but many users become frustrated with the difficulty of using the complex functions of their appliances. We are developing a framework that allows users to interact with appliances through a separate user interface device that they are already carrying. Smart phones are good candidates for providing interfaces because they are common, have communication capabilities to allow connection to appliances, and are already being used for a wide range of different applications. The most important part of any home security system is accurately detecting visitor who enter and leave through the door. An entrance guard can be managed remotely, detecting visitors at Door and alerting to user via mobile phone is the most natural way to perform security. The system identifies the visitors presence, capture and transfers the image through android app automatically to home owner to recognize the visitors. The user can directly interact with the embedded device in real time without the need to maintain an additional server. It has a variety of features such as energy efficient, intelligence, low cost, portability and high performance.

II. Literatur Survey

Several remote systems have been proposed whether for the academic or business domain. Such systems were intended to provide a remote control and monitoring tasks. For instance, a system has been proposed by [3] which is based on Zigbee technology. This system is composed of multiple modules such as the human detection module (HDM) which aims to detect the user at the door. This can be performed using the camera module in which the images or the video stream is being processed. Consequently, the results of the two-mentioned module will go through the Zigbee module that would identify a verification tag for each user. Once the user got failure in terms of the zigbee verification tag, a speaker phone will be provided with the owner of the property. Digital door lock in home automation system provides proper control

and home environment monitoring to the user. A system has proposed by [4] based on the RFID technology which provides a touch LCD monitor. Another system consists of a build in NFC capabilities of a smart phone which would eventually be the key to open the door by means of logical link control protocol, which then matches the user's own set of passwords to verify that user should be given permission or not [5]. Another system has been proposed by [5] which based on an NFC featuring smartphone abilities. Such system uses logical link control to identify the permission of the user's identities. In addition, a system proposed by [2] based on design of GSM digital door lock system using PIC platform. 5-digit password is used to lock/unlock the door. If the user submits an incorrect password the system notifies the owner. In [4] a system has designed that contains sensors to detect obstacle, touch, heat, smoke, sound. The whole system is controlled by a PIC microcontroller 16F76. It gathers the information from the sensors, makes a decision and sends SMS to a corresponding number by using a GSM modem. If an interruption has been identified, then PIC will send a SMS to the owner and another SMS to the Police Station. Similarly, for environmental threats such as fire interruption a SMS will be sent to the fire brigade and another to the owner [3]. In this system require extra hardware components like Sensors, GSM Modem. Alerts are sent through only SMS. In [2] an intelligent system for home security using illumination sensitive background model is presented. Such system enables tracking and detection of intruder and it is based on providing home security. For this purpose, a face recognition technique is utilized to identify the intruder and on finding him, an image of the intruder is sent on the owner mail id for further action. The implementation of this system also includes the comparison of different approaches for object tracking and then used an illumination-sensitive background modeling approach for the proposed security system. But this system doesn't use password for identification.

III. Problem Statement and Objective

Home security system or so-called Home OS has been proposed in order to provide more secure arrangements. We aim to turn the home into a smart home in which different tasks especially monitoring can be performed remotely. The earliest effort of home security system was relied on wired home networks however, due to the appropriate planning and construction works required to offer a wired home, such effort tend to be insufficient. As a solution for this problem, we will be working on wireless communication that has emerged to provide more flexible platform where the installation cost is significantly lower than the wired one. Recently, electronic door lock systems are one of the most popular security systems that is being installed for many residents and business places. The key characteristic behind such systems lies on the reliability in which the authorized individuals can gain the permission to access the doors throughout a secure system that has an interactive interface. We aim to present a novel door security system based on wireless network. The main goal is to develop a prototype that has the ability to simulate the wireless tasks including monitoring and controlling digital door lock. Such system would have the capability to provide secure and controlled home appliances.

IV. Requirements

A. Functional Requirements

- Arduino - Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. Arduino was used to control the door lock. It is used as control module in order to control input,processing and output of the automation system. Phone Camera capture image and send the file to the database.
- Firebase Firebase is used for storing the snaps of guests, verification and granting permission. Firebase provides a realtime database and backend as a service. The service provides application developers an API that allows application data to be synchronized across clients and stored on Firebase's cloud.
- Wireless Network like Wifi, Bluetooth - For connection between sensors and Arduino.
- LEDs - Used as signal for guest to know whether the entry access has been granted or not by the host
- Servo Motor - Servo motors are DC motors that allows for precise control of angular position. They are actually DC motors whose speed is slowly lowered by the gears. The servo motors usually have a revolution cutoff from 90 to 180. A few servo motors also have revolution cutoff of 360 or more. But servo motors do not rotate constantly. Their rotation is limited in between the fixed angles.Servo Motors are used for locking and unlocking of door by turning the lock lever when signal is sent from Arduino.
- IR Sensor - Used to sense and detect whether the guest is near the door or not. So, it can signal camera pi to take the snap of the guest.

B. Non Functional Requirements

- Android App - Security has been taken care while implementing the interface for door control.
- Profiling - user can access his/her profile for editing it and updating it.
- Usability - maximizing user experience for the controlling app.
- Performance - Speed efficiency, resource usage, throughput, response time has been implemented.

V. System Architecture

Smart digital door lock is a system to monitor and control several devices in the home. Our smart digital door lock system operates over internet network by using Arduino. Servo Motor is attached to door knob and this motor is been controlled by the help of Arduino. The Overall system

structure consists of the following three phases: (i) input, (ii) processing and (iii) output.

Input phase deals with sensing the motion of the person near the door and capture the snap of the person using camera. Arduino is used to connect the IR sensor and camera such that it can detect the person on the door and signal to the system about presence of the person and allows the camera to take images.

Once the Input phase is completed then comes processing phase where the image of visitor is been processed to know whether to allow the entry or not. The collected images are being match with images already in firebase database. And if the visitors image is already in the database, entry is automictically granted otherwise if is newcomer, notification through SMS is been send on his phone.

In output phase the owner access the android app present in his phone to know the visitor and if he allow the person then only entry will be granted and Led on the door will turn green showing access has been granted to visitor. Servo motor is been to control the locking and unlocking of door. And its been controlled by Arduino.

Android app has some of functionalities as :

- Add Whenever a new visitor whose snaps are not present in database visit, owner will have the right whether to add the user in existing database or not.
- Remove If the owner doesnt want the visitor to be an authorized person to enter in house. He can remove him from database.
- Notify Whenever owner want to activate the notification about status of visitor who are visiting in his absence in his home. Once this is activated the owner will able to receive messages whenever a visitor visit his home
- Check Check feature will the owner to view the recent visitor. If any known visitor enter in the house, owner will get notified and using check feature he can view the images of known person who already had the access of his house.
- Open and Close This will change the status of door lock from 0 to 1 or 1 to 0 whenever owner wants to open the door or close the door respectively.

VI. Methodology

Smart door lock is one of the most popular digital consumer devices because of the user convenience and affordable price. In actuality, it is replacing a lot of conventional types of locks. The whole security system works on different stages. The whole method of Smart door security system functioning is as follows.

Whenever a visitor comes at the door, IR sensor situated on the door senses the person and sends signal through Arduino to Camera. Once the signal is been received by the camera, it will turn on and will take the snap of visitor who has arrived at the door. The images of all authorized people to access the door are already added into the database. Images are then sent for processing and verification. The image of the visitor is matched with the images in the database. If the visitor is known and matches to an image in the database of authorized people then permission is been granted to visitor and door lock status which was earlier 0 changes to 1 indicating that the door has been opened and Green light led will turn on indicating to the visitor that he/she can enter. And through all this process notification is also been sent to owner telling him/her regarding the status of door on the admin app. If the visitor is not an authorized person then the image taken will be sent to the admin via Android app and a notification will pop up stating some unauthorized person is trying to enter. Owner will use his personalized app to view the image of the unauthorized visitor and will have the right to open the door or not using his app.If owner wishes to allow the visitor the access to the door, he can add the new user image to existing database and open the lock else he can discard the request and door will remain closed. Owner can change the status of door (lock or unlock) anytime he wants through his app.

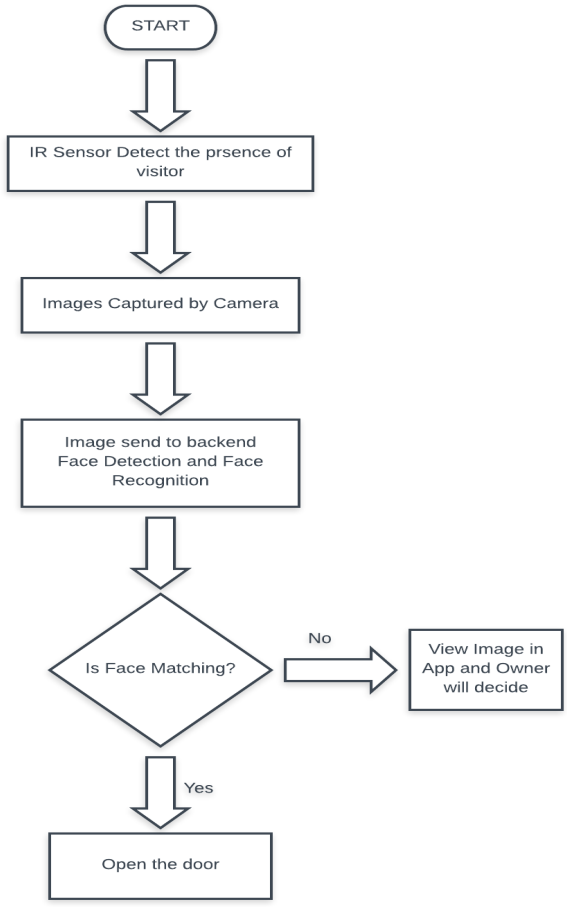
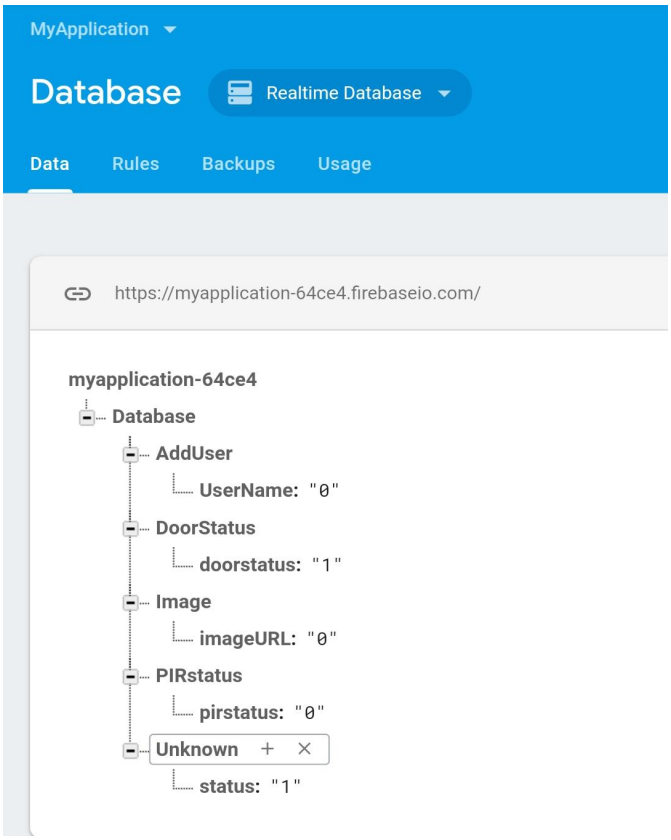


Figure 1 : Flowchart of Design Methodology

VII. Results and Analysis

A. Database Structure

We have used Firebase Realtime Database and realtime storage for our project.Below is a state snapshot of how our database looks like.



We have five entities in our database which are responsible for tracking,verification and lock controls.

1) AddUser: This variable keeps track of username of any unrecognized person as per admin input.We have a listener in our database which triggers whenever the value of username changes adding the person to our facial database of KAIROS.

2) DoorStatus: This variable is what our Nodemcu keeps track of for opening and closing the door.If DoorStatus/status is zero that means our door is closed and when it is one it means our door is opened.Nodemcu checks for this variable in order to perform action. This is the most last variable to be accessed in the programm flow hierarchy.

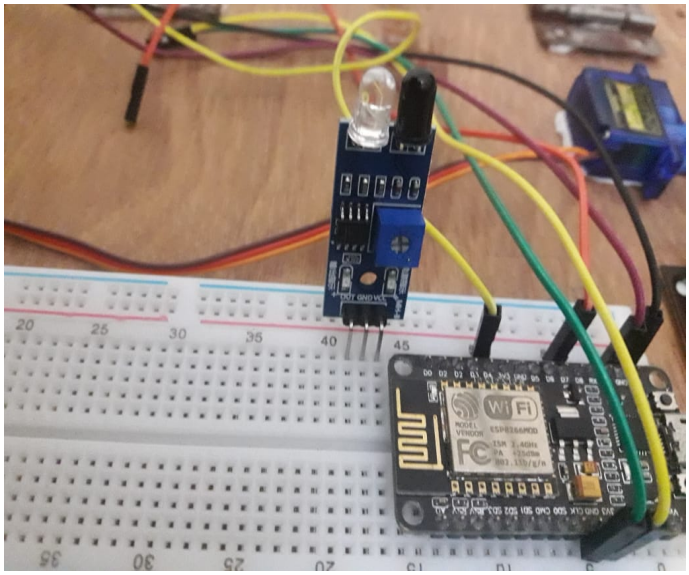
3) Image: This variable stores the URL of the latest unrecognized person's image.When there is no one unrecognized then this variable's default value is zero.

4) PIRstatus: This variable is controlled by our IR sensor which whenver detects a motion sets the value as one else zero, which triggers the camera.

5) Unknown: This variable checks wheather the person at the door is known or unknown.If the value is one that means person is unknown else the person in known.

B. Movement Tracking and Image Capturing

We are tracking motion using an IR sensor embedded on our door system.It flicks the value of a variable in our database which triggers our custom camera at door to capture an image.The image captured is sent to our database where it is verified.This camera can be installed with the help of any deprecated and unused smart phone having a front camera.Below is a screenshot of our camera processing a user at the door.

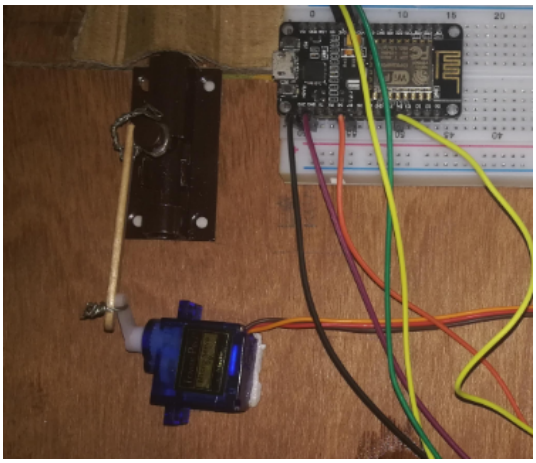


C. Image Processing & Verification

After the camera sends the picture to the database.our cloud function processes the image and returns a value of true or false.If a true value is returned then the door will automatically get unlocked. But if the returned value is false there are a lot of things waiting to be processed.The picture is tagged as unknown and is added to the admin application and a notification is sent to the admin about the person. The notification sent is from the app and in sms form.Admin can take actions accordingly wheather if he/she wants to add the person to the database.

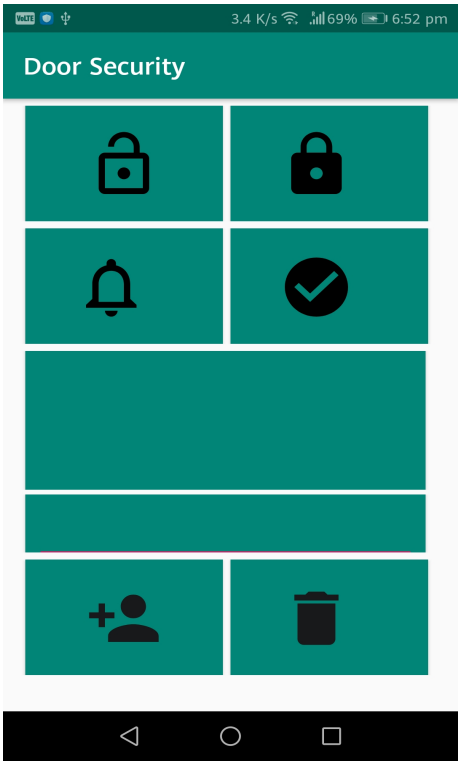
D. Door Lock System

Below is the system which executes whenever the required conditions are met.The door clutch motion is controlled by the doorstatus variable.



E. Admin Application

We have developed an admin side application to provide the door owner the flexibility to add more users.Using the application the door owner can manually open and close the door using the buttons provided in the application.



1) Unlock Button: This button sets the doorstatus value to one which means the door is unlocked.Admin can use this button to manually open the door.

2) Lock Button: This button sets the doorstatus value to zero which means the door is locked.Admin can use this button to manually lock the door.

3) Notify Button: This button activates notification service to the user's mobile phone.It just needs to be clicked once when the app is installed.

4) Check Button: This button checks the database for unknown users and displays the picture of the same in the third row element.

5) Add person Button: This button adds the unknown person to the database and provides the access to open the door when he/she visits the door next time.

6) Delete person Button: This button deletes the unknown person and clears the database.

VIII. Conclusion

Smart door lock is one of the most popular digital consumer devices because of the user convenience and affordable price. In actuality, it is replacing a lot of conventional types of locks. This report tries to propose a door access and monitoring control system which consist of different stages:

- Detecting by camera
- Fetching user-id
- Verification
- Information
- Process according to request

A low-cost authentication system based on Raspberry pi3 system and face recognition makes home automation system more secure and cost efficient. This technology can surely make change in the society to go down the percentage of crimes. Both NFC, RFID can be used in securing home but implementation cost and availability of supply to hardware requirements is not up to the mark. But the system based on Arduino system is a low cost and efficient device for such purposes.

In future, the android application should display support in controlling more doors, windows and basic home electronic appliances. An auto trigger report of the attempt to theft can be sent to nearest police station along with domestic address. This idea can be considered to make the proposed system better.

References

[1] G.) Jinsoo Han; Chang-Sic Choi; Ilwoo Lee, "More efficient home energy management system based on ZigBee communication and infrared remote controls," Consumer Electronics, IEEE Transactions on , vol.57, no.1, pp.85,89, February 2011.

[2] C.-H. Hung, Y.-W. Bai, J.-H. Ren, "Design and implementation of a single button operation for a door lock control system based on a near field communication of a smartphone", Consumer Electronics-Berlin (ICCE-Berlin) 2015 IEEE 5th International Conference on, pp. 260-261, 2015.

[3] I.-K. Hwang, J.-W. Baek, "Wireless access monitoring and control system based on digital door lock", IEEE Transactions on Consumer Electronics, vol. 53, 2007.

[4] A. Ibrahim, A. Paravath, P. Aswin, S. M. Iqbal, S. U. Abdulla, "GSM based digital door lock security system", Power Instrumentation Control and Computing (PICC) International Conference, pp. 1-6, 2015.

[5] C.-H. Hung, Y.- W. Bai, J.-H. Ren, "Design and implementation of a door lock control based on a near field communication of a smartphone", Consumer Electronics-Taiwan (ICCE- TW) 2015 IEEE International Conference on, pp. 45-46, 2015.

[6] Y. T. Park, P. Sthapit, and J.-Y. Pyun, "Smart digital door lock for the home automation," in TENCON 2009-2009 IEEE Region 10 Conference, 2009, pp. 1-6.

[7] C.-H. Hung, Y.-W. Bai, and J.-H. Ren, "Design and implementation of a door lock control based on a near field communication of a smartphone," in Consumer Electronics-Taiwan (ICCE-TW), 2015 IEEE International Conference on, 2015, pp. 45-46.

[8] A. Ibrahim, A. Paravath, P. Aswin, S. M. Iqbal, and S. U. Abdulla, "GSM based digital door lock security system," in Power, Instrumentation, Control and Computing (PICC), International Conference, 2015, pp. 1-6.

[9] S. R. Khan, A. Al Mansur, A. Kabir, S. Jaman, and N. Chowdhury, "Design and Implementation of Low Cost Home Security System using GSM Network," International Journal of Scientific Engineering Research, vol. 3, p. 1, 2012.