Access control and Intrusion Detection in Door Lock System using Bluetooth Technology

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***Abstract*—Due to the growing demand of technology it has become non trivial to improve security in home automation. The way of using the door lock has been changed over last few years. This paper proposes a novel system that uses Bluetooth technology to establish connection with user and the PC Admin so as to access the door. The system involves Human detection module which makes use of sensors like motion sensors and vibration sensors. The PC Admin acts as main control unit through which all devices communicate for their operations. Android app has been developed for the owner to interact with the system that helps to see the live feed by using camera and then allow user to access the door. The system is also facilitated with features like SMS, Email, anti burglar that provide easy way for the owner to get notified when user appears at the door as well as when user try to access the door without permission. Owner can also check the log details by interacting with the PC Admin. Thus making door lock a good practical product for the realization of ideal access monitoring and control system. Which thereby helps to incorporate these system in areas like home networking system, bank lockers, offices to improve security in smart environment.**

Keywords—AtMega; Bluetooth; Camera; Sensors; Human Detection Module; Home Networking; PIR(Passive Infrared) Motion Detector.

I. INTRODUCTION

Technology plays an important in human life. Over the years many social problems in our environment need to be technologically advanced. Increase in the popularity of mobile phones and computing systems have made people to rely heavily on technology. Home automation deals with the integration of technically advanced appliances to monitor and control them. Due to advancement in home automation it has got the attention of most of the commercial and industrial vendors. Due to complexity and high maintenance cost involved in the wired communication systems has forced people to adopt the wireless communication techniques. The implemented door lock system includes interaction between the client and the hardware system which is located at the door. The client uses Bluetooth to connect to the hardware which is further connected to the database that verifies the B-id of client. The system also facilitates other features like sending SMS to the owner, turning burglar alarm, vibration sensors and camera. The camera is connected to micro-controller which is used to take snaps of user at the door and also further notifies the owner about the current status of the door. System also includes different modules like Admin module, owner application, client, database, server, Bluetooth verification and lastly sensors. To provide privacy we also included burglar alarm which will be turned on if any unauthorized user try to access the door. Accordingly camera is also turned on when hardware unit sends signal to camera module so that camera can take snaps of user at the door and send snaps further to owner through database. Furthermore system also allows owner to remotely monitor and control the door through Internet or any other private network. The installation of system is easy as it does not require any big infrastructure and planning procedure which is one the advantage over existing system. Which makes door lock system a better equipment that can be incorporated in many areas including home networking system, banks and also help disable people who are paralysed from legs to waist level.

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II. RELATED WORK

- Jayant Dabhade, Amirush Javare, Tushar Ghayal, Ankur Shelar, Ankita Gupta: A novel approach towards home automation which uses bluetooh as main part of system. The system has different features like SMS, Burglar alarm, Vibration sensor and motion sensor and android application. It includes two modes of operation emergency and door lock/unlock for guest user. Thus this system tries to make door lock system more secure and better to be used in home networking, banks, offices.[1]
- Kyu Hwang, Jin-Wook Baek: Digital door locks operate by combination of different ways like digital key, security password and number codes. It uses ZigBee protocol as major part of system. When a person is detected by human detection module the ZigBee module comes into work and sends signal to video door phone and checks whether the person has ZigBee tag or not. Video door phone further also sends command to camera module which is turned on. If the ZigBee tag is valid then a motor which is connected locking system is operated that allows user to access the door. Otherwise user can interact with speaker phone which thereby connects him to owner. [2]
- Yong Tae Park, Pranesh Sthapit, Jae-Young Pyun: Door lock system proposed here includes Radio Frequency Identification(RFID) reader which is used for authentication purpose, touch Liquid Crystal Display (LCD), motor, sensor module for detecting the condition inside house and lastly communication and control module. Sensor nodes are placed at different places house for sensing environment conditions. Centralized controller is used to monitor and control the status of ZigBee modules. This system enables user to conveniently control and monitor condition all at once before entering and leaving the house [3]
- N.H, Ismail, Zarina Tukiran, N.N. Shamsuddin, E.I.S saadon: In this system Bluetooth is used to establish connection between user and smart phone as well as controller board. Manual and micro controller controlling is used to lock and unlock door. By providing connection with relay board and connection to Arduino board we can control door lock remotely from tablet or smartphone. [4]
- Pavithra.D, Ranjith Balakrishnan: In this project home appliances are controlled using Wi-Fi as communication protocol and rasberry pi as server system. The user is provided with web based interface which helps him to interact with system. Thereby different home appliances like lights, fans, doors are remotely controlled easily through web site. [5]
- Nateq Be-Nazir Ibn Minar, Mohammed Tarique: This paper presents vulnerabilities in the security protocols of different technology and also further include some past security threats and their circumstances. It also provide some tips that end user should take care while working with such technologies.[6]
- Chi-Huang Hung, Ying-Wen Bai, Je-Hong Ren: This paper proposed a door lock system that uses near field communication and smart phone. It uses built in NFC capabilities of smart phones which is incorporated in application which would be the key to access the door. Logical link control protocol (LLCP) is used with a time stamp to match the users own set of password information to verify who is a permissions user or not and allow access to the door. [7]
- Chi-Huang Hung, Ying-Wen Bai, Je-Hong Ren: This design uses near field communication of smart phone to control the door lock system by a single button operation. It has three modes of operations to the user which allows to match timestamps permission to match users password and allow it to access the door. There by enhancing security, also system includes sleep state and standby state to save power consumption for long time operation. [8]
- Mrutyunjaya Sahani, Chiranjiv Nanda, Abhijeet Kumar Sahu, Biswajeet Pattnaik: This paper describes about the implementation and deployment of wireless control system and accessibility in to a home environment for authenticated people only. It uses wireless technology ZigBee and also image processing Principal Component Analysis(PCA) based which makes system security alive as per the request. [9]
- Adnan Ibrahim, Afhal Paravath, Aswin P. K., Shijin Mohammed Iqbal, Shaeez Usman Abdulla: This paper introduced a Global System for Mobile communication (GSM) based digital door lock system using PIC platform. For authentication it makes use of 5 digit password to lock/unlock the doors by employing a gear motor. If there are unsuccessful attempts thrice then it results a warning message which is sent to present mobile numbers as a means of notifying unauthorized access to door. [10]
- Sachin Khadke: This paper designs a way to control the appliances by using android smartphone which includes Graphics User Interface(GUI) designed in android smartphone. The user makes use of interface which includes buttons that sends message commands from GUI to home information centre via GSM module. The users can manipulate appliances any time, anywhere, letting our houses become more and more automated and intelligent. [11]
- Dai Wei, Yoshigoe K, Abramson M , Alexander Jacobs: This paper awares the people about privacy of smart home devices in home residence settings and show how home owners privacy could be compromised via simple network traffic analysis. Authors first measured normal traffic patterns generated on commercial off-the-shelf (COTS) smart home devices, and identify possible privacy vulnerabilities. They also designed a smart home hub-integrated solution to mitigate such risk by obscuring real network traffic with synthetic traffic. [12]

III. SYSTEM STRUCTURE

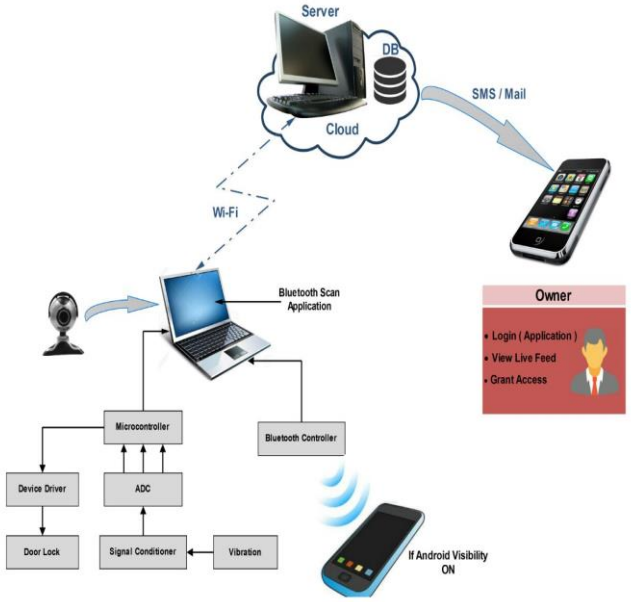

Fig. 1. System Structure

A. *Communication Modul*

The system operates in two modes which includes centralized mode and emergency mode. While working in centralized mode digital door takes the control to establish communication and on the other hand sensor nodes operates by taking values as their programmed in the system. This flow occurs when there is everything operating properly. It also reduces unnecessary communication between sensor nodes and central controller which thereby reduces energy consumption. In the second mode when there is emergency at the door like burglary or fire the system enters into the emergency mode. When system determines this mode by receiving signals from the sensor nodes takes appropriate actions like start the alarm and also call for police on 100.

B. *Sensor Module*

Sensors in our system includes vibration sensors and motion detector sensors. The motion detector sensors used is REES52 PIR(Passive Infrared). PIR is an electronic semiconductor type sensor that first detects and then measures infrared light which is emitted from objects in its area. This module detects and then send signal to PC app when there is any motion observed by heat radiating object in its range of view. Every object emits some amount of heat which is in infrared wavelength. Such wavelength are not visible with naked eye but it can be measured by infrared devices. This Sensor is covered with Fresnel Lenses, which create a wide angle of detection and also used for noise ltering. This PIR includes an adjustable delay before firing (approx 0.5 - 200 seconds), has adjustable sensitivity. It runs on 4.5V-20V power (or 3V by bypassing the regulator with a bit of soldering) and has a digital signal output (3.3V) high, 0V low. Its sensing range is up to 7 meters in a 100 degree cone Input and Output Module[14].

C. *Input and Output Module*

Bluetooth Id of user or visitor is given as input to the control module. After receiving signals control module then turns on the camera which is connected to the PC app. Camera then takes repetitive snaps of the user at the door and sends this file into the database. Vibration and motion sensor are also given as input to the control module. The output is giving access to the user at the door. These sensors will detect any movement near the door and vibration sensor will detect the vibrations that are made by the user which includes using any hard devices that will try to break the door knob. Then try to access the door without owner permission. The owner can also see the live feed that is captured from the camera. System also notifies the owner about which user entered the house and also when user has left the house.

D. *Control Module*

All the operations like turning on camera, alarm, communications between server is performed by this module. This module acts as main part of the system from which all the process cycle starts. Control module is connected with server to verify the user B-id. Control module has other responsibilities also namely sending SMS, turning alarm On, notify to the owner and lastly it also checks that the door is opened or not after the user has entered the house. If the door is kept open then its the responsibility of control module to close the door.Mode of Operation

E. *Door Lock/Unlocking for Guest and Owner*

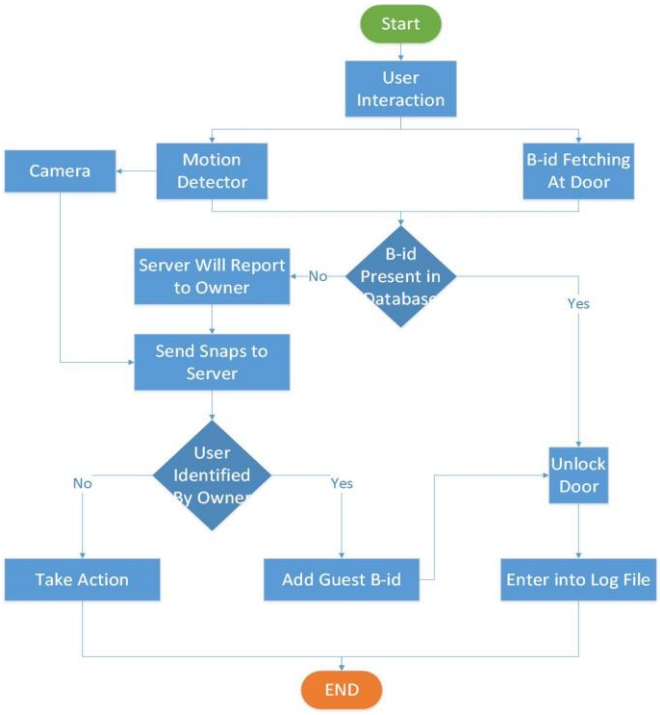

Fig. 2. Owner/Guest interaction

PIR which is the motion detection module detects the movements at the door. It then sends signal to control module which establish connection with the guest and fetch B-id. Control module then sends the fetched B-id to the server for

verification. Server searches for guest B-id and if the B-id exists in the database then server sends signal back to control module as a response. Control module then rotates the motor which is connected to microcontroller and unlocks the door. If the server does not find B-id then server sends signal to control module which further sends command to activate camera and take snaps of the user at the door. Simultaneously the server notifies the owner that guest has appeared at the door. Then later owner can see snaps of guest and send signal to server to register B-id of that user and update the log. Otherwise owner can take appropriate action. Fig. 2 shows user trying to access the door with B-id.[1]

F. Emergency Mode

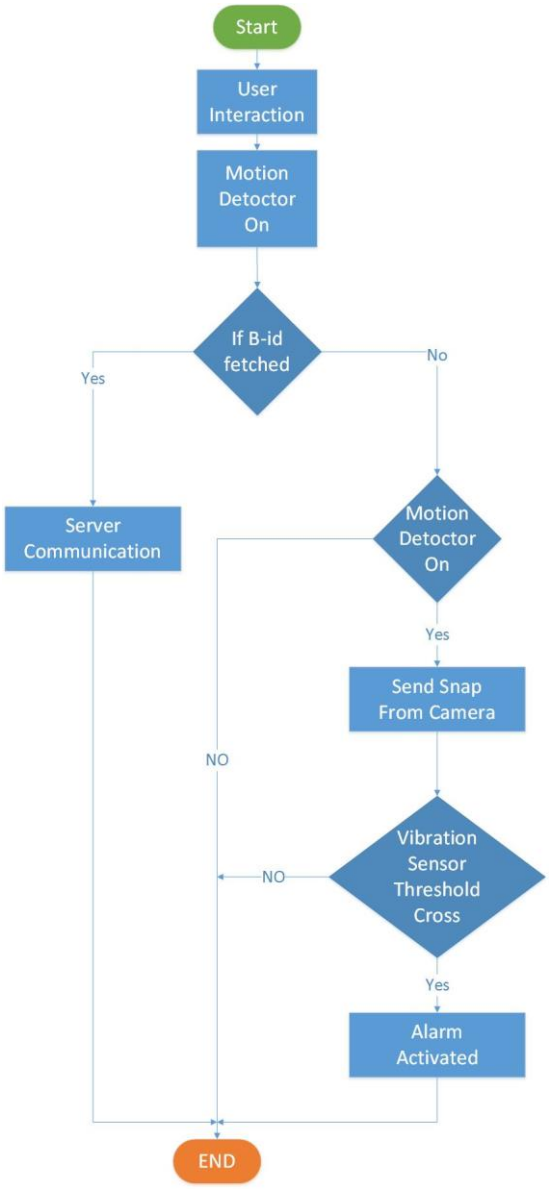

Fig. 3. Emergency Mode

Motion detector will detect the guest at the door. control module then fetches B-id from guest and communicate with server to verify the user and if B-id does not exist then camera will be activated to take snaps of the guest. If guest tries to access the door by using some equipment or if sensor threshold limit has been crossed, then alarm is triggered and the owner is notified that unauthorized user is trying to access. Fig. 3 shows user trying to unauthorized access to the door.

IV. SYSTEM IMPLIMENTATION

Fig. 4. Android Application

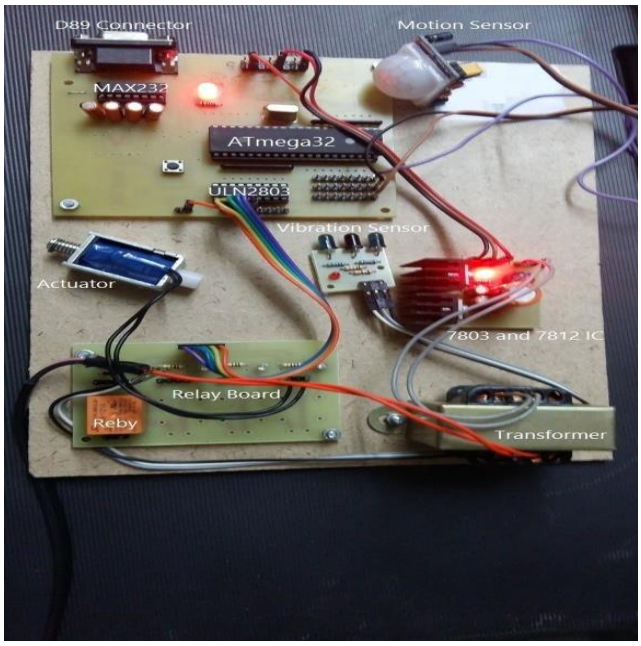

Fig. 5. Hardware Components

We implemented a prototype system to provide easy access to the door and also provide a better way to control the system

from owner point of view. There are different technologies that are used in door locks system but among that we have made use of Bluetooth technology. Due to low power and availability and other some advantages makes Bluetooth more suitable than other technologies. As shown in fig. 5 we have made use of micro-controller which is Atmal Mega 32. It is a low power complementary metal-oxide-semiconductor (CMOS) 8 bit micro-controller based on the AVR enhanced RISC architecture. The MAX232 IC is used to convert the TTL/CMOS logic levels to RS232 logic levels during serial communication of micro-controllers with PC. The MAX232 is a dual driver/receiver and typically converts the RX, TX, CTS and Regional Transit System's (RTS) signals. A ULN2803 is an Integrated Circuit (IC) chip with a High Voltage/High Current Darlington Transistor Array. It allows you to interface Transistor-Transistor Logic(TTL) signals with higher voltage/current loads. Transformer is used to decrease actual voltage (230V AC) to 0-15V AC. Diode Bridge is AC to DC converter which is been used to convert voltage from AC to DC, as per the requirement of all other ICs. Capacitor has been used to remove fluctuation of AC voltage from DC voltage Generated by Diode Bridge. Actuator is used as it will indicate the movement of opening and closing the door. Motion sensor is used to detect the object when it comes in its area. The fig. 4 shows android application which will be used by owner to control the system and perform actions accordingly. Android application has different options like grant access, watch live feed, enter B-id. The system starts operating when all the components are integrated and powered is on. Motion detector sensor starts radiating infra-red rays to check that any object is in its area or not. When a particular user comes near to door his/her B-id is fetched from smartphone and checked into database. If the B-id exists in database then that user is allowed to access the door and actuator operates by opening the door. Appropriate log is maintained of the user which entered and left the house. While in other case if B-id does not exists in database the hardware unit sends signal to camera which take snaps of user at the door. This images are send to server in bytes form which further converted to bitmap form and forwarded to owner via android application. The system is also incorporated with vibration sensor so if the user tries to access the door without owner permission and uses any instrument to unlock the door then vibration sensors comes into operation. When threshold value set for vibration sensor is crossed then burglar alarm is turned on and also owner is notified via android application that some intruder is trying to access the door. Android application is used by owner which has grant access button so owner after watching the live feed using live feed option can click on the grant access button and allow the user to access the door. System also has time period for guest user so if a particular user would be at the house 15.00.00 then time period is set for that time. So system will check the time and accordingly actuator will open the door so that guest user can enter in the house. Android application is also has add B-id option that is used by owner to add Bluetooth id of user in database. The developed system can be applied practically in real time market for home networking systems and also extended to control and monitor other appliances of house.

V. GRAPH AND RESULTS

The implementation of system is plotted in the following graph which shows the actual and expected output for the system that has been developed. By implementation of this system it was observed that high performance results can be obtained through reasonable adjustments of some parameters and try to improve security issues that were concerned with door lock system.

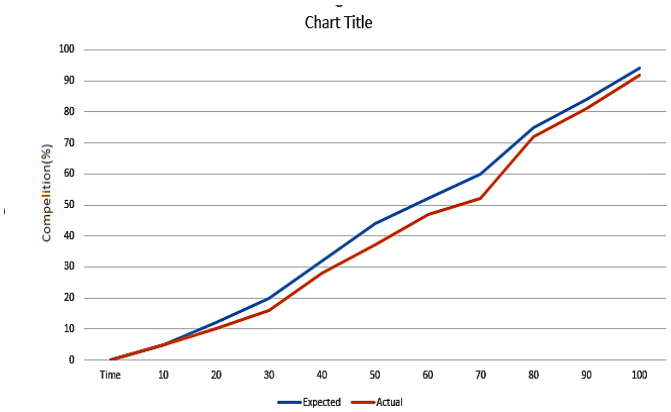

Fig. 6. Actual and Expected Output

VI. CONCLUSION

Digital door lock is one the most popular devices that is used by people due to its low power, less expensive, easily to use nature. In reality there are many convenient locks but this system tries to meet all the user requirements. In this paper we proposed a wireless access and monitoring control system which consist of many different activities like Detecting user, Fetching B-id, Verification, Notifications, Perform actions according to request. (emergency mode, turn alarm on, live feed) This low cost authentication system which is based on Bluetooth technology is trying to take home automation to more advanced level. This technology will surely bring change in society to drop the percentage of crime. Other technologies Near-field communication (NFC), RFID can also be used but their cost and availability of hardware makes them difficult to use in home networking system. So we can say using Bluetooth for implementing this system makes door locks more intelligent and better to be equipped in smart environment.

VII. FUTURESCOPE

There are obviously many improvements to the system that can be made. More work can be carried on Android application that can offer controlling other home appliances. Having a battery backup will make sure the completeness of system. There are different new ideas that can be worked on in the field of home automation to enhance security to better level then present. When intruder tries to access door without owner permission in such cases a auto trigger report of the attempt to theft can be send to nearest police station with

residential address. This is one such idea other ideas can be thought and implemented accordingly.

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