XBEE MODULES BASED SECURITY SYSTEM FOR HIGH LEVEL SECURITY

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Submitted to the Faculty of Department of Electrical Engineering, Military College of Signals, National University of Sciences and Technology, Islamabad
in partial fulfillment for the requirements of a B.E Degree in Telecom Engineering
JUNE 2015

ABSTRACT

XBEE MODULES BASED SECURITY SYSTEM FOR HIGH LEVEL SECURITY

Physical security describes security measures that are designed to deny unauthorized access to facilities, equipment and resources, and to protect personnel and property from damage or harm. Our project, XBEE module based security system, provides highly accurate and effective access control in real time for security sensitive organizations. Each individual allowed in the premises of room, provided with this security system, is allotted a unique code. XBEE module detects RF radiation from individual module whose broadcast is coded. A Data Base containing detail of every authorized personal is saved in central microcontroller. Software code captures and compares entering individual's identity data with information stored in database. When an intruder enters premises of the room, provided with this system, an alarm is generated. Software will repeat verification process for each individual who tries to move into area provided with this system. By doing so it provides next level security where every person coming in remains oblivious of security system installation hence provides real time intruder detection.

CERTIFICATE OF CORRECTNESS AND APPROVAL

It is certified that the work contained in this thesis title "Xbee module based security system for high level security", carried out by Anum Umer, Hasan Raza and Syed Daniyal Nasir under the supervision of Lt. Col. Dr. Tayyab Ali in partial fulfillment of Degree of Bachelors of Telecommunication Engineering, is correct and approved.

Approved by

_____

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DECLARATION

No portion of the work presented in this dissertation has been submitted in support of another award or qualification either at this institution or elsewhere.

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DEDICATION

In the name of Allah, the Most Merciful, the Most Beneficent

To our parents, without whose unflinching support and cooperation,

a work of this magnitude would not have been possible.

ACKNOWLEDGEMENTS

What seemed to be a long endeavor a year before is finally over. There is no success without the will of ALLAH Almighty. We are grateful to ALLAH, who has given us guidance, strength and enabled us to accomplish this task. Whatever we have achieved, we owe it to Him, in totality. Looking back in time, many people have contributed towards the accomplishment of this project and they all deserve our deepest gratitude. We are also grateful to our parents and family and well-wishers for their admirable support and their critical reviews.

We are indebted to our supervisor Lt Col Dr. Muhammad Tayyab Ali for extending his kind support in making it a successful project. We are thankful to the faculty of Electrical department for guiding us in our academic pursuit. In addition, as always has been the tradition of our college, we would like to thank all our seniors and batch mates for guiding us through the difficult phases.

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CHAPTER 1: INTRODUCTION

Security is the degree of resistance to, or protection from, harm [1]. It applies to any vulnerable and valuable asset, such as a person, dwelling, community, nation, or organization [1]. As noted by the Institute for Security and Open Methodologies [3], security provides "a form of protection where a separation is created between the assets and the threat". Physical security describes security measures that are designed to deny unauthorized access to facilities, equipment and resources, and to protect personnel and property from damage or harm (such as theft, or terrorist attacks) [2]. Physical security involves the use of multiple layers of interdependent systems which include CCTV surveillance, keypad security, security, protective barriers, locks, access protocols, and many other techniques [2].

1.1 WHY XBEE BASED SECURITY SYSTEM

Despite CCTV surveillance, keypad security, security guards and various other forms of security there has always been a threat to assets and personnel. XBEE module based security system to provide a highly accurate and effective access control in real time for security sensitive organizations. Biggest advantage it offers is that whole of the verification process is carried out in real time while the authorized personal or intruder remains oblivious to this security system. XBee module detects RF radiations emitted from user module fixed on jacket of the individuals where each of them is assigned a unique code. When an intruder enters in premises, provided with this security system, an alarm is generated. Software will repeat verification process for every person who tries to move in area where this system is installed.

1.2 PROBLEM STATEMENT

Increased level of security for the highly sensitive labs/departments in military/ governmental organizations and banks has always been the greatest demand. Current situation in our country makes such security efforts a need of time. This project offers a viable solution to that by presenting a prototype of a real time efficient XBEE module based security system which

- Provides high level security system for real time intruder detection in areas where sensitive nature of job is being carried out, valuable assets are being kept or personnel security is necessary
- No one can overwrite it unless known
- provides results in real time for in time intruder detection
- Is affordable
- synchronizes its operation with doorway and keypad security system installed

1.3 PROJECT DESCRIPTION AND SALIENT FEATURES

We have developed an XBEE module based security system to provide a highly accurate and effective access control in real time for security sensitive organizations. Whole of the verification process is carried out in real time while the individual/intruder remains oblivious to this security system. XBee module detects the RF radiation emitted from the module fixed on jacket of individuals. Data Base containing detail of every individual allowed in the department has been developed and installed in central microcontroller. When an intruder enters in premises provided with this security system, an alarm is generated. Verification process is repeated for every person who tries to move in the area where this system is installed.

1.3.1 PROSPECTIVEAPPLICATION AREA TARGETED

Increased level of security for the highly sensitive labs/departments in military/ governmental organizations and banks has always been the greatest demand. Especially current situation prevailing in our country i.e. increased number of crimes and burglary make security a need of time. This project offers a viable solution to that

by presenting a prototype of a real time efficient XBee module based security system. We have chosen XBee module and central microcontroller i.e. Arduino UNO board to perform the process of individual verification and intruder detection. Our primary objective is development of an XBEE module based security system to provide a highly accurate and effective access control in real time for security sensitive organizations.

1.3.2 SALIENT FEATURES

Project has been completed following order of modules given in the figure 1. Figure below shows the flow chart explaining the four project modules:

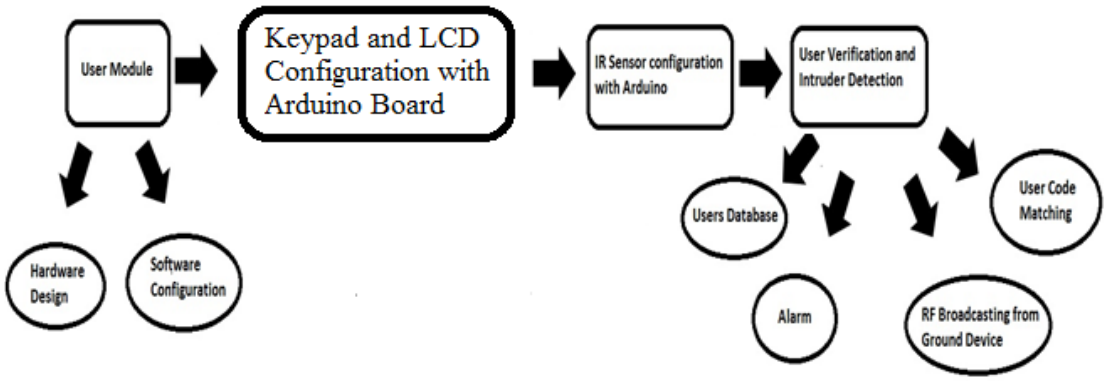

Figure 1-1 Project Modules Flow Chart

System model diagram prepared in ISIS professional is shown in figure 2:

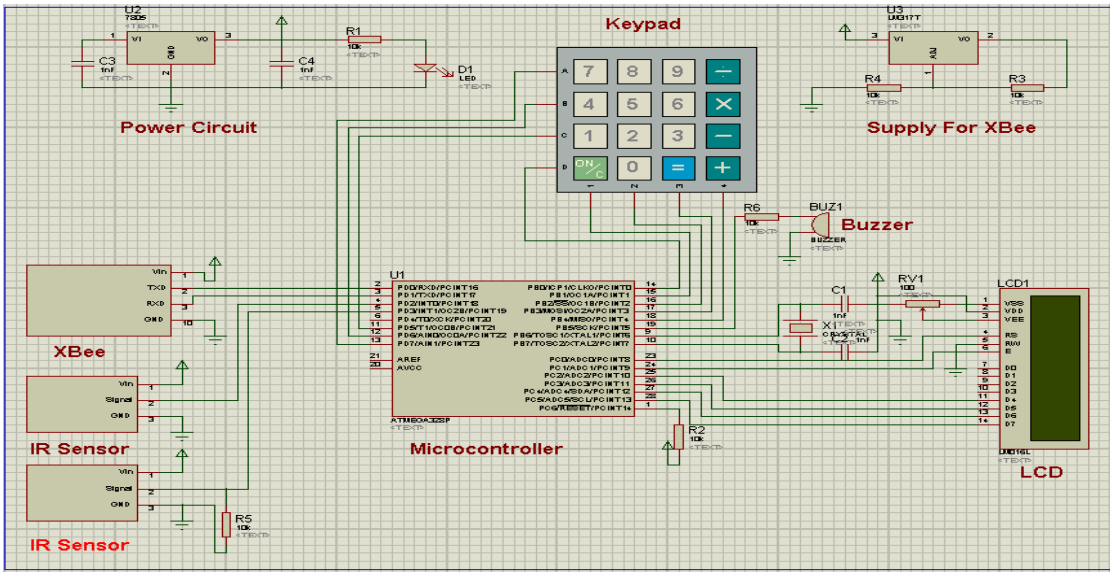

Figure 1-2 project schematics in ISIS

Salient features of project include:

- Real time intruder detection
- Synchronization of central security module with keypad security module and entrance door
- Power savage offered by usage of IR sensors
- Each allowed individual is allotted a unique code increasing security level
- Cannot be overrun or overwritten unless known to intruder

1.4 PROJECT SCOPE, OBJECTIVES, SPECIFICATIONS AND DELIVERABLES

1.4.1 SCOPE

Due to increasing number of crime and burglary, need of security system is very essential. A security system that monitors the area throughout and reacts effectively to threats is in need. We have lots of security systems in the market for both indoor and outdoor applications such as ultrasonic detectors, CCTV, microwave detectors, photoelectric detectors, infrared detectors etc. [1]. Background study shows that XBee modules use for an ever increasing range of applications have grown tremendously. XBee module based security system can be used to provide a highly accurate and effective access control in real time for security sensitive organizations. Research related to security systems is being undertaken in many areas going from the design of more efficient system aimed at more specific applications, to the development of improved control electronics that provide for better detection, to optimized detection strategies, or to opening new application domains. The goal of this project is designing of an XBee module based security system operating in real time with an improvised application of IR sensors and password setup for efficient alarm generation and intruder detection.

Future scope of project is quite vast based on various application fields it can be applied to. It can be used for conducting intruder detection operations where it's humanly impossible to detect. In terms of its military applications it can be more widely used for security purposes. As more advanced forms of this project are being developed, there range of applications increases and hence we can ensure there

commercialization. Thus XBee module based security systems can be used in day to day working of a human life, ensuring their well-being.

With further study and advancement in technology, designers are quite sure that XBee module based security systems can be used for advanced applications [3]. The main advantage in the future use of XBee module based security systems for various purposes is that risk to sensitive technology and human life, may it be because of security threats or due to commercial accidents can be greatly avoided.

1.4.2 OBJECTIVE:

Development of an XBEE module based security system to provide a highly accurate and effective access control in real time for security sensitive organizations.

1.4.3 SPECIFICATIONS

The objective "development of a high level security system for real time intruder detection in extremely sensitive areas" would technically be stated as "designing and development of a basic prototype of XBee module based security system and making it capable of real time intruder detection by integrating the suitable microcontroller programmed to provide real time results with it".

XBee based security system is an advanced next level security providing system that is assembled by IR sensors, microcontroller boards, XBee module, signal processing systems and password enabled keypad to make it capable for double security while it remains hidden so that individuals remain oblivious to its installation. Specifications of prototype developed are given below:

1.4.3.1 PASSWORD ENABLES KEYPAD FIRST LEVEL SECURITY

This final prototype developed has a keypad password security module and it is configured with central operating system i.e. Arduino UNO board providing first level security from outside of the room. The individual who intends to enter the room will have to enter the password. If the entered password is correct individual is shown allowed to enter on LCD display else interrupted to try again.

1.4.3.2 IR SENSOR MODULE FOR ACTIVATING CONTROL SYSTEM

The final prototype developed has an IR sensor module on board. This setup serves a very important purpose that is whenever any person tries to enter the premises of the room provided with this security system, IR sensors, fitted right at the entrance, detects it and serve to activate the central security module for further operation thus offering great deal of power savage.

1.4.3.3 INDIVIDUALS MODULE

Final prototype developed by hasan individual module for each individual allowed entering. Whenever control system is awakened by IR sensors, it broadcasts RF rays via XBee module and expects a reply from individual module in return. In response individual module sends a reply back that contains code assigned to that particular individual. In case of no reply an alarm is generated indicating intrusion .

1.4.3.4 SECURITY SYSTEM DESIGN COMPONENT SPECIFICATIONS

As stated in the attached copy of the proposal, we have completed the design of proposed security system by assembling various components that were necessary to make prototype design possible. The figure 3shows the XBee module selected:

Figure 1-3 XBee Module

As shown in figure 3 this XBee module has been configured to give designed security system. For making it capable of broadcasting the RF signals it is controlled with the help of Arduino board. While in case of individual module it is controlled by a single microcontroller chip ATMEGA328P.

XBee module has following specifications:

Specification	XBee	XBee-PRO
Performance		
Indoor/Urban Range	Up to 100 ft (30 m)	Up to 300 ft. (90 m), up to 200 ft (60 m) International variant
Outdoor RF line-of-sight Range	Up to 300 ft (90 m)	Up to 1 mile (1600 m), up to 2500 ft (750 m) international variant
Transmit Power Output (software selectable)	1mW (0 dBm)	63mW (18dBm)* 10mW (10 dBm) for International variant
RF Data Rate	250,000 bps	250,000 bps
Serial Interface Data Rate (software selectable)	1200 bps - 250 kbps (non-standard baud rates also supported)	1200 bps - 250 kbps (non-standard baud rates also supported)
Receiver Sensitivity	-92 dBm (1% packet error rate)	-100 dBm (1% packet error rate)
Power Requirements		
Supply Voltage	2.8 – 3.4 V	2.8 – 3.4 V
Transmit Current (typical)	45mA (@ 3.3 V)	250mA (@3.3 V) (150mA for international variant) RPSMA module only: 340mA (@3.3 V) (180mA for international variant)
Idle / Receive Current (typical)	50mA (@ 3.3 V)	55mA (@ 3.3 V)
Power-down Current	< 10 µA	< 10 µA
General		
Operating Frequency	ISM 2.4 GHz	ISM 2.4 GHz
Dimensions	0.960" x 1.087" (2.438cm x 2.761cm)	0.960" x 1.297" (2.438cm x 3.294cm)
Operating Temperature	-40 to 85° C (industrial)	-40 to 85° C (industrial)
Antenna Options	Integrated Whip, Chip or U.FL Connector, RPSMA Connector	Integrated Whip, Chip or U.FL Connector, RPSMA Connector
Networking & Security		
Supported Network Topologies	Point-to-point, Point-to-multipoint & Peer-to-peer	
Number of Channels (software selectable)	16 Direct Sequence Channels	12 Direct Sequence Channels
Addressing Options	PAN ID, Channel and Addresses	PAN ID, Channel and Addresses

Figure 1-4 XBee Module Specifications

1.4.3.5 SECURITY SYSTEM PERFORMANCE SPECIFICATIONS

These are some performance attributes of the configuration design of Security system:

- Real time intruder detection
- Real time broadcasting of signals by XBee module
- Real time response from the individual module
- Keypad password matching with database
- Auto opening and closing of door according to access grant
- Synchronized performance of XBee security, keypad and doorway

1.4.3.6 SECURITY SYSTEM ELECTRICAL SPECIFICATIONS

- **XBee module:** The XBee Modules were engineered to support the unique needs of low-cost, low-power wireless sensor networks. The modules require minimal power and provide reliable delivery of data between devices. The modules operate within the ISM (2.4 GHz ISM) [5]
- **Arduino Uno Board:** The Arduino Uno is a microcontroller board based on the ATMEGA328P. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack and a reset button. [3]
- **IR Sensors:** An infrared sensor is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. All objects with a temperature above absolute zero emit heat energy in the form of radiation. It radiates at infrared wavelengths and can be detected by electronic devices designed for such a purpose. [4]

1.4.3.7 ARDUINO UNO BOARD SPECIFICATIONS

Arduino board selected for microcontroller operation is Arduino UNO. It is a microcontroller board based on the ATMEGA328P having 14 digital input/output

pins, 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack and a reset button [6]. Figure 5 shows the Arduino UNO board selected:

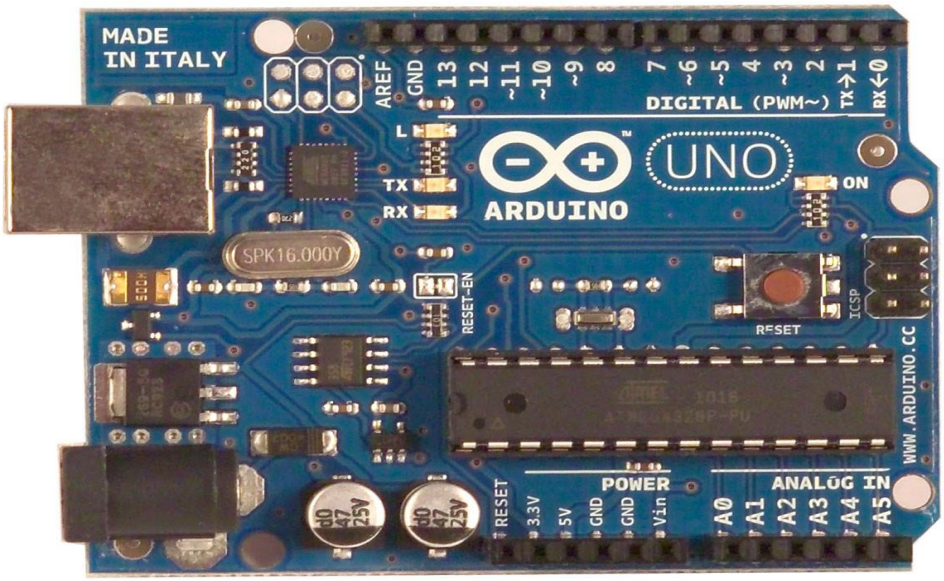

Figure 1-5 ArduinoUno Board

Technical specification of the Arduino UNO ATMEGA328P [6] is shown figure 6:

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB of which 0.5 KB used by bootloader
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

Figure 1-6Arduino Uno Specifications

1.5 DELIVERABLES

A fully assembled security system consisting of IR sensors, XBee modules, Arduino board, and various chips is the final product. XBee module, keypad module and doorway have synchronized operation. This security system is capable of providing a next level security for security sensitive organizations. As discussed above, highly secure environment provision is main target in this project.

CHAPTER 2: BACKGROUND STUDY

Due to increasing number of crime and burglary, the need of security system is very essential. The security system that monitors the area throughout the time and reacts effectively to threats is always in need [1]. We have lots of security systems in the market for both indoor and outdoor applications such as ultrasonic detectors, CCTV, microwave detectors, photoelectric detectors, infrared detectors etc. [1].

Performance Analysis of XBee ZB Module Based Wireless Sensor Networks by Rajeev Piyare and Seong-roLee [7] discusses performance of XBee base module of wireless sensor network. It discusses performance analysis of ZigBee networks based on XBee modules have been evaluated in terms of following performance metrics: received signal strength (RSS), network throughput, and packet delay and energy consumption in an indoor environment. The wireless sensor node hardware designed for this experimentation consists of ZigBee (XBee S2 with 2mW wire antenna) wireless communication module from Digi International.

The results of this study are useful for building Wireless Home Area Network (WHAN) using the ZigBee where there are reflections due to indoor objects and also for scenarios where communication between nodes require multi-hop transmissions.[7]

"XBee Wireless Sensor Networks for Temperature Monitoring" by VongsagonBoonsawat, JuraratEkchamanonta, KulwadeeBumrungkhet, and SomsakKittipiyakul [8] presents an embedded wireless sensor network (WSN) prototype system for temperature monitoring in a building. The ultimate goal of this paper is to help saving the energy cost and reducing energy consumption. The network consists of a data gateway or coordinator which wirelessly polls each WSN temperature-monitoring node located in each classroom. Each WSN node consists of a microcontroller on Arduino board and an XBee wireless communication module based on the IEEE 802.15.4/ZigBee standards. The coordinator also has an Ethernet interface and runs a simple data web server. Hence, the coordinator allows data collection over XBee and data access from web browsers [8].

The results of this study are useful for building Wireless Sensor Network (WSN) using the ZigBee module [8].

Forest Fire Detection Using Optimized Solar – Powered ZigBee Wireless Sensor Networks" by U. Arun Ganesh, M. Anand, S. Arun, M. Dinesh, P. Gunaseelan and R.

Karthik [9] discusses two main modules present in the project are the Monitoring Area Module and the Forest Area Module. All these together are split into five sub-modules for step-by-step development and implementation. Those include Sensors' Module, Serial Communication Module using XBee, Optimized Solar Energy Harvester, PC-based Web Server and Mechanical Modeling. The first three sub-modules belong to the Forest Area Module. They are integrated together and mechanical modeling is done to place it in the forest, whereas, the PC-based Web Server is developed for the Monitoring Area.

The outcome of the above implementations reveal that various sensors used in addition to the temperature sensor improves security level for areas located near the forests. [9]

"Design of intelligent sensor based on BP neural network and ZigBee wireless sensor network" by Yun Wang and KunpengXie [10] discusses intelligent sensor in addition to the basic function, zero self-calibration and has the function of automatic adjustment, along with logic judgment and the ability of information processing, can be a measurement signal conditioning or signal processing. Multilayer BP neural network is a one-way transmission of feedforward network, and it uses the error output estimation error directly leading layer to output layer, and then the error estimation error of a layer.

The paper proposes design of intelligent sensor based on BP neural network and ZigBee Wireless Sensor Network. Experiments show that the proposed intelligent sensor has higher efficiency. [10]

CHAPTER 3: DESIGN AND DEVELOPMENT

Chapter includes detailed design and development of project discussed in the form of various modules.

3.1 PROJECT MODULES

Project is divided into four main modules, as shown in figure 1 and 2, including:

Module-I: Configuration design and assembly of individual module consisting of XBee and microcontroller ATMEGA328P chip for controlling its operation. XBee module transits coded RF response to message broadcasted by the central operating system's XBee module.

Module-II: Designing of the keypad password security and LCD module and its configuration with the central microcontroller board.

Module-III: Designing of the IR sensor security module and its configuration with the central operating microcontroller such that whenever any person enters the premises of the room, IR sensors detects it and serves to activate the central security module for further operation of broadcasting and verification. Hence offer power savage.

Module-IV: Designing of central security module which is composed of a microcontroller i.e. Arduino UNO board and XBee module for broadcasting coded RF signals first and then receiving response from the individual module. Data base containing information of all allowed individuals, keypad password verification and response and alarm configuration to central microcontroller is worked out in this module.

Modules description is as under:

3.1.1 MODULE-I

This module deals with configuration design and assembly of individual module. This is accomplished by interfacing XBee module with ATMEGA328P microcontroller for controlling its operation so that XBee module transits coded RF response to the message broadcasted by the central operating system.

We have used XBee module based on IEEE 802.15.4/ZigBee Wireless Personal Area Network (WPAN) standards to build a low-power, low maintenance, and self-organizing WSN [2]. It works in 2.4GHz ISM band. Small size, low power and low cost are reasons of using XBee module. Figure 3 shows the selected XBee module.

Whenever central control system is awakened by IR sensors, it broadcasts coded RF rays via XBee module and expects a reply from individual module in return. Individual module response contains code assigned to that particular individual. In case of no reply an alarm is generated indicating intrusion.

Module schematics are shown in figure 7.

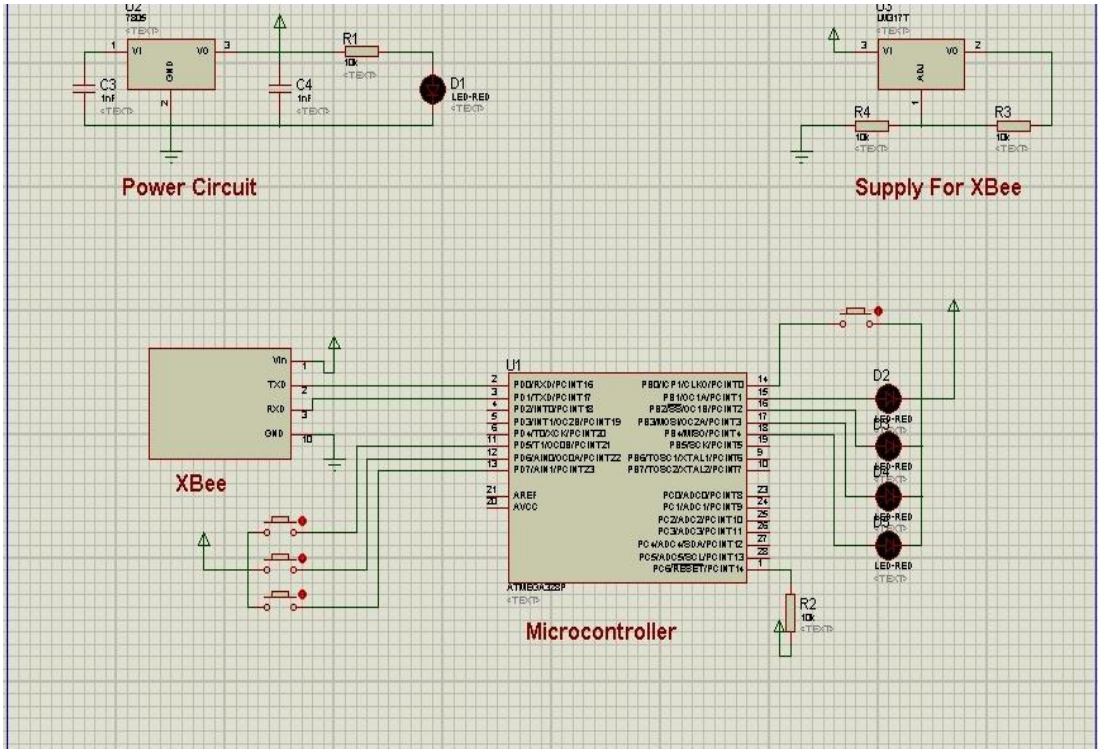

Figure 3-1 User Module Circuit Diagram

Figure 7 represents the detailed design of module basic elements being XBee module, microcontroller, power circuitry for XBeemodule and microcontroller, LEDs for output and push buttons for input indication.

Final hardware integrated circuit of individual module is shown in figure 8. ATMAGA328P microcontroller is integrated for controlling module functionality. User module contains fours buttons and four LEDS to represent four users respectively. Source voltage of this module is 12V which is converted into 5V by using IC Regulator 7805 as integrated controller works properly on 5V.

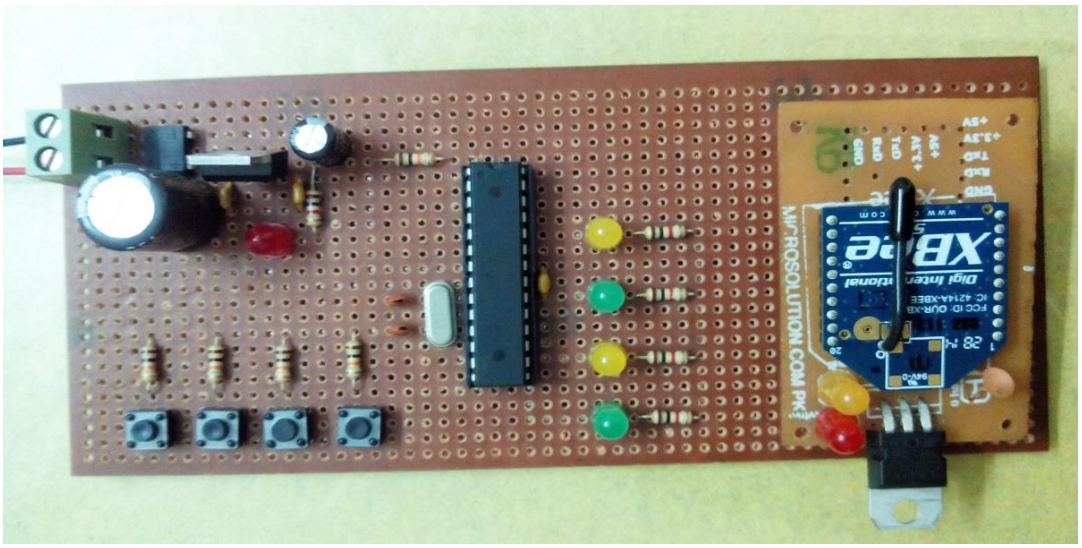

Figure 3-2 User Module Integrated Hardware

Working of the user module is explained in figure 9:

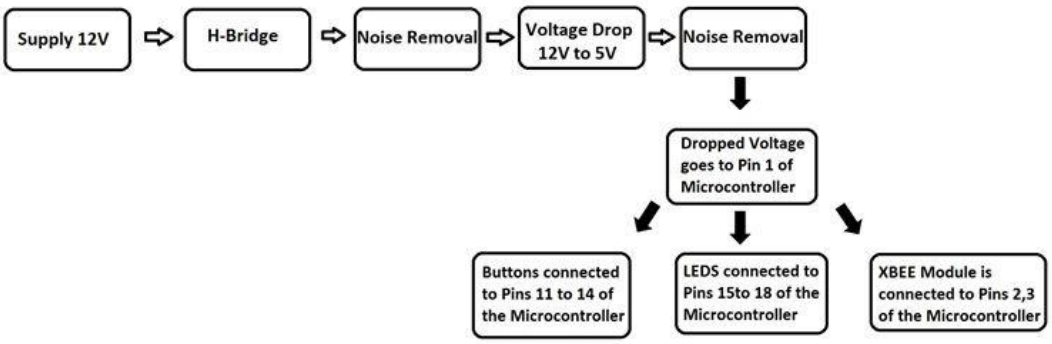

Figure 3-3 Working of the User Module

Power supply is 12V and an H-Bridge is integrated to control polarity of voltage source. IC Regulator 7805 performs voltage down conversion and capacitor is used for removal of noise. Four buttons, fours LEDS and the XBEE module is connected to microcontroller. Pins of controller used to connect those elements are shown in figure 9.

First Module is working as required providing response in real time. It broadcast unique password of selected user after receiving character 'Z' from central broadcasting module. Developed prototype has four defined users having codes a, b, c and d respectively.

3.1.2 MODULE-II

This module deals with designing of keypad password security, LCD module and its configuration with central operating system i.e. Arduino UNO board. Main reason for including this module is enabling general level security from outside the room. Each authorized individual is allotted a unique password to enter on entrance keypad security system. If entered password is correct individual is shown allowed to enter on LCD display else interrupted to try again. Keypad selected is a simple 4x4 keypad as shown in the figure 10.

Figure 3-4 LCD, Keypad

Keypad and LCD is connected to the central Arduino UNO board via the wired system where board is programmed to control the behavior of keypad. Detailed configuration design is shown in figure 2.

Final hardware integrated circuit of module II is shown in figure 11 and 12 respectively. Keypad connections are made at input pins of Arduino UNO board while LCD is connected at output pins. Module II contains a Keypad, LCD, Arduino Uno board and some resistances. Source voltage of this module is 12V which is converted to 5V via IC Regulator 7805 as integrated Arduino Uno board works properly on 5V.

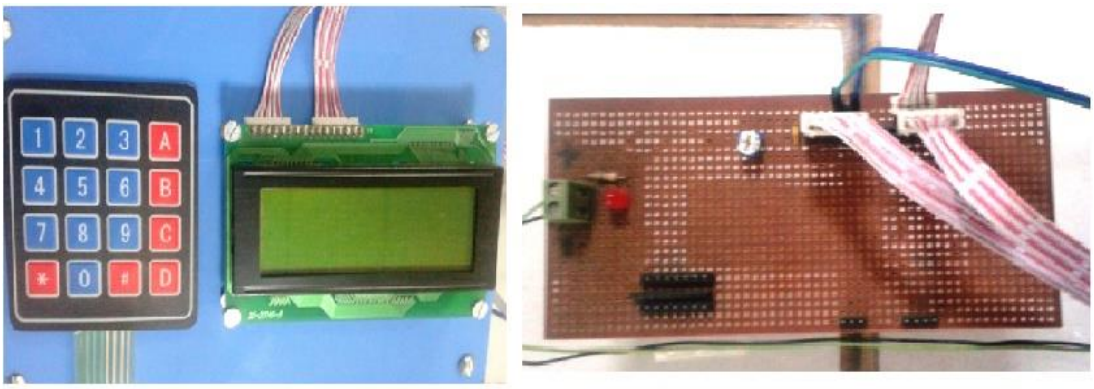

Figure 3-5 keypad, LCD and Power circuit

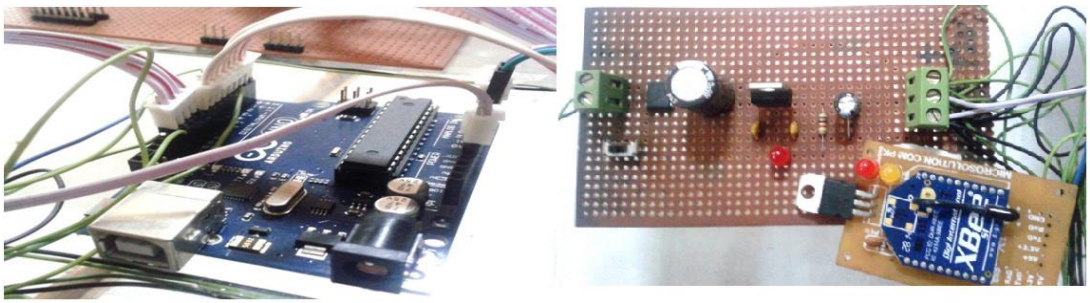

Figure 3-6 Keypad and LCD connection to Arduino UNO board

Working of this module is explained in the figure 13 given below. Power supply is 12V and an H-Bridge is integrated to control the polarity of the source. IC Regular 7805 is integrated for the voltage drop and capacitor is used for the removal of noise. LCD and Keypad is connected to the microcontroller. The pins of the controller used to connect those elements are given in figure 13.

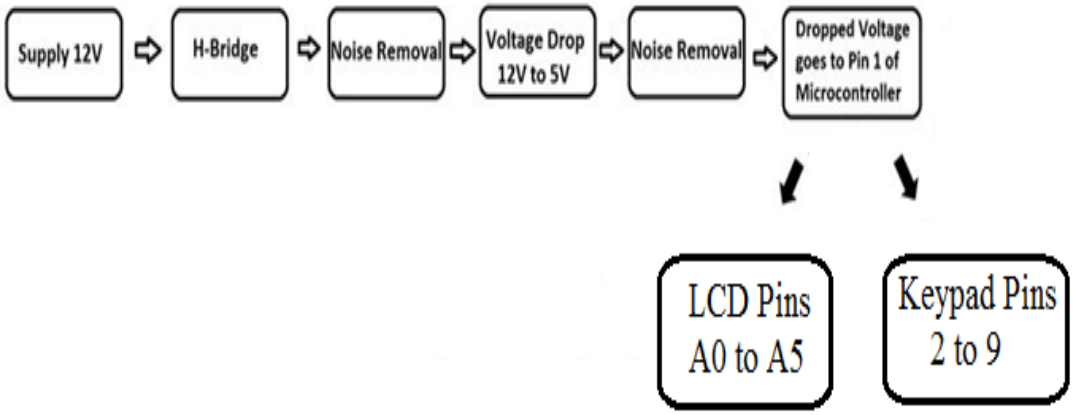

Figure 3-7 Working of the keypad, LCD Module

Module II is working as required providing response in real time. Arduino board matches the password with its database given by the user through keypad and LED displays either the password is correct or not.

3.1.3 MODULE-III

In this module designing of the IR sensor module and its configuration with central operating microcontroller is carried out. This setup serves important purpose that is whenever any person enters into the premises of the room provided with this security system, IR sensors, fitted right at entrance detects it and serve to activate central security module for further operation. Figure 14shows selected IR sensors

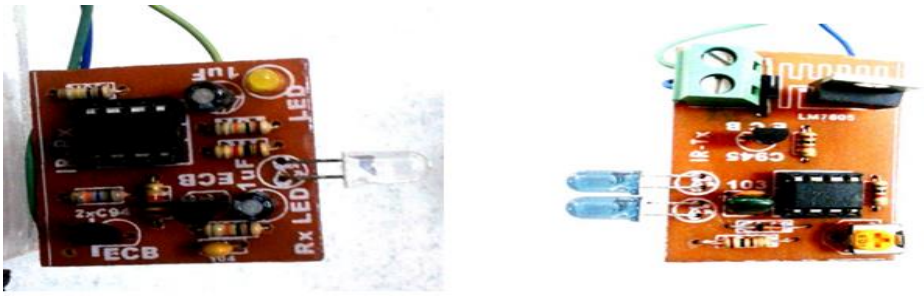

Figure 3-8 IR Sensor Receiver and Transmitter

Purpose of including this IR sensor module is

- To save power such that the central security system is not always broadcasting RF waves instead it is only activated once the person enters the premises of area provided with security system.
- Moreover as person leaves, IR sensors inform central security module so that count of number of people in the room goes down accordingly.

Configuration diagram of module is shown above in figure 2.Final hardware integrated circuit of module III is shown in figure 15. ATMAGA328P microcontroller is integrated in the ground module for controlling function of this module. Module III contains two IR sensors, one Arduino Uno board. The source voltage of this module is 12V which is converted into 5V by using IC Regulator 7805 as Arduino Uno board works properly on 5V.

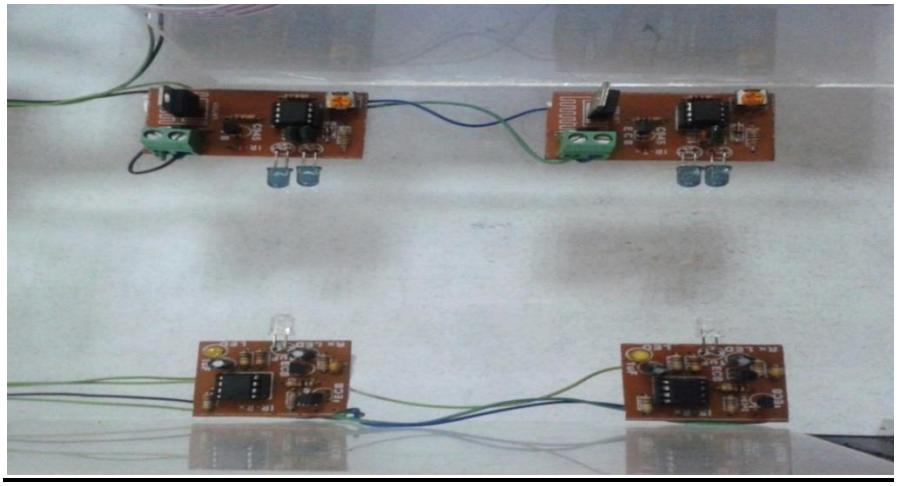

Figure 3-9 IR Sensor Module

Working of moduleis explained in figure 16. Power supply is 12V and an H-Bridge is integrated to control polarity of source. IC Regulator 7805 is integrated for voltage drop and capacitor is used for removal of noise. IR sensors are working on 5V supply and transmitters on 12V supply. IR receivers are connected to the microcontroller and the pins of the controller used to connect with the IR receivers are shown in figure 16.

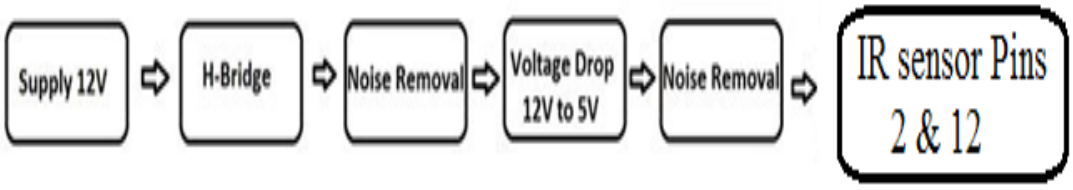

Figure 3-10 IR Receivers Working

Module III is working as required providing response in real time. IR sensors detect entering and leaving of the person. Arduino Uno collects data from IR sensors and checks for either person is entering or leaving the room and display the result on the LCD accordingly.

3.1.4 MODULE-IV

- This module deals with design of the central security module which is composed of the Central microcontroller i.e. Arduino. These board servers to control the whole security system. It is provided with database of all authorized personals.
    - It controls operation of IR sensors fitted at the entrance as well as the keypad for password security outside the room. If wrong password is entered then it will not allow to open the door for the user.
    - It is responsible for keeping the count of individuals present inside the organization.
- The XBee module: Whenever Arduino UNO board is interrupted by IR sensors indicating entry of person this XBee module serves to broadcast RF signal. In response to this broadcasting, individual module generates response message consisting of code assigned to that individual. Central XBee module receives response and provides it to ArduinoUNO board. ArduinoUNO board performs comparison of code thus either display valid person on LCD or else generate alarm indicating intrusion.
- Central power system for energizing the whole system
  After the completion of the Module IV, the required final working of this project is shown in figure 17 and figure 18.

Figure 17 shows all the possible outcomes when a person is entering the area where this project is being implemented. The sequence will be like this:

- Person will enter his password. If the password is correct, the door will be opened otherwise it will remain close.
- After entering the correct password, if the person does not enter the room in 10 seconds, the door will be closed again.
- If the person enters the door after disturbing the second IR sensor, the door will be closed again and the ground station XBee module will start to broadcast its sequence.
- The user module will broadcast its own sequence after receiving the sequence of the ground station, the ground station receive the sequence of the user module and compare the user sequence with its keypad password.
- If the matching is correct, the counter will be incremented by one. But if the matching is incorrect or the ground station does not receive any sequence of the user module, the control unit of the ground station will set off the alarm which will indicate the entering of the intruder.

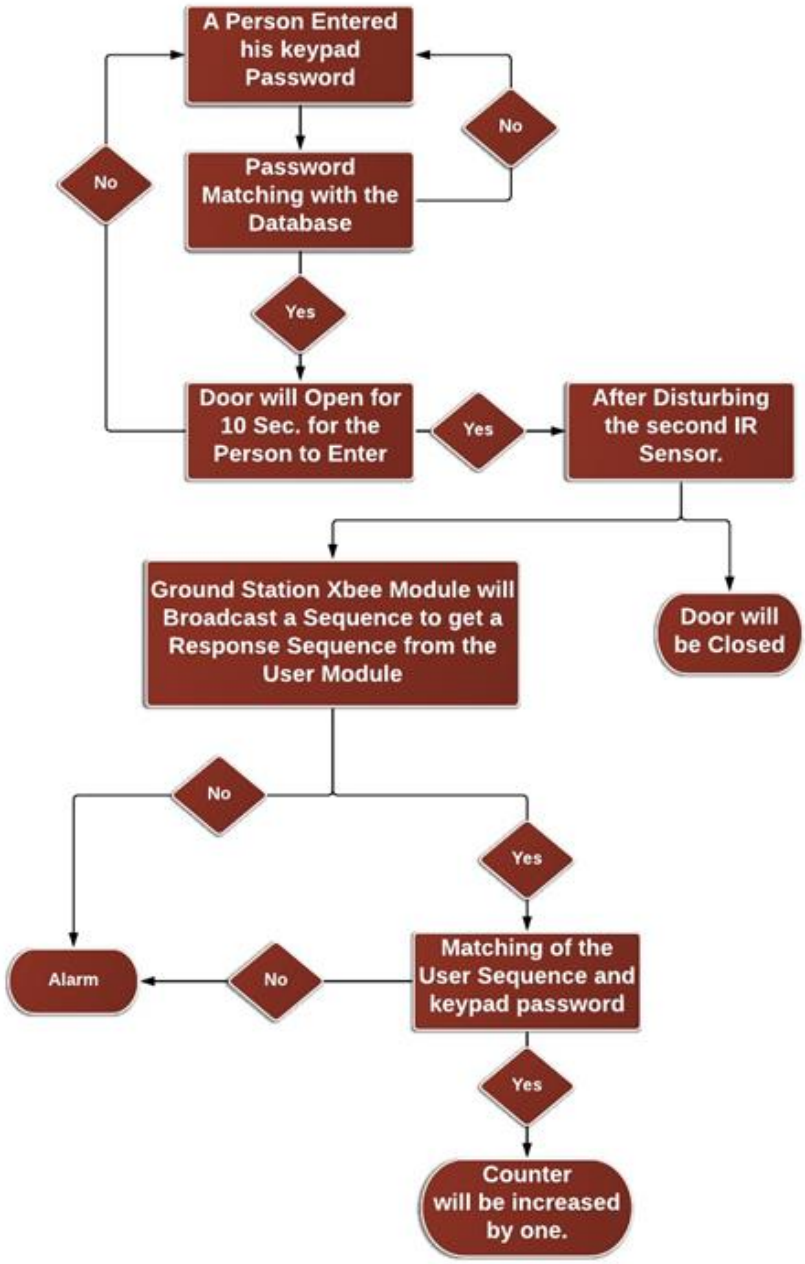

Figure 3-11 Final Working of the Prototype

Figure 18 shows all the possible outcomes when a person is leaving the area where this project is being implemented. The sequence will be like this:

- When the user wants to leave the area, the door will be open after disturbing the first IR sensor.
- The counter will be decremented after disturbing the second IR sensor.

- The door will be closed within 5 seconds after the disturbing of the second IR sensor as well.

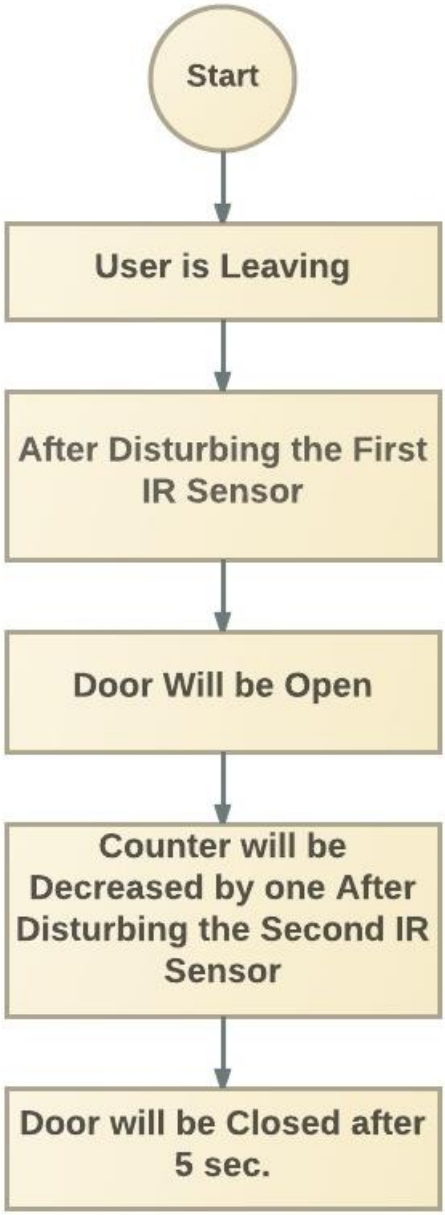

Figure 3-12 Working of the User Leaving

CHAPTER 4: PROJECT ANALYSIS AND EVALUATION

The XBee based security system was successfully integrated and all the motives were successfully achieved. Real time results milestone was successfully accomplished. Logics to make various modules workout together in complete synchronization were successfully formulated. Concept of security via XBee modules was successfully achieved by synchronized operation of user module and main security module. Security achieved now allows single person approval of entry at a time, however in future skipping the keypad security part model can be made to verify multiple users at a time before reaching in near premises of area provided with this security. Double security check was achieved using keypad security module. A significant efficiency in operation of XBee module was achieved with the help of IR sensors module making XBee to broadcast only when someone has attempted to enter room. Auto opening and closing of door by synchronized operation with keypad module was successfully achieved. A CD Rom came in handy in place of door. User module encompassing four users; allotted different codes was successfully worked out.

The security system was enabled to detect intruder in minimum time and generate alarm. Intruder detection is carried out at two positions: before entering at the keypad and after entering via XBee, so that security system offers maximum detection probability.

As the authorized person enters a valid password, is shown ‘allowed to enter’, and proceeds towards the door which opens automatically. Door operation is controlled by Arduino UNO board. If entered password is wrong user is interrupted to try again. If three attempts go wrong an alarm is generated indicating intrusion.

After the authorized person has entered, he passes through IR sensors door closes, XBee module is awakened, verification is carried out and count of number of individuals inside increases by one or in case of intrusion alarm is generated. When any person leaves the room he passes through IR sensors which serve to decrease count of number of individuals by one and door opens automatically.

Final form of project with various modules integrated onboard is shown in figure 17:

Figure 7 Project Prototype

CHAPTER 5: RECOMMENDTAIONS

The security system was successfully developed using essential components and all the motives were successfully achieved. However many improvements can still be made, which are as under:

- Improvement can be made in process of intruder detection by carrying out intruder detection from outside security concerned organization
- Further decrease time of intrusion detection
- More number of sensors can be added to make security system more efficient
- Instead of XBee module use infrared sensors
- Interface of finger print scanner to increase the security level
- Interface with the internet so that it can be handled remotely
- Interface of camera to detect the person's face whether he is an authorized person or not

CHAPTER 6: CONCLUSION

In totality, XBEE module based security system provides highly accurate and effective access control in real time for security sensitive organizations. All the modules set out for project completion were successfully achieved.

Objective of developing such a security system which is specific to allowing in workers of an organization only and any kind of intrusion is totally intolerable was successfully achieved. All the project modules i.e. user module that incorporates four users where each one of them is allotted a unique code, keypad security module for intruder detection from outside room where each authorized individual is allotted a unique password, IR sensor module for the purpose of power savage so that XBee module does not broadcast all time, central security module where whole of the verification process takes place including keypad and XBee were successfully completed. Final prototype developed by integrating all modules is efficient enough to detect intruder first from outside the room via keypad and then inside via XBee and provide results in real time.

Project contributes towards wellbeing of the society assuring physical security of personals and assets. It is more likely to be used in security concerned governmental and military organizations.

Limitation only lies with intruders from within the organization for they can overwrite the central security system.

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APPENDIXES

APPENDIX A

Main Code:

```
int led1 = 9;
int led2 = 10;
int led3 = 11;
int led4 = 12;
int button1 = 5;
int button2 = 6;
int button3 = 7;
int button4 = 8;
int check1 = 0;
int check2 = 0;
int check3 = 0;
int check4 = 0;
void setup() {
  // put your setup code here, to run once:
pinMode(led1,OUTPUT);
pinMode(led2,OUTPUT);
pinMode(led3,OUTPUT);
pinMode(led4,OUTPUT);
pinMode(button1, INPUT);
pinMode(button2, INPUT);
pinMode(button3, INPUT);
pinMode(button4, INPUT);
digitalWrite(led1, HIGH);
digitalWrite(led2, HIGH);
digitalWrite(led3, HIGH);
digitalWrite(led4, HIGH);
```

```
Serial.begin(9600);
}
void loop() {
  check1 = buttonState(button1, led1, check1);
  check2 = buttonState(button2, led2, check2);
  check3 = buttonState(button3, led3, check3);
  check4 = buttonState(button4, led4, check4);
if(Serial.available())
  {
charxbee = Serial.read();
if(xbee == 'Z')
    {
if((check1 == 1) || (check1 == 2))
        {Serial.print("A");}
if((check2 == 1) || (check2 == 2))
        {Serial.print("B");}
if((check3 == 1) || (check3 == 2))
        {Serial.print("C");}
if((check4 == 1) || (check4 == 2))
        {Serial.print("D");}
xbee = 0;
    }
  }
}
```

APPENDIX B

Toggle button code:

```
intbuttonState(intbutton,intled,int check)
{
if((digitalRead(button) == HIGH) && (check == 0))
   {
digitalWrite(led, LOW);
check = 1;
   }
if((digitalRead(button) == LOW) && (check == 1)){check = 2;}
if((digitalRead(button) == LOW) && (check == 3)){check = 0;}
if((digitalRead(button) == HIGH) && (check == 2))
   {
digitalWrite(led, HIGH);
check = 3;
   }
return check;
}
```

LCD Code:

```
#include <Keypad.h>
#include <LiquidCrystal.h>
LiquidCrystallcd(A0, A1, A2, A3, A4, A5);
```

```
const byte ROWS = 4;

const byte COLS = 4;


charhexaKeys[ROWS][COLS] = {

   {'1','2','3','A'},

   {'4','5','6','B'},

   {'7','8','9','C'},

   {'*','0','#','D'}

};

byterowPins[ROWS] = {9, 8, 7, 6};

bytecolPins[COLS] = {5, 4, 3, 2};

Keypad customKeypad = Keypad(makeKeymap(hexaKeys), rowPins, colPins, ROWS, COLS);

int Sensor1 = 2;

int Sensor2 = 12;

int Buzzer = 13;

int Motor1 = 10;

int Motor2 = 11;

int Counter = 0;

int Sen1Check = 0;

int Sen2Check = 0;

intDoorCheck = 0;

unsignedintpincode[5];
```

```
unsignedint pincode1[5]={1,2,3,4};

unsignedint pincode2[5]={1,1,1,1};

unsignedint pincode3[5]={1,1,1,2};

unsignedint pincode4[5]={1,1,1,3};

byte index = 0;

int user = 0;

intEnterCheck = 0;

intVerifyUser = 0;

intCounterCheck = 0;

intOpenCheck = 0;

int OpenCheck2 = 0;

int OpenCheck3 = 0;

intLeaveCheck = 0;

void setup(){

Serial.begin(9600);

lcd.begin(20, 4);


digitalWrite(Buzzer,HIGH);

digitalWrite(Motor1,HIGH);

digitalWrite(Motor2,HIGH);


pinMode(Sensor1, INPUT);

pinMode(Sensor2, INPUT);
```

```
pinMode(Buzzer, OUTPUT);

pinMode(Motor2, OUTPUT);

pinMode(Motor1, OUTPUT);

welcomeNote();

DoorOpen();

}
```

Access Granted Code:

```
voidAccessGranted()

{

        if((pincode[0] == pincode1[0]) && (pincode[1] == pincode1[1]) && (pincode[2] == pincode1[2]) && (pincode[3] == pincode1[3]))

        {

lcd.clear();

delay(500);

lcd.setCursor(3,1);

lcd.print("Access Granted");

delay(2000);

DoorClose();

user = 1;

OpenCheck = 1;

        }
```

```
        if((pincode[0] == pincode2[0]) && (pincode[1] == pincode2[1]) &&
(pincode[2] == pincode2[2]) && (pincode[3] == pincode2[3]))

        {

lcd.clear();

delay(500);

lcd.setCursor(3,1);

lcd.print("Access Granted");

delay(2000);

DoorClose();

user = 2;

OpenCheck = 1;



        }


        if((pincode[0] == pincode3[0]) && (pincode[1] == pincode3[1]) &&
(pincode[2] == pincode3[2]) && (pincode[3] == pincode3[3]))

        {

lcd.clear();

delay(500);

lcd.setCursor(3,1);

lcd.print("Access Granted");

delay(2000);

DoorClose();
```

```
user = 3;
OpenCheck = 1;
        }
        if((pincode[0] == pincode4[0]) && (pincode[1] == pincode4[1]) && (pincode[2] == pincode4[2]) && (pincode[3] == pincode4[3]))
        {
lcd.clear();
delay(500);
lcd.setCursor(3,1);
lcd.print("Access Granted");
delay(2000);
DoorClose();
user = 4;
OpenCheck = 1;
        }
}
```

Check Entry Code:

```
voidCheckEntry()
{
if(((digitalRead(Sensor1) == LOW) || (Sen1Check == 1)) && (Sen2Check == 0))
   {
while(digitalRead(Sensor1) == LOW);
      Sen1Check = 1;
if(digitalRead(Sensor2) == LOW)
```

```
      {
         Counter++;
         Sen1Check = 0;
EnterCheck = 1;
while(digitalRead(Sensor2) == LOW);
      }
   }
}
```

Check Leaving Code:

```
voidCheckLeaving()
{
if(((digitalRead(Sensor2) == LOW) || (Sen2Check == 1)) && (Sen1Check == 0))
   {
while(digitalRead(Sensor2) == LOW);
      Sen2Check = 1
if(digitalRead(Sensor1) == LOW)
      {
         Counter = Counter - 1;
         Sen2Check = 0;
LeaveCheck = 1;
while(digitalRead(Sensor1) == LOW);
      }
   }
}
```

Enter Password Code:

```
voidEnterPassword()
{
```

```
char key = customKeypad.getKey();
if(user == 0)
  {
lcd.setCursor(0,0);
lcd.print("Enter Pin Code :");
delay(200);
  }
if (key)
  {
pincode[index] = key;
pincode[index]=pincode[index]-48;
lcd.setCursor(index,1);
lcd.print("*");
if(index==3)
      {
AccessGranted();
if(user == 0)
          {
lcd.clear();
delay(500);
lcd.setCursor(0,0);
lcd.print("Wrong Pin Code");
delay(5000);
          }
       }
index++;
if(index==4){index=0;}
```

```
    }
}
```

Motor Routine Code:

```
voidMotorForward()
{
digitalWrite(Motor1, HIGH);
digitalWrite(Motor2, LOW);
}

voidMotorReverse()
{
digitalWrite(Motor1, LOW);
digitalWrite(Motor2, HIGH);
}

voidMotorStop()
{
digitalWrite(Motor1, HIGH);
digitalWrite(Motor2, HIGH);
}

voidDoorOpen()
{
MotorForward();
delay(1000);
MotorStop();
}
```

```
voidDoorClose()
{
MotorReverse();
delay(1000);
MotorStop();
}
```

Verification Code:

```
void Verification()
{
Serial.print("Z");
CounterCheck++;
if (Serial.available())
   {
charxbee = Serial.read();

if((user == 1) && (xbee == 'A'))
     {
lcd.clear();
lcd.setCursor(1,1);
VerifyUser = 1;
lcd.print("User 1 has entered");
delay(5000);
lcd.clear();
     }

if((user == 2) && (xbee == 'B'))
```

```
    {
lcd.clear();
lcd.setCursor(1,1);
VerifyUser = 2;
lcd.print("User 2 has entered");
delay(5000);
lcd.clear();
    }

if((user == 3) && (xbee == 'C'))
    {
VerifyUser = 3;
lcd.clear();
lcd.setCursor(1,1);
lcd.print("User 3 has entered");
delay(5000);
lcd.clear();
    }

if((user == 4) && (xbee == 'D'))
    {
VerifyUser = 4;
lcd.clear();
lcd.setCursor(1,1);
lcd.print("User 4 has entered");
delay(5000);
lcd.clear();
```

```
    }


if(VerifyUser == 0)
    {
digitalWrite(Buzzer, LOW);
lcd.clear();
lcd.setCursor(2,1);
lcd.print("Unverified Entry");
while(1);
    }


user = 0;
EnterCheck = 0;
VerifyUser = 0;
CounterCheck = 0;
DoorCheck = 0;
OpenCheck = 0;
    OpenCheck2 = 0;
    OpenCheck3 = 0;
  }
if(CounterCheck == 5)
  {
user = 0;
EnterCheck = 0;
VerifyUser = 0;
CounterCheck = 0;
DoorCheck = 0;
```

```
OpenCheck = 0;
    OpenCheck2 = 0;
    OpenCheck3 = 0;
lcd.clear();
lcd.setCursor(2,1);
digitalWrite(Buzzer, LOW);
lcd.print("Unverified Entry");
while(1);
   }
}
```

Welcome note code:

```
voidwelcomeNote()
{
lcd.setCursor(0,0);
lcd.print("Project Name:");
lcd.setCursor(3,2);
lcd.print("Invisible Eye");
delay(5000);
lcd.clear();
lcd.setCursor(0,0);
lcd.print("Superviser:");
lcd.setCursor(0,2);
lcd.print("Lt Col M Tayyab Ali");
delay(5000);
lcd.clear();
lcd.setCursor(0,0);
lcd.print("Project Members:");
```

```
lcd.setCursor(0,1);
lcd.print("Anum Umer");
lcd.setCursor(0,2);
lcd.print("Hasan Raza");
lcd.setCursor(0,3);
lcd.print("Syed Daniyal Nasir");
delay(5000);
lcd.clear();
}
```