

# **DESIGN AND IMPLEMENTATION OF ARDUINO BASED HOME SECURITY SYSTEM**

**A Project and Thesis submitted in partial fulfillment of the  
requirements for the Award of Degree of  
Bachelor of Science in Electrical and Electronic Engineering**

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# Certification

This is to certify that this project and thesis entitled “**Design and implementation of Arduino based Home Security System**” is done by the following students under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held on November 2018.

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**Dedicated to**

**Our Parents**

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## List of Abbreviations

GDP	Gross Domestic Product
GSM	Global system for Mobile Communication
PIR	Pyro Electric Radiation
RFID	Radio-frequency identification
SMS	Short Message
GPRS	General Packet Radio Services
LCD	Liquid crystal Display
PWM	Pulse Width Modulation
UART	Universal Asynchronous Receiver/Transmitter
IDE	Integrated Development Environment
GPL	General Public License

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# ABSTRACT

Safety of home or other establishment is a prerequisite of a peaceful life. Sometimes security cannot be guaranteed with security guard as they also get involved in crimes. On the other hand, very few can afford security guard in our economic condition. In our project titled “**Design and implementation of Arduino based Home Security System,**” we proposed and developed a security solution that is affordable as well as usable in residence or other establishments.

As a part of access control, main door is interfaced with electric locking system that can be open or closed upon successful authentication. To verify legitimate user, RFID authentication is integrated with the system. Each user of the system will have an RFID card by which he can verify his identity to the system. In addition to access control, various sensors are interfaced to detect unwanted situation to avoid accident or reduce possibility of loss by taking immediate action. All incidents including entry, exit, gas leak, presence of unwanted person inside room will be sent to the owner’s mobile phone immediately. Thus, the system will provide a security and emergency solution for an establishment.

# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

Residential robbery is still now a threat to a peaceful and secured life in Bangladesh although it has increased in a great extent. Steps from the law enforcement agencies are insufficient for small crimes like burglary where other crimes are highly prioritized. This situation imposes a threat to peaceful living of common people. In Bangladesh's context, most of the citizen has not ability to employ security guard for their home or small business. Thus, it creates a vulnerable situation for most of the citizens for their home and small institutions e.g.: business, education etc.

This threat full phenomenon can be solved in great extent by applying modern technology in our household life. To ensure the safety of the people, we have this plan to develop a system with our technical knowledge.

### 1.2 Problem Statement

Our life has become more comfortable and efficient due to technological advancement in recent years. The comfort of being able to control and monitor devices over the network has become a time and effort consuming solution. Therefore demand arises to do so in home security system which has been tried to implement in this system. In this system, we have proposed an extended approach to automatize home security control and monitoring system. With the use of our system, some jobs can be done automatically which needs continuous attention. Application of the system becomes worthy when people get to know that if something unpleasant happen in his home from anywhere.

## 1.3 Objectives

The objectives of this project and thesis are:

- i. To design and implement security system for home as well as other organizations.
- ii. To make an access system for authentication.
- iii. To make the door automatic.
- iv. Deploy a system so that it can notify unusual activities to other members via mobile communication system.
- v. To prevent unnecessary entry in the premises.
- vi. Notify owner about the intruders.

## 1.4 Scopes

Table: 1.4 Crime statistics of Bangladesh in recent years.

Sl	Year	Burglary	Dacoity	Robbery
1	2010	3166	659	1068
2	2011	3101	656	1059
3	2012	3501	656	1059
4	2013	3101	656	1059
5	2014	2800	655	1149
6	2015	2494	491	933
7	2016	2213	412	772
8	2017	1626	202	434
Average per year		2750.25	548.375	941.625

In Bangladesh, crime like burglary, robbery, and dacocity occurs an average 2750, 548, 941 respectably [1]. Previous report shows that the person who is in charge of safekeeping are involved in crime.

Private security service has become popular with the development and it has a significant share in national GDP. This proposed system will provide a technological solution that will decrease crime rate as well as security cost.

## **1.5 Project Outline**

This Project report is organized as follows:

Chapter 1: Introduction, problem Statement, objectives, scope, outline and summary.

Chapter 2: Introduction, types of security systems, Some existing home security systems, technologies and summary.

Chapter 3: Introduction, block diagram, program flow diagram, implementation and demonstration and summary.

Chapter 4: Introduction, hardware components used, software development and summary.

Chapter 5: Introduction, test for different operations and summary.

Chapter 6: Conclusion, limitation and future Scope.

# CHAPTER 2

## LITERATURE REVIEWS

### 2.1 Introduction

Security systems are designed in such a way for preventing intruders, burglars and detect invasion in personal, business, industrial property to protect those properties as well as ensuing personal safety. Additionally, security systems also ensure economic growth by saving man-hour and enhanced productivity.

### 2.2 Types of Security System

There are many types of security system in the world. They are [2]:

1. Monitored Security System.
2. Unmonitored Security System.

#### 2.2.1 Monitored Security System.

This kind of systems are actively monitored by professional home security company. Whenever any security or emergency issues arrive, it notifies the responsible security organization as well as the owner.



Fig 2.1 Monitored security system

### 2.2.1.1 Advantages:

1. Leaving the monitoring job to the professionals is reliable.
2. Installation and maintenance are provided by the company.
3. Comprehensive, hassle free and convenient.

### 2.2.1.2 Disadvantages:

1. Costlier.
2. Monthly or yearly subscription fee.

## 2.2.2 Unmonitored Security System.

In unmonitored security systems, equipment will be provided to the consumer that can be installed by professionals or own. A typical unmonitored security system can have the following equipment e.g.: control panel, motion sensor, smoke and fire sensor, door and window sensor, glass break sensor and alarm bell. Some systems may compatible with smartphone and other computing device to provide capability of monitoring the system from remote place.

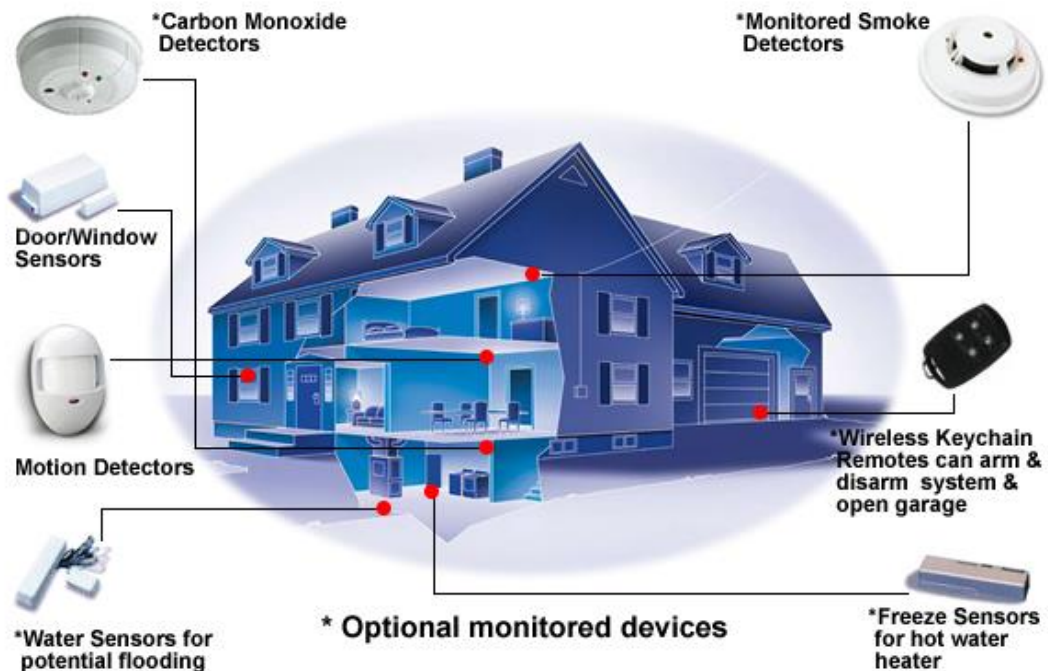


Fig. 2.2: Unmonitored security system

### 2.2.2.1 Advantages:

1. Comparatively less expensive.
2. Onetime expense.



#### 2.2.2.2 Disadvantages:

1. It does not ensure much security because no dedicated monitoring is not ensured.

## 2.3 Some Existing Home Security Systems

There are many security systems available in the world with different features, some of them are discussed below:

### 2.3.1 Ring Alarm

It is a security system with various detector sensors and contact sensors. This system will notify owner via mobile application. It has contact sensors that can detect window open, glass breaking, fire and gas leakage etc. [3].



Fig 2.3 Ring alarm

### **2.3.2 Nest Secure**

This security system consists of various sensors for detecting any adverse situation. It has separate tag devices for every user to detect their entry and exit, thus it can track their movement [4].



Fig 2.4 Nest Secure

## **2.4 Technologies**

In this section, some technologies related to security system are discussed.

### **2.4.1 RFID Authorization**

A Radio-Frequency Identification system has three parts which are a scanning antenna, a transceiver with a decoder to interpret the data and a transponder - the RFID tag - that has been programmed with information. The scanning antenna puts out radio-frequency signals in a relatively short range. The RF radiation does two things those are, it provides a means of communicating with the transponder and it delivers the RFID tag with the energy to communicate. This is an absolutely key part of the technology; RFID tags do not need to contain batteries, and can, therefore remain usable for very long periods of time. The scanning antennas can be permanently affixed to a surface; handheld antennas are also available. They can take whatever shape you need; for example, you could build them into a door frame to

accept data from persons or objects passing through. RFID tags can be read in a wide variety of circumstances, where barcodes or other optically read technologies are useless. The tag need not be on the surface of the object and is therefore not subject to wear [5].

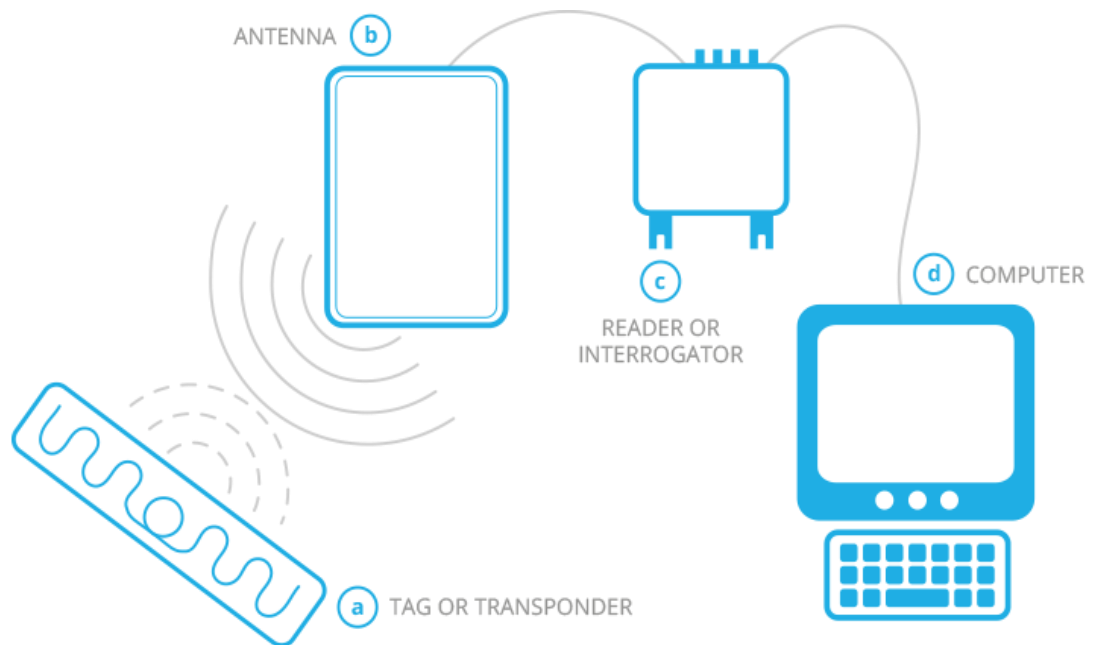


Fig 2.5 RFID authentication system

### 2.4.2 Motion Detection Using PIR

The PIR sensor has two slots in it, each slot is made of a special material that is sensitive to IR. When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room or walls or outdoors. When a warm body like a human or animal passes by, it first intercepts one half of the PIR sensor, which causes a positive differential change between the two halves. When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change. These change pulses are what is detected.

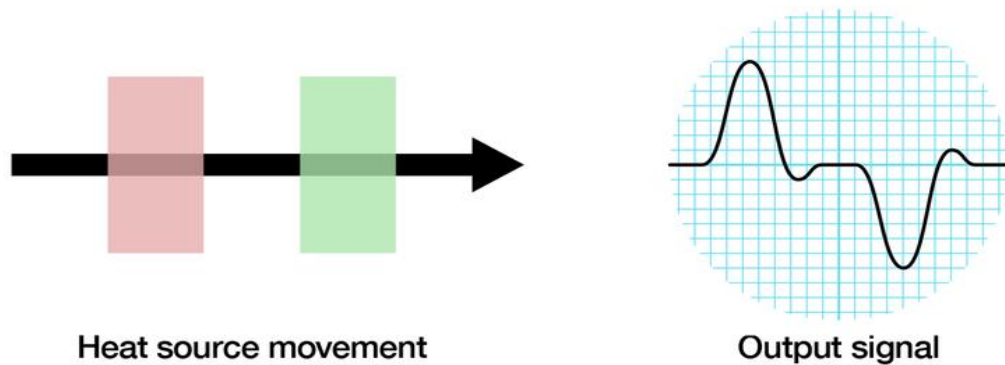
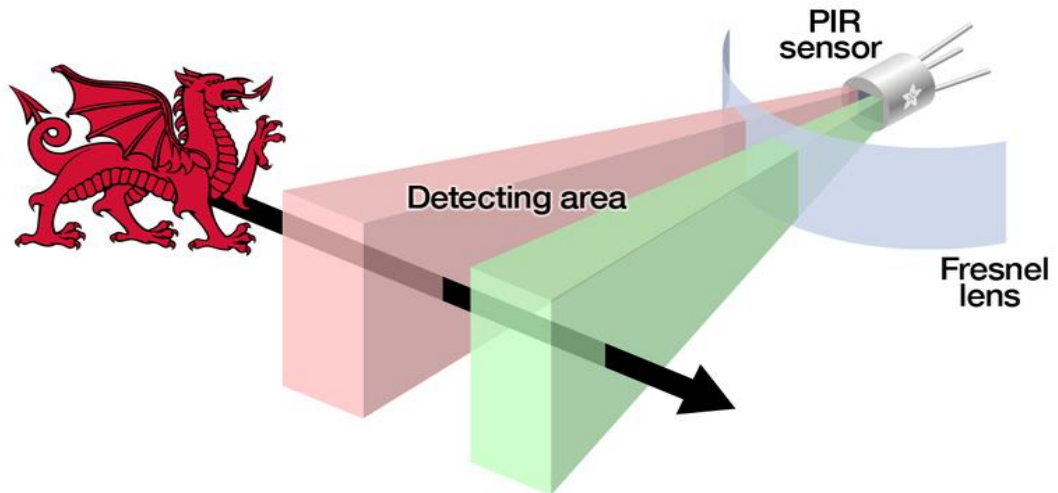


Fig. 2.6 Motion detection using PIR sensor.

## 2.5 Summary

In this chapter we have discussed about different types of monitoring system with their advantages and disadvantages. We also discussed about security technology, structure, working principle and others with a view to clarify about our proposed work.

# CHAPTER 3

## DESING AND FABRICATION

### 3.1 Introduction

The prime main concern of this project is to obstruct any intruders, trying to illegitimately break into one's establishment. An alert will be sent to the owner immediately on unauthorized attempt. The RFID reader which will be used as authentication device is placed outside the door, hence the system can be accessed from outside. An unlock button is placed inside the door to open from inside any time. Because normally the person who try to open the door from inside will be legitimate one.

Moreover, if any perpetrator enters through other place except the door in absence of the owner, PIR sensor will detect the movement and system will send alert message to the owner immediately.

### 3.2 Block Diagram

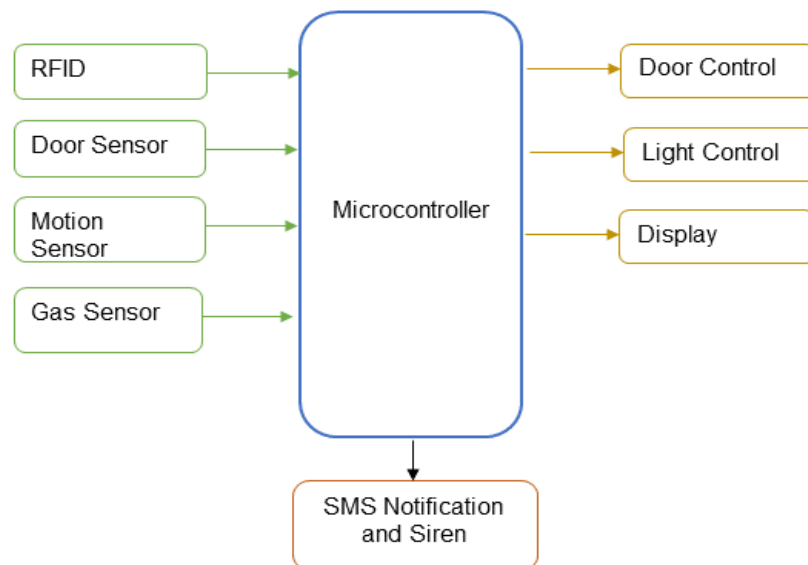


Fig:3.1 Blok diagram of the proposed system.

A microcontroller will work as main controller of the system and responsible for all kind of Input, Output and processing jobs. it will take input from RFID reader, gas detector sensor, motion sensor and take necessary action using servo motor, display, light and GSM device.

### **3.3 Program Flow Chart**

When the system is activated, the system will wait until any of the sensor will generate an interruption. If a user scans his RFID tag in order to enter home, microcontroller will read the hexadecimal value of the tag and match with user table. If the user become authorized by the system, the system then open or close the door depending on whether that particular person is inside or outside home. The system will also turn on or off the room light depending on owner's entry or exit. If the system detects any unknown RFID tag, it will send an alert message to the owner via GSM module and blow the buzzer for a while. It will also send alert notification if gas leak is detected.

The system will ignore any movement detected from PIR sensor while any of legitimate person stays inside home, in absence of any legitimate person, the system will detect him an intruder and immediately notify the owner.

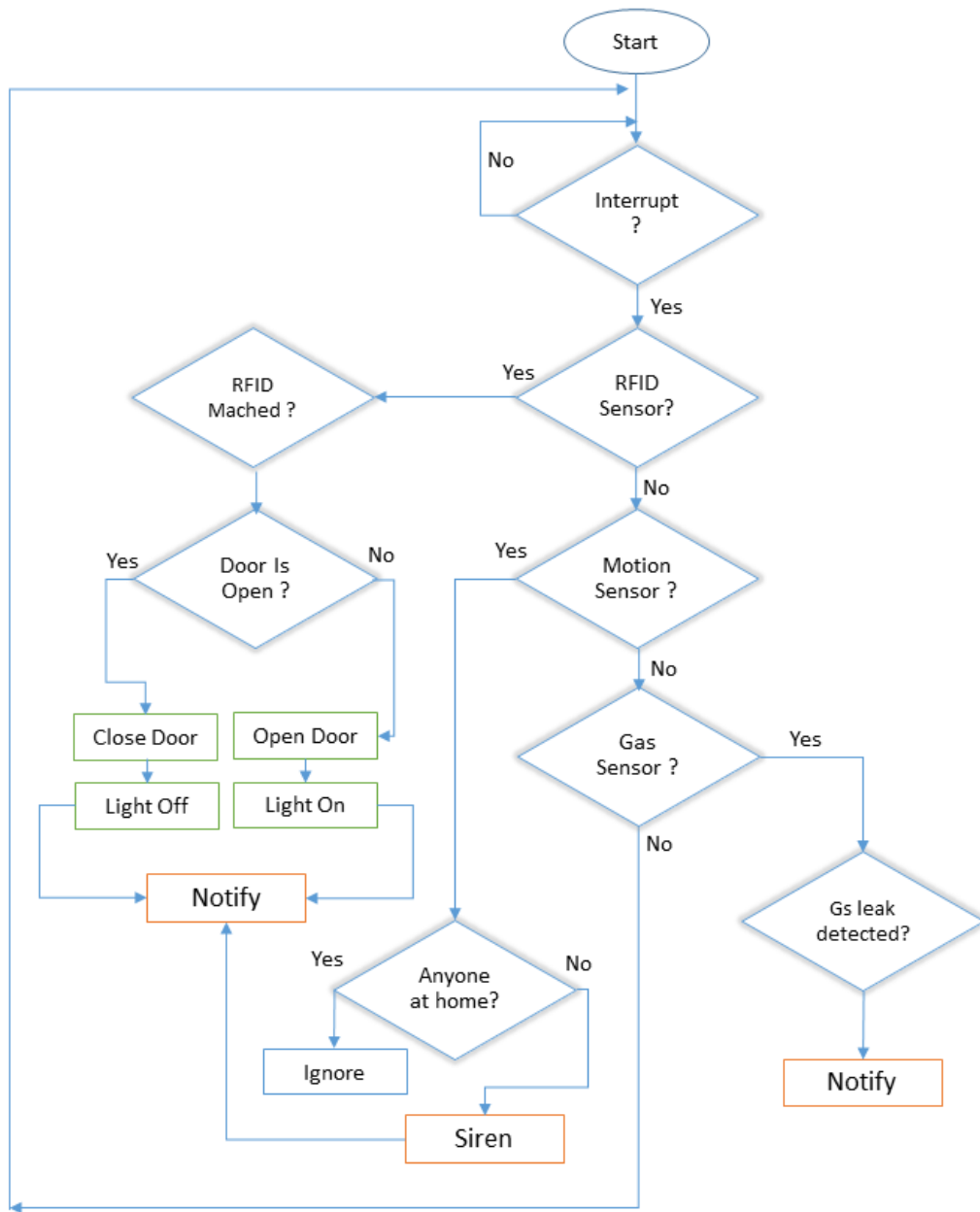


Fig 3.2 Program flow diagram of the proposed system.

### 3.4 Implementation and Testing

We have made a prototype for the proposed system to demonstrate working procedures and functionality. This prototype has all features contains in the proposed system.

#### 3.4.1 Hardware Arrangement

Figure 3.4 shows front view of the system. RFID reader and display is placed outside the home because authentication is needed only for entering home.

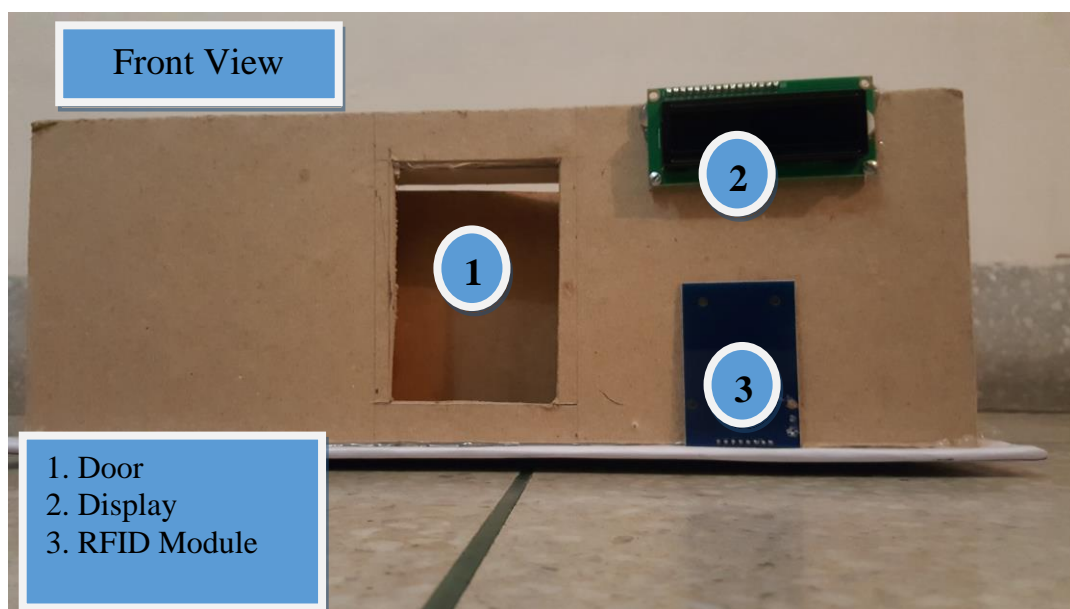


Fig. 3.3 Front view prototype.



Figure 3.5 shows how servo motor lock/unlock the door. To lock the door, servo motors position needs to be set at 0 degree position, and to unlock the door position needs to be set at 90 degree position. At the starting of the system, the door will be locked by default.

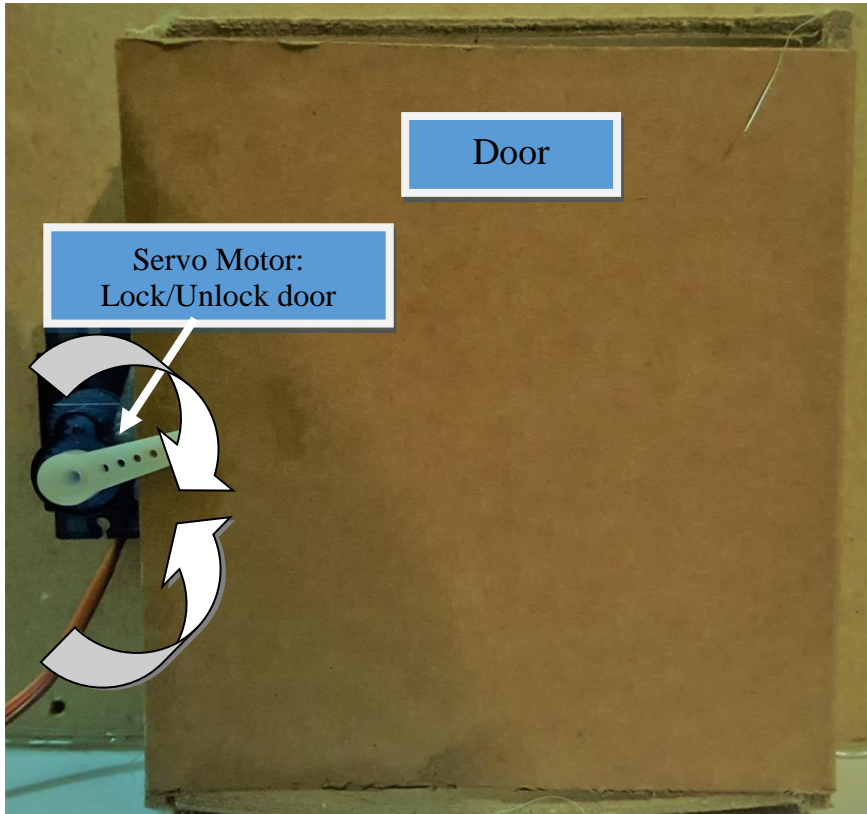


Fig. 3.4 Door Control.

This pictures shows GSM unit which is responsible for sending notification to uer as mobile SMS.

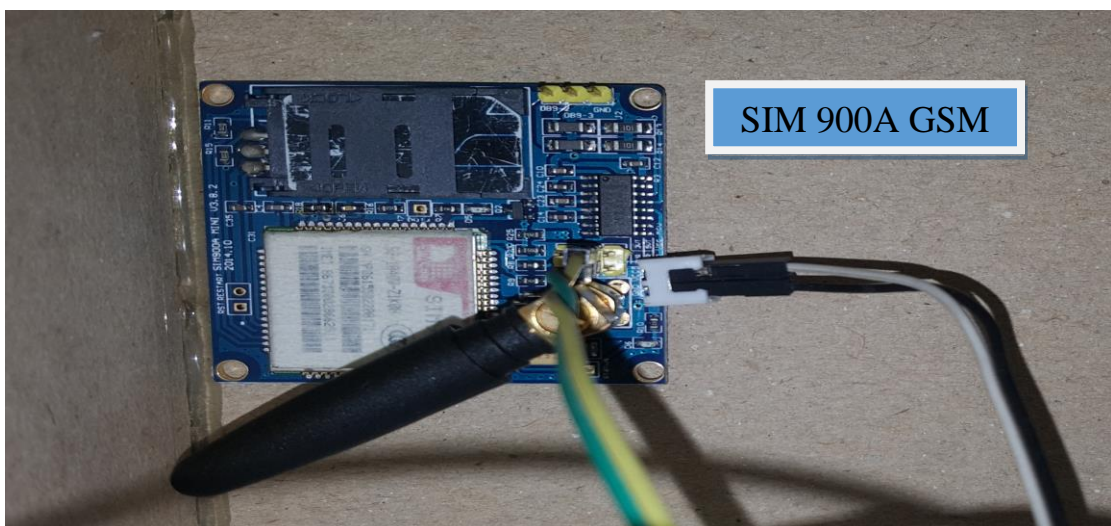


Fig. 3.5 GSM Unit.

### 3.4.2 Overall Demonstration.

This picture shows active state of the system. At this point, all sensors and actuator are active and door is locked by default.

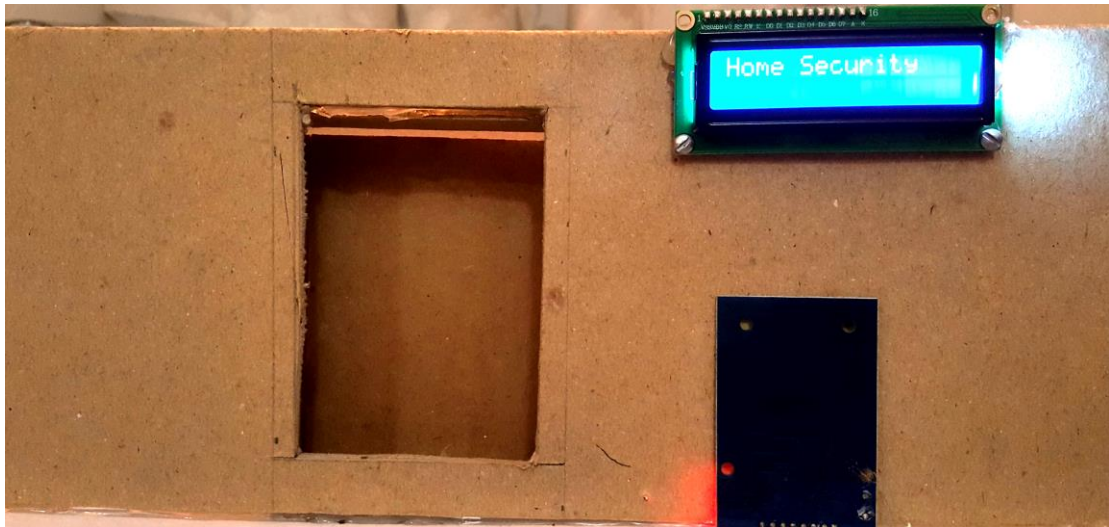


Fig. 3.6 Active state

Figure 3.9 shows door opened after successful authentication and showing welcome message to that particular person's name.

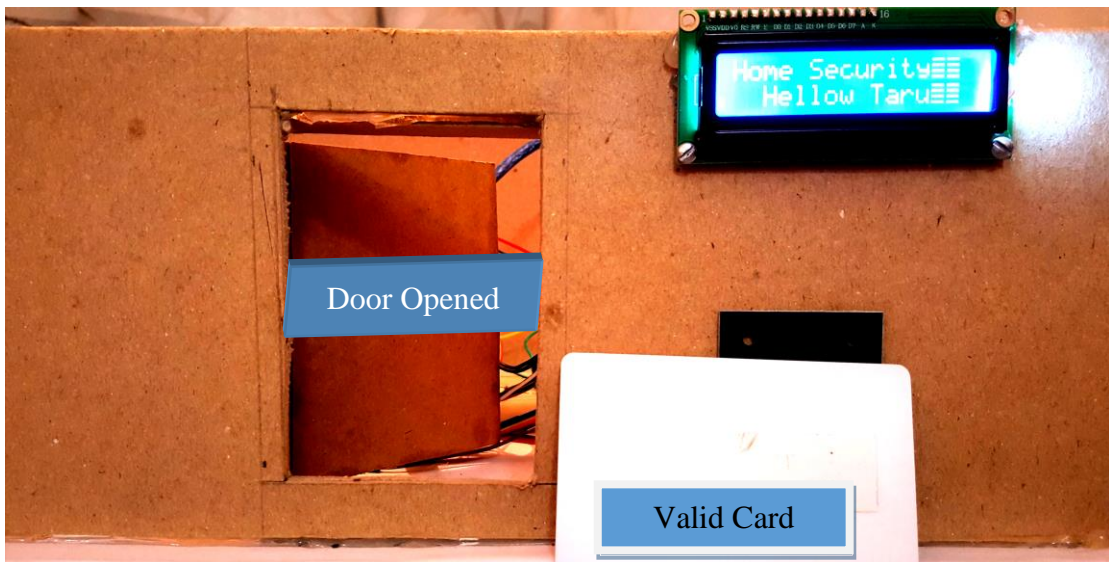


Fig. 3.7 Valid user authentication and entry.

System can detect presence and absence of a specific user inside home, so it turns light on or off on entry or exit of that particular person.

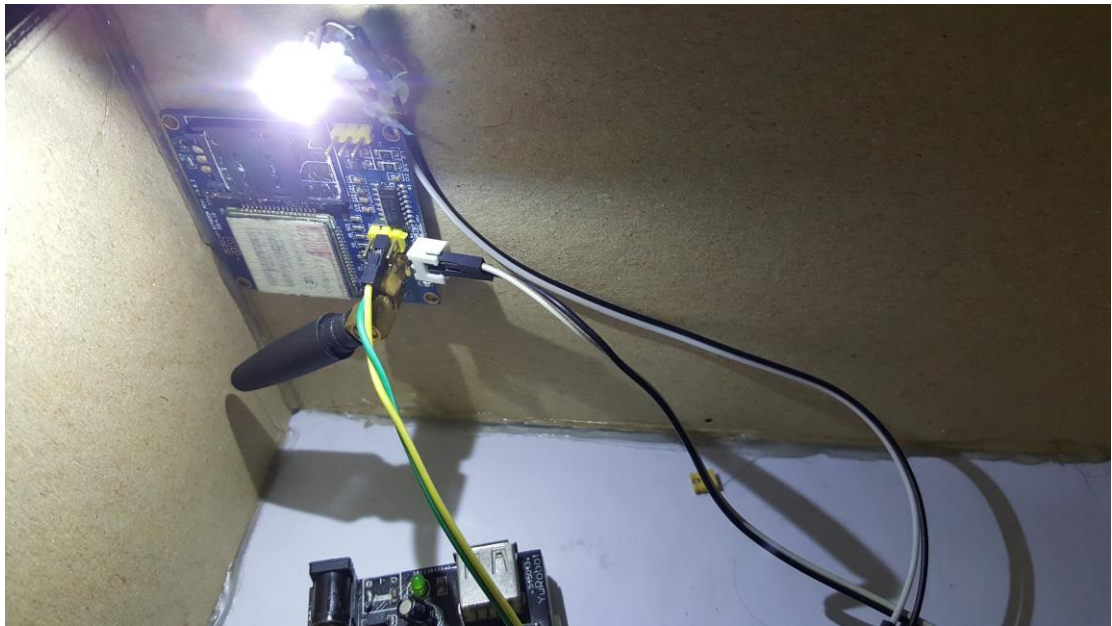


Fig. 3.8 Room light turned on after successful authentication.

In the figure 3.11 it shows that, system is denying entry of an unauthorized person and sending alert message to the owner.

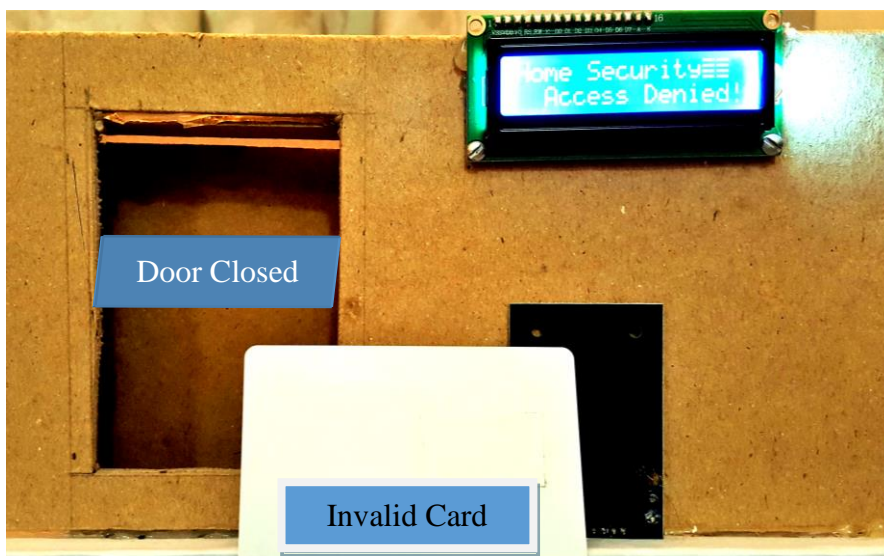


Fig 3.9 Invalid attempt and alert message to owner.



The system shows message to the person according to his name.



Fig. 3.10 Different welcome message and alert according to user's name.

System can detect presence and absence of a specific user, so it shows and notifies with different message on entry or exit.

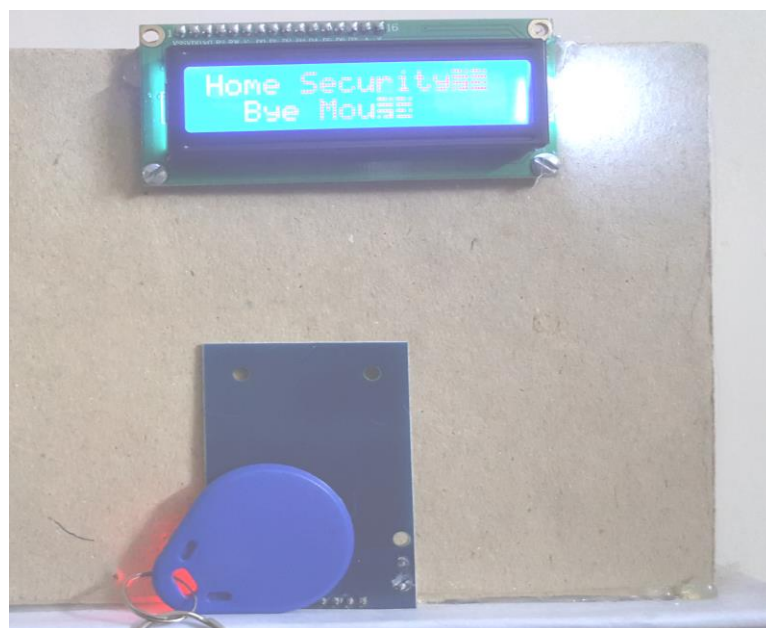


Fig. 3.11 System detecting entry or exit of a person.

A door lock/unlock button is placed inside home so that it can be opened or closed from inside without authentication. Also has option to disable or enable motion detection system because it is not always needed.

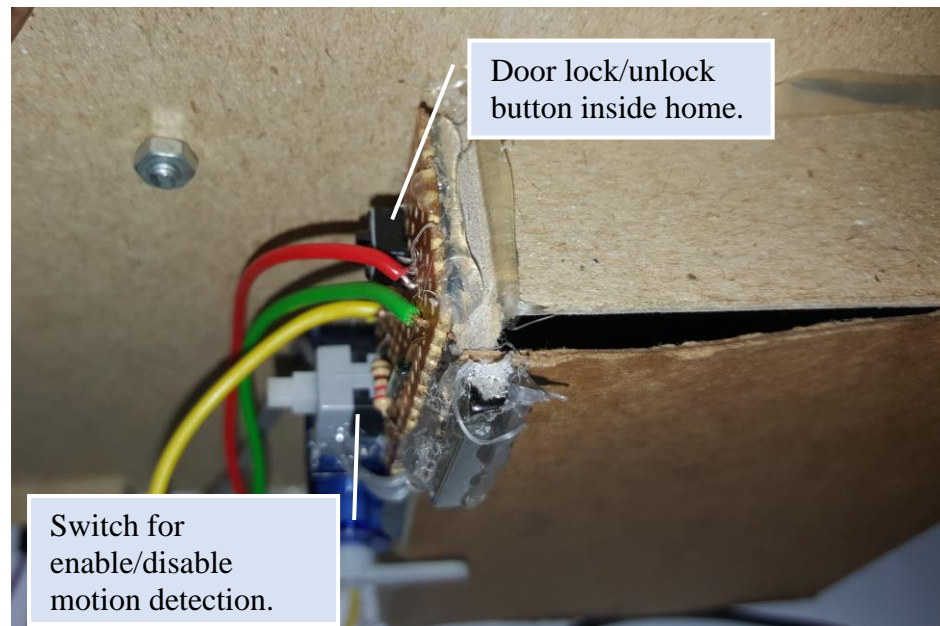


Fig. 3.12 Door Lock/Unlock and motion detector enable/disable switch inside home.

### 3.5 Summary

In this chapter we have shown design, working procedures and prototype for the proposed system. Structure of the system is described by the block diagram. Details working procedure and logical operations are shown in flow chart. Proposed design and overall demonstration are described with related images.

# CHAPTER 4

## HARDWARE AND SOFTWARE DEVELOPMENT

### 4.1 Introduction

In this project, we worked to develop a security access control system for home with reliable components for better performance. Besides that, we also concerned about overall cost for the system and tried to reduce as much as possible.

Major components used in this system are Arduino mega microcontroller, RFID module, SIM 900 GSM+GPRS module and other components.

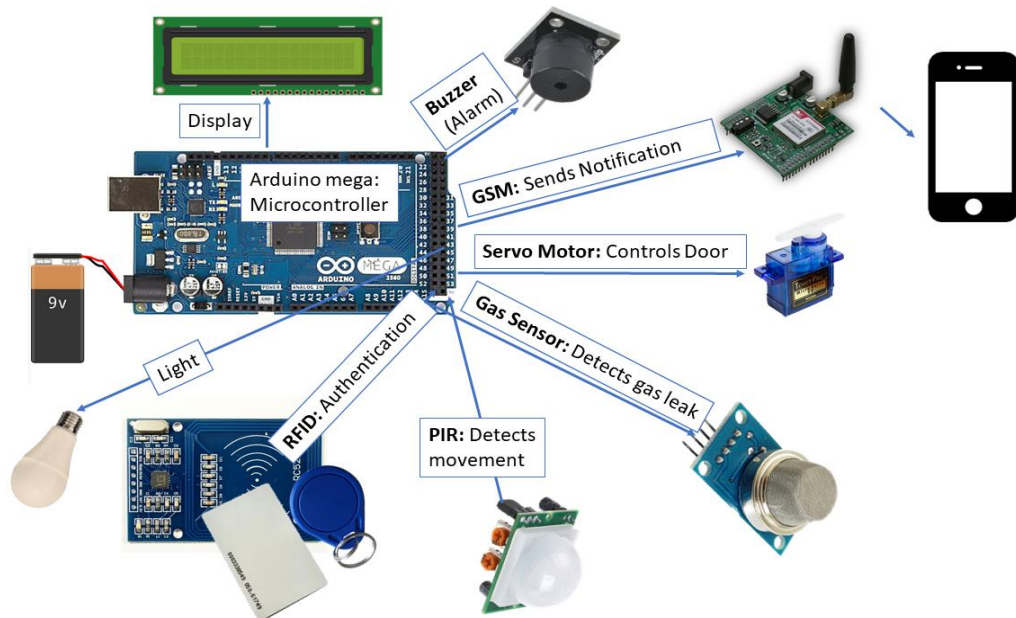


Fig. 4.1 Hardware components of the proposed system.

### 4.2 Hardware components used

List of all components used in this system [6]:

- Arduino Mega 2560
- Simcom SIM 900a GSM Module

- Arduino Nano R3
- RFID Reader Module
- RFID TAG
- 16\*2 LCD Display
- Servo Motor
- Gas Sensor

#### 4.2.1 Arduino Mega 2560

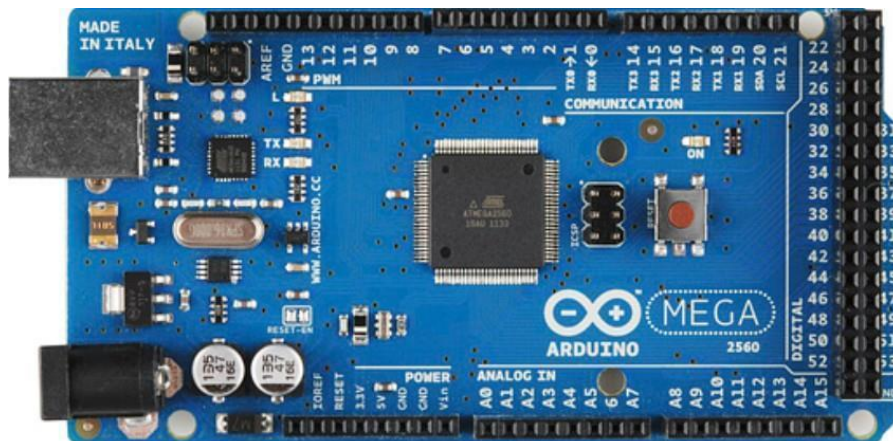


Fig. 4.2 Arduino Mega Microcontroller board

The system uses Arduino Mega 2560 as main microcontroller that has been selected for its beefy capacity comparing to other similar boards. It has large numbers of GPIOs, greater RAM and suits well with all the components used in this system. This device is solely responsible for controlling all other devices in this system.

The Arduino Mega consists of Atmega 2560 Microcontroller Chip. There are 54 I/O pins which are categorized as following:

- 15 PWM (Pulse width modulation) outputs
- 16 analog inputs
- 4 UARTs (hardware serial ports)
- A 16 MHz crystal oscillator
- USB connection
- A power jack
- An ICSP header
- A reset button

### 4.2.2 Simcom SIM 900a GSM Module



Fig. 4.3 Simcom SIM 900A GSM module

It is a Dual-band GSM/GPRS breakout board enables both IP and mobile communication. It can be controlled by AT command and can be interfaced via UAER/Serial communication. This module also supports software power on and reset [7].

#### Features:

- Dual-Band 900/ 1900 MHz
- Operates on 3.5-4.5 V.
- Antenna included
- Low power consumption: 1.5mA (sleep mode)
- SIM Card Slot (Flip)
- Operation temperature: -40°C to +85 °C
- Size: 49mm\*50mm

### 4.2.3 Arduino Nano R3

### 4.2.4 RFID Reader Module

RFID (radio-frequency identification) uses electromagnetic fields to transfer data over short distance. It is useful to identify people, to make transaction and related authentication jobs. Now a days, it is commonly used in security systems e.g: doors lock. RFID modules are very affordable, such as Mifare MFRC522 chip we have used in our project. This RFID readers works with a RFID's tag or card. The MFRC522



communicates with cards or tags up to 3 cm using a 13.56MHz electromagnetic field, then sends the data to an Arduino board through SPI communication [8].

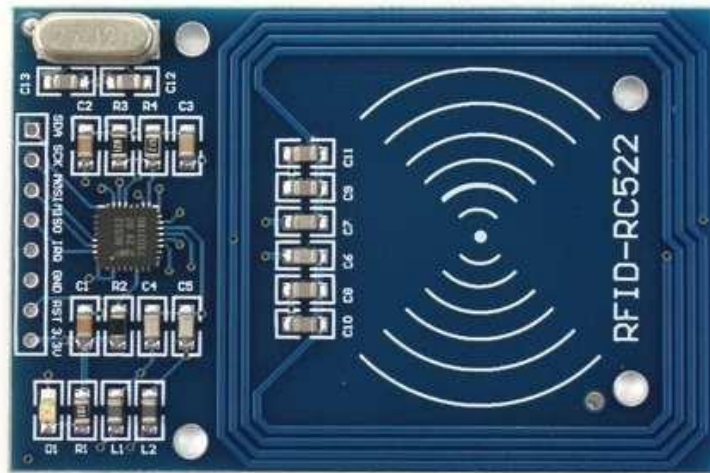


Fig. 4.4 MFRC522 RFID reader module

#### Specifications:

- Operating frequency: 13.56MHz
- Supply Voltage: 3.3V
- Current: 13-26mA
- Read Range: Approx 3cm with supplied card and fob
- SPI Interface
- Max Data Transfer Rate: 10Mbit / s
- Dimensions: 60mm × 39mm

#### 4.2.5 RFID Transponder

An RFID tag also known as RFID transponder consists of a chip, some memory and an antenna that exchanges data with a RFID reader through radio waves. RFID tags are either passive or active. Passive tags are mostly used because of less expense and smaller size, passive tags must be powered up by the RFID reader before transferring data. On the other hand, active tags have onboard power supply. In our project, we have used RFID tag and card both are passive.



Fig. 4.5 RFID transponder

#### 4.2.4 16\*2 LCD display

An LCD is an electronic display module which uses liquid crystal to produce a visible image. The 16×2 LCD display is a very basic module commonly used in DIYs and circuits. The 16×2 translates to a display 16 characters per line in 2 such lines. In this LCD each character is displayed in a 5×7 pixel matrix.

Specifications:

- Operating Voltage is 4.7V to 5.3V
  - Current consumption is 1mA without backlight
  - Alphanumeric LCD display module, meaning can display alphabets and numbers
  - Consists of two rows and each row can print 16 characters.
  - Each character is build by a 5×8 pixel box
  - Can work on both 8-bit and 4-bit mode
- It can also display any custom generated characters



Fig. 4.6 16\*2 Liquid crystal display

#### 4.2.4 Servo motor

Servo motor is a self-contained electrical device that rotate parts of a machine with great precision. The output shaft of this motor can be moved to a particular angle. In this security system, servo motor has been used to lock and unlock the door upon authentication. The rotating shaft of motor is set to a specific degree that locks the door and vice versa.



Fig. 4.7 Servo motor

#### 4.2.5 Gas Sensor

This MQ-5 gas detector sensor can detect LPG, natural gas, coal gas etc. Amount of gas level measured is represented by output voltage. It is fast responsive and sensitivity can be adjusted.



Fig. 4.8 Gas Sensor

## 4.3 Software Development

We used Arduino mega as microcontroller which is responsible for controlling other components. For programming the microcontroller, Arduino IDE has been used which is based on C or C++. This programming platform has been used for effective communications between sensors, actuators with the microcontroller.

### 4.3.1 Software Algorithm:

Step 1: Start

Step 2: User/Owner //who will try to open the door

Step 3: RFID authentication //user will put his RFID tag near the RFID reader

Step 4: Door unlocked //if the RFID tag matches

Step 5: Display status //status message will be displayed

Step 6: Door locked //when user push open/close button

If step 3 gets unsuccessful attempt

Step 7: GSM will be activated

Step 8: SMS //an alert SMS will be sent to owner

Step 9: Siren // buzzer will be activated for a while

### 4.3.2 Software Coding and Libraries:

Programming enables microcontroller to control other sensors and actuators used in this system. For each module, actuators and some sensors, different software libraries were used.

A software library is a package of codes that is used to control that particular sensor or actuator. Software library is developed to assist both programmer and compiler which executes the software. \

### RFID tag reading code:

```
#include <MFRC522.h> // Using "MFRC522" Library
#include <Servo.h>
#define SS_PIN 10
#define RST_PIN 9
MFRC522 mfrc522(SS_PIN, RST_PIN);
```

```

void setup()
{
  Serial.begin(9600);
  SPI.begin();
  mfrc522.PCD_Init();
}
void loop()
{
  // Look for new cards
  if ( ! mfrc522.PICC_IsNewCardPresent() )
  {
    return;
  }
  // Select one of the cards
  if ( ! mfrc522.PICC_ReadCardSerial() )
  {
    return;
  }
  //Show UID on serial monitor
  String content= "";
  byte letter;
  for (byte i = 0; i < mfrc522.uid.size; i++)
  {
    content.concat(String(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " "));
    content.concat(String(mfrc522.uid.uidByte[i], HEX));
  }
  content.toUpperCase();
  content.substring(1) // Contains hexadecimal code of RFID tag
}
}

```

### **Servo Motor Control Code:**

```
#include <Servo.h> //Using "Servo.h" Library
Servo myservo;
void setup()
{
  myservo.attach(6);
  myservo.write(90); //initial position of servo is 90 degree.
}
void loop()
{
  myservo.write(0); // set servo position into 0 degree
  delay(1500);
  myservo.write(90); // set servo position into 90 degree
  delay(1500);
}
```

### **LCD Display Code:**

```
#include <LiquidCrystal.h> // Using "LiquidCrystal.h" Library
// initialize the library by associating any needed LCD interface pin
// with the arduino pin number it is connected to
const int rs = 12, en = 11, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
void setup() {
  // set up the LCD's number of columns and rows:
  lcd.begin(16, 2);
  // Print a message to the LCD.
  lcd.print("Welcome Home");
}
void loop() {
  // set the cursor to column 0, line 1
  lcd.setCursor(0, 1);
  lcd.print("RFID matched");
}
```

## PIR Motion Detection Code:

```
int sensor = 2;          // the pin that the sensor is attached to
int state = LOW;        // by default, no motion detected
int val = 0;           // variable to store the sensor status (value)

void setup() {
  pinMode(sensor, INPUT); // initialize sensor as an input
  Serial.begin(9600);     // initialize serial
}

void loop(){
  val = digitalRead(sensor); // read sensor value
  if (val == HIGH) {        // check if the sensor is HIGH
    digitalWrite(led, HIGH); // turn LED ON
    delay(100);            // delay 100 milliseconds

    if (state == LOW) {
      Serial.println("Motion detected!"); //Motion Detected
      state = HIGH; // update variable state to HIGH
    }
  }
  else {
    digitalWrite(led, LOW); // turn LED OFF
    delay(200); // delay 200 milliseconds

    if (state == HIGH){
      Serial.println("Motion stopped!"); //Motion Stopped
      state = LOW; // update variable state to LOW
    }
  }
}
```

## SIM 900A SMS Sending Code:

```
#include <SoftwareSerial.h> // Using "SoftwareSerial.h" Library
SoftwareSerial mySerial(9,10); //Pins connected to GSM Module

void setup() {
  Serial.begin(9600);
}

void loop() {
  mySerial.println("AT+CMGF=1"); // Set to SMS Mode
  delay(1000);
  mySerial.println("AT+CMGS=\"+01631490995\"\\r"); //Set Mobile Number
  delay(1000);
  mySerial.println(message); //Send message command
  delay(100);
  mySerial.println((char)26); // ASCII code of CTRL+Z
  delay(5000);
}
```

## Arduino IDE

Arduino is an open-source platform used to develop electronics projects. Arduino consists of both programmable circuit board and a piece of software that is known as Arduino IDE (Integrated Development Environment). This IDE runs on computer and used to writing, compiling and uploading program to many varieties of physical board [9].



Fig. 4.9 Arduino IDE



The Arduino Platform has become very popular among hobbyist and developers. Arduino products are distributed as open-source hardware and software and are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL).

Here are some reasons of using Arduino IDE:

- It is open-source and extensible software.
- It has a large community all over the world.
- It is a cross-platform IDE and very popular.

# CHAPTER 5

## RESULTS AND DISCUSSIONS

### 5.1 Introduction

This chapter will present all the results and calculations and relevant discussions.

### 5.2 Test for different operations.

Table 5.1 The following table shows operational status of components in different situation:

State	Mode	Door Lock Status	Buzzer Status	GSM Status	RFID Status	LCD Status	Room Light	Comments
1	User Access (Authenticated)	Unlocked	Off	Off	Active	Active-Display welcome message	On	Successful
2	Unauthorized Attempt	Locked	On	Active-Notify Owner	Active	Active-Display alert message	Off	Successful
3	User Exit	Locked	Off	Off	Active	Active-Display goodbye message	Off	Successful
4	Ga Leak	Locked	On	Active-Notify Owner	Active	Active-Display Alert message	off	Successful
5	Idle	Locked	Off	Off	Active	Active	Off	Successful

# CHAPTER 6

## CONCLUSIONS

### 6.1 Conclusions

We implemented our idea in this project with reliable and comparatively low cost materials as well as friendly operations. We have studied to find out a security solution considering our socio-economic condition. However, this system is good enough to be implemented in home as well as other establishments. We will be working with this project with a view to more furnished and reliable implementation of our idea. We also have some future plan with this project.

### 6.2 Limitations of the Work

New technology comes with new risk and no system is full proof. Here are some limitations which are visible to us:

1. The door lock will only place a barrier to open the door but it has to be opened manually.
2. Total home or establishment will be unusable if any power or logical failure occurs.
3. The system can't count how many people are entering or exiting, this will create trouble for the system to make decision in some situations.

### 6.3 Future Scopes of the Work

This is an initial approach to implementation of our idea. We believe that we will make it worthier of usability and reliability through our future effort. We have plan to add some features e.g. biometric authentication, counting number of people inside the home, number of people entering and exiting etc.

Moreover, to make the system more user friendly and modern, we will make an android application that will show every happening to the owner and enable him/her to take immediate action through that application from anywhere.

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