THE UNIVERSITY OF TURKISH AERONAUTICAL ASSOCIATION

INSTITUTE OF SCIENCE AND TECHNOLOGY

Designing a Smart Safety Management System for Smart Cities

MASTER'S THESIS

Asmaa Slahaldin Ibrahim Al-JORANI

THE DEPARTMENT OF INFORMATION TECHNOLOGY

THE PROGRAM OF INFORMATION TECHNOLOGY

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Supervisor: Assist. Prof. Dr. Shadi AL SHEHABI

Co-Supervisor: Dr. Montadar Abas Taher

November 2016

Asmaa Salah, having student number 1403660075, enrolled in the Master Program at the Institute of Science and Technology at the University of Turkish Aeronautical Association, after meeting all of the required conditions contained in the related regulations, has successfully accomplished, in front of the jury, the presentation of the thesis prepared with the title of: "Designing a Smart Safety Management System for Smart Cities"

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THE UNIVERSITY OF TURKISH AERONAUTICAL ASSOCIATION

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I hereby declare that all the information in this study I presented as my Master's Thesis, entitled: Designing a Smart Safety Management System for Smart Cities, has been presented in accordance with the academic rules and ethical conduct. I also declare and certify with my honor that I have fully cited and referenced all the sources I made use of in this present study.

16.08.2016

Asmaa Slahaldin Ibrahim Al-JORANI

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November 2016 **Asmaa Slahaldin Ibrahim Al-JORANI**

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LIST OF ABBREVIATIONS

IoT	Internet of thing
IPV6	Internet Protocol Version 6
NFC	Near Field Communication
OSI	Open System Interconnection Model
BAS	Building automation System
RSS	Radio Subsystem
NSS	Network and Switching Subsystem
OSS	Operation and Support System
HLR	Home Location Register
VLR	Visitor Location Register
MSC	Mobile Services Switching
BSS	Base Station System
OMC	Operation and Maintenance Center
AUC	Authentication Center
EIR	Equipment Identity Register
MS	Mobile Station
ME	Mobile Equipment
BTS	Base Transceiver Stations
FCS	Frame Check Sequence
SCK	Serial Clock
SFD	Start Frame Delimiter
LAN	Local Area Network
ADC	Analog to Digital converter
EEPROM	Electrically Erasable Programmable Read Only Memory
GSM	Global System for Mobile Communication
ICSP	In Circuit Serial Programming
IR	Infrared
MISO	Master In Slave Out
MOSI	Master Out Slave In

PWM	Pulse Width Modulation
SIM	Subscriber Identity Module
SMS	Short Messaging Servicing
SMSC	Short Message Service Centre
SPI	Serial Peripheral Interface
SRAM	Static Random Access Memory
SS	Slave Select
USB	Universal Serial Bus
ADK	Accessory Development Kit
GUI	Graphical User Interface
I/O	Input /Output
RJ45	Registered jack
IDE	Integrated Development Environment
LCD	Liquid-crystal display
LPG	Liquefied Petroleum Gas
M2M	Machine 2 Machine
PC	Personal Computer
TCP/IP	Transfer Control Protocol / Internet Protocol
TTL	Time to live
PIR	Passive Infrared Sensor
RF	Radio Frequency
RFID	Radio Frequency Identification
FTDI	Future Technology Devices International

ABSTRACT

Designing a Smart Safety Management System for Smart Cities

Al-JORANI, ASMAA

Master, Department of Information Technology

Thesis Supervisor: Assist. Prof. Dr. Shadi AL SHEHABI

Co-Supervisor: Dr. Montadar Abas Taher

November 2016, 77 Pages

The building automation system becomes so important in our daily life because it gives us easy controlling and monitoring on our electronic home devices. This thesis presents the design and implementation of building automation system (BAS) that has been designed for internet of things (IoT) technologies to automate a number of home devices like TV, Fans, and Freezer and gets alert notifications when there is any risk in any home. BAS consists of two parts, hardware and software. The hardware part is smart home device, which consists of many hardware components Ethernet shield, GSM SIM900a, Microcontroller (Arduino Mega 2560) and some types of sensors such as Heat, Movement and Gas. Also, it includes access control system for family if they have permission to access this building depending on card IDs. Ethernet shield in BAS is used to communicate the microcontroller with the internet. Additionally, GSM module is used to send and receive alert notification between the owner and BAS. Moreover, BAS can make monitoring for doors and windows if they are open legally or illegally. The software part is BAS which is a web application that is developed by using PHP, MySQL, HTML5, and CSS3 programming languages. BAS is a real time monitoring and controlling and gives alert when there is any risk in any home in the city. Additionally, we can select who enters to the building by adding their IDs to the database for BAS. Furthermore, it can turn ON/OFF electronic devices in home via internet.

Keywords: Smart City, Intelligent Home, Smart home, Home Automation and Security, Arduino Mega 2560 module.

ÖZET

Akıllı şehirler için akıllı güvenlik yönetim sistemi tasarlama

Al-JORANI, ASMAA

Bilgi teknolojisi bölümü,Yüksek Lisans

Tez danışmanı: Assist. Prof. Dr. Shadi AL SHEHABI

Ortak danışman: Dr. Montadar Abas Taher

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Yapı otomasyon sistemi günlük yaşamımızda çok önemli bir hal almıştır çünkü bize kolay kontrol ve elektronik ev aletlerini izleme fırsatı vermektedir. Bu tez,TV, Fan, dondurucu gibi birçok ev aletleri gibi için tasarlanan Yapı Otomasyon Sisteminin (YOS) uygulanması ve tasarımını sunar, evdeki herhangi bir risk durumunda alarm uyarılarını alır. YOS donanım ve yazılım olmak üzere iki kısımdan oluşur. Donanım kısmı; Ethernet kalkanı, GSM SIM900a, Mikrokontrolcü (Arduino Mega 2560) ve sıcaklık, hareket, gaz gibi sensör türlerinden oluşan akıllı ev cihazıdır. Kimlik kartı ile binaya giriş yapmaya izni olan ailenin kontrollü olarak sisteme girişini sağlar. YOS'taki Ethernet kalkanı internet ile mikro kontrolcü telekomünikasyon amacıyla kullanılır ve buna ek olarak, GSM modülü, sahibi ve YOS arasında alarm uyarılarının gönderilmesi ve alarmın alınması için kullanılır. Ayrıca YOS, normal şekilde açılan ve başkası tarafından zor kullanılarak açılan kapı ve pencerelerin izlenmesini de sağlar. Yazılım kısmı, PHP, MySQL, HTML5, ve CSS3 programlama dillerinin kullanılmasıyla geliştirilen web uygulamasıdır. YOS, şehir içindeki herhangi bir risk durumunda alarm veren, gerçek zamanlı izleme ve kontrol sistemidir. YOS için veri tabanına binaya giren kişinin kimliklerini ekleyerek bu kişileri seçme imkanımız da bulunmaktadır. İnternet aracılığıyla evdeki cihazların açıp, kapatılması mümkündür.

Anahtar Kelimeler: Akıllı Şehir, Akıllı Ev, Ev Otomasyon ve Güvenlik, Arduino Mega 2560 Modü.

CHAPTER 1

INTRODUCTION

Science is progressing rapidly with the current technology representing the current summit reached by the human mind. In other words, it can be said that the current technology represents the product of man's past and present. When once a man speaking with his watch was considered science fiction, it is now reality. With this in mind, the contemporary world is witnessing unparallel development in the field of communication engineering. Analogue communication systems have evolved into digital systems and scientists and researchers are working hard to increase the speed of data transfer. The rapid evolution that underwent computer and computer systems in the nineties is not taking place with global digital communication systems, which is creating an ever more connected world.

Users become surprised and started to interact with these enormous developments in the world of digital communications significantly. An enlarging number of material items are being associated with the Internet at an extraordinary average understanding the possibility of the Internet of Things (IoT). A fundamental case of these objects incorporates indoor regulators; HVAC (Heating, Ventilation, and Air Conditioning) observing and controlling frameworks which empower keen houses. There are additionally different spaces, and situations in which the internet of things can assume an amazing part and enhance the nature of our lives. These applications incorporate transportation, social insurance, mechanical computerization, and crisis reaction to regular and man-settled on catastrophes where human basic leadership is troublesome [1].

The internet of things (IoT) empowers physical articles to see, listen, think and achieve tasks through having them communicate with each other to share data, and also to arrange choices [1]. The IoT changes such articles from being customary, to

Savvy via abusing its basic advancements, for example, universal and pervasive figuring, inserted gadgets, correspondence innovations, sensor systems, internet conventions and applications. Smart things alongside their assumed errands constitute an area of particular applications (vertical markets) while omnipresent registering and administrations generates application space autonomous administrations (horizontal markets). In Figure 1.1 a presentation to the general idea of the internet of things (IoT) in which each of area particular enforcement is associating with range free administrations, while in every field sensors, and actuators interact specifically with one another [1].

After some times, the IoT is required to have noteworthy homes and businesses functions, add to the personal satisfaction and develop the world's economy, for instance, making homes intelligent will empower their occupants to consequently open their carport, when achieving house, set up their espresso, control atmosphere, control frameworks, TVs, and different apparatuses. Keeping in mind the end goal to understand this potential development, rising advances and advancements, and administration applications want to become relatively to match mart requests and client requirement. Moreover, gadgets should be created to fit client necessities as far as accessibility in anyplace and at whatever time.

Additionally, new conventions are required to correspond with the similarity among heterogeneous things (vehicles, telephones, living things, machines, merchandise, and so on) [1].

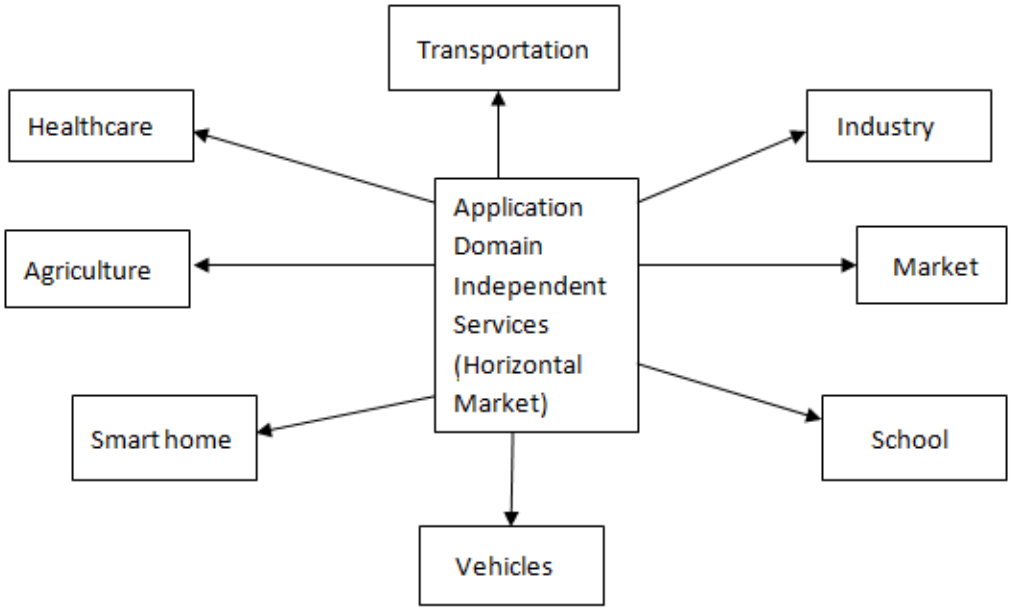

Figure 1.1: The idea of IoT

In 2010, the number of internet linked objects had exceeded the earth's human inhabitants [2] therefore, use a large addressing space. For example, internet Protocol version 6 (IPv6) becomes requisite to meet customer requirements for intelligent objects. Privacy and Security are other important requirements for the IoT , because of the inherent heterogeneity of the internet linked objects and the ability to control and monitor material things. Moreover, monitoring and management of the IoT should take place to guarantee the delivery of high quality services to customers at an effective cost.

1.1 Internet of Things

Despite the rapid progress techniques, Society is moving toward the "constant contact" type. Wiry and wireless networks anywhere, and also open standards, it's allowed and defined to address in particular Procedure. Associated with the "future concepts internet" that is being considered, advanced and constantly adapt in everyday life. One new notion is associated with the internet of the future which is

called internet of things (IoT). The IoT becomes seeing, where objects in the real world is portion of the internet: It's determined each unique object, and can be accessed for network, known position and status [3], where it was added many services and intelligence for actually expand internet, combining smoothly between the digital and the physical world, in the end that affect the personal and social environment.

1.1.1 Evolution of Internet of Things

Advanced internet technology expanded to the limits where internet connectivity has become cheaper and ubiquitous, and also in developing countries and rustic zones [3]. Storage device and processing power capacities are increasing significantly, whereas the sizes became smaller and allocated greatly for equipped with a various kind of sensor and servomotors. To bring together small and multi-function devices, sensors produce on a large scale across the communities in which devices are able to connect and have an online communication. It has the ability to sense, work, compute and to become actually a portion of the internet. Moreover, the material things are equipped with Radio Frequency Identification tags (RFID), and

Near Field Communications tags (NFC), or another electronic bar codes [3], which can be scanned via intelligent devices such as smart phones, tablet, computers, and another small device embedded with RFID\NFC readers.

This blend connects the material world and cyberspace by the intelligent device, which enhances internet abilities to the following generation of internet, which is called the internet of things [1]. Terms of the "things" in the side of lot is widespread and extremely featuring a range of materials [3]. For example, personal things; smart phones, smart watch, digital cameras, game, tablets, keyboards, etc., electronic equipment included with any Radio Frequency Identification tags or Near Field Communications tags, which can be connected to the internet by gateway device, see Figure 1.2 for a generic IoT structure.

The IoT connectivity is to connect from 'at whatever time, anyplace' for 'any-one' into 'at whatever time, anyplace' for 'anything' [3]. The IoT is able to relate real

world elements and embeds the intelligence in connection system for smartly process. It is specific information, and independent decision. Hence, the IoT is a key enabling the various kinds of useful applications and services which can sustain our environment, health, economies, and transportation that we never afforded before.

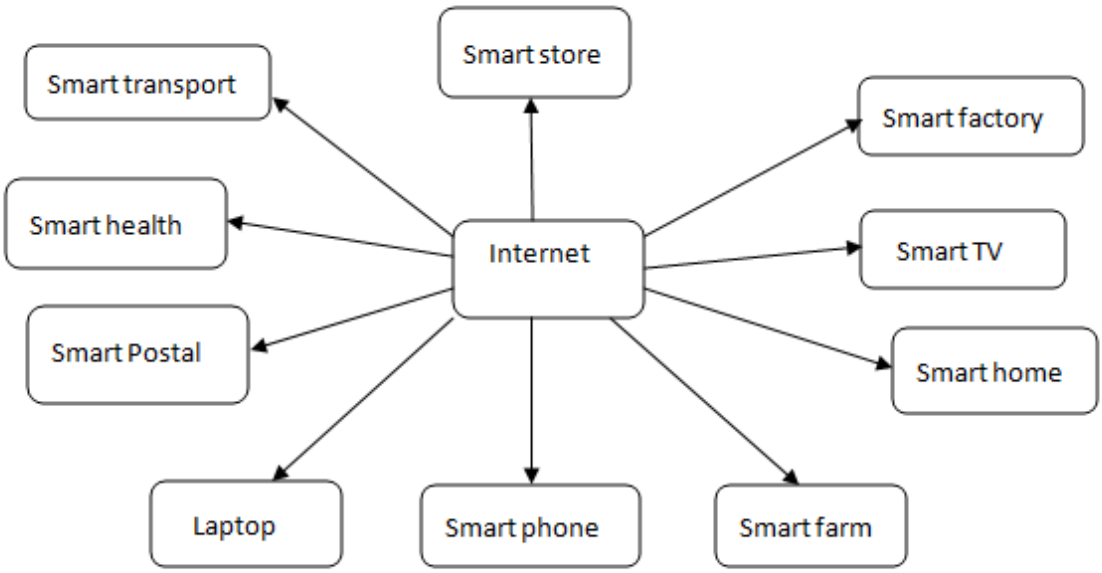

Figure 1.2: The generic structure of IoT

1.1.2 IoT Generic Architecture

The model of IoT architecture can be divided into five layers. It is shown in Figure 1.3 Each layer briefly is:

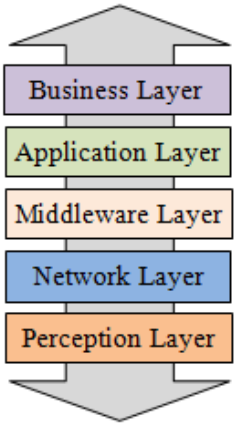

Figure 1.3: The IoT five layer architecture [4]

1. Perception Layer : it is similar to physical layer in Open Systems Interconnection model (OSI) that consist of the different kinds of sensor (such as infrared, Zigbee, RFID, etc.) devices and ecological basics. The perception layer mostly copes with the generally device administration Vis; identity, and accumulation of specific information by each kind of sensor appliance. The collected information can be locality, amount of dust in the air, shaking, wind speed, moisture, pH level, etc. This collected information send by this layer for its safe communication towards focal information processing system [4].
2. Network Layer: it plays an important part in safe transfer, and save the sensitive information secret from sensor device to the centric information processing system during 3G; 4G; WIFI, RFID ,UMTS, WIMAX, Satellite , Infrared, etc. depending on the kind of sensors. Hence, the network layer is mainly accountable for the transmission of information of the perception layer to the upper layer [4].
3. Middleware Layer : The appliances in the IOT system may create different types of services, when they are communicating and connecting with others. This layer has two main functions, including service administration and save less information layer to the database. Moreover, the middleware layer has the ability to process; account information retrieve, then automatically decide based on the calculation outcomes [4].
4. Application Layer : It is responsible for comprehensive applications administration based on the processed information in the middleware layer, and the loT applications can be intelligent health, intelligent glasses, intelligent transportation, intelligent postal, intelligent car, intelligent independent living, etc.
5. Business Layer: The business layer functions cover the full internet of things (IoT) applications and services administration; this layer can generate flow chart, executive report, executive report, business models, practically graphs, etc. Based on the amount of precise data extradited from lower layer and efficient data analysis process, based on the results of a good analysis. It will help the functional director to make more accurate decrees on the business strategies and roadmaps [4].

1.1.3 Applications of Internet of Things

According to the survey which has been done by the IoT -I project in 2010 [5], specified internet of things (IoT) circumstance applications could be assort in fourteen domains; intelligent home, lifestyle, intelligent city, transportation , retail, healthcare, intelligent factory, user interaction, emergency, environment, culture and touring, agriculture, energy and supply chain. This survey was based on 270 responses from 31 countries demonstrated the most interesting circumstance applications were: intelligent home, healthcare, transportation and intelligent city. However, some of the important applications of the IoT are shown in the next subsequent sections.

1.1.3.1 Mobile Ticketing

Electronic posters or billboards providing information about transportation services can be equipped with the Near Field Communications tags (NFC). The user can get information from the web by either pointing the mobile phone to the visual markers or hovering their mobile phone over the NFC tag [6]. The mobile phone automatically restores and combines information from the associated web services; costs, departure, stations and arrival time, available seats, number of passengers, type of services; and provides the proposition about tickets that suitable for each user.

1.1.3.2 Sensing

The IoT sensing, it means collecting data from the relevant objects within the network and send it back to the database, cloud, or data warehouse. The collected data is analyzed to take particular actions based on required services. The IoT sensors can be smarts sensors, wearable sensing device or actuators. For instance, companies such as pistols and smart things display intelligent hubs and mobile applications, which enable people to control and monitor the thousands of intelligent devices and appliances within buildings utilizing their smart phones.

1.1.3.3 Thefts

Application notifies the user to see if a precious objects moved from a restrictive zone, which denotes that the object is being stolen [7]. In this case, the incident has to be notified instantly to the security guards or owner through SMS, call, e-mail etc.

1.1.3.4 Comfortable Homes and Offices

Actuators and sensors distributed in homes and offices can make our lives easier in many ways. They can adapt room heating with specific preferences in advance, the weather, and the room lighting can be automatically changed according to the time of day. It can prevent dangerous incidents with the suitable alarm and control system [7], also it can dramatically reduce the cost of energy by automatically switching electrical equipments for instance, air conditioner, light bulb, television , kettle, fridge and so on, when they are not utilized.

1.1.3.5 Social Networking

This involved the application to automatically update information about the location and social activities in our social network sites, we possibly think of Radio Frequency Identification tags (RFID) that generate events for people and places for helping users in real time updates social networks [7]. The web/mobile application which users interface would offer a feed of events that their friends have precursory defined and the users are not only administer their friend lists, but also confer permission for each friend who has privileged access to information or events [5].

1.1.3.6 Losses

A search engine for objects is a tool that helps finding things which have been lost for a long time. The web based application is one of the best ways to find lost object that provide the latest recorded location for tagged objects or regain for certain object's location [7, 8].

1.2 Problem Statement

The privacy and security of information and network should be prepared with these basic principles like availability, integrity, authentication, confidentiality and authorization [9]. Unlike from the internet, the IOT will be applied to the most important global economy. For instance, intelligent city, home, transportation, health care, social and personal. Therefore, the privacy and security issues are the most concerned that need to be addressed in the internet of things (IOT). Thus, because of the increasing number of connected things, there should be a controlling system for these devices; especially the connected devices are increasing constantly. The connecting system must provide a certain level of security as well.

The IOT thus, will connect millions of devices around the globe. Homes, offices, companies, etc., as stated above, are going to be more intelligent and smarter. Around the world, there are many of such homes or working places. One of the projects of the IOT is to connect a complete city in one controlling system. Hence, everything inside home and city are controlled either by the owner or by the central system. Thus, some recognized points are noticed and listed below:

1. The existing system does not have plans to increase the number of controlled/monitored unlimited devices, or there are controlling systems but with poor plans.
2. Different things will be connected to the controlling system; therefore, different levels of security will be required.
3. Controlling systems must have a friendly interfacing panels, not expensive, household applicable, and could be resolvable if any network problem occurred.

1.3 Objective

In this thesis, a smart home automation system for green buildings will be designed. This system consists of two parts: hardware and software.

1. The first part is a smart device, this device consists of many hardware components such as Arduino Microcontroller (brain of the system) and some

type of sensors heat, motion (for power saving), gas, fire. And also include GSM module to send and receive alert notification between home and the owner. Also, this devise include access control system for the family they have a permission to access this building. The smart home device also control doors and windows if there was an illegal entry.

2. The second part is software like Building Automation system (BAS). This system works remotely by using internet to connect with many smart home devises in the city. Building automation system has two jobs: monitoring and controlling. Monitoring is to see all heat, gas and smoke values in all homes that connect to system (real-time monitoring). While controlling can turn on/off Anti-Fire system and Ventilation System remotely, in other words, a decision maker just like a human.

1.4 Thesis Organization

This thesis will be organized as follows:

- In the first chapter, and as shown above, a layout of the thesis has been provided.
- The second chapter contains Literature Survey. There will be a literature review for most of the previous works which have been implemented in the field of IoT.
- The third chapter contains a structure of the system which we suggested to achieve the objectives of this thesis.
- While in the fourth chapter, an implementation of the suggested system will be available, the results and their discussions.
- Last but not least, the conclusions and suggestions for future work will be given in chapter five.

1.5 Methodology

This research adopts the following methodology:

1. Defining the problem. The problem of a security and smart management system is explained in chapter two.
2. Problem statement. According to the literature survey, the problem statement was formed and the conceptual approach and problem formulation will be done accordingly.
3. Design specifications. Any system as an implementation must has design specifications. That is the most important parameters that directly affect the security and smart management and system values will be specified according to the standards.
4. Implementation model. Using the mathematical model in the third step, an implementation model was developed.

Figure 1.4 shows a flow-chart of the adopted methodology in this thesis. Each step, which is shown above, corresponds to a step in the flow-chart.

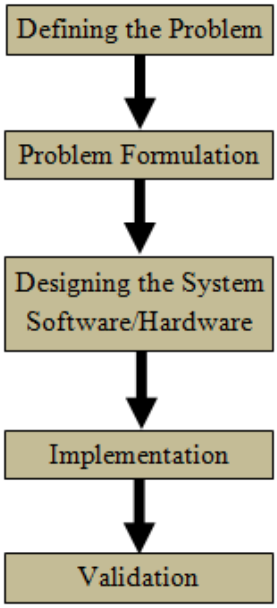

Figure 1.4: The adopted methodology in this thesis

CHAPTER 2

RELATED WORK

2.1 Introduction

This chapter consists of two parts. Firstly, a comprehensive literature review will be presented, and most of the previous related work. Secondly, the hardware components, which have been used in the previous work, will be discussed as the second part of this chapter. Furthermore, the required softwares which have been utilized will be explained as well.

2.2 Literature Review

With the great revolution of electronic devices and chips, the whole world is developing alongside, where a complete smart device can be seen nowadays. Smart home now is a required condition for a city to be smart. Various works have been done to achieve this goal. It becomes important for controlling house devices remotely utilizing the Wi-Fi technology [10]. A WiFi technology capable solution has confirmed to remotely control, provide house security and is cost-effective as compared to the previously existing systems. The home automation using IoT has experimentally proven to act satisfactorily via linking simple devices to it and the devices were successfully controlled remotely by the internet. The designed system not only watch the sensor data, such as motion and temperature sensors, but also actuates a process to let to perform a certain job, for instance switching-on the light when it gets dark. Also it saves the sensor parameters in a database in due course; this will help the user to anatomize the case of different parameters in the house any time and anywhere. The suggested system is preferable from the scalability and pliability point of view more than the commercially available home automation system [10].

Sirsath, N., et al., presented a home automation system by using mobile devices and cloud network [11]. This system works with the integration of multi-

touch mobile appliances, cloud networking, wireless communication, and power-line communication to provide the user with remote control of different devices and lights within their house, and this system utilizes a merger of the application of mobile phone, handheld wireless remote, and PC based program for providing a means of user interface to the customers [11].

Javal, D., et al., presented implementation of the home automation and security system by utilizing android ADK for designing and implement a control and monitor system for intelligent home [12]. Intelligent home system comprises of several subsystems that controlled via Lab VIEW software as the master controlling system in this work. Moreover, the intelligent home system prop via remote control system as a sub controlling system, besides the system is linked to the internet to control and monitor the home equipment's by using Lab VIEW from anywhere in the world [12]. Technological developments are giving large contribution for advancing the quality of human life and welfare, this technology can be used for monitoring and controlling the utilize of electrical energy and electronic appliances at house to ease the user [13]. Nowadays, automation technology in controlling electronic appliances and electrical energy is one of the main applications [14, 15] . In the prior study, the electrical installations for conditions controlling of lives equipment are still comparatively simple that is utilizing a traditional close-range control principle (manual). A few necessary points are involved when designing a house automation system. These points involve the facts that it should be commensurable so that new appliances can easily be integrated into it, and also it should be user friendly interface so that the appliance can be readily set up, controlled and monitored [14], and the established methods of house automation utilize an electrical appliance called microcontroller to control mission. Microcontroller is utilized as a support instrument to control the electric current. For instance, the control system with Short Message Service (SMS) on the cell phone as a remote control system automatically, and the connotation of electric current controlling utilizing this technicality is simple, but the operation will expend much data storage, and there will be many SMS sent from the GSM unit data carriage because the electric current is updated in every second [16]. Therefore, in order to reduce the data storage, the control system of electric current is made by utilizing an online space that links to

intelligent phone through internet. Intelligent phone is optional due to the intelligent phone has numerous characteristics, like QWERTY keyboard and a touch screen, accessing the mobile web, has an operating system. In other words, the intelligent phone is a small computer has the ability of a computer and a phone at the same time.

Fling, B [17], presented the mobile design and development: technicalities notions and practical to create web applications and mobile sites, in the intelligent phone, the technology that is applied known as mobile web application [17]. Mobile web application is a simple application for learning, most available, to be unified, and the easiest to be distributed. Also, the mobile web application is just a platform that is available and capable to be work on all mobile appliances, by utilizing a standard collection and the same protocol with a web desktop that is designed to intelligent phone [18]. Moreover, the advantage of the mobile web application system is that it is expected to ease electronic appliances control system greatly which can be controlled via an intelligent phone.

Lee, W.M. [19], is proposing an automation system in controlling the electronic appliances and electrical energy that is linked via the microcontroller and controlled via intelligent phone in two various running systems: iphone operating system (iOS) [19] and namely Android. This system is suggested for covering the problem that is encountered via the user; for instance, the difficulty for getting the information regarding the current utilize in each room and also the problem for controlling the electronic appliances manually from the outside. The smart home is not a new expression for science society, but it is still far more afar off people's seeing and audition, as electronic technologies are converging, the field of house automation is extending. Different intelligent systems have been suggested where the control is through internet [20, 21], or Bluetooth [22, 23], SMS based(short message service) [24], etc. The Bluetooth abilities are good and most of the current laptop, tablets, and mobile phones have built in adaptor that will indirectly reduce the cost of the system. However, it limits the control to within the Bluetooth domain of the environment, whilst most another systems aren't feasible to be executed as low cost solution.

ElShafee, A. and K.A. Hamed, proposes the Wi-Fi based house automation system [15]. It utilizes a PC with built in Wi-Fi card based web server that administers the linked house appliances; the users can operate and control the system locally (LAN) or remotely (internet).The system is supporting a spacious range of house automation appliances such as power administration components and security components. A similar architecture is suggested in [25], where the actions are coordinated via the house agent working on a PC. Also other papers like [26, 27] offered internet controlled systems comprising of a dedicated web server, database, and a web page to interconnect and administer the appliances. These systems use a PC that leads to a direct increase in power consuming and cost. Furthermore, the development and hosting of the web page will result in extra costs.

[28] Majeed, A.H., presented home security system which has been designed such that it has a special feature and which make a dial with the owner of the house to inform him that his house has been hacked. Arduino card was used which is considered one of modern programmable devices and utilize from speed dial function in mobile phone.

2.3 BACKGROUND THEORY

Home automation and to mention the automation of everyday missions with electric appliances utilized in houses, this can be a control of lights or more intricate chores like remote viewing of the house interiors for surveillance purposes. The emerging idea of intelligent houses offers a restful and safe environment for passengers. These contain automatic fire detection, motion detection, and temperature sensing. Moreover, it has developed security compared to another homes and also can send a message to the user about things happening inside our home, while we are a far from home. Also it can let a person control devices from a remote site via mobile phone utilizing GSM module [29]. The smart house system includes two units: the Arduino Mega 2560 Microcontroller and SIM900a GSM module. The SIM900a GSM unit is responsible to connect between the mobile stations and microcontroller. In addition, it utilized for sending and receiving instructions between the mobile station and the system, and alerts from the microcontroller unit.

Arduino Mega 2560 module is a brain module of the system, and it is used as the microcontroller board. For implementing a smart home system via controlling the electronic appliances a house remotely with the help of a mobile appliance, and get notices on movement around the restrictive premise. The Arduino Mega 2560 Board and SIM900a GSM module are utilized to connect between the devices and the mobile phone and sensors nominated at house .If the GSM network is available, it can use the mobile phone as a controller from anywhere in the world [30].

2.3.1 Arduino Products

The Arduino is an open source based on flexible hardware and software, and it is a built in AT-mega microcontroller model. The software system for Arduino is supported by Linux, Windows, and Mac. The Arduino is better than many kinds of the microcontrollers. And the software language is based on C- language. The different kinds of Arduino modules available in the markets containing the Arduino shields and Arduino kits, android [31].

2.3.2 Arduino Hardware Set

The Arduino is a device to make computers sense and control more of the physical world than your desktop computer. Also, the Arduino is an open source physical computing platform based on a simple microcontroller board, and a development environment to write software for the board. The Arduino platform works stand-alone or links to the PC through the USB. There are various kinds of Arduino hardware available in the markets. There are too many different kinds of Arduino hardware like Arduino Mega2560, Arduino Mini, Lily Pad Arduino, Nano, Arduino Bluetooth, These types are various in the type of microprocessor size and the number of ports and size [30].

2.3.3 Processor Selection

Arduino mega 2560 modules, it is a Microcontroller board and it is one of the devices which have many features one of the appliances that have several properties

to facilitate the users and integrate to other features. This appliance has 54 digital input/output, 14 pins are utilized to Pulse-width modulation (PWM) output and 16 is utilized as analog input. Four UARTs pins to hardware serial ports, it is worked properly when it is linked to 5V and a 16 MHz crystal oscillator, and each pin in Atmega 2560 is linked to another appliance as the output. Therefore, it receives the data from the web server and there after handled via microcontroller and sends it back by the pins to another appliance. Moreover, it receives the input from the linked appliance that will be processed in microcontroller and sends it back to the web server, the order of pin I/O (input or output) in intelligent home system gives in Table 2.1 [32].

Table 2.1: Configuration of Microcontroller Atmega2560 Pin

Pin	Microcontroller Atmega 2560
Reset	Arduino Board Reset System
3.3V	Output voltage , provided by Arduino Board for certain component
5V	Output voltage
GND	Ground
Vin	Input voltage 5 Volt
Digital I/O Pin	54 (of which 14 provide PWM output)
Analog Input Pins	16

The Arduino Mega 2560 can be powered via the external power or universal serial bus (USB) supply. The power can come either from an ADC converter (AC to DC) or battery, and the board can operate in 6V to 20V. If equip with less than 7V, and the 5V pin will equip less than 5V and the board may be uneasy. If utilizing more than 12V, the voltage regulator will overheat and harm the board. So it must range from 7 to 12 V. The power pins are volt input (Vin)**:** is the input power to the Arduino board when we are utilizing an external power source. The pin (5V) outputs a regulated 5V use to power the microcontroller, 3.3V: supply generated via the on-board Future Technology Devices International (FTDI) chip, and the GND**:** is Ground pins [30]. Memory**:** ATmega2560 has 256KB for storing code (with 8 KB utilized for the boot loader). Also it has 8KB of SRAM, 4 KB of EEPROM [30].

Input and Output**:-** each of the 54 digital pins can be utilized as an I/O pin , and select the input or output pin by utilizing pin Mode (), digital Write (), and digital Read () functions, and each these pins can provide a maximum 40mA. From these 54 pins, some pins have specialized tasks:

Serial 0: pin 0 (RX), pin 1 (TX), Serial 1: pin 19 (RX), pin 18 (TX), Serial 2: pin 17 (RX), pin 16 (TX), Serial 3: pin 15 (RX), pin 14 (TX). utilized to receive (RX) and transmit (TX).

SPI pins: SPI: 50 (MISO),51 (MOSI), 52 (SCK), 53 (SS) .The 16 analog input pins, each one provide 10 bits of resolution (1024 various values) and using analog Read() function [30]

The Microcontroller ATmega2560 has 4 hardware UARTs for TTL (5V) serial connection , and it has I2C pins and SPI pin connection [30].

2.3.4 Arduino Software Developing System

Arduino integrated Development Environment (IDE) is a software which is needed to be installed in a computer. The Arduino open source IDE makes it easy for writting code and uploads it on any arduino board. It works on Linux, Mac OSX, Windows and many other operating systems. This software can be free download from Arduino site or come with the Arduino. It utilizes a simplified version of C++ or C, making it easier to learn programming. In Figure 2.1, the three main steps that carried out in the IDE software. Firstly, program is coded and click the “verify” button. This is compiling the code and if there is no error then”upload” button should be clicked. This is done to upload the program to the Arduino board. Finally out is display in the serial monitor which can be viewed by clicking on serial monitor button. The basis of the IDE software includes two important tasks: the setup and loop**.** The setup () function is called when a sketch begins, pin mode (pin number, state). Use it to initialize variables, start utilizing libraries, etc. The setup function will just operate at one time, only after each power up or reset of the Arduino. On the other hand, the loop () function allows the program to respond and change when it is operating [33].

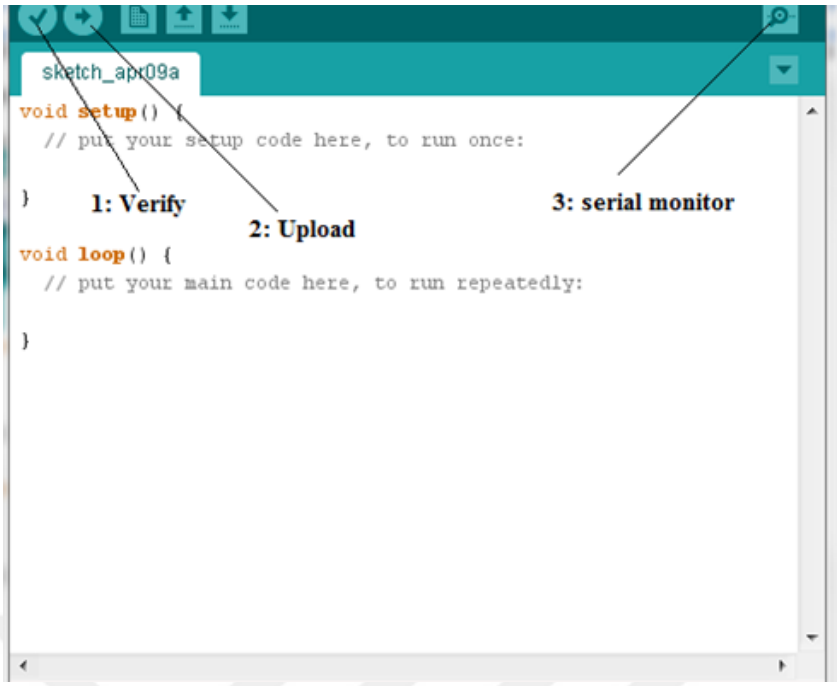

Figure 2.1: Arduino IDE environments [33]

2.4 Hardware Elements

The most necessary and most utilized shields in this work will be discussed completely in the next subsequent sections.

2.4.1 GSM Network

The GSM (Global System for Mobile Communication) is different from analog mobile network, the subscription and the mobile equipment are separated, and the smart card handling and the subscription data is saved in Subscriber Identity Module (SIM), the SIM is an intelligent card. The radio equipment is mobile equipment (ME). The mobile station is the integration of the Subscriber Identity Module and the mobile equipment (MS = SIM + ME) [34]. The Short Messaging Service (SMS) is one of the integrated services in the GSM network that provides a way to send messages of a limited size to and from the mobile stations (MS). The processing of the SMS is done via the Short Message Service Center (SMSC) that has to be supported via the GSM network for the transmit of messages between the

MS and the SMSC .The Figure 2.2 shown the Functional architecture of the GSM network [34].

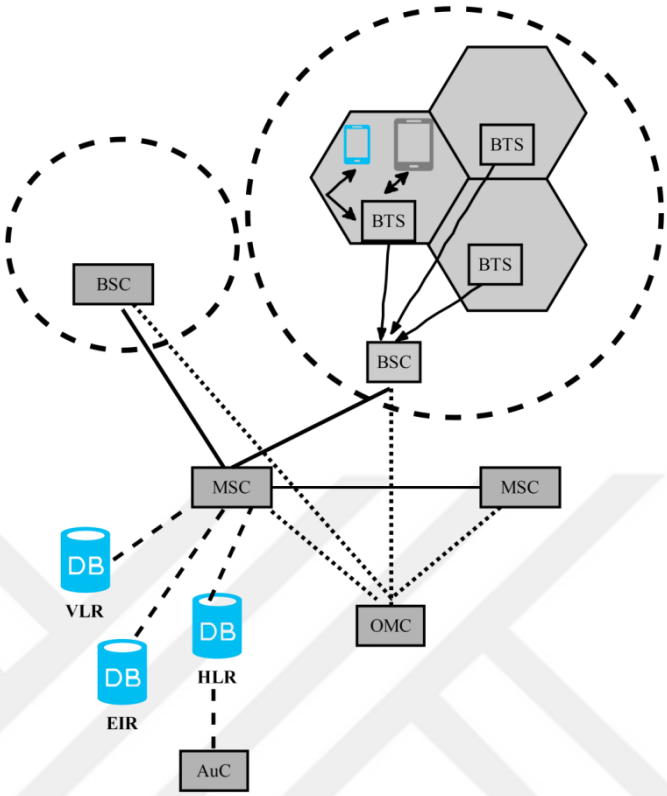

Figure 2.2: Functional architecture of a GSM system

The GSM network is divided into three main systems: the radio subsystem (RSS), the network and switching sub system (NSS), and the operation and support system (OSS) [35].

2.4.1.1 The Network and Switching Subsystem (NSS)

It is the heart of the GSM system. It links the wireless network with standard public, and performs handovers between various BSS, include tasks for worldwide localization of users and supports accounting, roaming, and charging of users between various providers in various countries networks, the NSS includes the following functional parts [35]:

-The Home Location Register (HLR), it is the most important database in a GSM system. it includes data of all mobile subscribers registered in its area. It stores

permanent data about subscribers, location information; subscriber's serving profile, and activity case.

-The Visitor Locations Register (VLR), the VLR includes data of all mobile subscribers visiting its MSC service area. When a mobile station (MS) roams into a new MSC area, the VLR connected to that MSC will request data about the mobile station from the HLR. Later, if the mobile station makes a call, the VLR will have the information needed for call setup without having to interrogate the HLR each time.

-The Mobile Services switching center (MSC), the MSC switches the calls between MS. It performs the phone switching tasks of the system. Furthermore, it controls calls to and from other phone and data systems. And also it performs for instance, tasks as toll ticketing, network interfacing, and common channel signaling.

2.4.1.2 Operation and support system (OSS)

It is the third portion of a GSM system; and the OSS includes the important tasks for network operation and maintenance, and the operation and Maintenance center for BSS (base station system). In addition, the operation and Maintenance center for NSS. (See Figure 2.2). The following entities have been defined:

-Operation and maintenance center:

The OMC controls and monitors all other network by the O interface. The OMC administration functions are security management, case reports of network, subscriber and traffic monitoring.

-Authentication Center:

The AUC handles confidentially and security facilities with the system. The authentication center (AUC) protect network operators from various kinds of fraud found in today's cellular world.

- Equipment Identity Register:

The EIR includes information on all mobile station equipments (MS) in the system which prevents calls from unauthorized, defective mobile stations or stolen.

2.4.1.3 Radio Subsystem (RSS)

The RSS comprises the MS and the BSS (base station subsystem). The Figure 2.2 shows the communication between the NSS and the RSS by the solid lines (A) interface, the connection to the OSS by the dashed lines (O) interface. And the BSS, all radio related tasks are performed in the BSS. It comprises of base transceiver stations (BTSs) and the base station controllers (BSCs). The base station controllers (BSC) controls call set-up and physical links between the BTS and the MSC. It is a high amplitude switch that provides functions like cell configuration data and control of radio frequency (RF) power levels in base transceiver stations. A number of the BSC are served via an MSC. Finally, the base transceiver stations handle the actual radio interface to the mobile station. It is the radio equipment (transceivers and antennas) needed for servicing each cell in the network. A set of BTS are controlled via the BSC.

2.4.2 SIM900A GSM Module

It works to connect with the GSM network, and it is an important portion of the system responsible for connections between the mobile phone and microcontroller. This shield is accountable to send information from the microcontroller unit to the mobile station and to send the instruction from the mobile station to the microcontroller. The instruction sent via the user from the mobile station is performed via the microcontroller and also to the microcontroller unit. The SIM900a GSM shield is easy to use and small in size. The SIM900a work in many frequencies 850 MHZ, 900 MHZ, and 1800 MHZ, the SIM900a design in 3.3V and 5V to work readily and connect directly with the microcontroller. This modem connect with the Ardiuno by using UART connection, also it is appropriate for SMS [36]. The

SIM900a GSM has many of the features are built in SIM Card holder, Built in TTL (serial communication), Speaker and Headphone jacks, Input Voltage 5V to 12V DC. The normal operation temperature: is -20 ℃ to +55 ℃ [36]. Also the SIM900a GSM uses to transfer data between (Machine 2 Machine) in various places. It is used to transfer sensor data to the web server by using a remote in wireless sensor Network. Also, remote control of the appliance.

2.4.3 RFID Unit

The Radio frequency identification (RFID) offers security and particularity danger that must be accurately mitigated through operational, administration, and technical controls in order to realize the many benefits the technology has to offer. The Radio frequency identification can be utilized to identify several kinds of objects, for instance manufactured goods, people, and animals. This Shield is a form of automatic identification that utilizes electric or magnetic fields at radio frequencies (RF) for transmitting information. The cards save electronically the information. The RFID Shield prop a wide range of applications everything from asset administration and tracking to access control and automated payment. The Radio frequency identification systems can be very complicated, and implementations differ greatly across industries and sectors. The RFID system consists of three subsystems. The first is the RF which is performing identification and related transactions utilizing wireless connection, the second is Enterprise subsystem which includes computers running specialized software that can store, process, and analyze data acquired from RF subsystem transactions to make data beneficial to a supported business process. The third is inter-enterprise subsystem which connects enterprise subsystems when information needs to be shared across organizational frontiers. Every RFID system contain an RF which consists of two components: The tags and readers. The RFID tags are small electronic appliances that are affixed to objects. Each tag has a unique identifier, also have other characteristics like memory for storing additional data, security mechanisms, and environmental sensors. The RFID readers are appliances that wirelessly connect with tags to identify the item linked to each tag and probably associate the tagged item

with related data [37]. The communication between the reader and intelligent card is a serial port, of important advantages for the intelligent card is the data stored inside the intelligent card is a protected very well. And also, the smart card is utilized in banking [38].

2.4.4 Ethernet Shield

It is a kind of network cabling and signaling specifications developed via Xerox in the late 1970. While internet is a global network, Ethernet is a LAN (local area network). With Ethernet, it is possible for printers to share files sharing between machines. The term "ether" was coined by Greek philosopher Aristotle. Ethernet means a network of everywhere. The Ethernet technology is cheap, easy for installing, troubleshoot, expand and maintain, very reliable. Installation of Ethernet is easier also less expensive than another network protocols. Also, it presents efficient ways to communicate across Linux, PC, Mac, UNIX workstations, IBM mainframe, and several another types of computer systems. And also, Ethernet is more popular than other network protocol. It uses CSMA/CD (carrier sense multiple access) when transmitting data, carrier sense enables a computer appliance to sense whether or not other transmission is being carried over the network. CSMA/CD works as collision detection [39]. The Ethernet just defines the data link and physical layers of the OSI (Open Systems Interconnect) as shown below:

APPLICATION
PRESENTATION
SESSION
TRANSPORT
NETWORK
DATA LINK
PHYSICAL

-ETHERNET FRAMES

1-Aso the DIX called Ethernet II, frame contains the following fields:

Table 2.2: DIX Frame (Ethernet II)

8 bytes	6 bytes	6 bytes	2 bytes	46-1500 bytes	4 bytes
Preamble	Destination	Source	Type	Data	FCS

1- The Preamble of the frame, the first 7 bytes is the beginning of a new Frame and establishes synchronization stipulation and the last byte, has a 10101011bit pattern.

2- The hardware (MAC) address of the receiving appliance is the Destination Address.

3-The hardware (MAC) address of the sending is the source address.

4-The kind field specifies the network layer protocol utilized for sending the frame such as (TCP/IP).

5- The Data field includes information utilized via the network layer and mentions the kind of connection.

6- The Cyclic Redundancy Check (CRC), it is checking that the frame received is free from corruption.

Table 2.3: IEEE 802.3 Frame Format

7 bytes	1 bytes	6 bytes	6 bytes	2 bytes	46-1500 bytes	4bytes
Preamble	SFD	Destination Address	Source Address	Length	Data and Pad	FCS

The field's one and two do the same mission as the DIX preamble, and the start frame delimiter (SFD) has the same10101011-bit sequences found at the end of the DIX and both formats utilize the same number of bytes for performing the synchronization of the signals. The source and the destination addresses can be 2 or 6 bytes. The numbers of bytes indicates the length field in the data field. The data field

includes the data to be transmitted from appliance to appliance. If the data field is less than the required 46 bytes, in this case will be added a pad field to the data frame, the bytes added for padding purposes are commonly zeros and the Frame Check Sequence field (FCS) is utilized as fault detection task. The fault detection task is a computation completed via both the destination and the source appliances. If the calculations correspond, a fault is then generated.

2.5 Temperature, Gas, Movement Sensors

The sensors are appliances that measure a physical quality. For instance, temperature or light o and convert it to a voltage, also that the device detects events and give us the output value. We can use the sensors in our lives on a daily bases, like LM35 sensor, which is utilized for converting the temperature to the V (out). Sensors consist of two kinds: analog and digital sensors. A digital sensor's output can only be in one of two probable states. It is either ON (1) often +5V or OFF (0), 0V. The digital sensibility is constant with the unit. The kind of this sensor is called a linear sensor because the proportion is steady at all points of measurement, and analog sensor is needed for converting to the digital form via utilizing the analog to digital converter (ADC). There are various compilations of sensors according to various standard. Such as; the sensors can be categorized according to the substance and technology, transduction principles, property, application [40]. The sensor itself possibly can be active or a passive appliance. A passive sensor was designed for receiving and measuring the signal while an active sensor appliances utilized to measure signals transmitted via the sensors which were reflected. The variation between the passive and active sensor is about transfer the signal via the appliance. There are several properties of the sensors, response time and recovery time, sensitivity, dynamic range, cost and size [41].

2.5.1 Temperature Sensor

It is an integrated circuit to read temperature value, and V (out) of this kind is being linearly symmetrical. The characteristics of temperature sensor are easier to

use, more accurately than using athemistor, the output voltage more than thermocouples. And the types of temperature sensor are (LM35), LM35C, LM35CA, and LM35D. Moreover, available in various transistor packages TO-92, T0-46, TO-220 [42]. The LM35 is available packaged in hermetic TO-46 transistor packages; while the LM35C, LM35CA, and LM35D are available in the plastic TO-92 transistor package. Also the LM35D is available in the plastic TO-220 package. The LM35 sensor can be utilized as a basic centigrade temperature sensor to sense the temperature from +2 ºC to +150 ºC, and the full-range centigrade temperature sensor to sense the temperature between -55 ºC to +150 ºC. The voltage supply (+V) to LM35 sensor. The resistance (R1) is linked between –V(s) and V (out), and the temperature can be obtained in degree Centigrade from output voltage of the sensor V (out). Features of LM35 are: Calibrated directly in ° Celsius (Centigrade), 0.5°C accuracy guaranteeable (at +25°C), Low cost due to wafer-level trimming, rated for full −55° to +150°C range, nonlinearity only ±1⁄4°C typical ,Linear + 10.0 mV/°C scale factor, operates from 4 to 30 volts, suitable for remote applications, less than 60 μA current drain, Low impedance output, 0.1W for 1mA load, Low self-heating, 0.08°C in still air [42].

2.5.2 Gas Sensor

It is an appliance to detect several of gases in the zone. It is used in the security systems. Since this sensor detects several kinds of gases Methane, Smoke, hydrogen, and LPG. Mostly, this sensor includes two portions, ionized material and steel exoskeleton from the Gases. When the sensor subjected for any Gases, the ionized material becomes heated, and close to the sensing element, and this alteration in the resistance of the sensing element this change value of the current is going out from the sensor. The kinds of Gas sensor available in the market are MQ2, MQ306, MQ135, and MQ137. Each one of these works with the particular kind of Gas, the MQ2 semiconductor sensor use in the generic combustible gas. It is a work of sensitive components. MQ2: Sensitive for Methane, Butane, LPG, smoke. This sensor is sensitive for flammable and combustible gasses .The heater uses 5V. This sensor has 6 pin, and 4 of them are utilized to bring signals, and another 2 are utilized

to provide heating current. Some of the most important properties of this type of sensor are: Good sensibility to combustible gas in wide range, low cost and long life, high sensitivity to propane, LPG, and Hydrogen, simple drive circuit [43].

2.5.3 Movement Sensor

It is an electronic device utilized for detecting moving objects. This sensor gives an automatic notice to the person if there are any motions in the particular zone. There are several kinds for this sensor, the Passive infrared (PIR), Ultrasonic, Tomographic motion detector, Microwave. The PIR is the electronic appliance that measures infrared (IR) light radiating from objects in its field of view, also the passive infrared sensor are utilized in building the PIR based motion detector. This sensor detects any infrared source with one temperature, like a human passes in front of an infrared source with other temperature, like a wall. This doesn't mean that this sensor detects the heat from the object passing infront of it, while the object breaks the field which the sensor has determined like, the normal case. Generally, infrared radiation is invisible to the human eye but can be detected by electronic appliances for such a purpose. Infra mean below our ability for detecting it visually, and it is Red because this color symbolizes the lowest energy level that our eyes can sense before it becomes invisible [42]. The motion sensor has two slit; each slit is made of a special material that is sensitive to infrared (IR). The lens utilized here is not really doing much, so we see that the two slits can see out past some distance. This PIR sensor has a potentiometer to calibrate distance and delay time [44]. The sensor unit is easy for using with affordable price. The PIR sensor requires 100uA to 150uA and the voltage condition 3Volt -5Volt to run and also has precision from 0.1 to 6 meters with the ability for working at a temperature of-200C to700C. This sensor has a running wave length 7um - 14um and angle of coverage in 1200.

2.6 Buzzer Alarm

It is a sound warning device. It is used in many devices, timers, clocks, security system. It will be able for controlling the buzzer sounds. The pins for Buzzer alarm are: the output, power supply, and ground**.** This kind is very popular due to the small size, cheep, and connect directly with the Microcontroller [44].

CHAPTER 3

METHODS OF SMART HOME DISTANT CONTROL

3.1 Introduction

It is necessary to clarify SMS transmission by the Internet and GSM network, as it is needed in this work since the transmission speed of the SMS is important in the security system. Hence, this chapter will contain the modes of SMS transmission across both the Internet and GSM networks; we conduct an experimental study to compare the transmission of SMS across these networks. This chapter will also make a clear comparison of the differences between our work and the work stated in [30].

3.2 SMS Overview

SMS originally presented in in 1991 in Europe as a content informing administration considering the European Telecommunications Standards Institute (ETSI) measures for portable systems. SMS service is extensively used as part of a vast number of social and business applications such as delivery of e-mail notification, electronic voting, and delivery of stock quotations. Nowadays, SMS is used to supports most of the mobile networks including techniques: GSM, GPRS, CDMA. Moreover, SMS service supports sending and receiving audio, texts, animation and images. Originally, SMS can be found in Short Messaging Entities (SME) for example personal computers, mobile phones, servers [35].

3.3 Basic Network Architecture for SMS:

In a basic configuration of a network, the following elements can be found, as shown in Figure 3.1, Shorts Message Entity (SME), which sends or receives shorts messages, Shorts Message Service Centre (SC), where by which, stores, forwards

messages between the mobile station (MS) and the SME. Furthermore, there is a Gateway MSC For Short Message Service (SMS-GMSC), which receives messages from the SMSC, interrogates the home location register (HLR) for routing information and forward the messages to the mobile switching center (MSC) or Serving GPRS Support Node (SGSN), where GPRS is the abbreviation of General Packet Radio Service. The function of the HLR is a database uses for permanents storage and managements of user/subscriber profiles, while the MSC performs switching functions for mobile stations in a certain geographical area. On the other hand, the SGSN performs as a packet switching functions for MS in a certain geographical area. The SGSN is utilized instead of the MSCs when SMSs information is transferred over the GPRS. There is also the Inter Working MSC for Shorts Message Services (SMS-IWMSC), which receives messages from the MSCs or SGSNs and forwards them to the SMSC. The Visitor Locations Register (VLR) has a database that contains temporary information about roaming subscribers. The MSC and the VLR are always on the same platform. All of the above elements must work properly to be able to deliver the message to the mobile station [35].

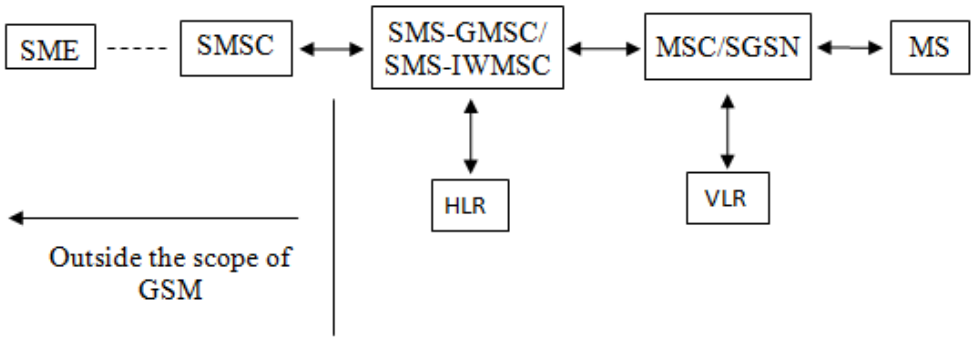

Figure 3.1: Basic mobile cellular architecture network

3.4 SMS Mobile Originated and Delivery Flow

SMS path between mobile device to another mobile device can be depicted in the following steps, see Figure 3.2; assume there are two mobile stations, MS-A and MS-B. Suppose MS-A originated an SMS to send it to MS-B, the message will leave

MS-A going to the base transceiver station (BTS), then from the BTS to the MSC, of course there are other stations to be passed away not shown in Figure 3.2 such as the base station controller (BSC) and the remote transcoder (RXCDR). However, the message will go from the MSC after many processing, as given in the previous section, to the SMSC, after that, the message will reach the HLR for other processing, as it has been stated in the previous section, then the SMS will travel to VLR of the MS-B, then from the VLR, the SMS will go to the BTS of the MS-B, where the MS-B is currently covered. Afterword, the BTS will deliver the SMS to MS-B. These procedures can be seen in Figure 3.2. The same path can be followed by the SMS of the MS-B to reach to MS-A, as shown in Figure 3.2 [35].

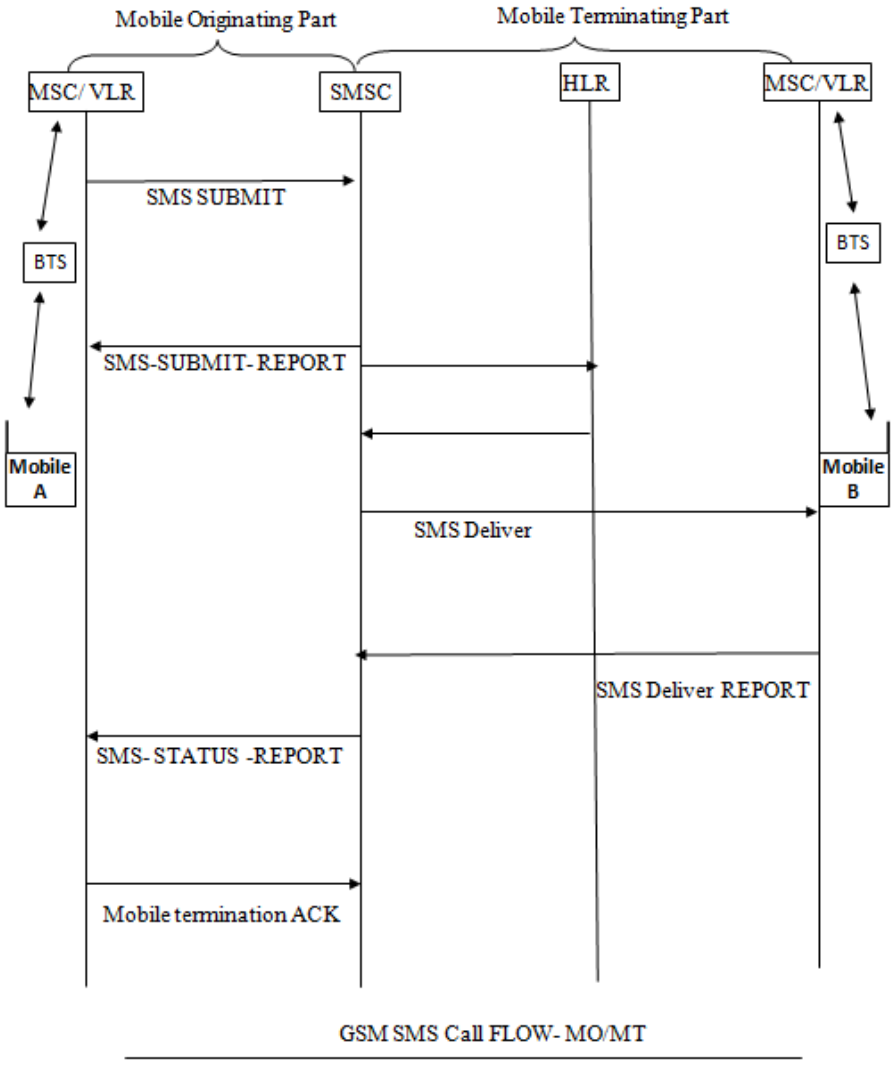

Figure 3.2: SMS Mobile Originated and Delivery Flow

SMS messages are transported in the core network utilizing SS7 (Signaling System 7). An important fact should be stated in this part that the SMS may not delivered instantly, it may delayed more than a minute or even more than an hour, while the internet message may delivered instantly. It is worth mention here that the SMS message can contains up to 140 octets, which stands for 160 English characters, or 70 Chinese/Arabic characters [35].

3.5 The Internet Today

Internet today cannot be considered as a simple graded structure. Generally, internet involves some wide and local area networks combined by providing sort of connection between appliances and transform stations. Nowadays, internet users can have access to the internet through internet service providers (ISPs). There are international internet service providers, local service providers, national service providers, regional service providers. Moreover, internet today can be provided by private companies not the government [45]. However, two kinds of connections can be found these days:

1. Point-to-point: It offers a specific link between two devices. The full power of the link is kept for a proper transition between those two devices. Most point to point connections need a wire or cable to connect the two ends. For instance, the process of changing a T.V channel by infrared remote control is an example of a point-to-point connection as in the shown Figure 3.3a [45].

2. Multipoint: it is the kind of connection in which more than two specific devices share one single link. The connectivity provided by a multipoint environment is shared either spatially or temporally. When more than two devices use the link at the same time then it is spatially share connection and when they use it in turns then it is a timeshared connection. As shown Figure 3.3b [45].

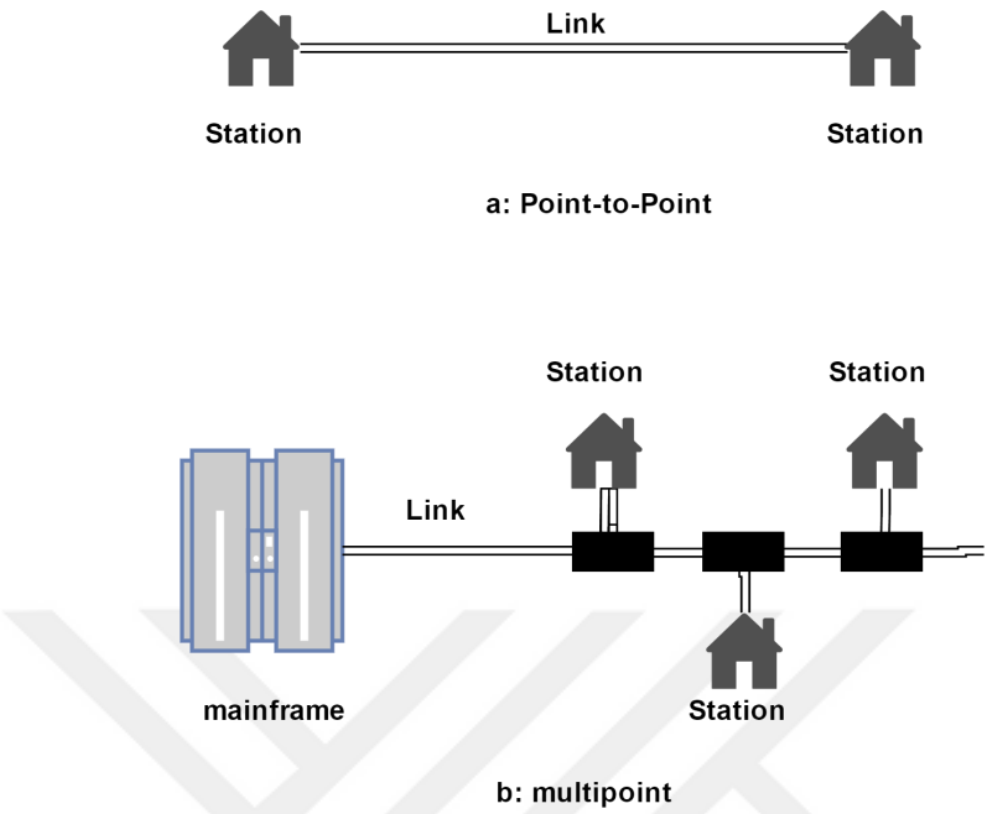

Figure 3.3: Types of connections: point-to-point and multipoint

3.6 LAYERED TASKS

The concept of layers is constantly used in our daily life. For instance, the process of sending a letter from one friend to another through postal mail would be very difficult without a service available from the post office. Figure 3.4 shows the steps in this task and we have a sender, a receiver, and a carrier that transports the letter [45]. The tasks are graded, as follows:

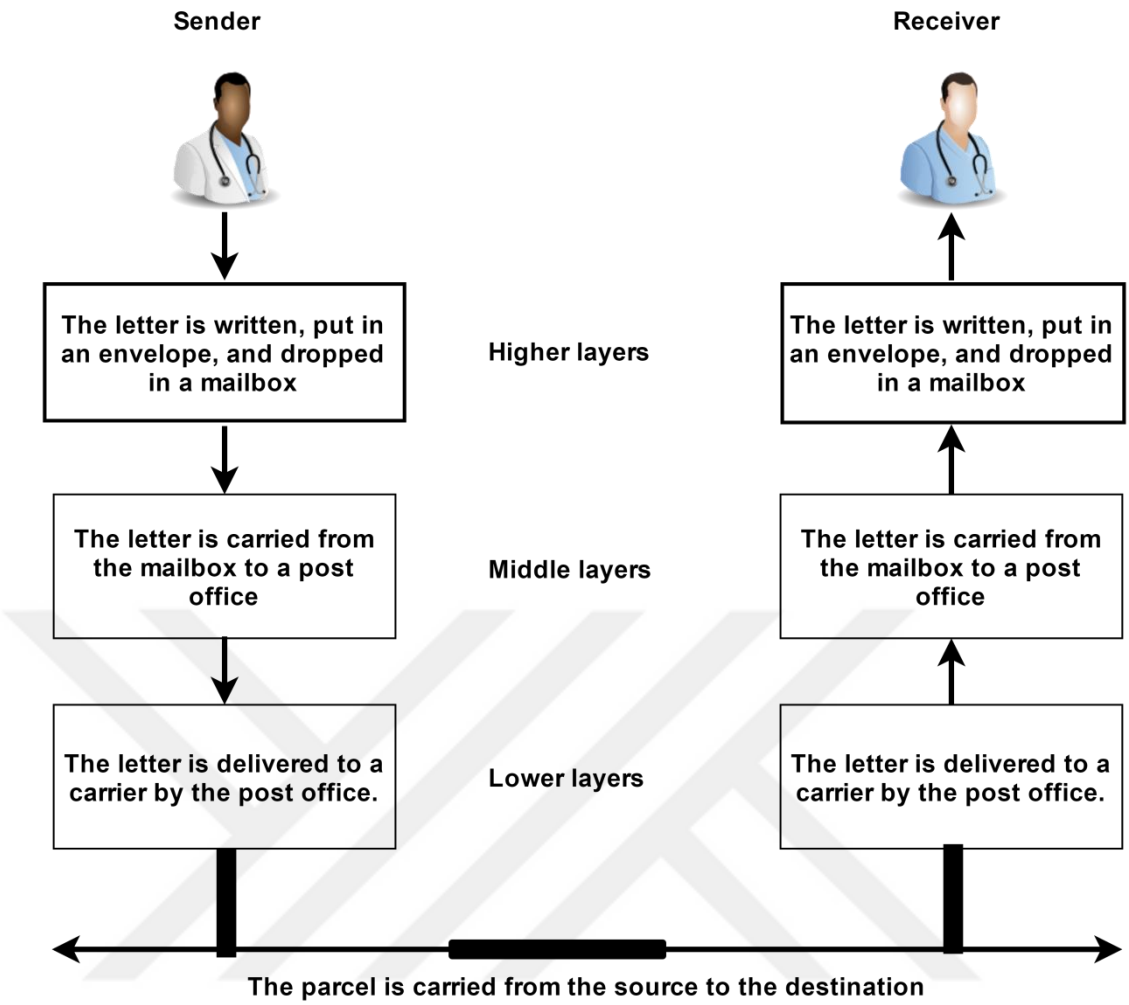

Figure 3.4: Tasks involved in sending a letter

-At the sender site [45]

1. Higher layer. The one who writes and sends a letter need to put the letter in an envelope and writes his/her address along with the receiver address, and drops the letter in a mailbox.
2. Middle layer. The letter carrier takes the letter and deliver it to the post office.
3. Lower layer. At the post office, the letter is sorted and carried for transportation.

-At the Way:

The letter would be on the way to reach the recipient. It may pass through the central post office on its way to the recipient's local post office. Afterword, the letter might be transported by truck, train, airplane, boat, or a combination of these [45].

-At the Receiver Site [45]

1. Lower layer. The carrier carries the letter to the post office.
2. Middle layer. The letter is sorted and taken to the recipient's mailbox.
3. Higher layer. The receiver picks up the letter, opens the envelope, and reads it.

-Hierarchy

Consistent with our analysis, both at the sender and receiver sites have different kinds of activities. The process of transporting the letter from the sender and the receiver is done by the carrier. Remarkably, the tasks mentioned must be done in the graded layers (hierarchy) provided. At the sender site, the process of writing and dropping the letter in the mailbox must be done before picking it up by the carrier and taking it to the post office. At the receiver site, the letter must be dropped in the recipient mailbox before being picked up and read by the recipient [45].

-Services

The layers at the sending site uses the services of the layer following it. The sender at the higher layer utilizes the services of the middle layer. The middle layer utilizes the services of the lower layer. The lower layer utilizes the services of the carrier. The Open Systems Interconnection (OSI) model was the model that controlled data communications and networking literature before 1990. Significantly, everyone had the belief that OSI model would be the standardized model for data communications; however, this was not the case. The TCP/IP protocol suite had the domination feature and controlled commercial architecture because it was mostly utilized and experienced through the Internet; the OSI model was never fully implemented [45].

Hence, the message will travel from transmitter to the receiver as indicated in Figure 3.5. Anode with physical address 10 sends a frame to a node with physical address 87. A link (bus topology LAN) connects the two nodes. This frame involves physical (link) addresses in the header at the data link layer. Remarkably, these addresses are the only ones needed. The header also involves information needed at this level. The trailer most likely involves extra bits necessary for error detection. As the figure illustrates, the sender is the computer with physical address 10 is, and the computer with physical address 87 is the receiver. At the sender layer, the data link receives data from an upper layer. It compresses the data in a frame, adding a header and a trailer. The header functions as the carrier of the receiver and the sender physical (link) addresses. It is important to note that the destination address, 87 in this case, comes before the source address (10 in this case) and this occurs in most data link protocols. We have illustrated a bus topology for an isolated LAN. In a bus topology, the frame is moves in both directions (left and right). The frame moved to the left dies when it reaches the end of the cable if the cable end is terminated properly. Sent to each station on the network, each one with physical addresses other than 87 drops the frame because the destination address in the frame does not suit its own physical address. However, the destined computer finds a match between the destination address in the frame and its own physical address. The frame is checked, the header and trailer are dropped, and the data part is compressed and delivered to the upper layer [45].

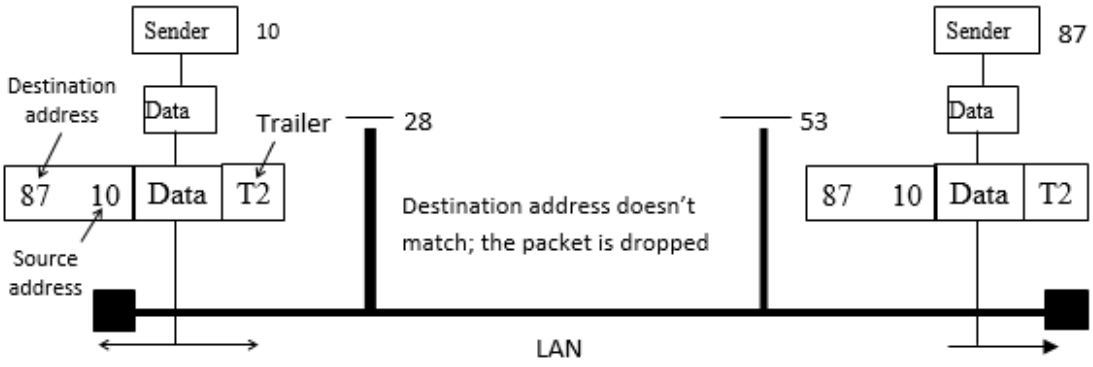

Figure 3.5: Physical addresses

-Comparison with the previous version of the System [30]

There are many new types of features added to the current study when compared with the previous one such as the type of connection environment, data storage and how it performs.

Firstly, this study uses a different type of environment connection. The type is an internet connection to send and receive the instructions between smart device with the server, which is more flexible.

Second, this thesis uses a server and a database to save the homes sensors data. This is a better way and easier to make a central controlling and monitoring system.

Third, the new system also includes a central controlling system (online system) to manage and control the homes that connected with it. In this feature, any home device includes an ID, the system use it to read and save all information for this home in the database server.

Fourth, the access control system uses a central server database. In this part, the administration saves all people's information in the city in one database and their card ID's. When any person wants to enter to any home, the smart home device sends his ID to the server to check it for authentication. The system send open the door or not, unlike the previous system [30].

Fifth, the new system uses two different types of controlling (owner or online system). Owner is controlling during send (“M”) character by SMS to the smart device, and send (“S”) character to change system-controlling mode. This new controlling component provides more security and controlling flexibility [30].

Sixth, the current system uses an employee management system for adding, deleting, and printing reports.

Seventh, online system includes one page to show all homes that are connected to the system, and sorts them depending on temperature and gas sensor values. If there is, any danger in the home, the central control system makes an alert.

Eighth, the new system uses a username and password to log-in to the system. No one can access to the system who just has permission.

Finally, as a comparison with the internet connection; usually, the SMS can follow this path, shown in Figure 3.2, to reach its final destination. During this path, at any block or in between the block, the message may dropped due to many reasons, such as, link problem, or one of the blocks went down, due to power problems, the subscriber may be deactivated in the HLR or in the VLR, etc. Therefore, the Internet connection is perform better than the GSM or other mobile cellular networks, since the mobile network includes too much air-links, unlike the internet network, which certainly has less number of air-links.

CHAPTER 4

SYSTEM ARCHITECTURE

4.1 Introduction

The system built in this thesis consists of two parts; hardware and software parts. The hardware comprises of two parts; the mobile phone station and the microcontroller unit. The mobile phone station is responsible for giving the command and the control instruction to the devices, and gets the response from the sensors. The second part of the hardware is the Microcontroller unit. It is responsible for controlling the devices and sensors. It connects all these parts and do the required processing operations on the information which are collected from the devices and from the mobile station. The Microcontroller is the system that controls and processes all information to and from all the other units of the system. Figure 4.1 shows the block diagram of the final system. From this block there are two important parts which are the Microcontroller Board and Sim900a GSM Module. In this system several sensors have been used, for example temperature sensor, gas detector sensor, motion sensor. Microcontroller unit connects with three sensors, Smart RFID card reader. The Ethernet Shield connects Arduino to the internet and the home light. Lm35 sensor is the temperature detector and the passive infrared sensor (PIR) is the motion detector of the system, while the MQ2 sensor is the gas/Smoke detector of the system. The data from all these sensors continually processed by the microcontroller and an alert is sent to the mobile station if there are any events in our home by sending SMS to our mobile phone directly. The software includes Building automation System (BAS) and it works remotely by using internet to connect with many smart home devises in the city. Furthermore, there are an ID number will be programmed in a card to each home in the city, to store all of the data of a home.

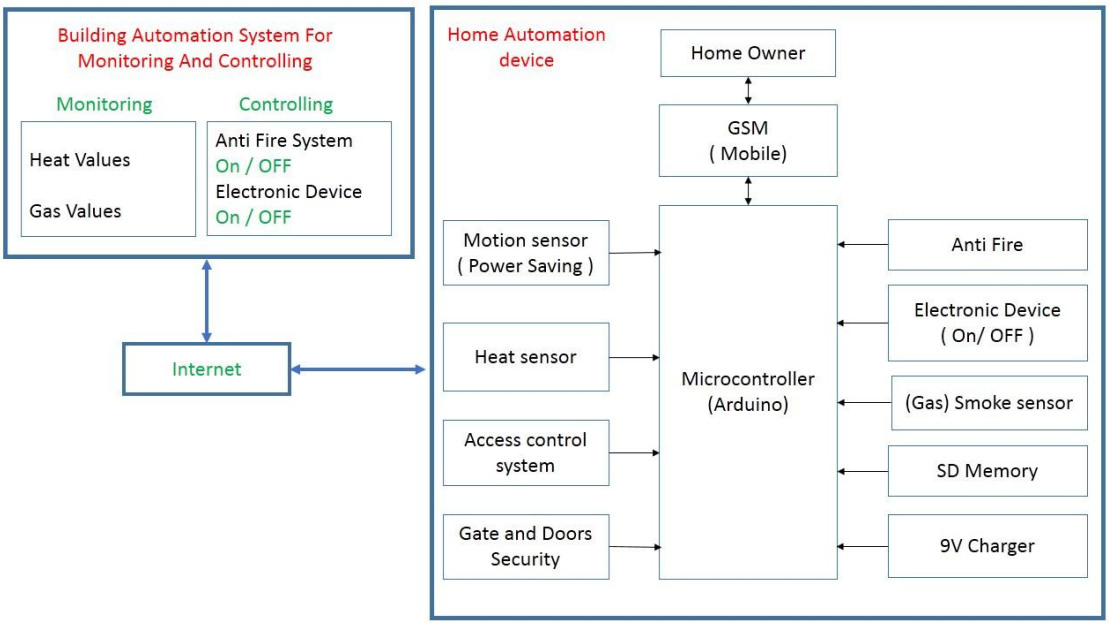

Figure 4.1: Block diagram of the system

These units are responsible for the security of homes and Light Home unit can be operated remotely by using our mobile station. In this system LED light is used to show the demo of the remote light management by using mobile station. The user can control the state of light, also make ON or OFF Remotely.

The SIM900a GSM module is the interfacing part between Microcontroller unit and mobile station; also, it is responsible for the communication between them. Thus, SIM900a GSM module is responsible for sending information from the microcontroller to the mobile station and sending from the mobile station to Microcontroller. The command sent by the user from the mobile station is executed by the microcontroller. The command to the microcontroller is sent by using text messages. The system works as a smart home system providing security and providing a remote management system for the devices inside the home.

4.2 Interfacing SIM900A GSM Module

The SIM900a GSM shield is an important part of the system for communication between Microcontroller and the mobile station. The GSM shield is

utilized to send / receive messages by Arduino, the SIM card is activated by pin code of SIM. The communication between GSM unit and Arduino is serial. It connects the Tx pin of GSM module to Rx (19) pin of Arduino and Rx pin of GSM module to Tx (18) pin of Arduino, and connects the ground pin of GSM unit to ground pin of Arduino. The microcontroller performs the action based on the instruction sent via the mobile phone as an SMS message. The interfacing SIM900A with an Arduino board is shown in Figure 4.2.

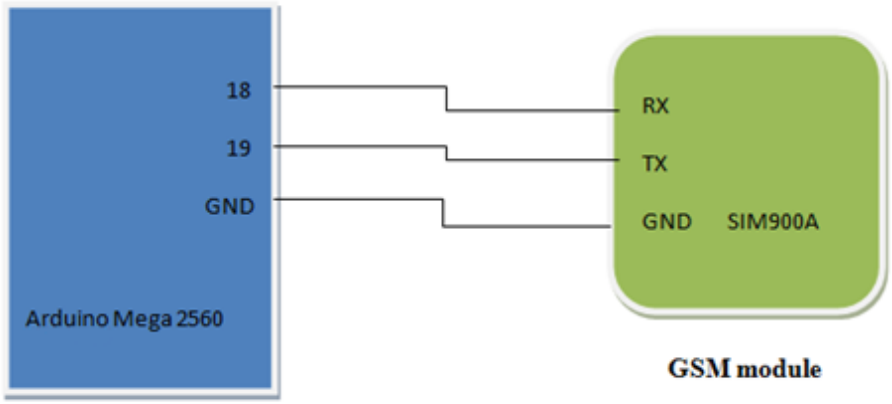

Figure 4.2: Block diagram of SIM900A with Arduino mega 2560

4.3 Structure and Implementing Sensors

Many different areas which have to be monitored repeatedly and devices which have to be checked in the house, such as the doors and windows need to be monitored from thieves, in case they try to open them and also it helps to know the state of electronic devices after leaving home. The temperature at home has to be monitored to give us alert when arrive it reaches a critical point. The monitoring of temperature, the movement of strange, and opening and closing doors and windows are assigned to sensors. We can implement sensors for different types of detectors according to the necessity of the application and the human desire, managing the process of the sensor by software. There are different kinds of sensors, they are

linked according to the output and the characteristics of the sensor. Some of the sensors need an external circuit to interact with the application that depends on the type of the sensor while others do not need.

4.3.1 Arduino Ethernet Shield

Arduino cannot connect to internet without the Ethernet shield. It provides a network IP stack, capable of both TCP and UDP modes. Moreover, it allows the Arduino board to connect with internet using Ethernet library. It can serve as a server, accepting incoming connections, or a client, making outgoing ones. The library supports up to four concurrent connection (incoming or outgoing or a combination). The user must include in the code the Ethernet library sketches, which support the communication with the internet. Most of these shields have a micro-SD card slot. This card is used to store files for serving over the network [46]. A standard RJ 45 connector is needed to make Ethernet enabled For internet connection, the shield should mount over the Arduino, also the shield should be connected to the internet using standard Ethernet cable then provide a power. As for the network setting, it should be assigned to the Ethernet shield MAC (Media Access Control) address and fixed IP address by using the function Ethernet. Begin(), if the network has DHCP which is enabled, then Ethernet begin(MAC address) is enough due to IP address is assigned automatically and it should be added fixed IP address as the argument of the function as Ethernet, begin (MAC address, IP). In the function, MAC address of the Ethernet shield which is array of 6 bytes and IP address of the Ethernet shield is array of 4 bytes. For the time being, MAC address of Ethernet shield is printed in its back. So we should utilize that during internet connection, while there is no MAC address printed in old Ethernet shield. In this case unique array of 6 byte must be assigned manually.

4.3.2 RJ 45

It is a type of connector for network cables, the connectors are commonly with Ethernet cable. RJ45 connectors contain 8 pins. The RJ45 is known as registered jack 45. Different colors in the cable identify different features. Each has its own identity [47]. There are various colors in the cable identify different features. RJ 45 is used to connect between network router and Ethernet shield.

4.3.3 Unit for detecting of heat level

It is one of many important fields to be monitored in the house and must to be known at any time. It is better to monitor the temperature of the house. LM35 is sensitive to measure the temperature and use in heat detector in this system. The advantage of Lm35 low cost, most sensitive between +2 C^o to +250 C^o and low power just +5v DC. The pin connection of LM35 is shown in Figure 4.3 The analog input port A0 of the Arduino board connect to the analog pin for LM35 and the power supply for LM35 connect to the 5V output port of the Arduino board, The other pins in LM35 connect to GND output port on Arduino Board. Now will be reading the output voltage of the sensor every second by the microcontroller via using the function analog Read. The function of output voltage is temperature. The temperature is calculated from the output voltage by using this formula this equation temp = (SUPPLY_VOLTAGE *100)/1024) 5.0V is SUPPLY_VOLTAGE, temp = (5.0*100)/ 1024= 0.48828125, thus temperature can be determined by using mathematics temp= temp* 0.48828125**,** to convert temperature value from analog to digital because microcontroller cannot understand analog signal, it can just understand digital signal.

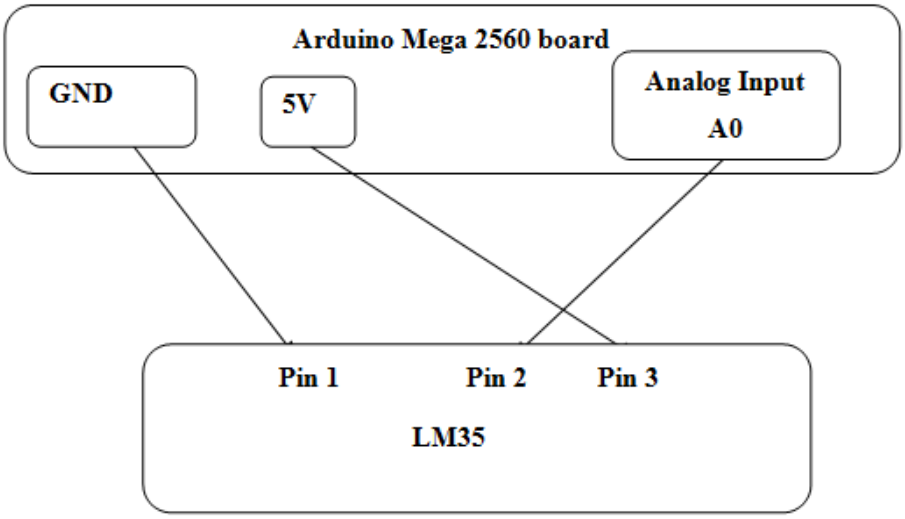

Figure 4.3: Block diagram of LM35 with Arduino

4.3.4 Unit for detecting of movement level

It is used to detect undesirable movement of people inside or outside the house. We can use the Passive Infrared sensor as a motion detector; also the passive Infrared is used as a motion detector in the system which allows you to sense motion. The passive Infrared sensor manufactured by Panasonic. This sensor contains three pins as shown in the Figure 4.4. The 5V power supply is given to this sensor through the Arduino board, and the digital input of the Arduino board connects with the output of the sensor, and GND gives from the Arduino board to PIR sensor, 30 seconds maximum the circuit stability time to this value to make ON/OFF [48].

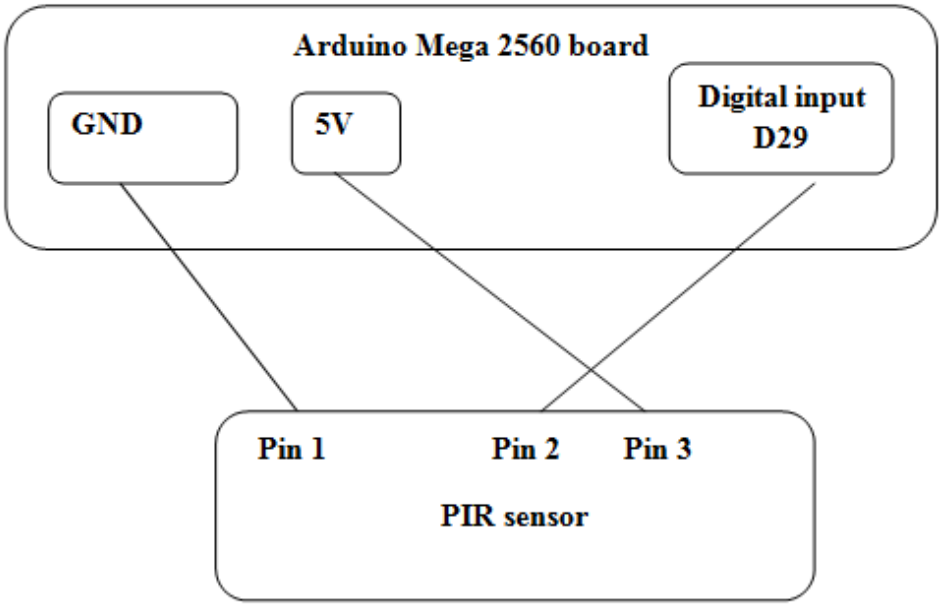

Figure 4.4: Block diagram of PIR sensor with Arduino

There are only two states for the output of the sensor; high or low. The output sensor is connected to the digital input port of 29 the board and by using the function digital Read will the state is read in the software. Then microcontroller takes necessary decision by reading the detector output. As soon as there is a person's movement all over the place where you installed the sensor, it will send an alert to your mobile phone to inform the person movement. The interfacing PIR sensor code with an Arduino board is shown in Figure 4.4.

4.3.5 Unit for detecting of gas level

The Gas detector (MQ2) is one of the kinds of Gas detector. It uses a small heater inside with an electrochemical sensor and it has a fast response time. Some of the features of this sensor are it is considered as stable and long life, wide detecting scope, fast response time, more sensitive [30]. So we can use it inside the room to detect Gas and smoke inside the house. This sensor has three pins, the two pins used in power supply, and the other one used in output signal.

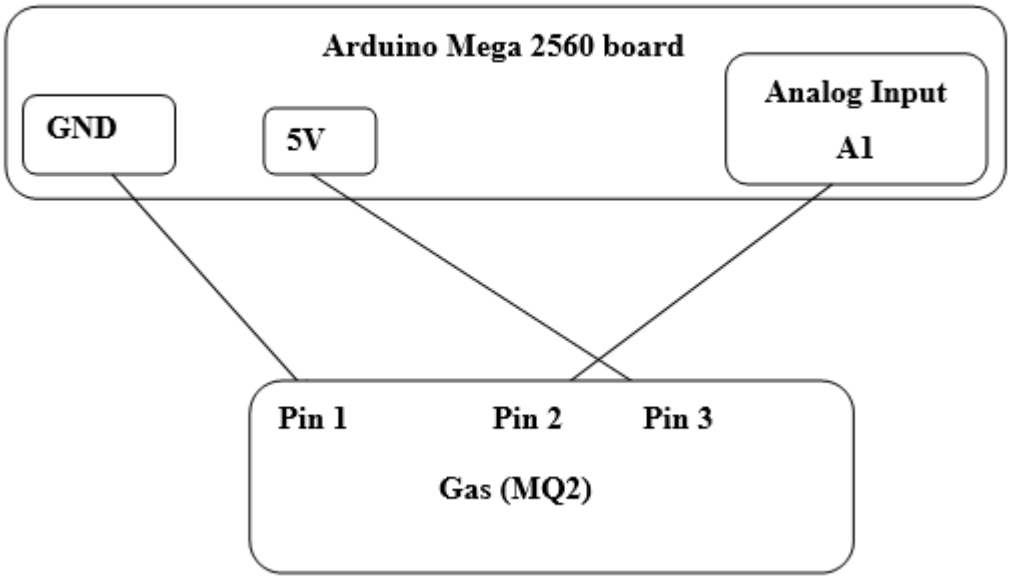

Figure 4.5: Block diagram of gas sensor with Arduino

The analog input port of the Arduino Mega board (A1) connects with the output pin, by using analog Read () function read Gas sensor value in the Arduino Mega as shown in Figure 4.5.

4.4 FRID reader unit

The RFID **(**The Radio Frequency Identification) is very cheap, small, and it can be found in any electronic place. It is running at 13.56 MHz and it is used in many applications, for example payment systems, automatic identification, robotics, etc. It

doesn’t need external power because it is working in low voltage 3.3v. Also it is easy to connect with an Arduino board through a Serial Peripheral Interface (SPI) bus. The Figure 4.6 showed a block diagram to how connect the RFID module with the Arduino Mega. The RFID module contains three important pins (SCK, MOSI, and MISO) [49]. To conveys data in the SPI bus clock initiated by master to check the slave if prepared to receive data. The Master is sending a bit on MOSI line and the slave device receives it in the same line. The salve is sending bit on the MISO line and the master receives it in the same line, to use the SPI code in the Arduino IDE, we must call SPI, RFID library in our sketch. Now we can work with RFID functions. The RFID is card() function used to check if there any card, read the serial number of this card, by utilizing this function RFID. Read card serial (), also, RFID. Halt () this function used if there any wrong RFID. Finally, print the card number and delay.

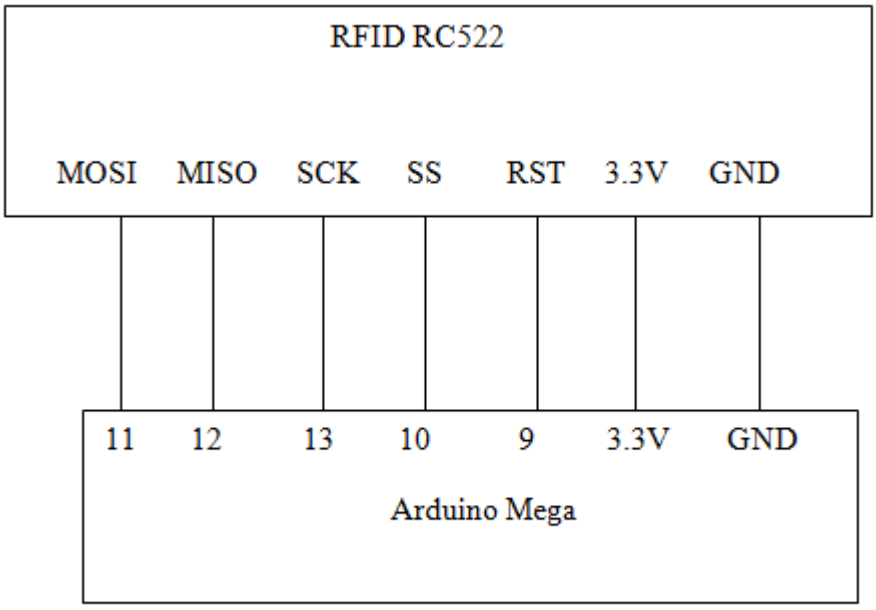

Figure 4.6: Block diagram of RFID with Arduino

4.5 The software part includes:

4.5.1Building Automation System for Monitoring and Controlling

It is an online system in smart homes. It is used for monitoring and controlling by using internet. In this system, we use building automation system to monitor heat, gas and smoke values in all homes and controlling it can turn on/off Anti-Fire system and Ventilation System remotely. This system has been programmed by database management system which includes like, HTML, PHP, and MySQL.

1) HTML

The Hypertext Markup Language (HTML) is a method of adding formatting to ordinary text so that it looks good when the browser displays it, and HTML is not a programming language but it‘s a markup language. There are some parameters in HTML language like (Element), (Tag), (Attribute). In every web page there are four elements, these are HTML, head, title and body elements. At first when start to write the HTML, <html> Element..</html>. <head> element, mean consider the header of the page. <title> element, to keep the <title > element in between of head element.<body> element**.** To show all the parameter, the HTML includes tags. The tag includes three main parameters, 1) opening tag 2) contents 3) closing tag. Tags have a start and an end and usually include other tags. The start of a tag has a **<**then the tag name, and then a **>**; such as,<html>.The end of a tag is similar but that it has a / after the <, for example, </html>.The tag <html> that contains a tab called <body>.All web pages should start with these tags. The body tag must be closed before the html tag. The h1 tag indicates a level 1 header that has the effect of displaying the text which it contains in a large bold font. And the p tag is a paragraph tag will all the text contained within it is displayed as a paragraph, 1) - opening paragraph tag. 2). Element Content- paragraph words .3) - closing tag. Cascading Style Sheets (CSS) is other web design language. This language is used for making the created page more beautiful. Through changing the code we can restyle our webpage again. ‘Selector’ is the heart of CSS. It refers to how you connect CSS with HTML. When using CSS in the internet, we need for adding new

tag such as <style> tag. It keeps in HTML <head>. For example, the following code is HTML that displays on a browser page [50].

2) PHP

PHP Hypertext Preprocessor server site cross platform, for developing a web page dynamically faster by using PHP. For writing the PHP code, we must maintain some parameter. And all PHP codes start with <? PHP and end with?>. A PHP scripting Block remains in the document, in PHP code we must finish several instructions with semicolon. In PHP we utilize ―$‖ as variable. Variable is such as a container wherever we can put so several information. If lay the data at ones of any variable we could utilize it so many times instead of utilizing the main data. In PHP ”string” is so important, this string can utilize directly in a function or it can save in a variable. We create the string by utilizing Double quotes and Single quotes. Also there is other important thing is called PHP Form. Form users are essentially used to get the data. In PHP there are two variables; those are able for getting the data from Form users. $_GET & $_POST are one of the HTML from that has two input field and one submit button. The data of from are utilized in PHP in two ways such as POST & GET. The data that are including in GET method got a visual in the browser as everybody can see. We can send approximate 250 characters and the GET method is utilized for lower amount of data. In POST method, whatever you send there won‘t be any visual in the browser. In this method, we can send as much as data you need (up to 8mb), the POST method used for large amount of data and password [50].

3) MySQL (Standard Query Language)

SQL is a language which we can manipulate and access any data in database system such as MySQL, Server, SQL, Oracle .MySQL which is not a programming language due to have limitation of supporting data structure such as loop, branch. The types of SQL are DDL (Data Definition Language) and DML (Data Manipulation Language). And there are some DDL statements such as, CREATE DATABASE: create a new database, ALTER DATABASE: maintain the database, CREATE TABLE: create a new table, ALTER TABLE: maintain the table, CREATE INDEX: create index, and DROP INDEX-destroy index. By DML we do

the Query and update in SQL, format SELECT: take data from database, UPDATE: update the data, DELETE: delete data from database, INSERT INTO: include data in database [50].

4.6 Buzzer Alarm

Buzzer Alarm is connected to the digital output port. The buzzer gives a tone. When the output port is high, it connects to analog pulse-width modulation to make a different tone. In the Figure 4.7 the block diagrams to how connect Buzzer module with Arduino.

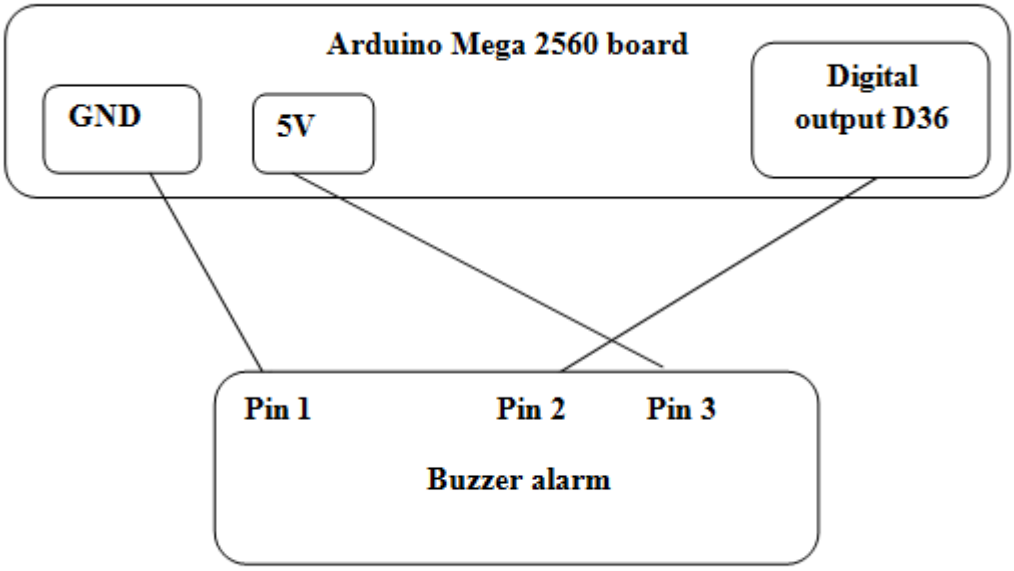

Figure 4.7: The block diagrams to how connect Buzzer module

CHAPTER 5

SYSTEM IMPLEMENTATION

5.1 Introduction

Recently, data controlling and monitoring have been so important in our life. This chapter is dedicated to the design and implementation of Building Automation System (BAS) in details. In this thesis, we try to combine three types of technologies, i.e., web application, Microcontroller and mobile network technology. First, web application technology is used to develop a real time system for controlling and monitoring homes and give us alert notification by using internet of things (IoT).

Second, microcontroller technology is used to create embedded system device by using Arduino Mega 2560 with many types of hardware components such us Heat, Gas, Smoke and Movement sensors, and RFID for access control system. This type of security system is used for building SD-Ram to save all events in the home, Ethernet shield to connect the microcontroller to the internet by using RJ-45 cable, Magnetic Lock Sensor and the other type of security for doors and windows.

Third, mobile network technology is used to communicate between the smart home device and the owner's cell phone. SMS service is used to send/receive alert notification and turn ON/OFF electronic device in the home.

In this thesis, we use LEDs as electronic device. For example, when click turn ON/OFF button, the LED is turned ON/OFF which depends on the button status. Finally, all previous issues are presented above and will be explained in more details.

5.2 System Description

The system overview consists of many different parts to achieve the purpose of this thesis. In this system, there are three main hardware components. Arduino Mega 2560, which connects sensors and other hardware components. Arduino includes many ports to INPUT and OUTPUT to interact with the outside world. Arduino collects all data from different parts and saves it in the database server. Arduino connects with Ethernet shield and this shield connects to the internet via Ethernet cable. In addition, GSM SIM900a connects with Arduino to send/receive SMS alert notification and turn ON/OFF electronic devices in the home. The web application server monitors and controls application. It is developed by PHP, HTML5, CSS3 and use MySQL database server.

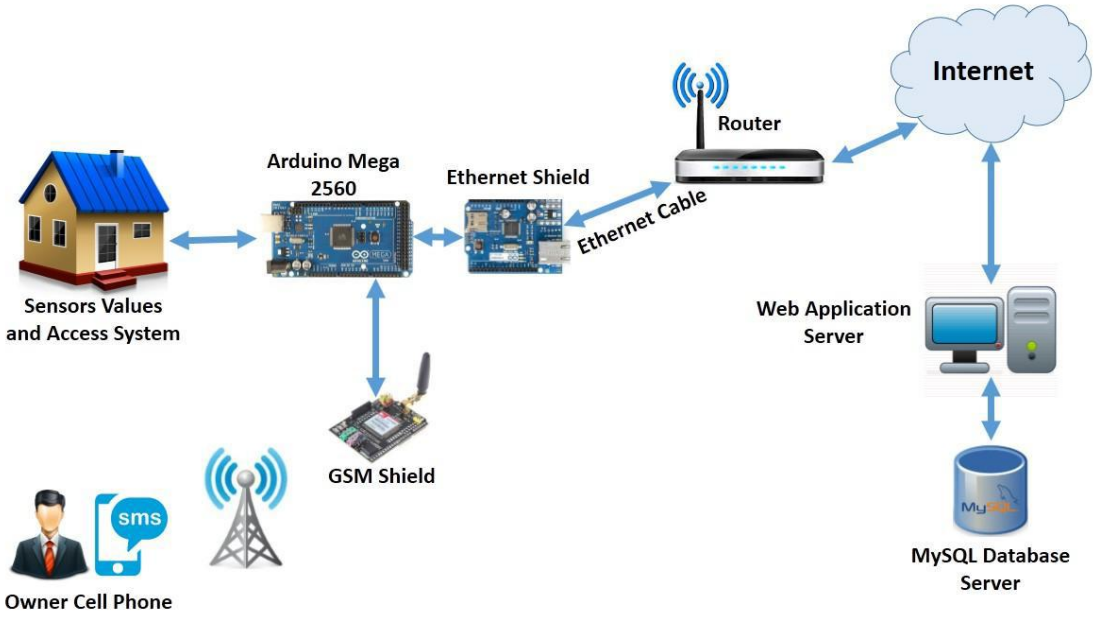

Figure 5.1: System Overview

5.3 Hardware Implementation

The building automation system (BAS) has been designed and developed in this thesis which consists of many hardware components. Figure 5.2 shows the final photo of smart device in the home.

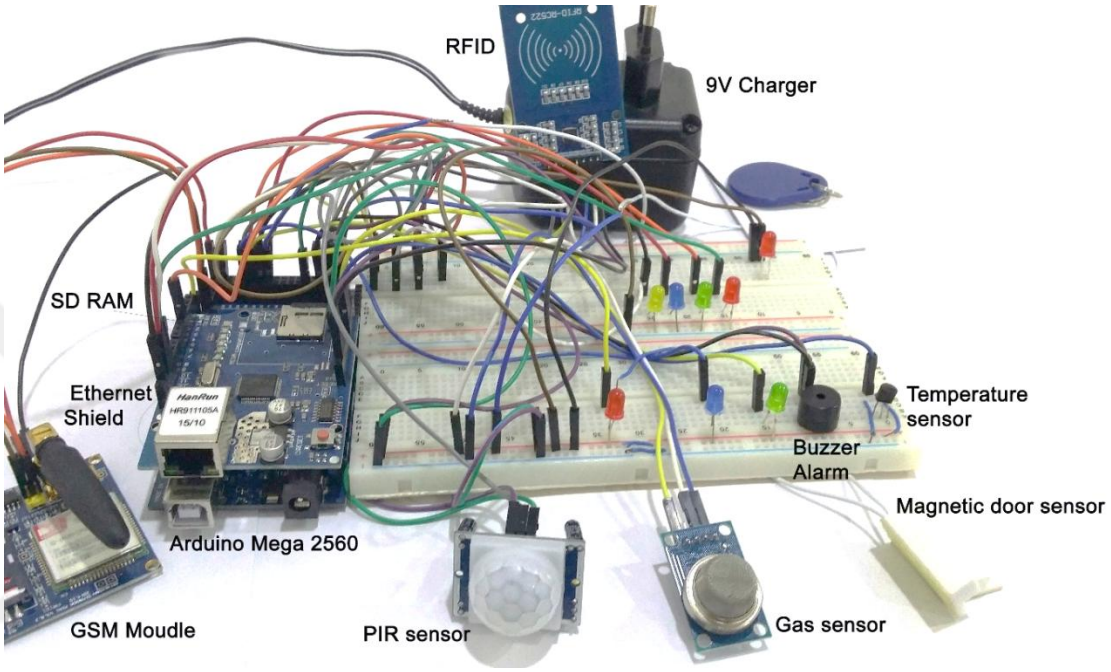

Figure 5.2: Photo of building automation system

5.3.1 Testing the Hardware System

Before starting to test the building automation system, there are some important points. We use LEDs to describe the following status and Figure 5.3 shows the LEDs description of the system.

1- In electronic device ON/OFF, when pushing the button ON, the system turns the LED ON and when pushing button OFF the system turns LED OFF.

2- Motion sensor: If there is any movement, the system turn LED ON, otherwise, it turns OFF.

3- When connecting with internet, if the device connects correctly to the internet, the system turns LED ON; otherwise, it turns LED OFF.

4- With magnetic lock sensor for doors and windows security, if the door/window opens, the system turns the LED ON; otherwise, it turns LED OFF.

5- With anti-fire system implanted by using LED, the systems LED turns ON when the anti-fire system is ON, otherwise, it turns LED OFF.

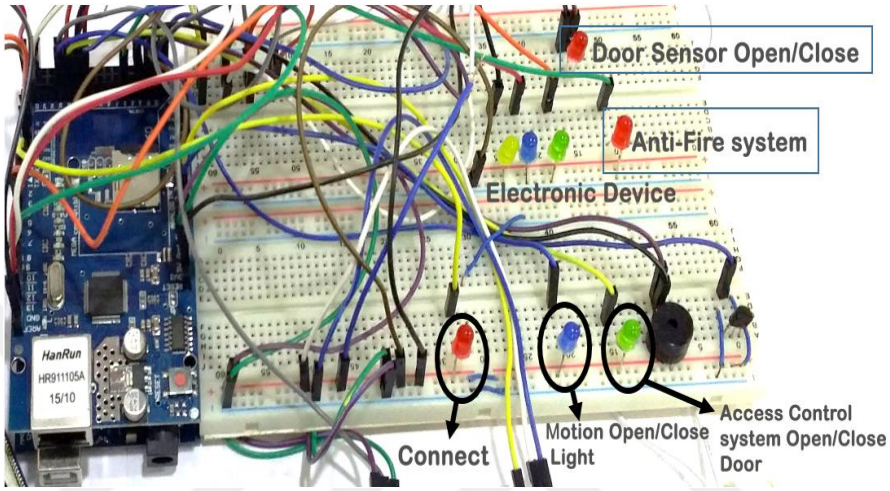

Figure 5.3: LEDs description of the system

First of all, the system checks the important parts in the system, and connection of Ethernet shield, whether connected to the server or not. This shield uses RJ-45 cable to connect with the network. This shield is used to send and receive the information between the home and the web application system. The smart device system turns LED ON, it means that it is connected to internet; otherwise, when LED is OFF it is disconnected. Figure 5.4 shows the system status when connected to the internet.

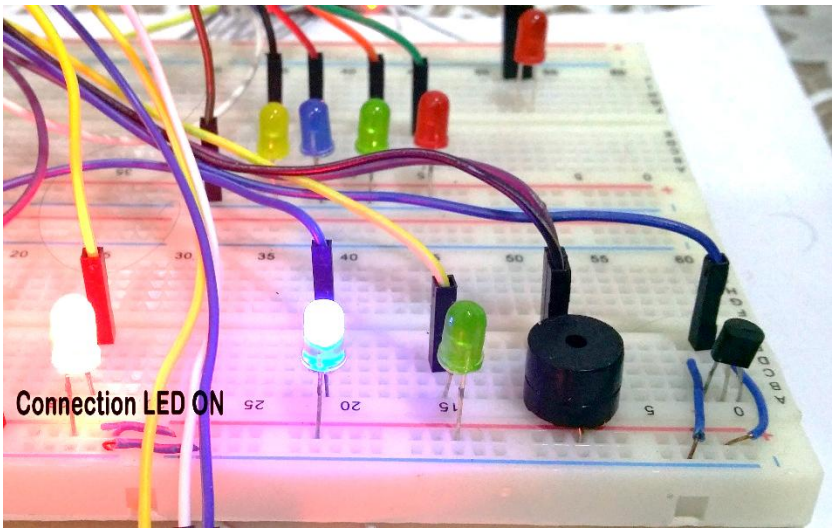

Figure 5.4: The system is connected to the internet

In addition, Ethernet shield includes micro SD slot which is used to read/save information. We can access SD Ram through the SD Library. The microcontroller initializes the SD card to be ready to save data as in Figure 5.5. After SD-RAM is initialized successfully, the smart device becomes ready to save all high temperature and gas sensor value in a text file separately as in figure 6. The connection details between Ethernet shield, SD-Ram with Arduino Mega 2560 is included in chapter 4.

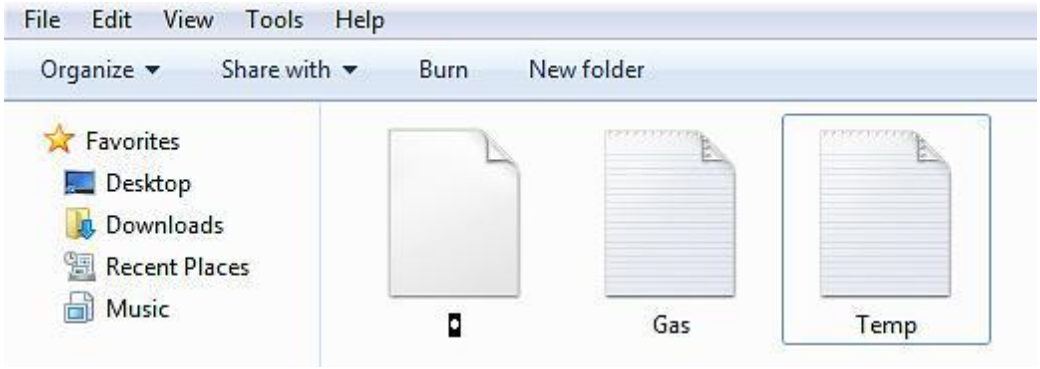

Figure 5.5: shows the initialize of SD-Ram

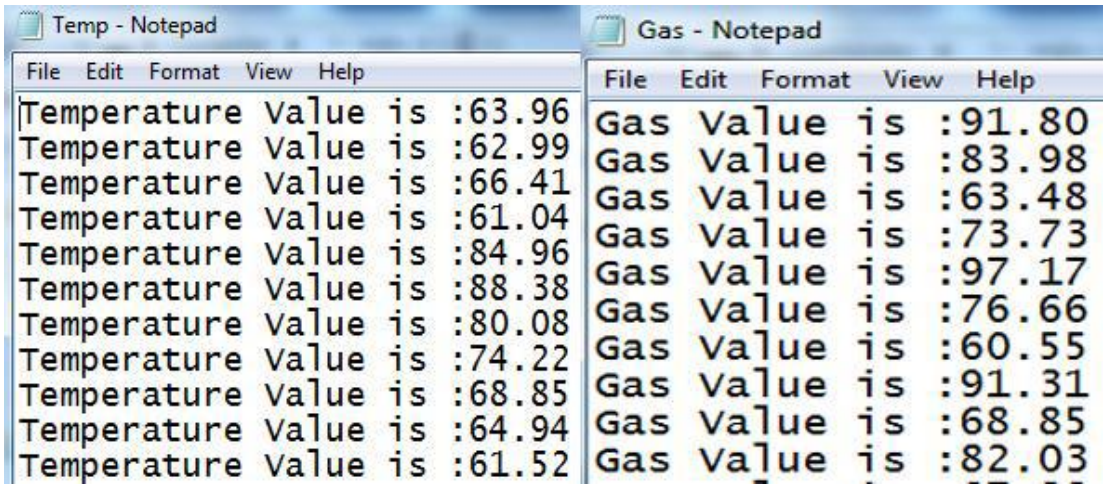

Figure 5.6: The smart device initializes the SD card to be ready to save data

Now, the system connects to the server. Second, the system checks the other important hardware components in the system. GSM SIM900a is a module which is easy to use when connected with Arduino Mega 2560. The GSM library includes many methods to communicate with the GSM module. The connection details between GSM SIM900a with Arduino Mega 2560 is included in chapter 4. The first step is the microcontroller checks the GSM module whether it is connected to the network provider or not. With print massage, the GSM module is ready to use. Figure 5.7 shows the GSM status is ready to use.

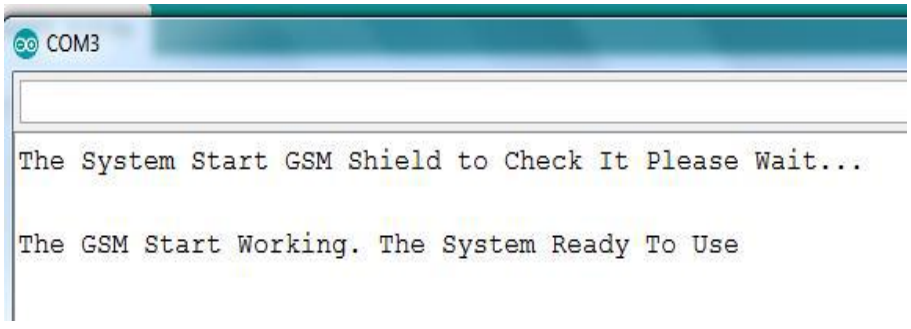

Figure 5.7: GSM module is ready to use

GSM module is used to connect between the owner cell phone and home device system. This module is also used to send/receive alert notification and turn On/OFF electronic device. Building automation system uses two ways for controlling status and monitoring. The first occurs by using cell phone by sending character “m” in a text SMS massage to change the mobile controlling status. This means that the owner of cell phone can turn ON/OFF electronic home device by sending text SMS massage. The second is by sending character “s” in text SMS massage to change the status of the controlling system status (online remotely). By default the system in mobile controlling status, the online application cannot be controlling just monitoring. The owner can give the permission to the online application to do the controlling for home electronic device. Figures 5.8 and 5.9 shows the owner cell phone when s/he changes the controlling status.

Figure 5.8: Changing the device status to mobile controlling

Figure 5.9: Changing the device status to system controlling

In mobile controlling status, the GSM module is used to turn ON/OFF electronic device in the home. This operation it easy in this system by sending text message to the device including the device number and ON or OFF like “D1on” or “D1off”. Figure 5.10 shows the mobile cell phone for owner when he turns ON device 1 in the home.

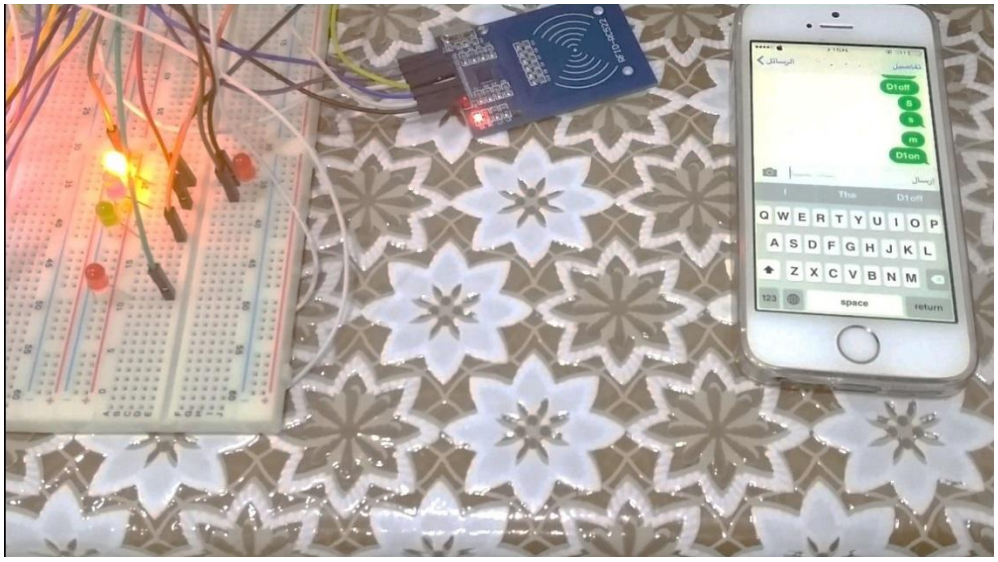

Figure 5.10: When cell phone owner turns electronic device ON

Furthermore, the SMS in this system is used to send the notification alert. When there is any high temperature value in the home, the system sends a SMS massage to the owner “Temperature is high in your home!” and makes a sound using a buzzer alarm. Figure 5.11 shows the cell phone owner as s/he receives the temperature alert massage. Also, if there is any gas or smoke in the home the device sends a SMS alert massage to the owner “Gas is high in your home!” Figure 5.12 shows the owner cell phone when s/he receives the gas alert massage.

Figure 5.11: cell phone owner as s/he receives SMS temperature alert

Figure 5.12: cell phone owner as s/he receives SMS Gas alert

This smart home device also includes Anti-Fire system in the home. We can remotely turn it ON by mobile or by online application. Figure 5.13 shows the Anti-fire system status in the home when it is ON.

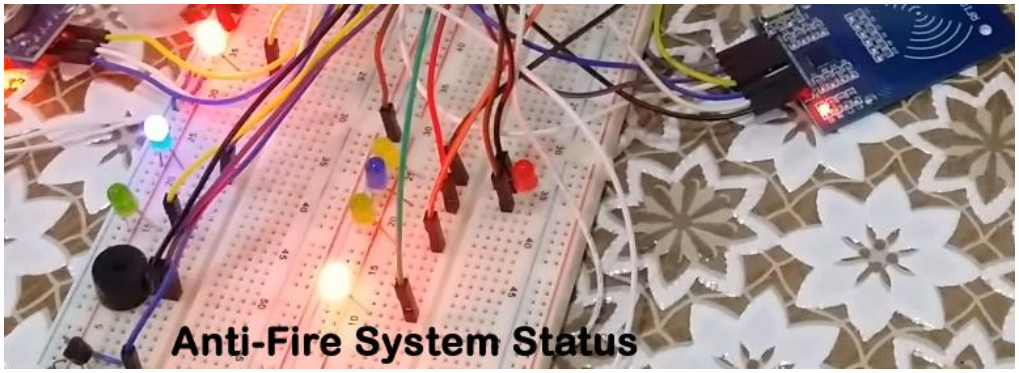

Figure 5.13: Anti-fire system status in the home when it is ON

In the smart home device system, we have two types of security. In the first type, we create a smart card and ID's for peoples in all buildings. Moreover, we

create a central database server to save all information and give people authorization to entry in which building they can access.

This device includes RFID reader to read the smart card ID for people. When it reads the ID for this card, the device sends the ID to the server and checks it in the database. The application checks if this ID is found in the database and checks authorization for access this building, the application sends agreement to the device to open the building door. If not found, the application sends "not found, do not open the door". The figure 5.14 shows RFID reader and the LED door status.

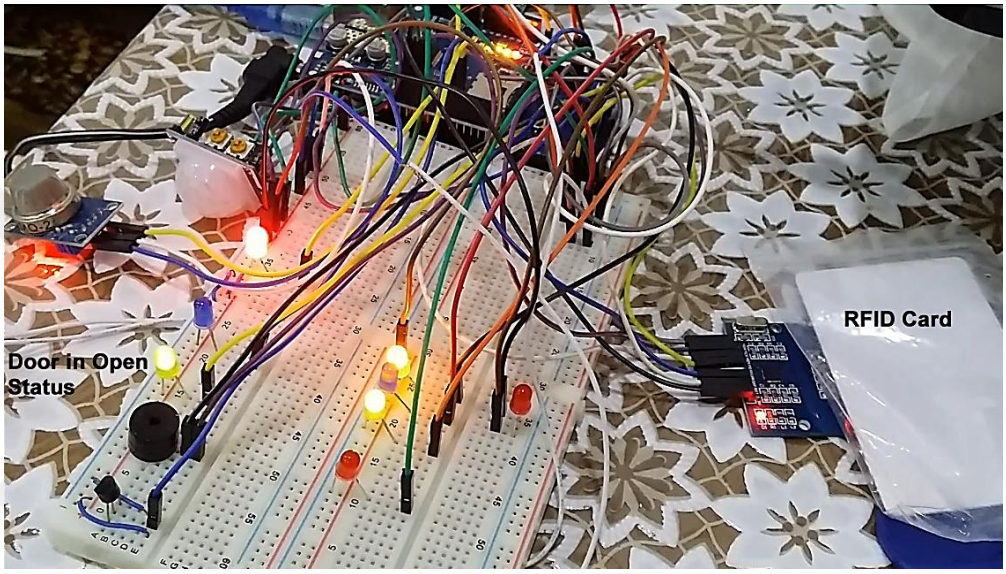

Figure 5.14: RFID reader with LED open door status

In the second type, we used a magnetic sensor to detect when a door is open. This sensor is like reed switch. Normally, the reed switch is open. The other part of this sensor is a magnet. When the magnet is far more than 13mm, the reed switch is closed. The aim of this sensor is to check the door or window if they are open or closed. If the door is open, the system makes a sound buzzer alarm. The system also includes LED to show the status of door. Figure 5.15 shows the door status.

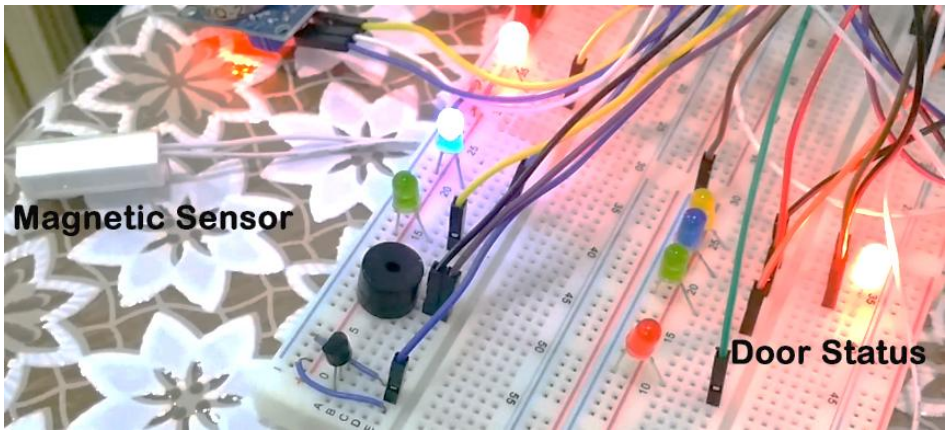

Figure 5.15: Door status in the home when magnetic sensor is active

Also, this system is used for power saving in the building. This device includes PIR sensor for motion sensing. This sensor is used to turn the light OFF if there is no one in the homes or rooms. Figure 5.16 shows the light status in the home when PIR sensor finds any motion.

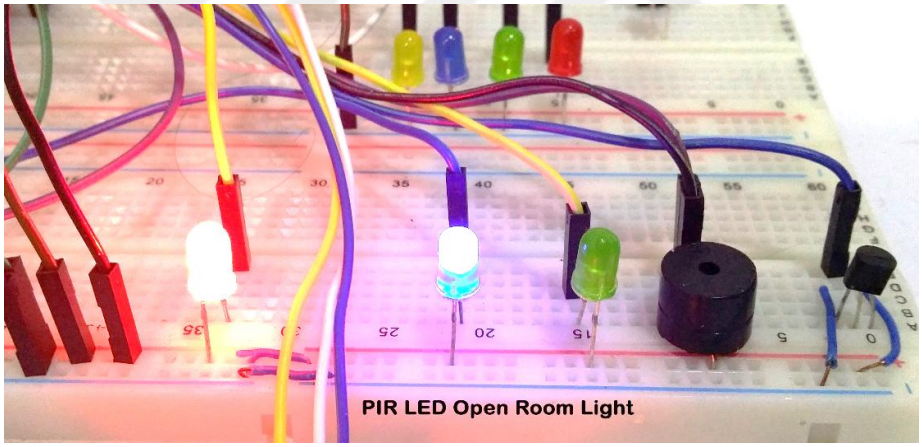

Figure 5.16: Light status in the home when PIR sensor finds any motion

5.4 Website Implementation

The website is developed for controlling and monitoring issues. All data saved in the database come from Arduino Client. The graphical user interface was created by using HTML5, CSS3 and PHP. This application uses MySQL database server to save all information in the city. The important point in this application must be clear, elegant and easy to use. In addition, this application can monitor and control any

home that is connected to this system. Also, it gives us a fast alert notification if there is any risk in any home.

The structure of the web application can be shown in Figure 5.17. Each page in this system is presented in a box.

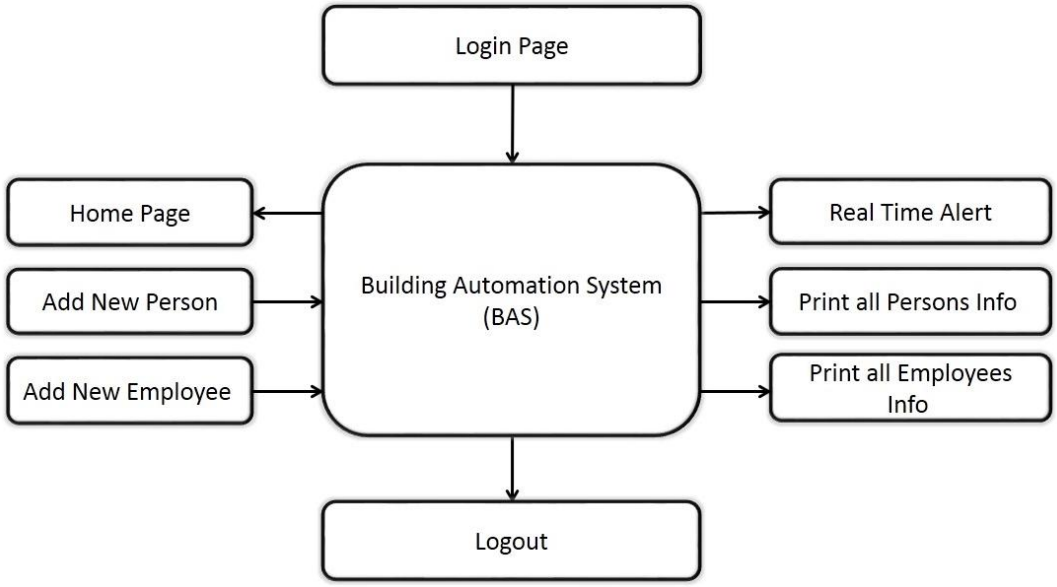

Figure 5.17: The structure of the web application for BAS

There is a login page in the system which needs a username a password to access it through this page. The employee can access to the system by using his information to do what he wants such as monitoring, controlling or turning ON/OFF device. Figure 5.18 shows the picture of this page.

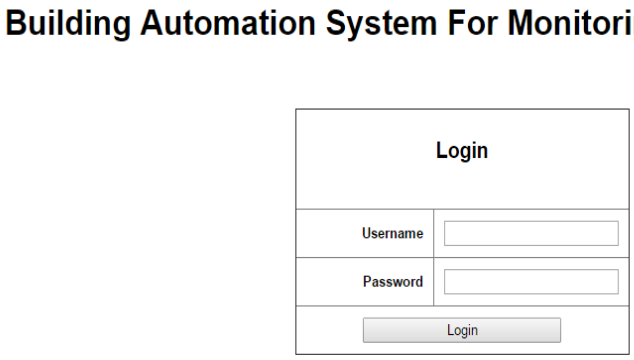

Figure 5.18: Login page of the system

If the information is correctly given, the home page will be open automatically, as it is shown in Figure 5.19. In this page, the employee can see all smart homes that are connected to the system. In addition, he can enter to any home and check the sensors values and switching electronic devices in the home after taking the permission from the home owner.

In the home page of the system, we have an important area (all homes that are connected with the system). Through these links, we can enter to any home we want.

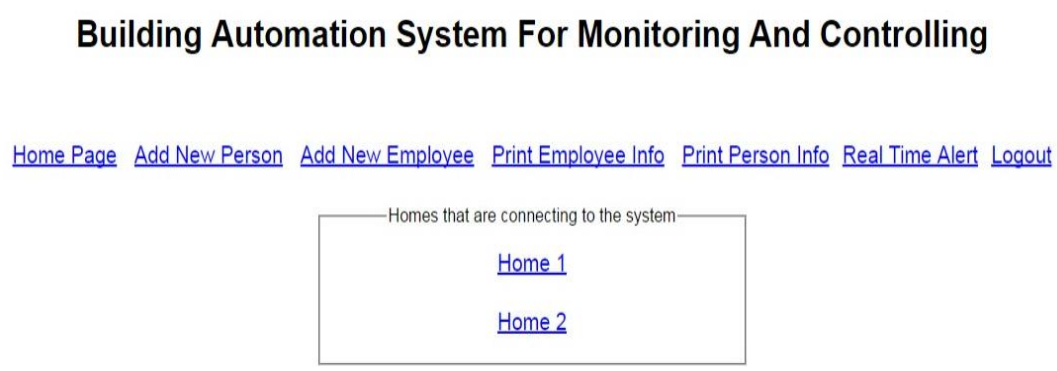

Figure 5.19: Home page of the system

In the Home page, there are five important links listed below:

1-Add New Person: in this page, the employee can add new person and his smart card ID to the database server for BAS. In addition, BAS can save additional information for any person like his mobile phone and address. Figure 5.20 shows the picture of this pag

Figure 5.20: Add New Person page of the system

2-Add New Employee: in this page, the administrator can add new employee to the system. This employee can be in charge of the monitoring and controlling for homes in the city. Moreover, he can add person's ID to city access control system. Figure 5.21 shows the picture of this page.

Figure 5.21: Add New Employee page of the system

3-Print all Employees Info: in this page, all employees' information can be printed or shown in the system. Also, he can delete what he wants. Figure 5.22 shows the picture of this page.

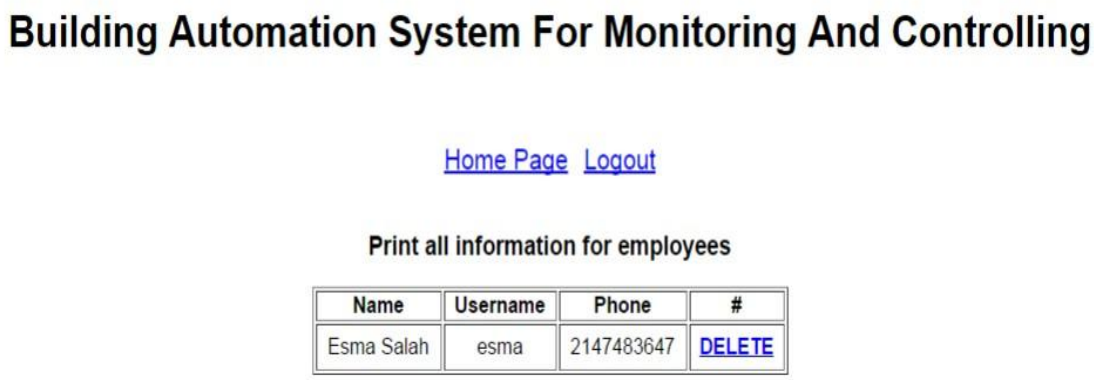

Figure 5.22: Print all Employee information page of the system

4- Print all Persons Info: in this page, all persons information can printed or shown in the city access control system such us (Name, Card_ID, Device_ID, and Home _ Address). Figure 5.23 shows the picture of this page.

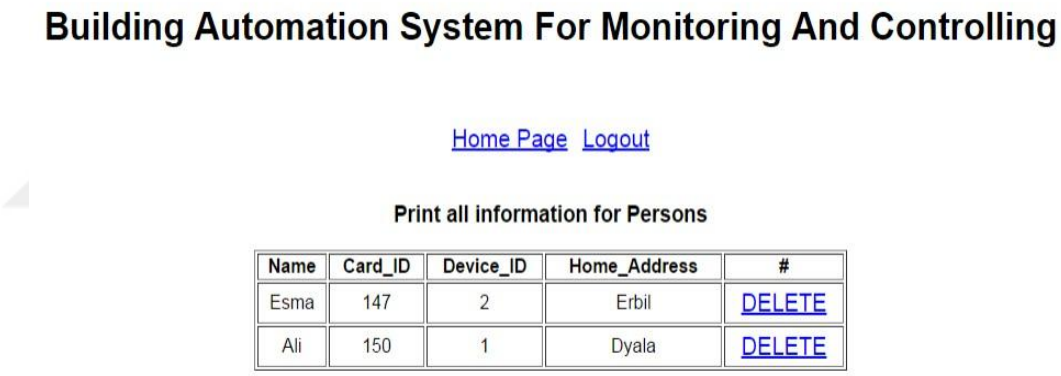

Figure 5.23: Print all Employee information page of the system

Real Time Alert: this is important page in the system. This page give us a notification alarm if there any risk in any home in the city. When any risk occurs in any home it prints a red notification and writes “Not Safe”. Also, this page sort all homes that are connected to the system and depends on the sensors values. It means putting the high sensor value at the beginning. In addition, this page auto loads and need not reload in any time. Moreover, this page changes the background color for cell “Home Status” to red if there is any high value for any sensor in the home. Finally, from this page, one can enter to any home just by one click. Figures 5.24 and 5.25 show the pictures of this page.

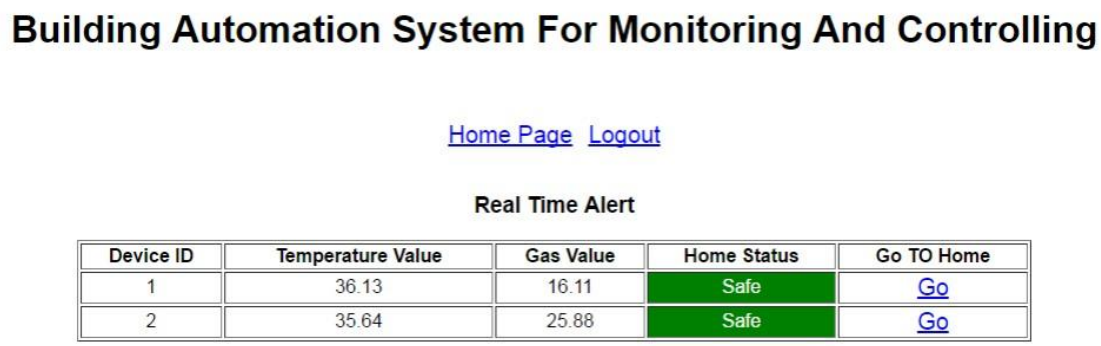

Figure 5.24: Real time page of the system in safe mode

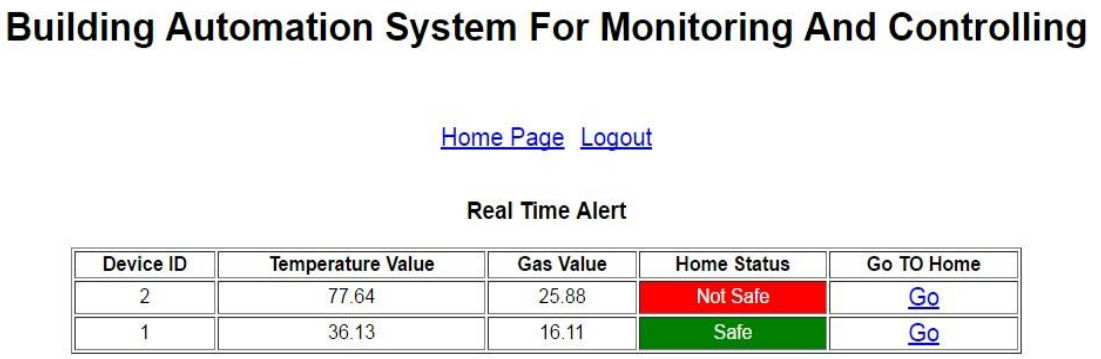

Figure 5.25: Real time page of the system in not safe mode

In real time page, we have important link (Go To Home). This link is used for short way to open the house page if there is any risk.

Home Page: in this page, we can see all real time information in the home by using internet of things. This page consists of three parts. First, Monitoring Part which includes the current sensors values in the home. Second, Controlling Part which includes button switch to turn ON/OFF devices in the home. Any button controls one electronic device. Finally, Anti-Fire System which is manual control part with anti-fire system in the home. Figure 5.26 shows the picture of this page.

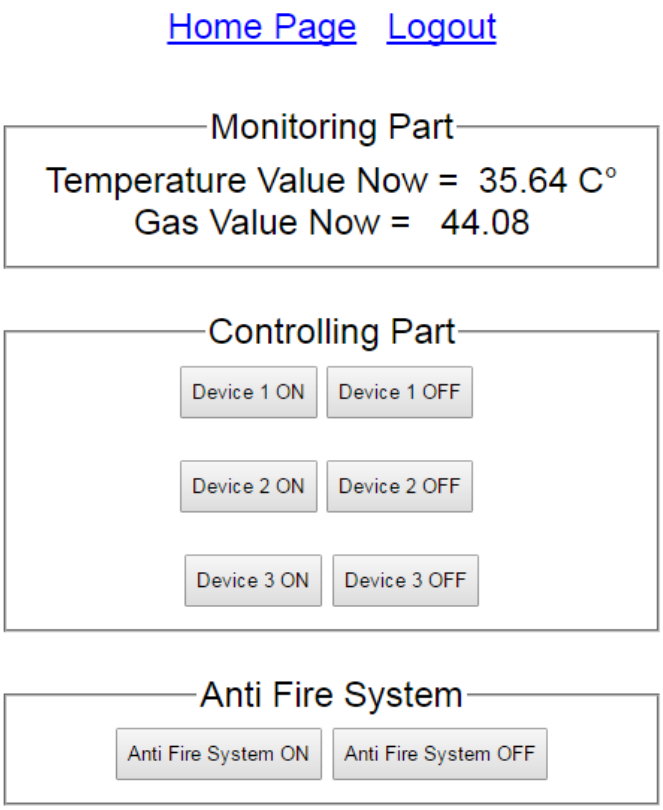

Figure 5.26: Home page of the system (Controlling and Monitoring)

5.5 Database of the system

Building automation system is used by MySQL database server. This database is hosted in a cloud server. BAS database consist of many tables for different things. Figures 5.27 and 5.28 show the database tables with relationships. In EMPLOYEE table, information for employees such as NAME, USERNAME, PASSWORD and PHONE is saved. The username and password are used to login to BAS.

The second table is SENSORS_VALUES; the embedded system device saves all sensors values in this table. The web application system reads these values in the screen.

The third table is DEVICE_STATUS. In this table, the web application system saves all the status of electronic devices like ON or OFF and sends it to smart device

in the home. The web application system reads all new status that come from smart device.

The fourth is ACCESS_CONTROL_INFORMATION table. It is used to save all information for peoples in all buildings. In addition, the information in this table is used to open/close the door that depends on person ID. If anyone wants to enter to any home, he must put his smart card in the RFID reader. The embedded device sends this ID to the server by using internet to check it in the web application database (MySQL server). If this device ID has permission, the smart device opens this door. Finally, all the operation programming in PHP language.

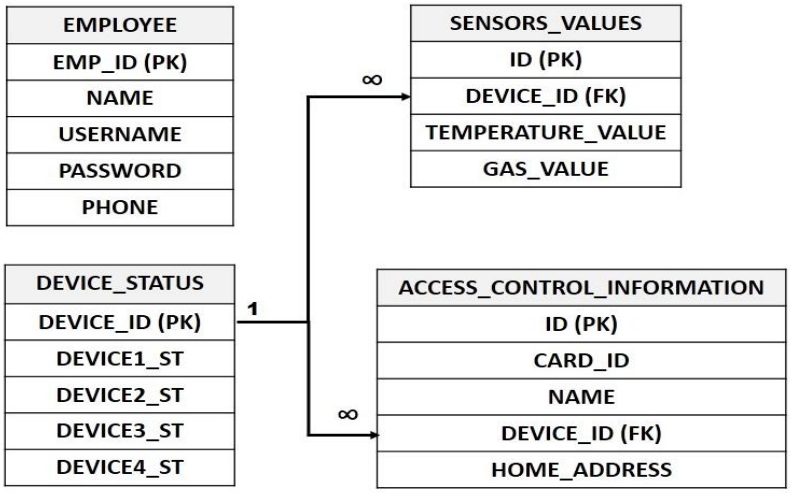

Figure 5.27: Database tables with relationship of the system

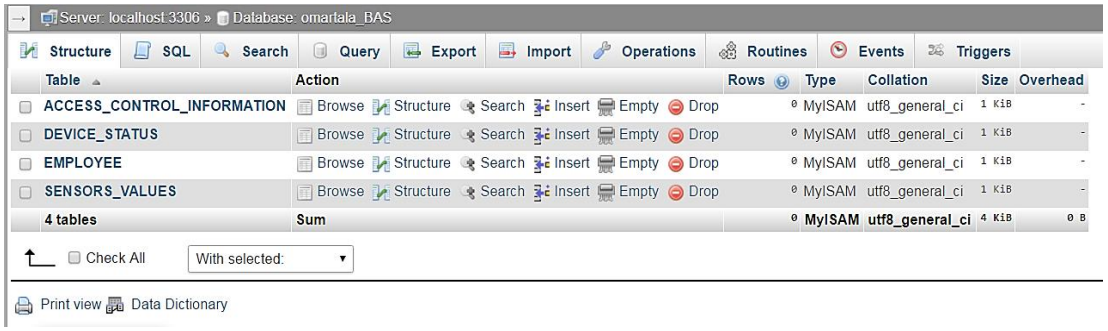

Figure 5.28: Database tables of the system in the server

CHAPTER 6

CONCLUSIONS AND SUGGESTIONS FOR FUTURE WORK

6.1 Conclusions

The aim of this study was to implement the smart home to connect a complete city by controlling the electronic appliances at home remotely and monitoring the sensors' temperature, gas, and motion by using a mobile phone. These sensors are used as detectors inside home using a GSM network to receive notifications when there is any problem. The appliances are controlled by sending SMS messages. The aim was achieved successfully in this system. A temperature sensor (LM35) was used as heat detector. Motion sensor (PIR) was used as motion detector, and gas sensor (MQ2) was used to detect gases. An LED was used to manage the electronic devices. Access control system was included as well. The Arduino Mega 2560 Board was used as a microcontroller unit. The SIM900A GSM model was used to communicate between the microcontroller and the mobile station. In addition, we succeeded to add a building automation system (BAS) for monitoring and controlling remotely all homes in the city by using the internet and the Ethernet shield,. The BAS was used to communicate the microcontroller with the internet .In this system, an ID number was programmed in a card to each home in the city to store all of the data of a home. We made a comparison between our work and the previous one, A new and more secure connection is used as internet connection, We added a new server and a database for storing data of homes sensors, We added two different types of controlling mechanism (owner and online system), online system is used in the new system. We made a comparison between SMS transmission by the internet and GSM networks, such that we figured out the advantages of the Internet and the defects of GSM network during SMS transmission: when sending message by mobile network, the SMS may not delivered instantly or it may delayed more than an hour or more than a day, because the mobile network has too much air links and

processing units, while the internet message may delivered instantly, which has less number of air links and processing units, we used the internet connection in our work, since we need faster operation to send or receive messages.

6.2 Suggestions For Future Work

After successfully achieving the objective of this study, we suggest the following points as future developments to improve the performance of our system;

- Our new system can be used to manage several homes at the same time. Due to the limitations of our hardware, it was not possible to perform these experiments.
- We plan to design a new system to manage several homes at the same time.
- We will design a new system for mobile devices and apply it on android devices.
- Connecting the smart city, not only with homes but also transportation, health care, cars, animals, and any other construction objects of the city.
- In case of GSM network problem, we suggest to add another way to collect data such as Tracking via satellite.
- Last but not least, we suggest to use the Intel Edison board as a microcontroller unit because it has more facilities than Arduino.

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