



Université Mohamed Khider de Biskra
Faculté des Sciences et de la Technologie
Département de Génie Electrique

MÉMOIRE DE MASTER

Sciences et Technologies
Electronique
Electronique des Systèmes embarqués

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Energy Saving Through Home Automation

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Année universitaire : 2019 – 2020

الجمهورية الجزائرية الديمقراطية الشعبية
Peoples Democratic Republic of Algeria
وزارة التعليم العالي و البحث العلمي
Ministry of Higher Education and Scientific Research



University Mohamed Khider Biskra

**Faculty of Science and Technology
Department of Electrical Engineering.
Sector: Electronique**

Option: Electronics of Embedded Systems

A Thesis prepared for the requirement of

MASTERS Degree

Theme

**Energy Saving Through
Home Automation**

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ABSTRACT

Reducing energy consumption or rather wasting energy is a way to save energy. Today, most of the energy is wasted on fans and lights that are not unplugged when not in use. In order to save energy, we can do simple things like turn off the light or the fan when we leave the room.

So that's why we created a home automation model with different operating modes, which can also be controlled using an Android app.

The proposed model allows users to control their electrical appliances automatically it also alerts them if there is a gas leak. As part of this research, we aim to integrate several elements like relays, GSM module and some sensors.

Finally, the design and realization of this model depend on Arduino, so that it will manage all the processes in this system.

KEYWORDS: Arduino, relay, sensors, GSM, electrical appliances, Android app.

ملخص

إن تقليل استهلاك الطاقة المفرط أو بالأحرى إهدار الطاقة هو وسيلة لتوفير الطاقة. في الوقت الحالي، تضيع الطاقة بسبب المراوح والأضواء التي لا يتم فصلها عندما لا تكون قيد الاستخدام. ولتوفير الطاقة، يمكننا القيام بأشياء بسيطة مثل إيقاف تشغيل الضوء أو المروحة عندما نغادر الغرفة.

لذلك أنشأنا نموذجاً للتشغيل الآلي للمنزل مع أوضاع تشغيل مختلفة، والتي يمكن أيضاً التحكم فيها باستخدام تطبيق

الاندرويد.

يسمح النموذج المقترح في هذا النظام للمستخدمين التحكم في أجهزتهم الكهربائية تلقائياً كما يقوم بتنبيههم في حالة وجود تسرب للغاز. في إطار هذا البحث، نهدف إلى دمج العديد من العناصر مثل المرحلات، GSM وبعض المستشعرات. وأخيراً يعتمد تصميم وتنفيذ هذا النموذج على الأردينو بحيث يقوم بمعالجة جميع المعلومات المتعلقة بهذا النظام.

الكلمات المفتاحية: أردينو، مستشعرات، GSM، مرحلات، أجهزة كهربائية، تطبيق اندرويد.

RESUME

Réduire la consommation d'énergie ou plutôt le gaspillage d'énergie est un moyen d'économiser de l'énergie. Aujourd'hui, la plus grande partie de l'énergie est gaspillée à cause des ventilateurs et des lampes qui ne sont pas débranchés lorsqu'ils ne sont pas en service. Afin d'économiser de l'énergie, nous pouvons faire des choses simples comme éteindre la lumière ou le ventilateur lorsque nous quittons la pièce.

C'est pourquoi nous avons créé un modèle domotique avec différents modes de fonctionnement qui peuvent également être contrôlés à l'aide de l'application Androïde. Le modèle proposé permet aux utilisateurs de contrôler automatiquement leurs appareils électriques, Il pourra aussi avertir le propriétaire au cas où une fuite de gaz se déclencherait.

Dans le cadre de cette recherche, nous visons à intégrer plusieurs éléments comme des relais, Module GSM, et de capteurs.

Au final, la conception et la réalisation de ce modèle dépend d'Arduino pour que ce dernier va gérer tous les processus dans ce système.

Mots-clés: Arduino, capteurs, appareils électriques, Relais, GSM, application Androïde.

DEDICATIONS

To my beloved mother, Houria

To my dear father, Abdelaziz

To my sisters and my brother

To my lovely nieces and nephews

Acknowledgements

First and foremost, heartfelt gratitude and praises go to the Almighty Allah who guided me through and through.

*I would like to extend my sincere thanks and appreciations to my honorable supervisor **Prof. Saloua Ouarhlent** for providing guidance and feedback throughout this project.*

My sincere appreciation needs to be addressed to the honorable board of examiners too.

I cannot forget to thank my family and friends for all the unconditional support

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List of abbreviations

ADC	Analog to D igital C onverter
CO	C hange O ver
DAC	D igital to Analog C onverters
DC	D irect C urrent
DT	D ouble T hrow
ECHO	E lectronic C omputing H ome O perator
FHSS	F requency H opping S pread S pectrum.
GFSK	G aussian F requency S hift K eying
GSM	G lobal S ystem for M obile C ommunication
GPS	G lobal P ositioning S ystem
I/O	I nterface O utput
ID	I dentification
IDE	I ntegrated D evelopment E nvironment, I ntegrated D evelopment E nvironment
iOS	I Phone O perating S ystem
IOT	I nternet of T hings
IR	I nfra R ed.
JPEG	J oint P hotographic E xperts G roup
LCD	L iquid C rystal D isplay
LDR	L ight D ependent R esistor
LTE	L ong T erm E volution
LAN	L ocal A rea N etwork
MCU	M icrocontroller U nit
mA	M illiampere
NC	N ormally C losed
NO	N ormally O pen
OS	O perating S ystem
PAN	P ersonal A ccount N umber
PC	P ersonal C omputer
PCB	P rinted C ircuit B oard
PDA	P ublic D isplay of A ffection

PIR	P assive I nfrared
PSK	P hase S hift K eying
PWM	P ulse W idth M odulation
RX	R eceiving x
RF	R adio F requency
SMS	S hort M essage S ervice
SPDT	S ingle P ole D ouble T hrow
TCP	T ransmission C ontrol P rotocol
TX	T ransmitting x
TDD	T est D riven D evelopment
UMTS	U niversal M obile T elecommunications S ystem
VSPE	V irtual S erial P orts E mulator
Wi-Fi	W ireless F idelity
zip	Z one I mprovement P lan
3G	T hird G eneration

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General

Introduction

GENERAL INTRODUCTION

Electricity availability is actually one of the main challenges that people face in daily life. Resources should be used wisely to conserve them for future use because they are limited and expire in one day. Therefore, we need to save energy every day to save our money and resources as well.

To deal the situation a system should be suggested in such a way as to switch the electrical appliances off while not in use. Switching off the electrical appliances is unpleasant for the user because the switches are placed far away from them. So a system is required for the electrical appliances to work automatically. We all need resource savings, but the most important thing is to find the best ways to do that. A variety of strategies for this management plan have been proposed.

In this research, we propose a simple home automation prototype where a user can turn on and off the power of an electrical device in the home through an application on a mobile phone or by using a relay with the help of sensors and microcontroller.

This prototype consisted of an Arduino controller, we are going to describe more detail about it in the following lines.

This thesis is separated into three main chapters: in the first chapter we will present a review about home automation and some it benefits. He second chapter Shows descriptions of each of the components that constitute our system. In the third chapter we will discuss about all the software that were used to implement the project, this chapter will contains also the block diagram, simulation and finally the obtained result. Then we have a conclusion about this process.

Chapter I

*Overview of home
automation*

I.1 Introduction

With rapid economic growth, living standards are also rising day by day. The modern society wants safe, economic, comfortable and convenient life which is ideal for every family.

Home automation is a very promising area. Its main benefits range from increased comfort and greater safety and security, to a more rational use of energy and other resources, allowing for significant savings. It also offers powerful means for helping and supporting the special needs of people with disabilities and, in particular, the elderly. This application domain is very important and will steadily increase in the future [1].

I.2 Home automation

I.2.1 Definition

Home automation (Figure I.1) is known as the automation of the home, housework or household activity. It commonly defines a residence that integrates technology and services through home networking to improve the quality of living. Home automation is not a new term for science society and has been around for a significant time. Home automation include mainly centralized control of lighting, temperature, appliances, and other systems, to provide improved comfort, convenience, efficiency and security. For disabled and elderly person home automation can be the substitute of institutional care [1].

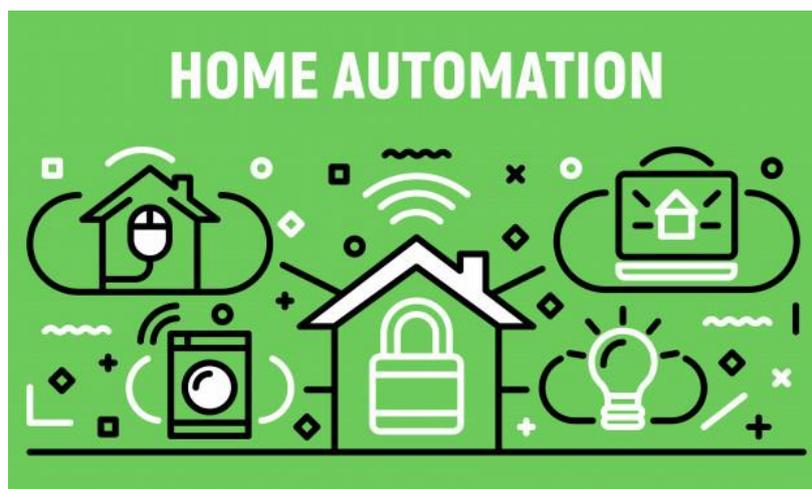


Figure I.1.Home automation[2].

I.2.2 Home automation in past

Home automation really started in a physical sense with the formation of mechanization items, starting with home apparatuses.

The capacity to enlighten the room from a solitary switch radically changed the way we lived by making it simple and moderately safe to light vast regions for broadened periods around evening time. The following awesome progress accompanied the presentation of the home TV in the 1950s and the later presentation of the infrared remote control. The two innovations were helpful for point-to-control correspondence between gadgets however did not have a two-route trade of data. X10 was discharged in the 1970's as a standard convention for wiring houses for home automation.

1901-1920: The invention of home appliances- like refrigerators, washing machine, dishwashers, irons, toaster and garments dryers.

1966-1967: The invention of ECHO IV and Kitchen Computer- the ECHO IV was the first brilliant device. In spite of the fact that it was not industrially sold, the device could register shopping records, control the home's temperature, and turn apparatuses on and off. The "Kitchen Computer" was made for the current year. The apparatus was equipped for putting away formulas, yet didn't offer many models because of poor advertising. The cutting edge came as the Internet, which made an overall system of PCs in the 1990s. Before long, remote Internet as Wi-Fi turned into a typical apparatus in American homes.

2000's: The early 2,000's saw a further ascent in brilliant home innovation, including local tech, home systems administration, and different devices showing up available. A combination of short-range technologies created by Zen-Sys in 2005, this wireless technology creates a mesh network at the user's home and sends signals at the 900 MHz spectrum. The Z-Wave technology is capable of connecting a variety of devices to control appliances, door locks and even flood monitors [3].

I.2.3 Home Automation in present

In recent years the Internet of Things (IOT) have enabled shrewd innovation to end up plainly a vital piece of our day by day lives. Everything from refrigerators, to apparatuses, to home security can be controlled with smart home innovation. Home devices, when remotely observed and controlled through the Internet, are an essential constituent of the Internet of Things.

The present smart homes are more about security and living greener. Current patterns in home mechanization incorporate remote versatile control, computerized lights, robotized indoor regulator modification booking machines, portable/email/content warnings, and remote video observation Sensors are the eyes and ears of the home system. There are sensors for an extensive variety of uses, for example, measuring temperature, dampness, light, fluid, and gas and recognizing development or commotion .

The various technologies used in home automation [3]

- Bluetooth
- Wi-Fi
- Zig-Bee
- Z-Wave
- X10

Table I.1: technologies used in home automation

	<p>Bluetooth is a remote standard that has a place with the PAN convention family. It works in the 2.4 GHz band partitioned into 79 sub channels with 1MHz separating, utilizing FHSS. GFSK and additionally PSK regulations are utilized, contingent upon the Bluetooth variant utilized. Full duplex exchanges are acknowledged by means of TDD.</p>
	<p>Wi-Fi is probably the most exploited wireless technology nowadays. It belongs to the family of (W) LAN networks. In distinction to Bluetooth, the Wi-Fi range is partitioned into just 13 halfway overlaying sub channels (fourteenth accessible in Japan just), each involving the band of 22MHz.</p>
	<p>The first remote home mechanization innovation, Z-Wave set models for remote home computerization. Z-Wave broadened the usable scope of home mechanization by influencing all gadgets to twofold as repeaters. Its expanded system unwavering quality additionally empowered business applications.</p>
	<p>ZigBee is a radio recurrence (RF) correspondences standard. The ZigBee organizer is in charge of making and keeping up the system. Each electronic gadget (i.e. Clothes washer, Television, Lamp and so on).</p>

I.2.4 The X10

The beginning of modern home automation technology can be argued to be found with the introduction of the X10 technology standard. Conceived in 1975 by Pico Electronics, who later partnered with Birmingham Sound Reproducers, X10 laid out the framework for allowing remote control access of domestic appliances.

Chapter I: Overview of home automation

The X10(Figure I.2)standard was designed to allow transmitters and receivers to work over existing electrical wiring systems by broadcasting messages such as "turn off" and "turn on" via radio frequency bursts.

Three years later in 1978, X10 products began to make their way into stores geared towards electronics enthusiasts and shortly after, in the '80s, the CP-290 computer interface made its way into the market for the Mattel Aquarius computer.

The CP-290 unit allowed computers to communicate with X10 compatible appliances in the home. Over the years, support for Windows and Mac has been included, and gave those interested in home automation the ability to program their lighting systems, thermostats, and garage doors from their home computers. [4]



Figure I.2. The X10 Logo[5].

I.3 Description of home automation system

In 21st century we are living in where automation is playing an important role in human -life. Home automation system (Figure I.3) helps us to control devices such as light, door, fan, Air Conditioner etc. it's not only refers to minimizing physical efforts but also helps in energy efficiency and is less time consuming. The primary motive of home automation is to domestic devices by using various techniques like android apps, web pages, global system for mobile communication (GSM) [6].

The system helps older ones by controlling home devices with the help of their mobile phones as they do not need to move physically for turning the appliances OFF. Important motive of home automation system is to "SAVE ELECTRICITY". With the help of this technology anyone can automatically control the home equipment or office equipment. The system is absolutely secure, easy to handle, reliable, flexible and kindly affordable. Various techniques have been implemented in order to implement home automation system and save energy. Home Automation system based on Arduino enwraps that whenever a person will enter the house then number of the persons will get increased, bulb will start glowing. The number of persons available in the room will be displayed on the LCD Screen. Whenever the room gets empty then the bulb will automatically stop glowing making the system power efficient. Home Automation system based also on global system for mobile communication (GSM) and Android application enwraps that while there is any danger happens in the house then a SMS will be sent to house owner's mobile phone indicating the existence of a danger in the house and the house owner can take some preventive action to protect his house. In most situations the person can operate the home appliances with help of an android app present in the mobile phone which will reduce the human efforts. The list of different home devices along with switching buttons will be provided in an android application. By just touching a particular button enables person to control switching of the home appliances using an Android application [6].



Figure I.3. Home automation system [7]

I.4 Benefits of a Home Automation

There are many benefits of using home automation systems (Figure II.4). If you forgot to turn off your lights or any device when you are out, you can switch them off remotely. You can also check your appliances' status remotely and determine whether to turn it on or off, without concern where you are located. You can control a device or light, a smart device or a centralized control. [8]

- **Convenience**

Convenience is one of the most important reasons why homeowners like to install home automation systems. You can easily control all the electrical devices and lighting in your home from one place. Besides, there is no need for you to rely on your neighbors to check whether the appliances or lights in your home are on or off when you are away.

- **Energy Saving**

Besides convenience, home automation devices also help you save energy. You can always keep up to date with the current status of the appliances and lighting and ensure that nothing is ON when they shouldn't be. In fact, some systems can even provide you help with optimal schedules to help achieve high energy efficiency.

Chapter I: Overview of home automation

When the lights and electrical appliances work only when you need them, you will be able to save more energy. This can translate into savings in the long term. At the same time, if you forgot to switch off a light, air conditioner or any other appliance, there will be no need to return back to switch it off. This will save you both time and money.

- **Security**

When you use home automation systems, you can enhance the level of security in your home. Whether you are at your home or away, you can always control the lights. You can even automate the lights or appliances to turn on when you are not at home. So, whether you are at work or vacation, you can the lights switch on to ward-off potential intruders. It can make it appear that someone is home. Similarly, you can also have lights turn on automatically when you enter a room or pathway [8].



Figure I.4. Benefits of Home Automation

I.5 Conclusion

In this chapter we've seen a review about home automation and its benefits.

Recently people have tried to control everything automatically without any physical effort to preserve their own energy and power both in their bodies and homes.

In general, home automation involves centralized lighting control, temperature control, appliances and other systems for greater comfort, convenience, efficiency and security.

Chapter II

Description of the Hardware

II.1 Introduction

This chapter consists of the Arduino board and various materials that have been implemented on the home automation system.

II.2 The Arduino Board

The Arduino was originally developed by teachers to make it possible for their design students who were not engineers to create interactive objects and environments. Since the original Arduino was released in 2005, it is estimated that over 1 million have been sold. Designers, educators, engineers, hobbyists, and students have

Built all kinds of projects that sense and respond to the world with Arduino. [9]

II.2.1 Definition

Arduino is an open-source design for a microcontroller interface board (use an AVR ATmega microcontroller), with a USB plug to connect to your computer and a number of connection sockets that can be wired up to external electronics, such as motors, relays, light sensors, laser diodes, loudspeakers, microphones, etc.

They can either be powered through the USB connection from the computer or from a 9V battery. They can be controlled from the computer or programmed by the computer and then disconnected and allowed to work independently. [10]

II.2.2 The different Arduino boards

There are many versions of the Arduino (Figure II.1), and each is designed for a specific function. Currently, there are more than 20 versions of Arduino module; we cite a few to clarify the evaluation of the scientific and academic product:

The Arduino Nano, a small program card using USB port this version using an ATmega168 microcontroller (Atmega328 for a newer version).

The Arduino UNO uses ATmega328 microcontroller [11].

The Arduino Mega2560, The Mega 2560 employs an ATmega 2560 as the main MCU, which has 54 general I/Os to enable you to interface with many more devices.

The Mega also has more (ADC) channels, and has four hardware serial interfaces (unlike the one serial interface found on the Uno).

The Leonardo uses the 32U4 as the main microcontroller, which has a USB interface built in.

Chapter II: *Description of the Hardware*

The Lily Pad is unique because it is designed to be sewn into clothing.

Using conductive thread, you can wire it up to sewable sensors, LEDs, and more.

The Due uses a 32-bit offers higher-precision ADCs, selectable resolution pulse width modulation (PWM), Digital-to-Analog Converters (DACs), a USB host connector, and an 84 MHz clock speed. [12]



Figure II.1.The different Arduino boards [13].

Chapter II: Description of the Hardware

The board that we are going to use during this thesis is the Arduino Uno, it is shown by the following figure:

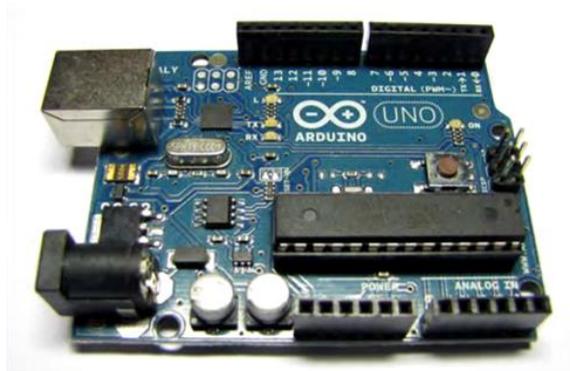


Figure II.2.Arduino Uno Board[14]

The Arduino Uno R3 contains different parts, every part has a specific function and the ATmega328P is the main part of it.

II.2.2.1 The ATmega328 Microcontroller

An ATmega328 microcontroller (Figure II.3) is an integrated circuit that resembles the elements of a computer, it is the brain that will process the data and information from the sensors (inputs), and this with a very reduced processing time, then gives the desired instructions on exit. Today, by soldering a large number of bulky components, such as transistors; resistors and capacitors everything can be housed in a small black plastic box with a number of pins which can be programmed in C language. [15]

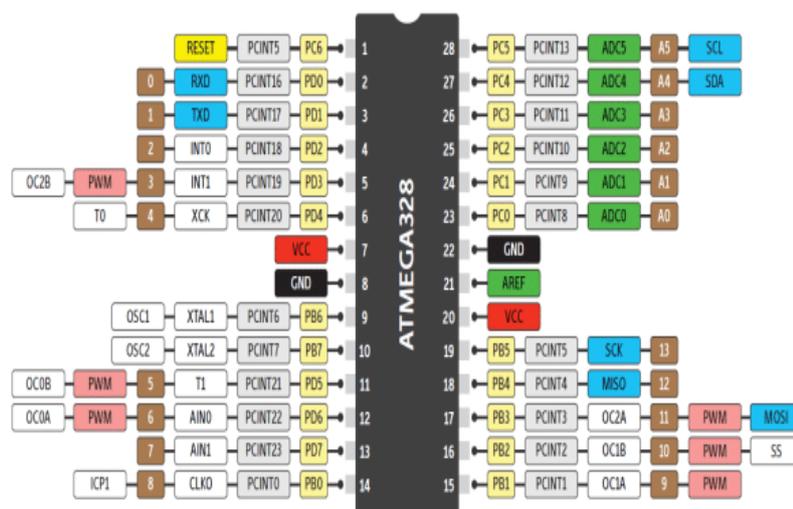


Figure II.3. The atmega328 microcontroller [16]

Features [15]

Table II.1: Features of the atmega328 microcontroller

Microcontroller	ATmega328
Clock frequency	16 MHZ
Operating voltage	5 V
Input voltage (recommended)	7-12 V
Input voltage (limit)	6-20 V
Digital ports	14 I / O (6 PWM outputs)
Analog ports	6 analog inputs.
Max current per pin 3.3 V.	50 mA
Max current per pin 5 V.	500mA
Memory.	32 Ko Flash 2 Ko SRAM 1 Ko EEPROM
Dimensions	6.86 cm*5.3cm

II.2.2.2 Arduino other parts.

- **Reset Button**

Much like turning your computer off and on again, some problems with the Arduino can be solved by pushing the reset button. This button will restart the code currently uploaded on your Arduino.

- **USB Port**

The USB port takes a standard A-to-B USB cable, often seen on printers or other computer peripherals. The USB port serves two purposes:

First, it is the cable connection to a computer that allows you to program the board. Second, the USB cord will provide power for the Arduino if you're not using the power port [2] so the Arduino is powered through a DC input or a USB connection.

- **Voltage Regulator**

The voltage regulator converts power plugged into the power port into the 5 volts and 1 amp standard used by the Arduino

- **Power Port**

The power port includes a barrel-style connector that connects to power straight from a wall source (often called a wall-wart) or from a battery. This power is used instead of the USB cable. The Arduino can take a wide range of voltages (5V–0V DC) but will be damaged if power higher than that is connected.

- **Built-In LEDs**

The LEDs marked TX and RX show whether your Arduino is sending or receiving data. The one marked L is connected to Pin 13.

- **ON Indicator LED**

This LED indicates that the Arduino is getting power when you turn it on.

- **Digital I/O Pins**

The holes on this side of the board are called the digital input/output

Chapter II: *Description of the Hardware*

Pins (Pins 2 to 13) they are used to either sense the outside world (input) or Control lights, sounds, or motors (output).

- **TX/RX Pins**

Pin 0 and Pin 1 are special pins labeled TX and RX. But it is good practice to leave these pins empty. Any changes you make to your program won't load if something is Plugged into Pin 0.

- **Power and Ground Pins**

Pins related to power are located here. You can use these pins to run power from your Arduino to your breadboard circuit.

- **Analog Pins**

(A0 to A5)These pins take sensor readings in a range of values (analog), rather Than just sending whether something is just on or off (digital). [1]

II.3 Arduino IDE Software

Arduino IDE is programming environment that allows the user to draft different kind of programs and load them into the Arduino microcontroller.

Arduino uses user-friendly programming language, which is based on programming language called Processing. After the user has written his code, IDE compiles and translates the code to the assembler language. After translating the code, the IDE uploads the pro-gram to the Arduino microcontroller. Arduino IDE has a built-in code parser that will check the user written code before sending it to the Arduino. IDE software includes the set of different kind of programs that are ready to be tested on the device. After testing the program it can be uploaded to the Arduino by USB cable that vary in different models . [19]

The Arduino IDE program files are stored in *C: > Program Files (x86) > Arduino*, which includes example sketches located in *C: > Program Files (x86) > Arduino > examples*.

Each example sketch is accompanied by a text file outlining the objective of the sketch, the breadboard layout of the components, and a circuit diagram.

The Arduino IDE is used to write, compile, and upload files to the microcontroller.

A file containing Arduino code is called a *sketch*.

Within the Arduino IDE, clicking one of the five IDE symbols Provides quick access

- ✓ To compile a sketch
- ✓ To compile and upload a sketch
- ✓ To open a blank sketch
- ✓ To open an existing sketch from a list of all sketches,
- ✓ And to save the current sketch.

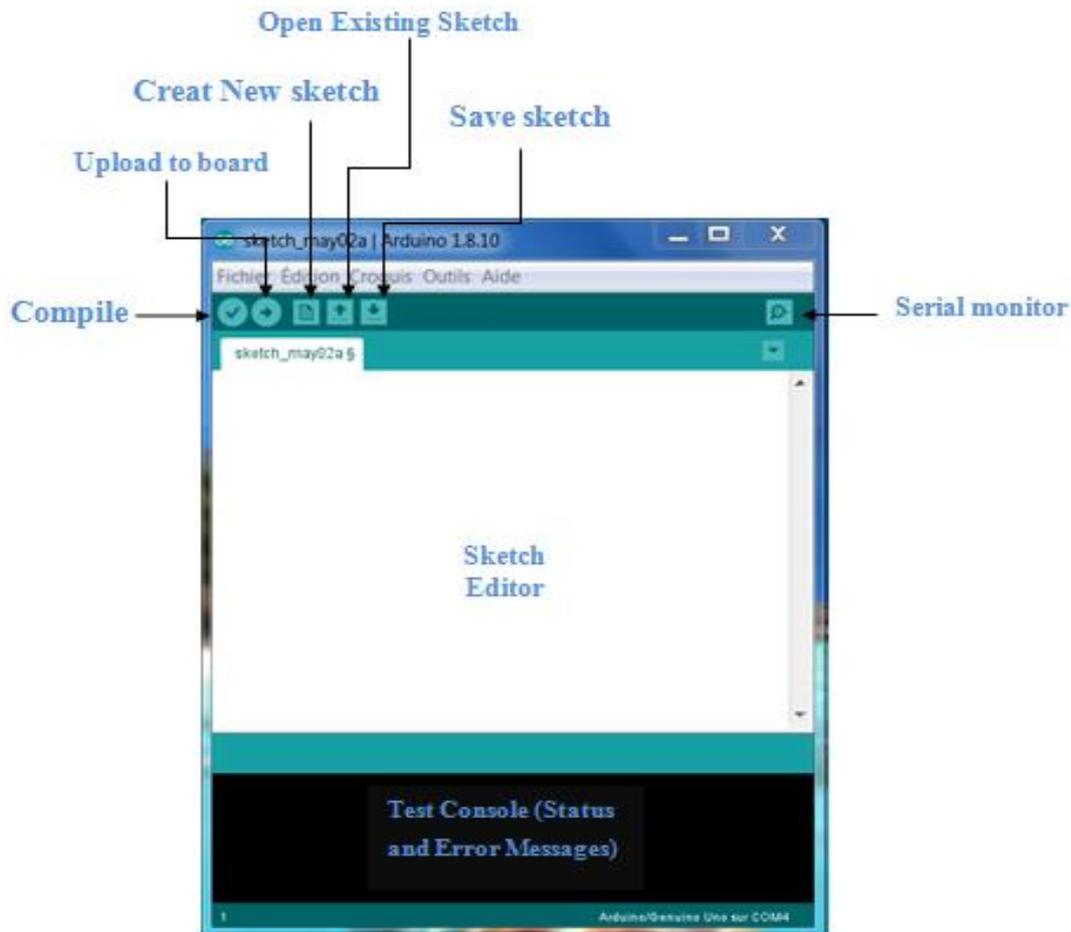


Figure II.5. Arduino IDE sketch

The *Open an existing sketch* option does not scroll the complete list of sketches, so use *File* ➤ *Sketchbook* instead. Some useful options from the drop-down menu are given in Table II.2. [53]

Table II.2: Drop-down Menu Options of the Arduino IDE

Options	Description
File > Open Recent	A list of recently accessed sketches
File > Examples	Arduino IDE built-in sketches
Edit > Find	Find and replace text in a sketch
Sketch > Include Library	Arduino and contributed libraries
Tools > Serial Monitor	Displays serial data to serial monitor
Tools > Serial Plotter	Graphic display of serial data
Tools > Board	Description of the microcontroller for example Arduino/Genuino Uno
Tools > Port	Detail of serial port, for example COM3 Arduino/Genuino Uno
File > Open Recent	List of recently accessed sketches

II.4 Arduino IDE Sketch

An Arduino IDE sketch consists of three parts: variable definition, the void setup (), and the void loop () functions.

The first part includes defining which Arduino pins are connected to sensors, LEDs, or devices, and declaring the values of variables. For example,

The int LED pin = 9 instructions defines a variable, named *LED pin*, with the integer value of 9.

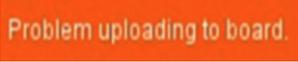
The void setup () function implements definitions in the first part of the sketch and only runs once. For example, the pinMode(LED pin, OUTPUT) instruction defines the Arduino pin 9 as an output pin, rather than an input pin by default, since *LED pin* has the value 9.

The void loop () function runs continuously and implements the sketch instructions. For example, a sketch may turn on and off an LED at given times. Declaring variables in

the first part of the sketch makes it easier to update the variable once at the start of the sketch, rather than having to check through the sketch and update variables throughout the sketch. Comments are prefaced by `//`, such as `// Set LED to pin 9`, and are not implemented by the microcontroller. With a couple of exceptions, all instruction lines end with a semicolon. [53]

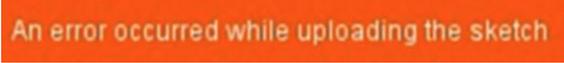
II.4.1 Run the Blink Sketch

1. Connect the Arduino to a computer or laptop with the USB-to-serial cable.
2. In Arduino IDE, select `File` ➤ `Examples` ➤ `01. Basics` ➤ `Blink`.
3. Click the *Compile and Upload*, button.

The  error message indicates that the serial

Port should be updated. Select `Tools` ➤ `Port` and choose the appropriate

Port (for example, `COM3` or `COM4`) for the Arduino. Go to step 3.

The error message  indicates

That the description of the microcontroller should be updated. Select

`Tools` ➤ `Board` and choose the relevant board (for example, *Arduino/Genuino Uno*). Go to step 3. [53]

II.5 Features of the Arduino UNO Board

- Arduino is a USB interface like a serial device. The board directly plug in to the computer so it is easy and comfortable to interface with the computer.
 - It is an open source device and very easy to debug the problem so it is more advantages between the large Community peoples. In order fast up for application it has 16 MHz clock.
 - It has inbuilt in voltage regulation in order to manage power inside and can be directly powered by USB without any external power.
 - This board has 13 digital and 6 analog pins to connect the hardware with the external environment.
 - With the help of these pins we can directly plug in the real-world data.
 - An onboard LED and reset button is attached in order to make debug process easy.
- [20]

II.6 Sensors

The purpose of a sensor is to respond an input physical property and to convert it into an electrical signal that is compatible with electronic circuits. Sensors are electronic devices that measure a physical quality such as light or temperature and convert it to a voltage

There are two types of sensors: digital and analog. Digital sensor output varies between one and zero, which translates to sensors voltage range. Analog sensor can output any value between its voltage ranges. Its voltage output changes according to the reading from the sensor. Digital sensor output is ON (1) often 5v, or OFF (0), 0v. Analog sensor is used to measure precise numerical information like temperature or speed. Analog sensors can output almost an infinite range of values.

Sensors are used to expand the capabilities of the Arduino. Sensor output is connected to input pin of Arduino and the data is converted to digital form. Some sensors have analog to digital converter embedded to the sensor so the data is outputted as digital data. Those sensors which don't have onboard analog to digital converter, data is sent analog to Arduino which then uses its onboard converter to convert data to digital. After data is processed to digital form, it can be processed on the microcontroller. [19]

II.7 Sensors used

II.7.1 Temperature Sensor (LM35)

Temperature sensor is a device which is used to measure the Temperature.

LM35 is a precision IC temperature sensor with its output proportional to the temperature (in °C).

With LM35, the temperature can be measured more accurately than with a thermostat. It also possesses low self-heating and does not cause more than 0.1 °C temperature rise in still air. The operating temperature range is from -55°C to 150°C. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. The LM35 temperature sensor is an analog temperature sensor manufactured by Texas Instruments. It is extremely popular in electronics because it is precise, inexpensive, very easy to use and extremely reliable. It is able to measure temperatures ranging from -55 ° C to + 150 ° C in its most precise version and with the right mounting, enough to measure any temperature.[21]

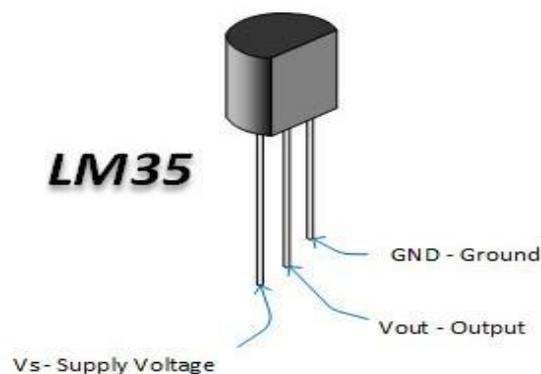


Figure II.4.LM35 sensor [22]

❖ Features

- Low cost
- more memory, processing and communication capabilities
- Low output impedance and linear output, precise inherent calibration make interfacing to readout or control circuitry especially easy.
- It can be used with single power supplies, or with plus and minus supplies. As it draws only 60μ A from its supply, it has very low self- heating, less than 0.10 in still air. [23]

II.7.2 Detected gas (MQ-2)

Gas sensor is a device which is capable to detect trace amount of gas or any other specific type of gaseous emission in a particular area. A gas detector can employ a variety of means to realize the presence of gas in particular surrounding. Gas sensor can be used to detect combustible, flammable, toxic, and nontoxic gases.

These types of sensors are generally used in industry, oil rigs, to monitor manufacturing process, emerging technology, firefighting, etc.

Some of the common gases detected by gas sensors are ammonia, VOCs, CO, CO₂, H₂S, aerosol, hydrogen, oxygen, NO_x, etc. [24]

MQ-2 module is useful for gas leakage detection in home and industry. It can detect H₂, LPG, CH₄, CO, Alcohol, Smoke, and Propane. Based on its fast response time measurements can be taken as soon as possible. Also the sensitivity can be adjusted by the potentiometer. When the target combustible gas exist, the sensor's conductivity is higher along with the gas concentration rising.[25]



Figure II.5.MQ-2 gas detector [25]

❖ FEATURES

- Power supply: 5 V
- gas sensor (LPG) easy to use
- Can be used in gas leak detection equipment in consumer and industrial applications
- Interface type: analog
- High sensitivity
- Quick response
- Stable and durable
- Simple driving circuit. [26]

II.7.3 Motion Sensor (PIR)

Motion sensors are used in a motion detector which is a device that contains a physical mechanism or electronic sensor that quantifies motion that can be either integrated with or connected to other devices that alert the user of the presence of a moving object within the field of view. [27]

The PIR sensor detects and measure the approaching IR radiations radiated from the human body and different objects present in the ambience of its view. Human Beings generally emit thermal energy with wavelength around 9-10 micro-meter every day. This sensor is designed to detect these wavelengths and operate accordingly.[28]



Figure II.6. PIR sensor [29]

❖ Features of PIR Sensor

- Low cost
- Low power consumption
- Minimal maintenance

II.8 Relay

A relay consists of coil and it acts as a electromechanical switch. The magnetic field is induced in the circuit and causes the switch to close or open the electrical connection when small current flows through the circuit. The relay can control the High voltage circuit using small DC voltage circuit without any direct electrical connection (i.e.) the high and the low voltage circuit are magnetically separated and electrically separated.

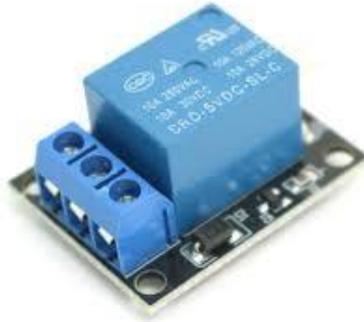


Figure II.7. Relay [30]

❖ **Functionality**

A relay will switch one or more poles, each of whose contacts can be thrown by energizing the coil in one of three ways.

Normally-open (NO) contacts connect the circuit when the relay is activated; the circuit is disconnected when the relay is inactive. It is also called a Form A contact or "make" contact. NO contacts can also be distinguished as "early-make" or NOEM, which means that the contacts will close before the button or switch is fully engaged.

Normally-closed (NC) contacts disconnect the circuit when the relay is activated.

The circuit is connected when the relay is inactive. It is also called a Form B contact or "break" contact. NC contacts can also be distinguished as "late-break" or NCLB, which means that the contacts will stay, closed until the button or switch is fully disengaged.

Change-over (CO), or double-throw (DT), contacts control two circuits: one normally-open contact and one normally-closed contact with a common terminal. It is also called a Form C contact or "transfer" contact ("break before make"). If this type of contact utilizes "make before break" functionality, then it is called a Form D contact.

SPDT – Single Pole Double Throw. A common terminal connects to either of two others. Including two for the coil, such a relay has five terminals in total.

[17]

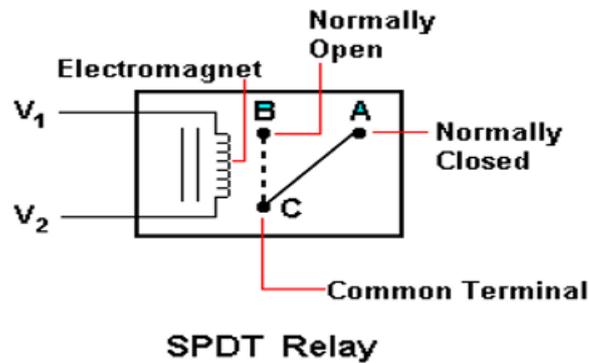


Figure II.8. Relay Circuits Operation [32]

II.9 GSM MODULE

GSM (Global System for Mobile communications) is the technology that underpins most of the world's mobile phone networks. GSM is an open, digital cellular technology used for transmitting mobile voice and data services. GSM operates in the 900MHz and 1.8GHz bands GSM supports data transfer speeds of up to 9.6 kbps, allowing the transmission of basic data services such as SMS. The GSM standard is intended to address these problems. In the current work, SIM900 GSM module is used, it is shown in Figure II.8



Figure II.9. GSM MODULE [33]

II.9.1 Advantages

1. Maximum range using GSM technology
2. User friendly
3. Easy to handle all people
4. Low cost

5. Power saving

II.9.2 Disadvantages

1. If GSM network fails system doesn't work.

II.9.3 Application

1. Home automation.
2. Industrial automation.
3. Lab automation.[34]

II.10 Light Detecting Resistors (LDR)

Light Dependent Resistor (LDR) is just another special type of resistor and therefore has no polarity. This means they can be connected in any direction

LDR will change its resistance depending on the light around it. It is when the resistor is placed in a dark room that it will have a resistance of a few mega ohms and as we gradually impose light above the sensor its resistance will start to decrease from mega ohms to a few ohms. This property helps the LDR to be used as a light sensor. It can detect the amount of light falling on it and thus predict light and dark.

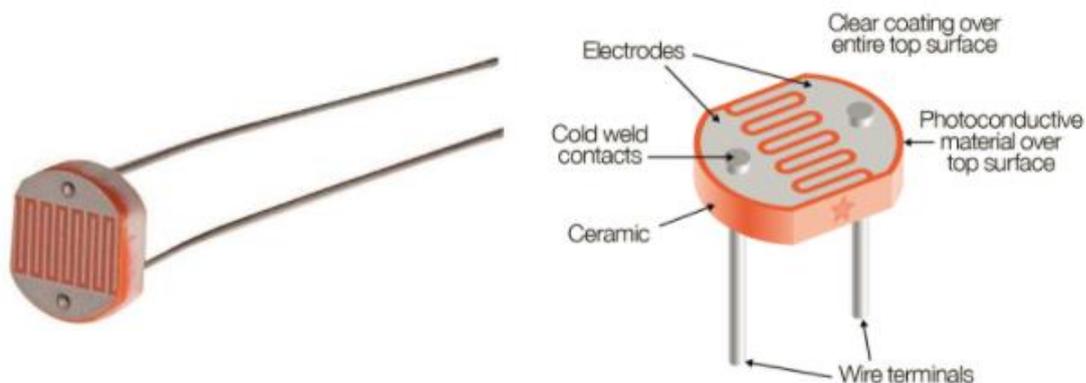


Figure II.10. Light Detecting Resistors (LDR) [35]

❖ The benefits of photoresistor

1. Low cost.
2. Wide spectral ranges.
3. Ease of implementation.
4. Static transfer ratio.
5. High sensitivity. [36]

II.11 BUZZER

A horn is an electromechanical or electronic component that produces a sound when voltage is applied. Some require direct voltage (electromechanical buzzers), others require alternating voltage (piezoelectric transducers) [36]



Figure II.11.Buzzer [37]

❖ **Description**

Type: Passive buzzer

Working voltage: 3.5-5.5v

Working current: <25mA

❖ **Functionality**

The buzzer has two small fixing brackets. The sound power of such a component is in the order of 85 dB / cm. It requires a DC voltage to operate, the latter should generally be between 3 V and 28 V, depending on the model. A buzzer designed to operate at 6 V, generally works very well for any supply voltage between 4 V and 8 V, and a buzzer designed to operate at 12 V, can work perfectly at a voltage between 6 V and 28 V. [36]

II.12 Liquid crystal displays (LCD)

Liquid crystal displays, otherwise known as LCD (Liquid Crystal Display) displays, are intelligent compact modules and require few external components for proper operation. They consume relatively little (from 1 to 5 mA), are used with great ease.

They are widely used in microcontroller fixtures. They can also be used during the development phase of a program, because you can easily display the values of different variables.[38]

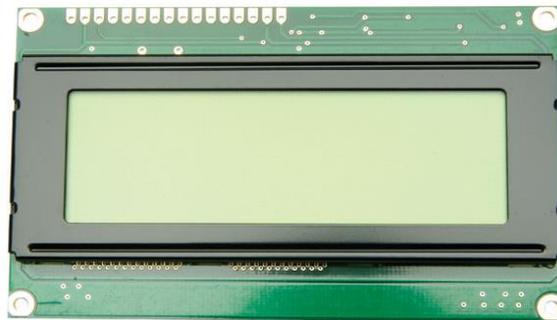


Figure II.12. Liquid crystal displays 16*4 [39]

II.13 Fan

In this module we are using a 12 volt cooling fan for which a adapter is used for power supply. [40]



Figure II.13.Fan [41]

II.14 Conclusion

In this chapter we have approached the electronic part of our project, by making the details of each of the components which constitutes our system. we discussed about Arduino Uno which is the main element in this project then the sensors, and other elements like fan, lcd, relay etc.

Chapter III

*Software conception and
Simulation*

III.1 Introduction

After having described the material part and the operation of each part of it, we will pass to the most important part of our thesis which is the realization of the system. Our realizations consist of two main parts:

- Software part.
- Simulation part.

But first of all we will be presenting the designed system, through the explanation of the block diagram, and the representation of the software used to achieve it.

III.2 Block diagram

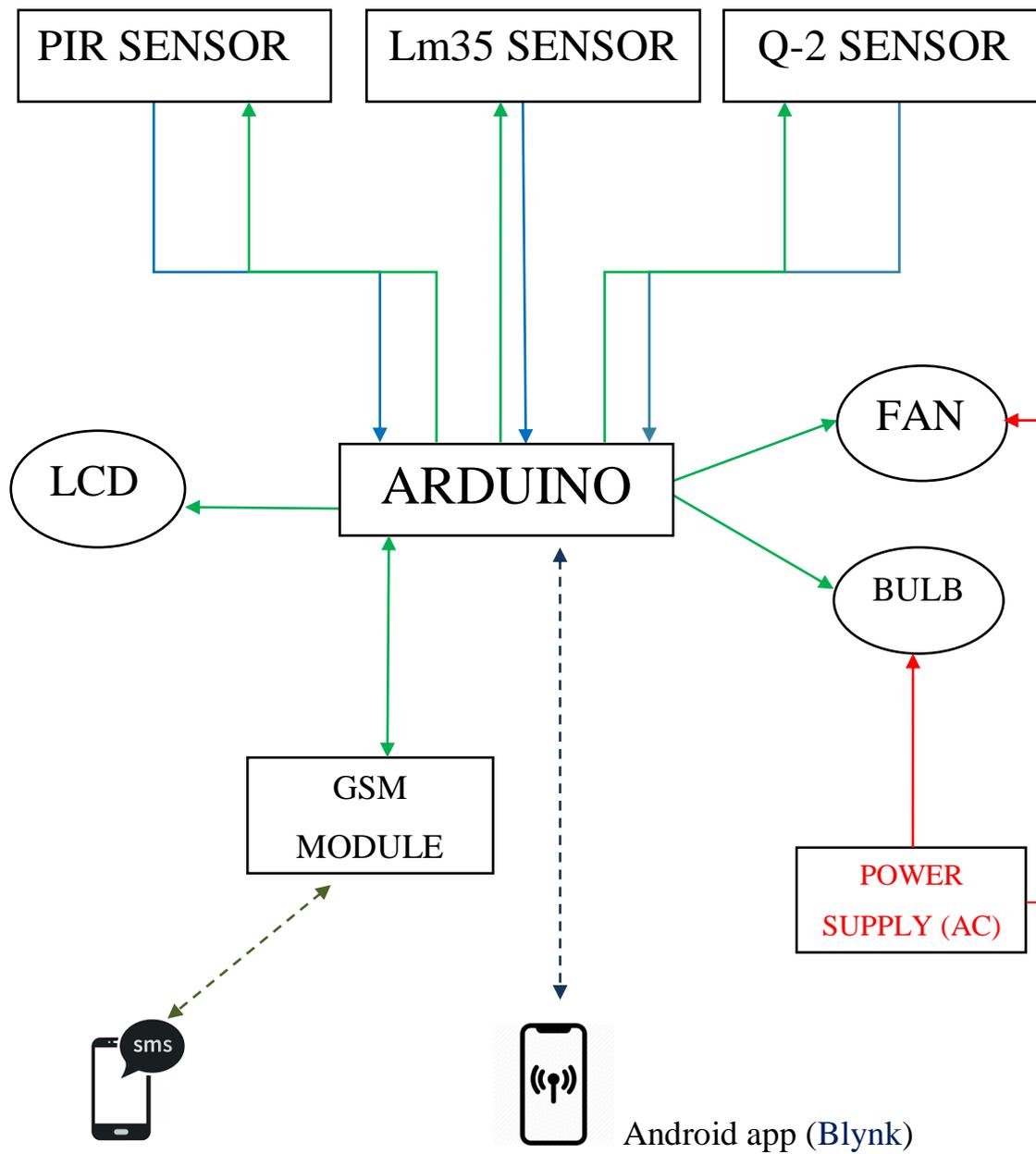


Figure III.1. A diagram representing the circuit developed.

Order →

Power →

Information →

Internet communication - - - - ->

GSM network communication - - - - ->

III.3 Description of the system

The project focuses on this particular aspect of an Arduino Uno and various sensors we have:

- PIR Sensor it is for detecting the presence of a human being.
- MQ-2 Sensor for detecting the presence of gas
- LM35 to measure the temperature

To achieve energy savings in a typical home without human intervention. An Arduino forms the basis of the home automation system , the system will automatically switch the appliances ON/ OFF based on the measured data received from the sensors [42]

- GSM module for sending SMS when there is any gas leak
- LCD to display the data like temperature, the warning message etc...
- Android app used to achieve the switching off and on of the electronic device.

III.4 Software used

To achieve this project we have used a good deal of software like Proteus Tinkercad, virtual serial ports emulator, Blynk and Arduino IDE.

III.4.1 Proteus

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation.

The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

It was developed in Yorkshire, England by Labcenter Electronics Ltd. [43]

- **Proteus ISIS:** is used by Engineering students & professionals to create schematics & simulations of different electronic circuits.
- **Proteus ARES:** is used for designing PCB Layouts of electronic circuits. .[44]

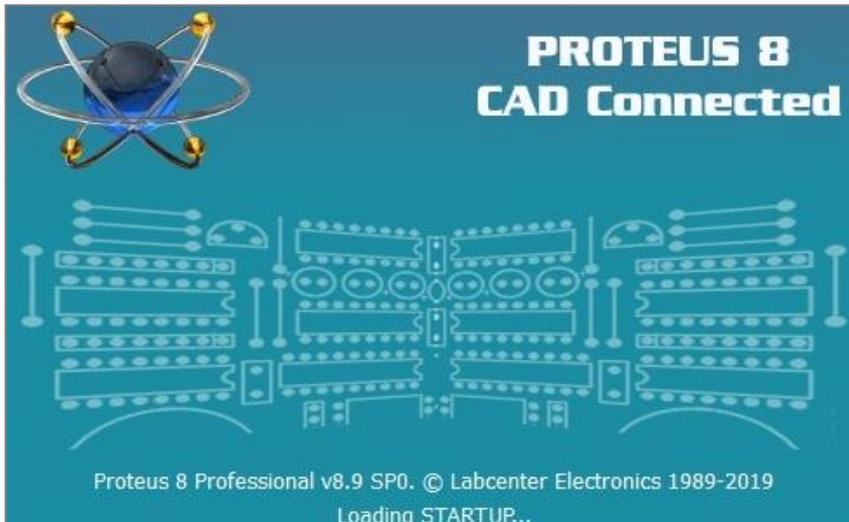


Figure III.2. Proteus software Version 8.9

III.4.1.1 Description of the Proteus software

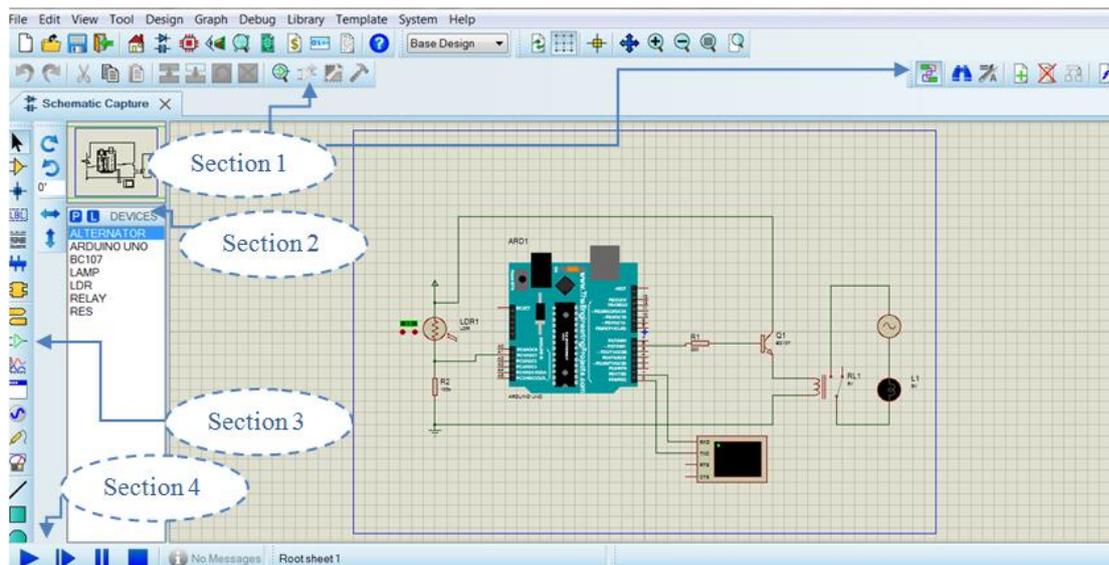


Figure III.3. Proteus software

Section 1: is a toolbar which has simple functionalities like zooming changing copy and move options and few other tools.

Section 2: has two buttons. P is used to open the components list and L is used for editing purposes, like you want to edit the properties of any component then simply click on that component and then click on L and it will open the properties of that component and you can easily edit it.

Section 3: has different tools, used for designing circuits.

Section 4 is the remote control section of Proteus, as it contains four buttons i.e. Play, Step, Pause & Stop. In order to run the simulation, we have to click on this play button. . [44]

❖ Proteus has many advantages like:

- Pack containing software that is easy and quick to understand and use.
- The virtual prototype creation tool helps reduce hardware and software costs when designing a project.
- The technical support is efficient.[45]

III.4.2 Android

Android is a complete platform for mobile devices (phone, PDA, notebook, tablets, etc.). The Android platform is an OS (Operating System) based on a Linux kernel, under an open source license. It is composed of an operating system, libraries (middleware), and a set of applications: an email client, a browser, a calendar, etc.

The services offered by Android facilitate in particular the operation of GSM, Bluetooth, WIFI and UMTS telecommunications networks, the manipulation of media, in particular video, audio and JPEG images as well as other formats, sensors such as motion sensors, camera, compass and GPS receiver, touch screen operation, database storage, viewing web pages, multitasking applications and sending messages .[46]



Figure III.4. Android logo.

To build an android application we used Blynk.

Blynk is an IoT (Internet of Things) platform using which you can easily and remotely control hardware.

Additionally, you can also view sensor data, store the data; visualize the data etc. all over the internet.

The Blynk platform supports a wide range of boards and MCUs like:

Arduino UNO, Arduino Nano, Mini, Mega, etc. Basically all Arduino boards.

There are three major components in the Blynk Platform. They are:

- Blynk App
- Blynk Server
- Blynk Libraries

The Blynk App, which is available for both Android and iOS, allows the user to create intuitive interfaces for their projects. The Blynk Server is responsible for the communication between your hardware like Arduino and your application on the Smartphone.

Finally, the Blynk Libraries allows the hardware to communicate with the server and process all the incoming and outgoing commands.

First, your hardware is made ready with the help of the necessary libraries. When a command is given through the Blynk App on your Smartphone, like Toggle an LED, it reaches the Blynk Server and gets redirected to your hardware and based on the command received from the server, the hardware responds accordingly.

To control Arduino using Blynk There are different ways to use:

- Ethernet
- Bluetooth
- Wi-Fi
- GSM / 3G / LTE
- USB

So first of all we have to install the Blynk App on your Smartphone. You might have to register with a valid e-mail ID to completely utilize the Blynk services.

1. Install the Blynk app from App Store or Google Play Store depending on your device. Open the app and enter your credentials, if required. Then select “New Project”. Provide an appropriate name to your project and also select the hardware i.e. Arduino UNO in my case.

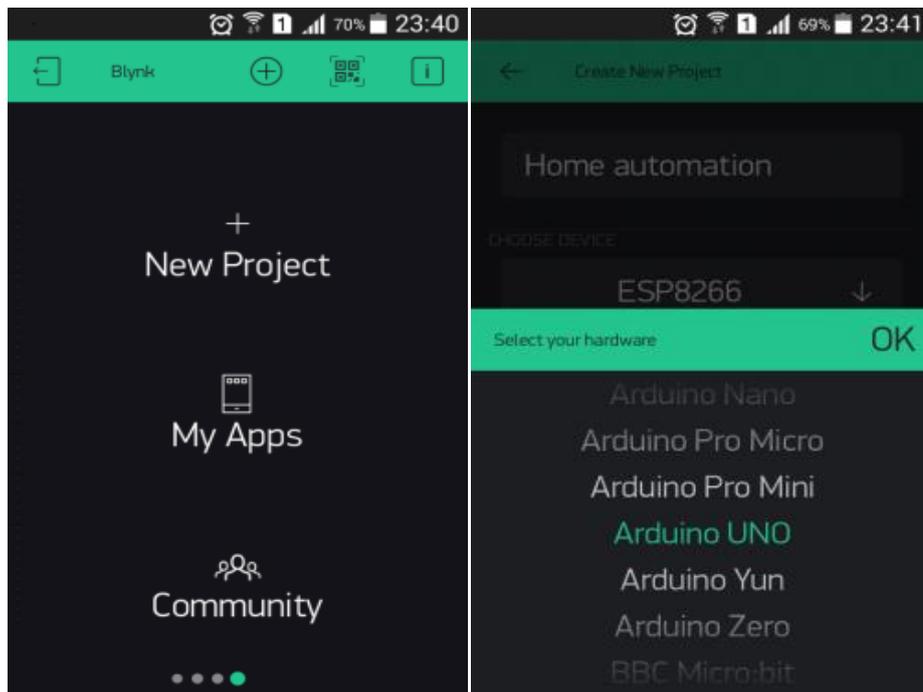


Figure III.5. Blynk app, create a project and choosing the board.

2. Select the type of connection you are going to use. So, select “WI-FI”. Then click on “Create” option. Your Blynk project will be created and an Authentication Token will be sent to the registered e-mail address. Make a note of this Auth Token.

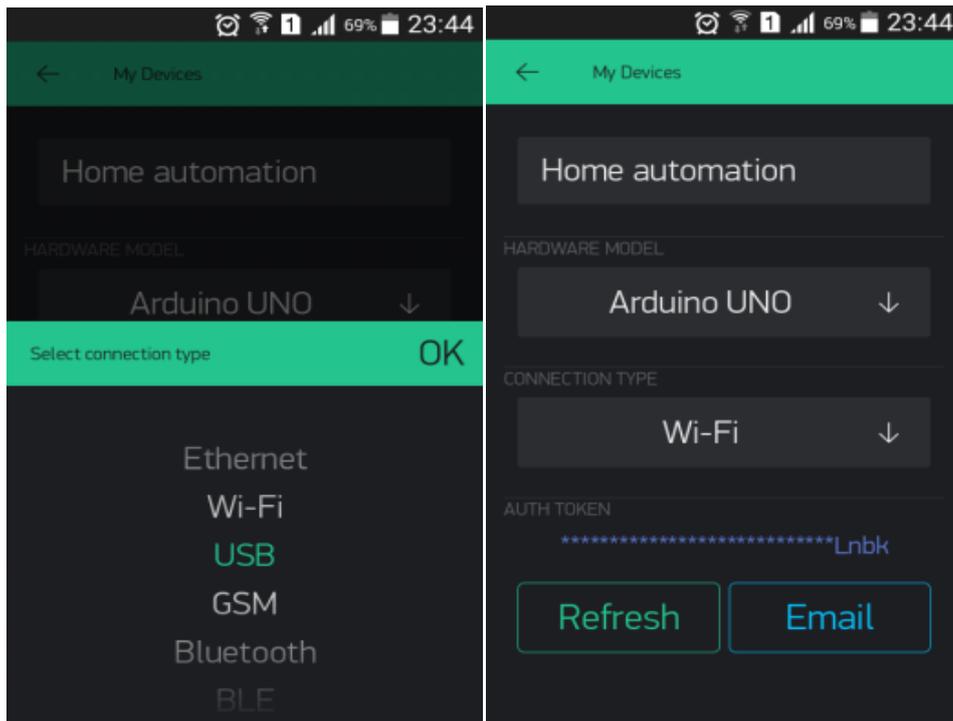


Figure III.6.Blynk app .choosing type of connection.

3. In the project space, select the “+” symbol to add a widget to your project. Since I will toggling an LED connected to one of the Digital I/O pins of Arduino, I will select a “Button”.

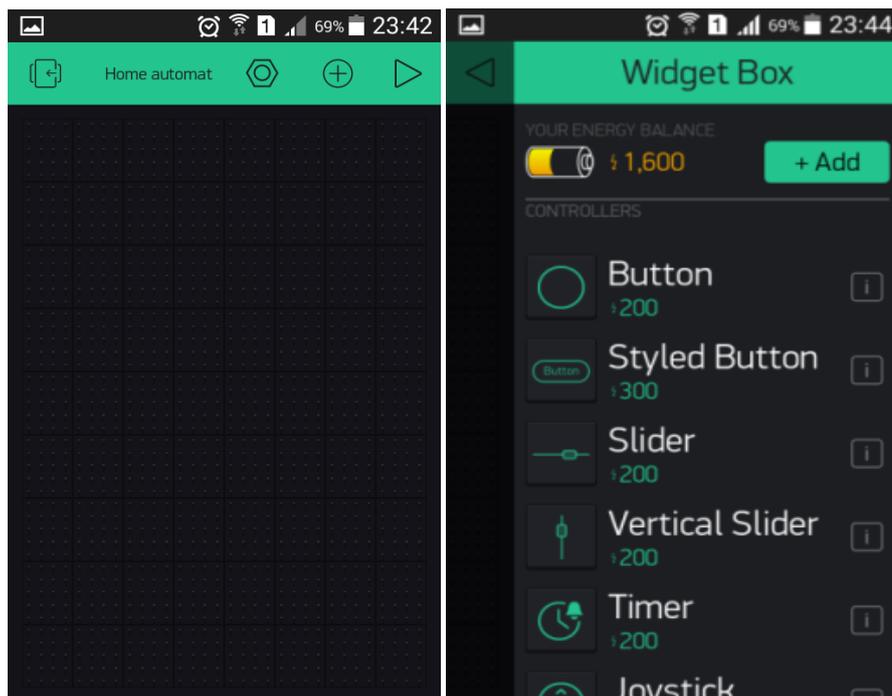


Figure III.7.Blynk app Set Button.

4. Select the Button to change its settings. First, select the LED Pin of Arduino. I have used the onboard LED of Arduino UNO. So, select “PIN” and set “Digital” and “D13”. Also, the mode of the button can set as “Switch”, for toggle action.

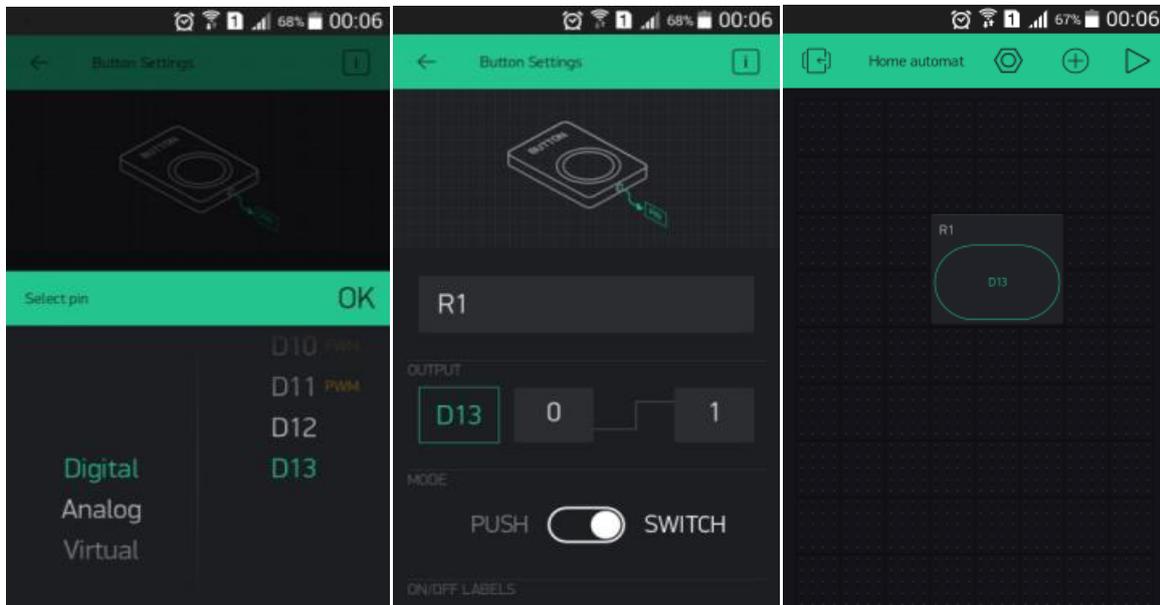


Figure III.8. Blynk app Adjusting the Pin.

That is it. The Blynk App is set. The next step is installing the libraries.

- Go to the official GitHub page of Blynk and download the latest release.
- Download the zip file. Extract the contents of the zip file and copy the contents of the “libraries” folder and paste them into the libraries folder of Arduino.
- open Arduino IDE and select File → Examples → Blynk → Boards_USB_Serial → Arduino_Serial_USB sketch.
- Scroll down to the line that says ‘char auth [] =”YourAuthToken” and add the Auth Token you received in mail in place of YourAuthToken.
- Select the correct COM Port and upload the sketch to Arduino.
- The final step is run a small script in your laptop / PC. Open Command Prompt with Administrator Privileges and change the working directory to

Chapter III: Software conception and Simulation

“C:\Program Files (x86)\Arduino\libraries\Blynk\scripts” using the cd command.

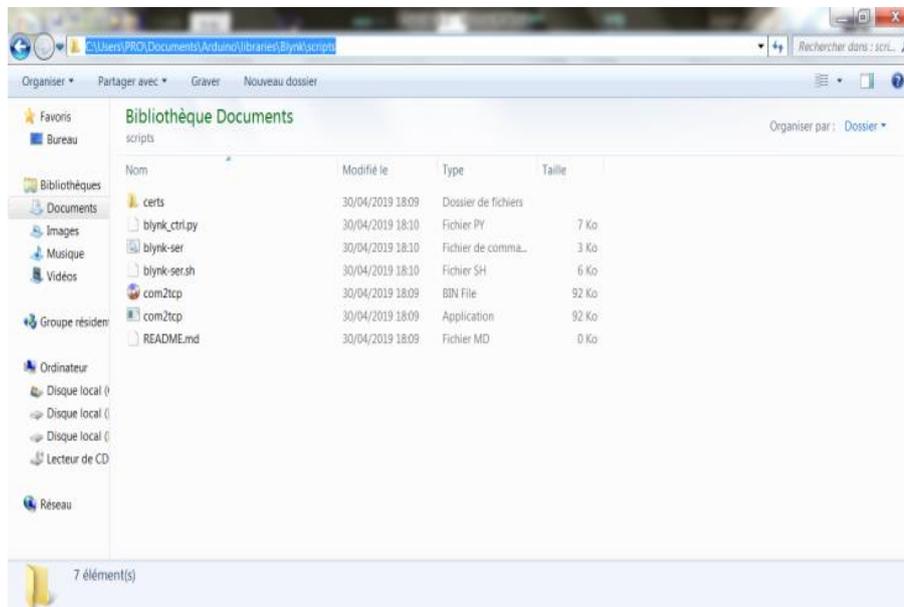


Figure III.9. Window folder.

Now we use the .bat file. In the command, enter the following and hit enter. *Blynk-ser.bat* -c COM5

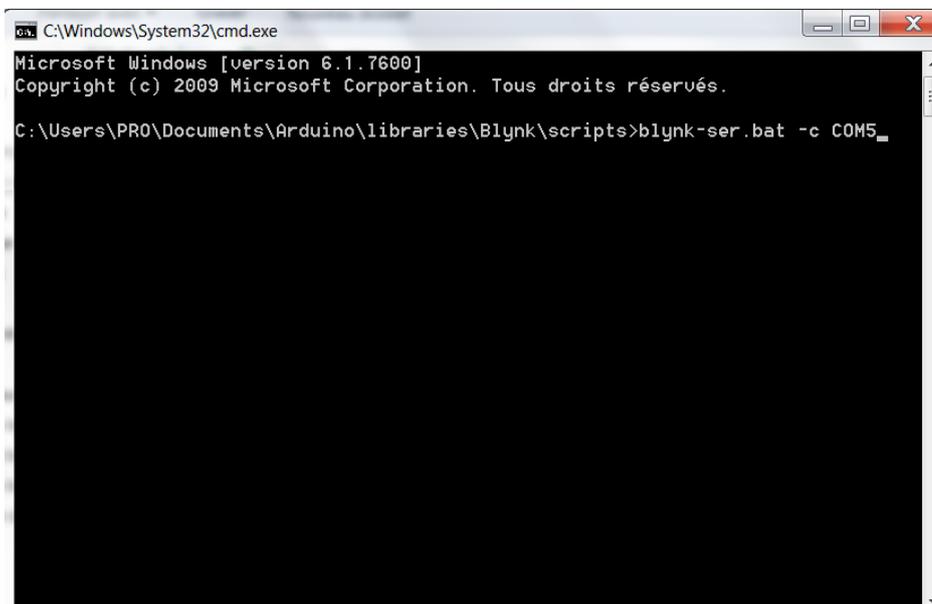


Figure III.10. Command Prompt

Here, COM5 is the COM Port to with Arduino UNO is connected to in my case.

This step allows the Blynk Server to communicate with the device connected to COM5 of this PC. Since Arduino is connected in our case, Blynk will be able to control Arduino Board.

Now, we open the Blynk App the Phone and press of the button to see the LED ON and OFF according to the status of the Button. [47]

III.4.3 Virtual Serial Ports Emulator (VSPE)

VSPE is intended to help software engineers and developers to create debug test applications that use serial ports. It is able to create various virtual devices to transmit or receive data. Unlike regular serial ports, virtual devices have special capabilities: for example, the same device can be opened more than once by different applications, that can be useful in many cases. With VSPE you are able to share physical serial port data for several applications, expose serial port to local network (via TCP protocol), and create virtual serial port device pairs and so on.[48]



Figure III.11.Virtual Serial Ports Emulator (VSPE)

❖ VPSE FEATURES

- VSPE help developers to create and debug applications without real hardware installed.
- It helps people to make data stream from any source (like TCP connection, USB port and so on) visible to any program via virtual serial port.
- To create a lot of virtual serial ports working simultaneously. You can do it without installing serial ports extension board.
- To share serial port for many applications. [49]

Chapter III: Software conception and Simulation

III.4.4 Tinkercad

It is possible to use the Arduino without Arduino. The Tinkercad website indeed hosts a virtual Arduino.

The virtual Arduino is as real as life. It also allows you to experiment, save or share new connections. You can even use components that you don't have at home, or safely test some questionable connections. to try it, go to this address: <https://www.tinkercad.com/circuits>

Click Register (or Login, if you have already registered). Follow the registration process to the end. Then, log in and select the Tours section. Then click on Create new Circuit or on Edit (available by hovering over an already created circuit).

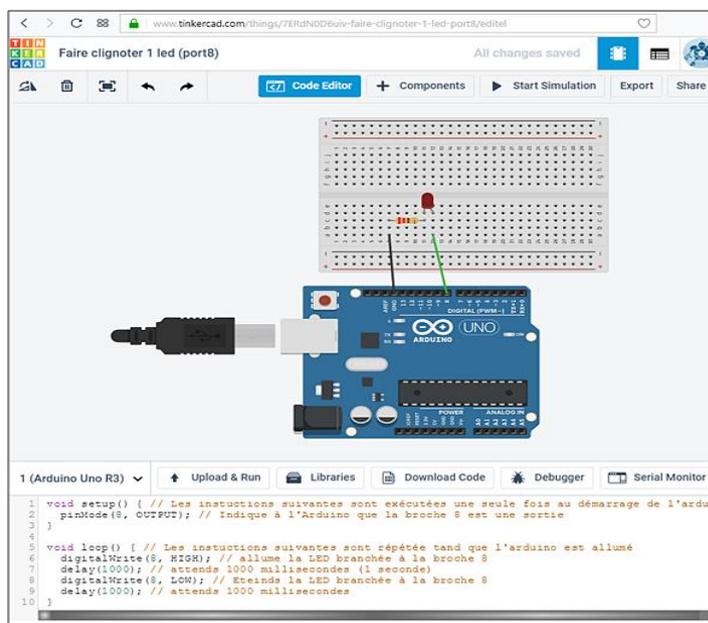


Figure III.12. Tinkercad

The different commands available:

Code Editor: edit and upload the code.

Components: add components (Arduino, breadboard, LED. Resistors)

Start Simulation: feeds the virtual Arduino (and starts the execution of the sketch).

Export: save the circuit as a file (on the computer).

Share: photograph the circuit.

Then, to save the circuit and return to the general menu, click on the Tinkercad icon.[50]

III.4.5 Arduino IDE

It is a programming language, which is inspired by several languages. We find in particular similarities with C, C ++, Java. The language imposes a particular structure typical of embedded computing. The setup function will contain all the operations necessary for the configuration of the board (directions of inputs / outputs, serial communications rates, etc). [45]



Figure III.13.The Arduino IDE.

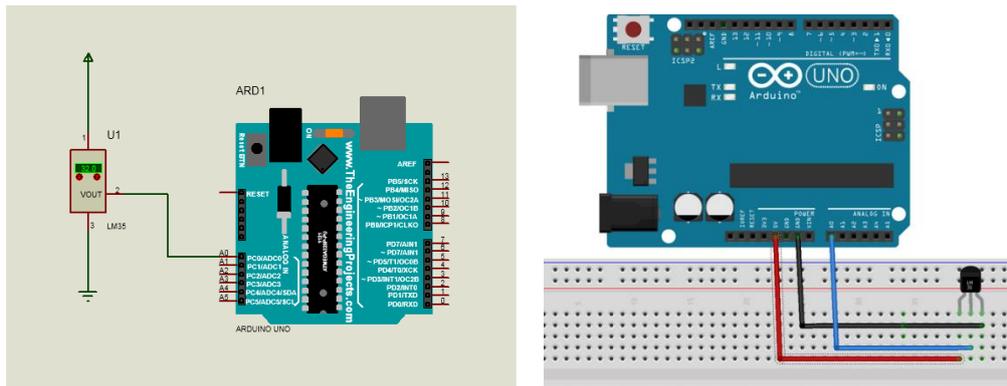
- ❖ The Arduino IDE allows
 - To edit a program: sketches.
 - to compile this program in the Arduino machine language,
 - to upload the program to the memory of the Arduino,
 - Communicate with the Arduino board through the terminal. [51]

III.5 Simulation

The simulation which can be used for the purpose of checking the project in software design and it produces the correct outcome. [52]

III.5.1 Interfacing lm35 with Arduino

The electronic diagram of the Arduino with the sensor lm35 is shown in the following figure:



(a)

(b)

Figure III.14.Interfacing lm35 with Arduino: (a) in Proteus (b) on the Arduino board.

III.5.1.1 Flow chart of lm35 sensor

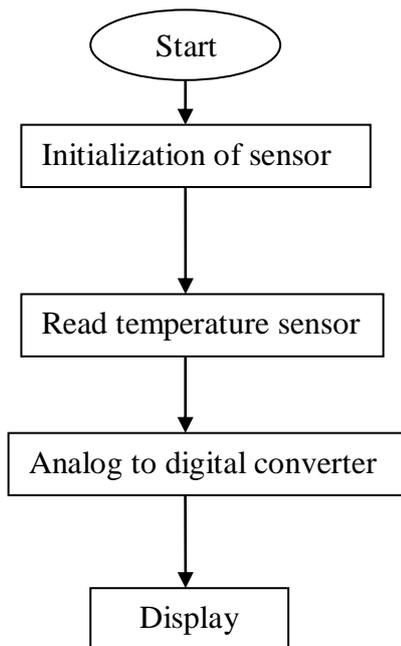


Figure III.15. Flow chart of lm35.

III.5.2 Interfacing PIR with Arduino

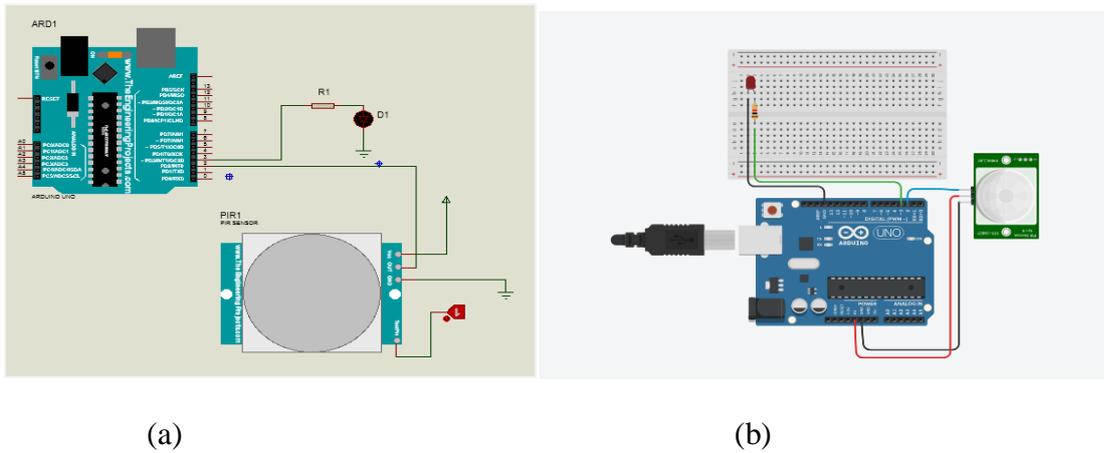


Figure III.16. Interfacing PIR sensor with Arduino: (a) Proteus (b) tinkercad.

III.5.2.1 Flow chart of PIR sensor

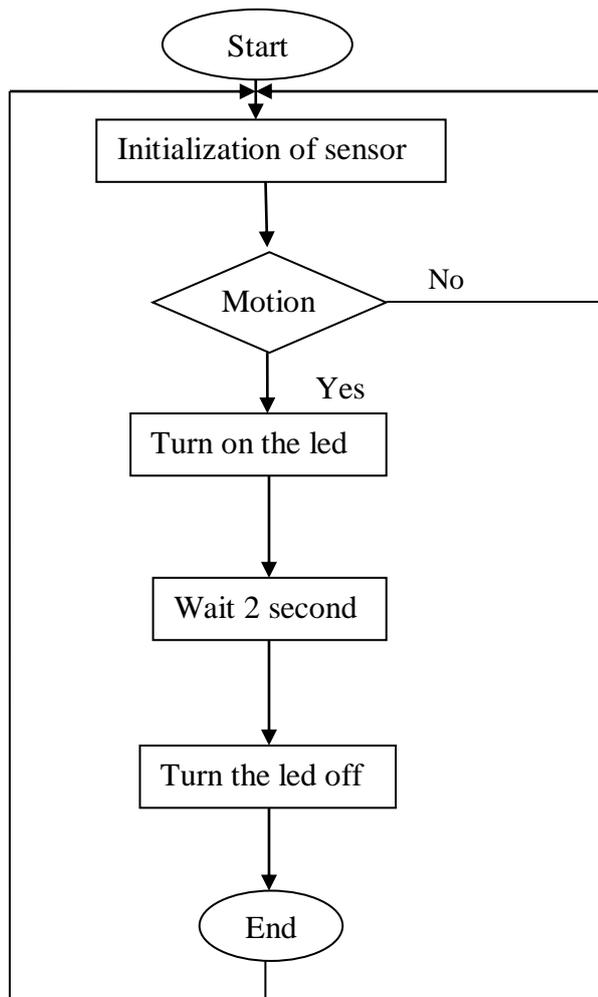
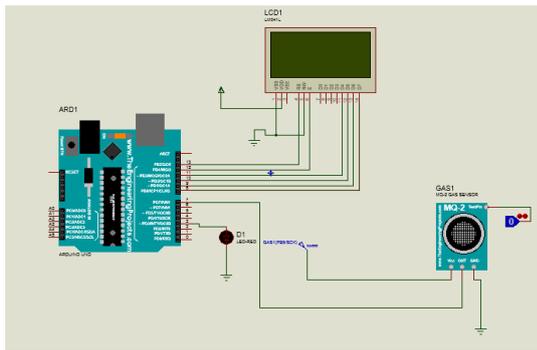
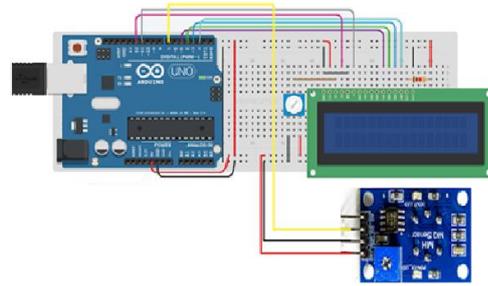


Figure III.17. flow chart of PIR sensor.

III.5.3 Interfacing MQ-2 with Arduino



(a)



(b)

Figure III.18. Interfacing MQ-2 sensor with Arduino. (a) Proteus (b) on the Arduino board.

III.5.3.1 Flow chart of MQ-2 sensor

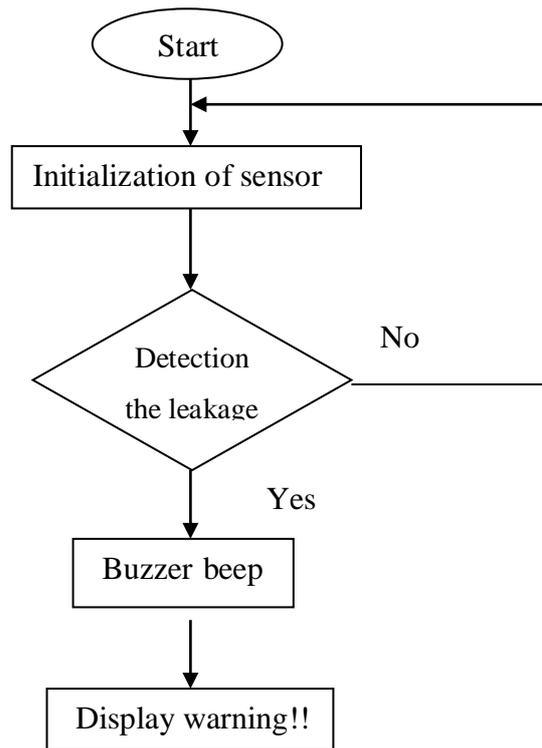
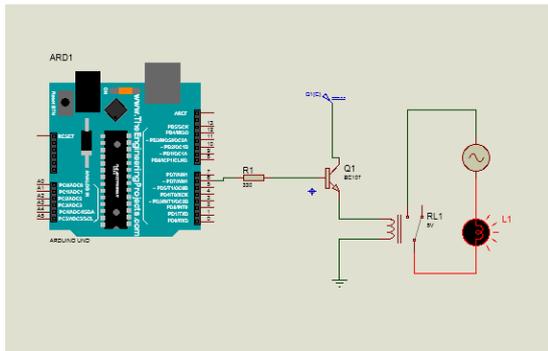
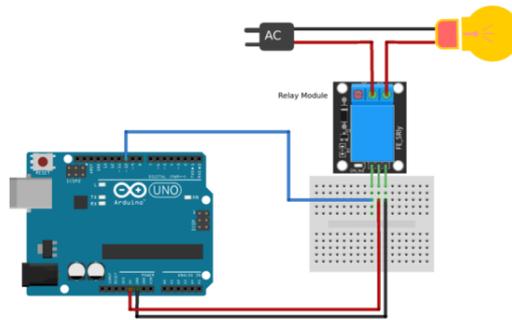


Figure III.19. flow chart of MQ-2 sensor.

III.5.4 Interfacing Relay with Arduino (controlling bulb)



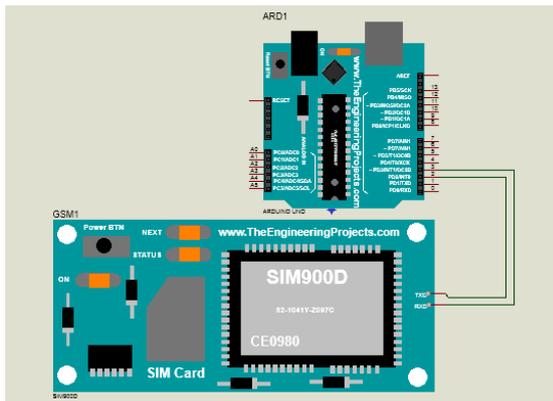
(a)



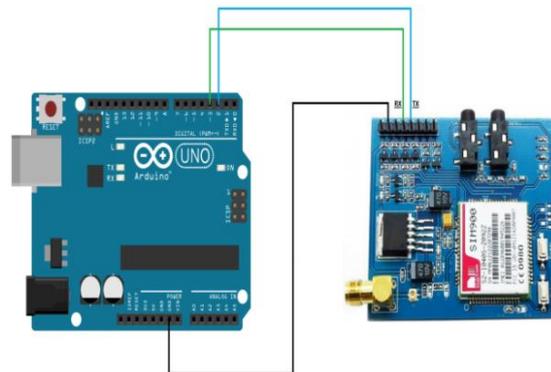
(b)

Figure III.20. Interfacing Relay with Arduino. (a) Proteus (b) on the Arduino board.

III.5.5 Interfacing GSM module with Arduino



(a)



(b)

Figure III.21. Interfacing GSM with Arduino. (a) Proteus (b) on the Arduino board.

III.5.6 Interfacing LDR with Arduino

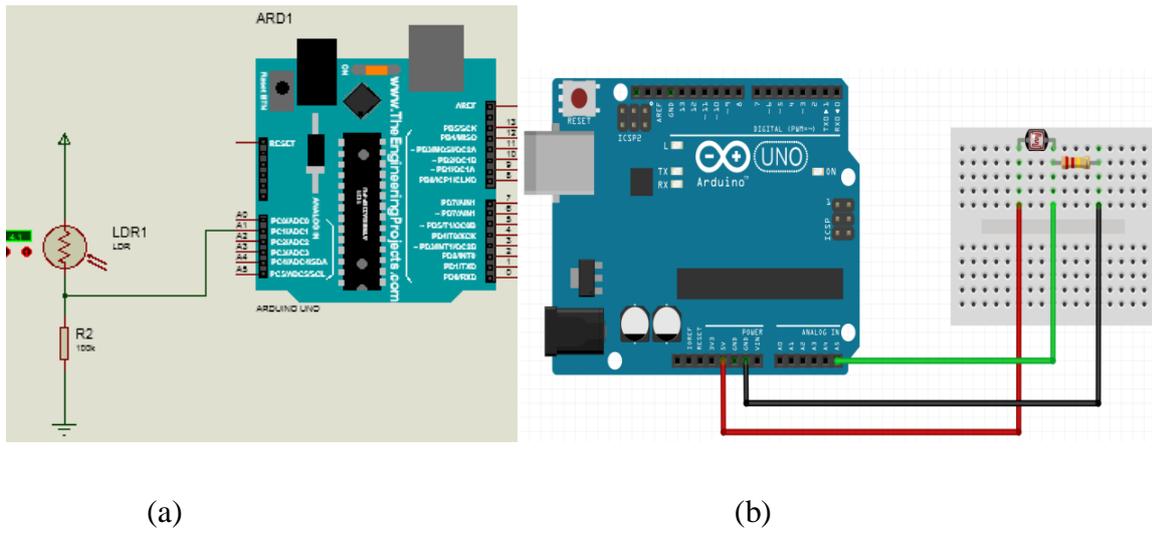


Figure III.22. Interfacing LDR with Arduino. (a) Proteus (b) on the Arduino board

III.5.7 Interfacing Buzzer with Arduino

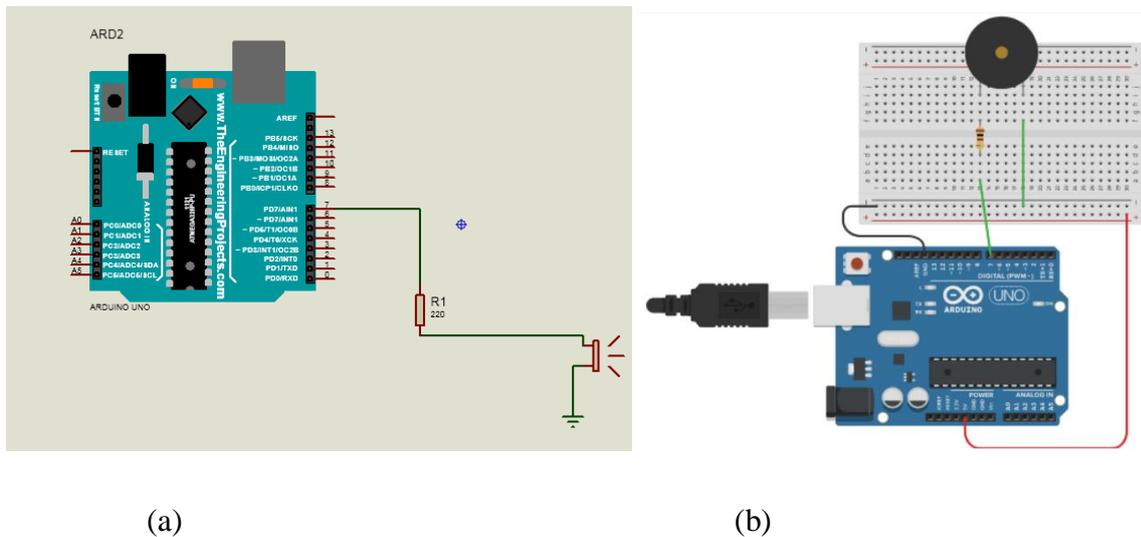


Figure III.23. Interfacing Buzzer with Arduino. (a) Proteus (b) on the Arduino board.

III.6 Functionality of the System

Our system is based on three main modes which are automatic, alarm and the remote mode.

- **Automatic mode:** the load will be controlling automatic by obtaining both of temperature, lighting values from the sensors used and acting according to the information collected.

- **Alarm mode:** if the gas detector mentions a leakage of a gas the alarm will activate (the Beep of the Buzzer) than the Arduino will send a Warning message to the user by GSM module.

- **Remote mode:** the user can control the load manually (turn on/off) by an android app irrespective of the values received from the sensors.

III.7 Explanation and Result

The general aspect of our system is summarized in the following diagram.

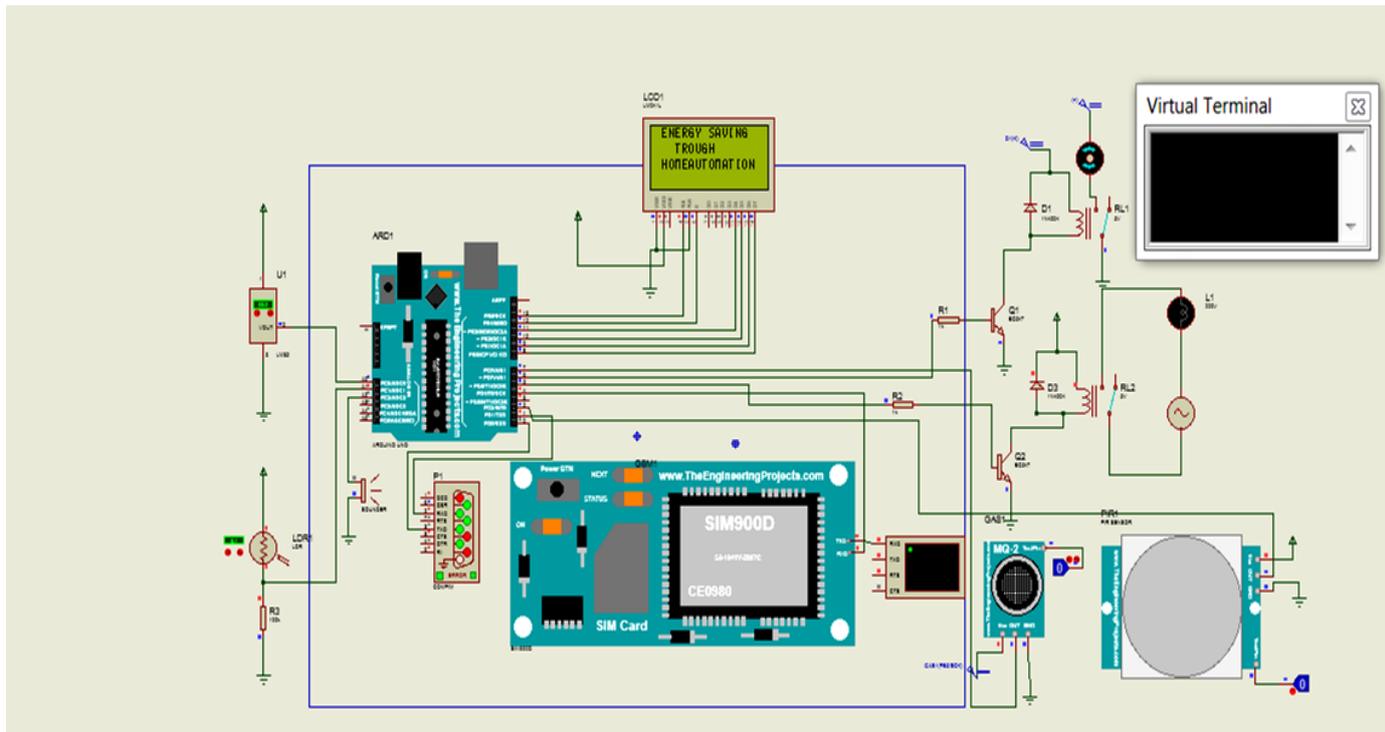


Figure III.24. The connection diagram of the system.

The Arduino Uno scans the inputs of the sensors (presence, gas, temperature), when there is a gas leak, the Arduino will activate the alarm (BUZZER) then transmitted a message by GSM module and display Warning message on the LCD, “Alarm mode”

When there is a detection of human presence, he’s going to check the temperature sensor first if it higher than 30°C he will turn the fan on if not, the fan is off.

The light will turn on when there is a detection of human being and the Light Depending Resistor (Voltage) is superior to the threshold value. “Automatic mode”

Plus the load status will be displayed on LCD

In this part of the project we tried a command by a mobile application without a relay switching. “Remote mode”

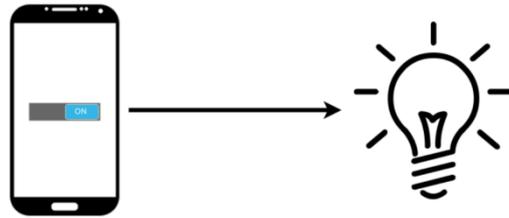
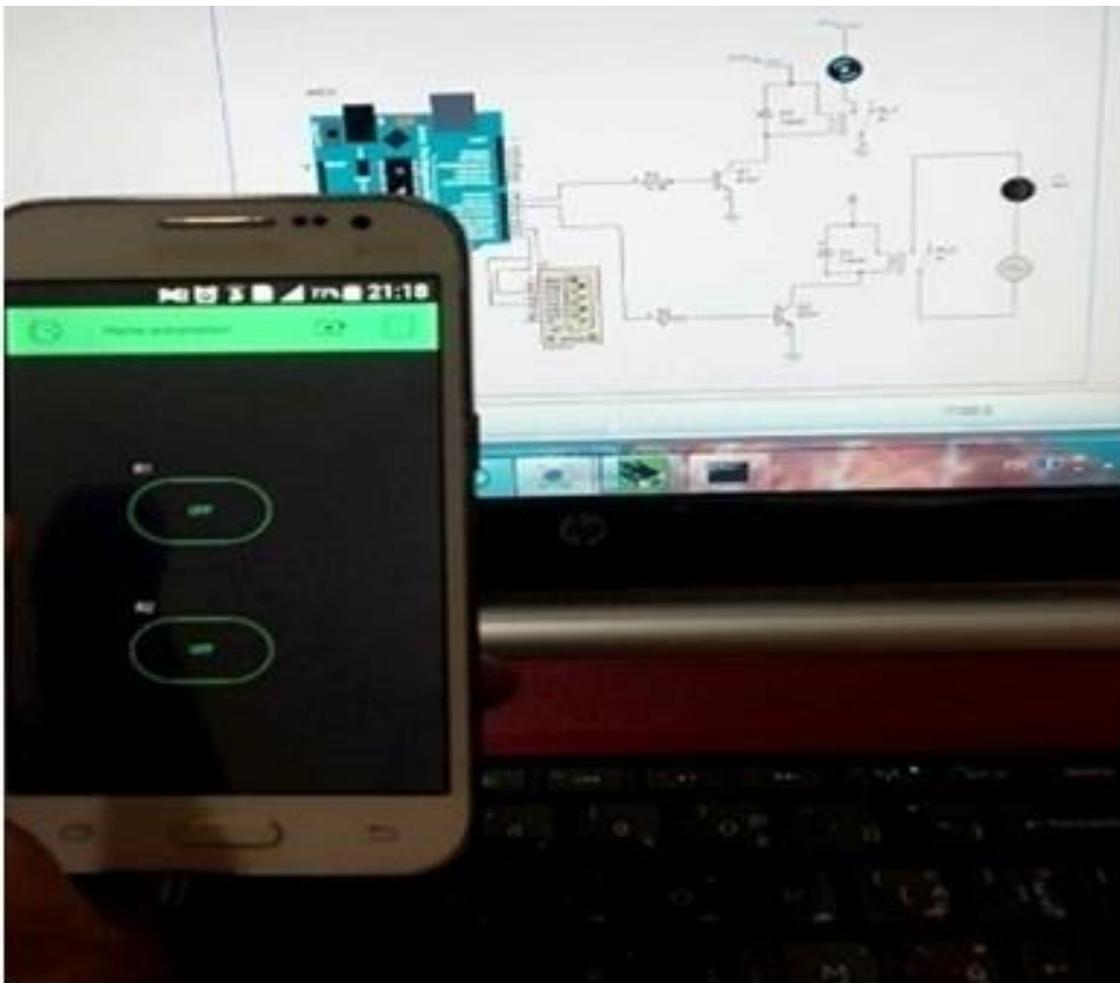
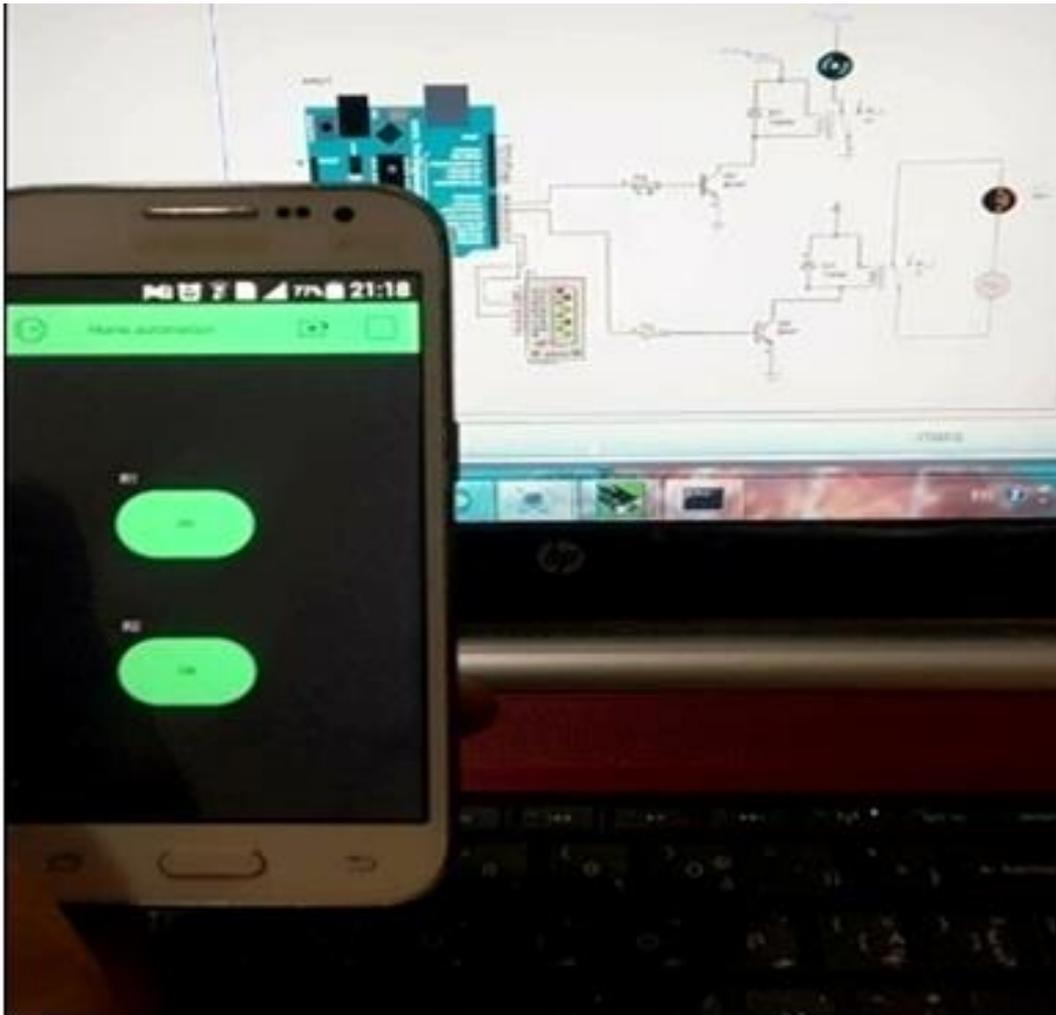


Figure III.25. A command by a mobile app.

The results that we get after using both of Blynk app and VSPE to control Arduino through the simulation (Proteus) is shown in Figure III.26



(a)



(b)

Figure III.26. (a). (b) Controlling the load (turn on/off) by Blynk app.

III.8 Conclusion

In chapter three we discuss about different software used, we describe the model of home automation system and finally we were shown the results that's we obtained by using android app to control the Home Appliance .

General

Conclusion

GENERAL CONCLUSION

Throughout the preparation of our final project, we wanted to implement the knowledge obtained during our university studies in order to develop a system that will automatically control the electrical devices in the home in order to save energy.

In this project, we tried to implement a system that would respond to the main home automation tasks in a simple way.

The operational design as well as the methods of representing domain information was discussed in detail, we have seen the progress made in the home automation domain since its creation in the 1980s, up to today.

We have also outlined various technologies that are used in home automation. We may assume home automation is an innovative system that is expected to develop further in the future.

This system enables you to control an entire house using your Smartphone from a touch of a button. Or by another method using simple relay sensors and with the help of Arduino.

we build a platform capable of controlling appliances with a focus on low cost and open source configurability.

In the Future home automation will provide almost all the required facilities, such as communication, medical, energy, service, entertainment and fitness.

We may assume that home will be more automated tomorrow as we move on to the next generation and technology advancements.

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