

**REPUBLIC OF TURKEY
FIRAT UNIVERSITY
THE GRADUATE SCHOOL OF NATURAL AND
APPLIED SCIENCES**



**IMPLEMENTATION OF A SMART HOUSE
APPLICATION USING WIRELESS SENSOR
NETWORKS**

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**Master Thesis
Department: Computer Engineering
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MASTER THESIS
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ABSTRACT

Implementation of a Smart House Application Using Wireless Sensor Networks

Digitization and automation are becoming increasingly prevalent in our daily lives, both inside and outside the house. They are all attempts to simplify, use easily, monitor and be aware of any devices in a house that are connected to the system. These automated systems can be an alternative to other home manual settings. Smart homes are rarely found in my country, Iraq. People's unfamiliarity with them, the lack of use, the costs and a failure to see the importance of such systems are all possible explanations for this.

Nowadays, IT is generally advancing very rapidly, the internet and smart phones in particular. Using such technology and devices is inevitable and difficult to avoid. Such smart systems are able to indicate and control light, temperature, dew point, gas flow, fire ignition, opening doors and buzzing alarms. Now, as IoT is emerging more widely than before, it is expected that IoT will become more prevalent and occupy wider areas of the world. IoT enables a better connection among devices in a smart home or to other smart systems via the internet and WSN. In this study, a smart home via smart phones and PCs will be explained. Controlling and indicating electrical and electronic devices in houses and buildings will also be presented.

Keywords: Smart home, IoT, Arduino Mega2560 and UNOR3, Ethernet Shield 5100, WSNs, sensors, GSM, Wi-Fi Node MCU ESP8266-12E, 01, Solar Tracker.

ÖZET

Kablosuz Sensör Ağları Kullanılarak Akıllı Ev Uygulamasının Gerçekleştirilmesi

Günlük hayatımızda hem iç ortamda hem de dış ortamda dijitalleşme ve otomasyon kullanımını gün geçtikçe artmaktadır. Ev otomasyon sistemleri; evimizdeki aygıtların daha kolay ve basit kullanımını, internete bağlı bir bilgisayar, telefon veya tablet ile izlenmesini sağlamaktadırlar. Bu otomasyon sistemleri, evimizdeki tüm manuel ayarlamalara birer alternatif oluşturabilmektedirler. Akıllı ev kavramı kendi ülkem olan Irak'ta halihazırda çok nadir uygulanmış olan çok yeni bir kavramdır. İnsanların alışık olmaması, kullanım izinlerinin zorluğu, kurulum ve işletme maliyetlerinin yüksek olması bu durumun temel sebeplerindendir. Günümüzde IT alanında, özellikle cep telefonu ve mobil uygulamalar alanında çok hızlı gelişmeler gerçekleşmektedir.

Bu teknolojiiden faydalanmamak ve kullanmamak çok zordur. Bu akıllı ev otomasyon sistemleri ile evdeki ışıkların durumu, sıcaklık, nem, gaz akışı, yangın alarm sistemi, güvenlik sensörleri ve alarm sistemleri izlenip kontrol edilebilmektedir. Nesnelerin İnterneti kavramının daha da zaruri olmaya başladığı bu günlerde, evdeki tüm cihazların internet yetkinliği kazanacağı ve hayatımızdaki tüm nesnelerin bu teknolojiye bürüneceği beklenmektedir. Akıllı ev otomasyonunda, IoT ile cihazlar daha kullanışlı hale gelmektedir ve internet veya kablosuz sensör ağı ile daha kolay bağlantı yapılabilir. Bu tez çalışmasında; tablet veya akıllı telefon ile kontrol edilebilen bir akıllı ev uygulaması gerçekleştirilmiştir. Evdeki cihazların bağlantısı için kablosuz sensör ağı kurulmuştur. Kurulan akıllı ev sistemi uzaktan izlenip yönetilebilmiştir.

Anahtar Kelimeler: Akıllı Ev, IoT – Nesnelerin İnterneti, Kablosuz Sensör Ağı.

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ABBREVIATIONS

WHAN	:Wireless Home Area Network.
WSNs	: Wireless Sensor Networks.
GND	: Ground.
GSM	: Global System for Mobile Communications
HVAC	: Heating, Ventilation and Air Conditioning.
I/O	: Input/output.
IDE	: Integrated Development Environment
IoT	: Internet of Things.
KHZ	: Kilohertz.
LCD	: Liquid Crystal Display.
LDR	: Light Dependent Resistor.
LED	: Light Emitting Diode.
LPG	: liquefied petroleum gas
OS	: Operating Systems.
PC	: Personal Computer.
PIR	: Pyroelectric Infrared Sensor.
PWM	: Pulse Width Modulation.
RFID	: Radio Frequency Identification.
V	: Volt.
WAP	: Wireless Application Protocols.
WHAN	: Wireless Home Area Network.
WSN	: Wireless Sensor Network.

1. INTRODUCTION

1.1. Overview

A smart home is an automated and intelligent home which can be designed and set due to the technology being used [1]. Smart homes can be programmed to fit the client's needs. Programming can lead to a fully automated system where every device in the home can communicate with others via sensors. A smart home can provide good security, convenience, entertainment, good communication, economy and an information system [2].

Different smart house systems have been made where the control is through Android applications, Bluetooth, WIFI, web, call and/or short message administrations (SMS) based through GSM808. WIFI capability is great and the vast majority of current devices can be connected easily and coordinated so as to reduce the system's costs. Bluetooth's range, however, limits its usage to inside the home [3].

Several methods can be used to secure a smart home, such as: RFID, Password or fingerprint. These smart homes serve well in pre-alarming and controlling the temperature, air-conditioning, bulbs equipped with sensors, gas detecting sensors and flame sensors. As well as all this, a smart home alerts the home owner to thieves and burglars, several unwanted conditions with the use of IR waves. Furthermore, smart home sensors take advantage of different ranges of electromagnetic waves including GSM, IR, Bluetooth and Wi-Fi. With these different frequencies a home's devices are connected in a Wireless Home Area Network (**WHAN**)[4].

It is also important in this project to alert homeowners to any unwanted events and intruders who might try to enter the house without legal permission. The alert can be given via a ring to a phone, an SMS or an email. More interestingly, the system can be set to alert governmental and national bodies about unwanted accidents in cases when the owner of the house might be travelling to another country. In this way, fire fighters can reach the home and tackle a fire even without the help of the homeowner. Another aspect of this project is to involve the smart house in the upcoming age of the Internet of Things (IoT). Thus, different sections of the house can be accessed via a phone, tablet or PCs [5]. The programs of the system can easily be edited and updated and its problems fixed properly.

WHAN, which is established via a Wireless Sensor Network (**WSN**) and an IP, is granted to each peripheral to run the system via the internet too [6]. Having this access remotely enables the homeowner to perform preparation, such as turning an air conditioner ON for their return while they are away from home. Two types of Wi-Fi have been used: ESP8266-01,12E. Each of these is important. An Ethernet shield and Router can be used as a third way. A smart home reduces the use of electric energy or can use alternative energy, such as solar energy [7]. It reduces costs and is environmentally friendly[8]. As an Iraqi student I study in Turkey and encountered several problems regarding establishing this project. In Iraq, such systems are new and a smart home designer usually faces numerous problems, like inability to get hold of the pieces for the project, high prices and unreliable delivery of the parts for a project. Such homes are very important for our country in terms of security, economy and a proper use of electricity. Such systems would work very well for those who are disabled and have lost their limbs in the continuous battles in our country[9].

In this project, a prototype of a smart home is presented. Generally, the system consists of these parts: WiFi, IR, Keypad, GSM, Ethernet shield, Arduino (Uno and Mega), humidity, Temperature, Gas sensor, Flame sensor, ESP8266-01,12E, Buzzer, PIR and LCD.

In chapters 3 and 4, the design and parts of the systems will be explained. Numerous trials been carried out before the results of this project, were presented[10].

Alongside the advancement of technology and among all of the aspects of life, there have been some very important inventions which have all served humans very well. Electrical devices are among these innovations. The smart house has advanced rapidly. All the necessary equipment is to hand and Arduino is easy to use.

Scientists have tried to develop tools and techniques for the smart house. They have come up with very powerful and effective techniques for smart house systems. Robotics and wireless sensor networks (WSN) are recent ways of developing smart systems that have become a more and more popular technique. Both of these can provide the data collection necessary after an event, such as a gas leakage or smoke detection or any command given by the user.

The smart house today seeks to make use of the latest technological components available. In this thesis, I will present the design and implementation of a smart house system where communication technologies such as GSM (Global System for Mobile Communication), the Internet and speech recognition will be used. This system will offer a

complete, low cost, powerful and user-friendly means of real-time monitoring and the remote control of a house(Figure 1.1).

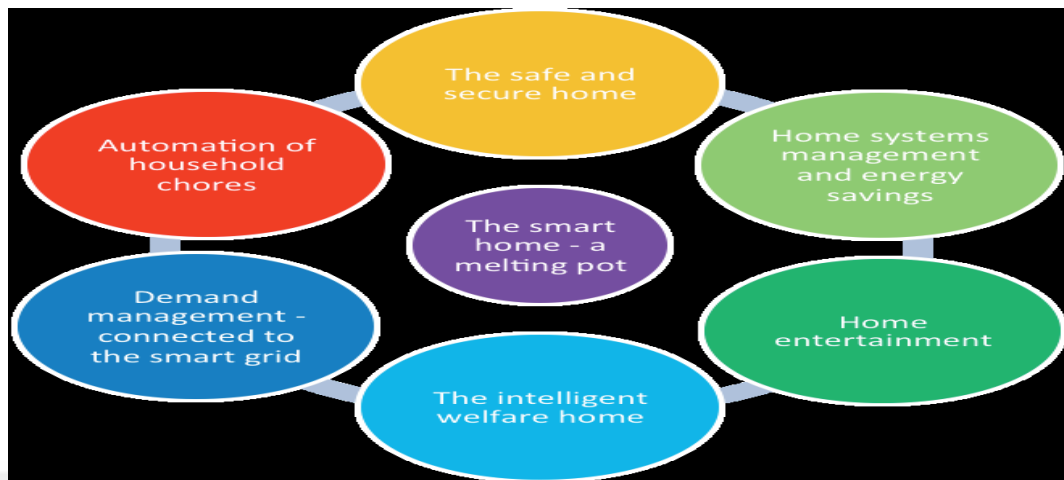


Figure 1.1 The melting pot of the smart home.

1.2. Problem definition

There has been too little use of smart home systems and there are many ways intruders can enter houses. People are mostly unable to control and face some of the problems that occur in a house. Hence, using smart home systems is an urgent project for those who can afford to apply the systems. It is known that such systems are used widely in the public places such as malls, directorates, etc.

This has led to some uncertainty for families in houses, especially from the following three aspects:

1. Services certainty: less certainty concerning the use of services in houses, especially in terms of water, electricity and gas, which are important services. With such systems the aim is to reduce the danger from these services and to protect home and a family from expected problems, reducing the overuse of services when they are not necessary.
2. Security certainty: as crime escalate, there is not enough protection for those who are exposed to burglary and intrusion, or other risks like fire and gas leakage. These systems can even be installed to recognise family members and distinguish people and relatives from strangers. Providing services and protecting the

homeowner from the execution of all of these instructions and performances is called feedback.

3. Social and humanitarian assurance: having family problems, especially looking after special cases at home, such as children, the elderly, patients and necessary burdens. Sometimes protecting home possessions, especially when they are out of the home. These systems have not been used well.

Economic certainty: when mechanical, electrical and chemical devices are overused there is more waste and costs for the maintenance and development of public services. The least use of the public electronic system.

1.3. Importance and Benefits of the Smart Home

1. A smart house clearly has the power to make life easier and more convenient.
2. Saving all the data and using them when necessary.
3. Monitoring all movements remotely.
4. The security is robust, which is in fact very important, such as changing the IP automatically.
5. Controlling all devices.
6. Looking after children and the elderly while at home.
7. In an emergency, fire alarm and or in case of burglary, a ring will be sent to the head of the family and/or the family members.
8. As well as this, a pre-recorded call, email or text will be set up for the ambulance, fire-rescue department or police

1.4. Aim of the Thesis

1. To implement a robust smart house
2. Safety (for example, alarms)
3. Environmental control systems (for example, remote control or programmed control of doors, windows and lights)
4. Communication (linked to the telephone or the Internet)
5. Energy-control systems (for example, adjusting the heating at all hours)
6. Entertainment (for example, television, film and music)

1.5. Objective

1. Connecting all peripherals at home, in a wireless network.
2. Using them (turn them ON/OFF) easily, at home or from outside.
3. Recording all events and movements in home or outside.
4. To mitigate the electricity consumed, which in turn serves the environment.
5. It creates the kind of developed and easy lifestyle that many dream of achieving.
6. Protects all property from loss.
7. It provides reasonable and proper security.
8. It costs less, thus it is better.
9. It is always easy to add peripherals to the network or remove them.
10. Looks after children, patients and the elderly, when they are home alone. When they go out, opening windows and doors or going fire alarms off ... etc.
11. Cautioning the owner and being aware of the house at any unthinkable incidents.
12. Recognising all of the members of that household and when they cruise in the house. Opening the doors and windows in emergencies, such as fire.
13. Familiarising people with the Arduino board
14. Introducing programming language.
15. Understanding embedded programming.
16. Learning how the sensors work.
17. Focusing on all the requirements of humans when it comes to a house.

1.6. Report Outline

My project has been described in five chapters:

Chapter 1. This is an Introduction containing an overview about the smart house and an outline of the report.

Chapter 2. This describes the Smart Home System and its functions and the basic elements of the system (System Block Diagram).

Chapters 3. describe the basic elements of the system and all the different I/O ports and design the blocks and connect all of the parts in the sections, different the Arduino parts used in this project . It also write the codes and uploading used to implement the our

system. In the Chapter 3 also used the smartphone application programming such as ESP8266 application and Bluetooth application.

Chapter 4. This presents the Results and Discussion, Limitations and Problems Encountered.

Chapter 5. This presents the Conclusion and Future Recommendation, and an evaluation of the system.



2. SMART HOME DESCRIPTION SYSTEM (RELATED WORKS)

2.1. Smart Home System

Our system runs with Operating Systems (OS) such as Android and the Internet of Things (IoT), which are well known to those who deal with such systems. We have endeavored to abide by the limitations of commonly used systems. Comfort, security and flexibility are some common features of the system[11]. This system is able to work with android phones, laptops, tablets or a PC. The main components are: a board of Arduino (MEGA 2560& Uno R3), which can be called the brain of the system, a Router, Wi-Fi (Node MCU ESP8266-12E and ESP8266.01) with a good range, an IR device, an Ethernet shield (network interface W5100), a GSM device and a User device with an Android OS, such as smartphone or computer (through the web). These devices are connected through either the internet or Wireless Application Protocols (WAP). The user controls the entire system through an android enabled device (by either a smart phone or tablet).

The system is also controlled through an IR device (control). This has made the system more desirable and famous, as it does not necessarily need the internet or a wired connection. The Wi-Fi network is the main grid. Through it, the instructions of the user are transmitted. Bluetooth and IR are also used inside the house as alternatives when needed despite their specific importance. The user's necessities are the foundation steps that the system is built upon (Figure 2.1).

Home appliances are also controlled through a relay circuit, which can be connected to many house devices, like heating, ventilation and air conditioning (HVAC) (Figure 2.2).

Along with the Arduino and network interface (W5100), the RDIF module and sensors also play a very important role in the system. An RFID (Radio Frequency Identification) reader and a key pad are integrated into the system, to sense the state changes of the main door of the house and to control it (door lock).

RFID is a module to transmit data over a short range. It includes a tag scanner/reader that is capable of scanning as many tags as we set to it. Every tag has an ID that can be determined (authorized or not authorized) [12].

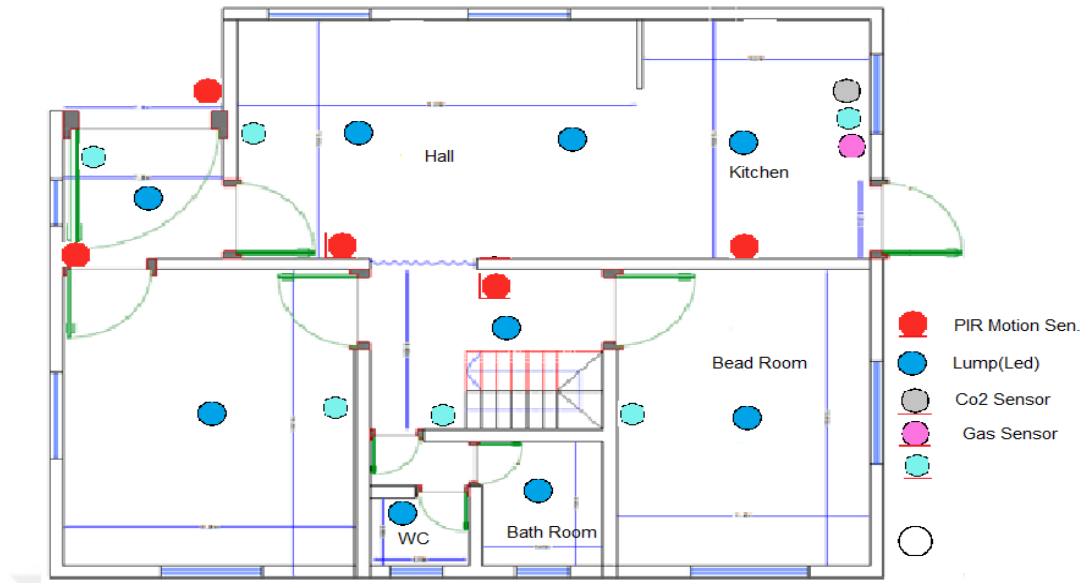


Figure 2.1 Design of Sensors.

All sensors communicate with a microcontroller (where all input data are processed), depending on the program; the microcontroller decides and sends signals to the user and related relays to operate the house devices.

Therefore, the flame or smoke detection sensor collaborates with an Arduino, which is attached to relays that open to the door and operate the fan when the gas or fire spreads inside the home. The Arduino also signals the buzzer to shoot out and the leads to come on. These all constitute the (fire alarm system) which can call the owner of the house (ringing) through the GSM system (Figure 2.1).

The GSM system is also activated by Pyroelectric Infrared Sensor (PIR), which is used to detect human bodies as it can detect any change in infrared radiation. At the point when a human goes through this sensor, the temperature out of sight will ascend from room temperature to the body temperature and in this manner movement will be detected; i.e. it detects motion. The motion detector sensor collaborates with an Arduino and the GSM808, which contain a mini simcard (mobile simcard) which calls the number saved in the program.



Figure 2.2 Block Diagram of the System.

The temperature sensor coordinates with an Arduino that is connected to an LCD and a relay that controls the heater or an air-conditioning system.

The light detector sensors collaborate with an Arduino which is connected to relays that control the lamps. Besides these, this system has a photo sensor (photo resistor) which is economic and friendly to the environment.

In our work, the essential concepts of the automated house system were included (that is developing daily).

This system has the ability to expand and be integrated as an up-to-date involved system, so new devices and more security levels may be added to the systems.

2.2. Wireless Sensor Network (WSNS)

WSN is a collection of many sensor hubs. Each can sense, process and connect to a microprocessor unit to work together in a coordinated manner (Figure 2.3). Physical or environmental conditions, such as motion, temperature, humidity, smoke and gas, etc., are monitored by these sensors in a coordinated way [13].

These sensors run through an algorithm to the main control unit (Arduino Node MCU ESP8266-12E), which has much more computational power and links and acts as the main way that links the sensor nodes and the end users. The principal features of WSN include power consumption constraints for node; capability of accommodation with node and communication tasks; scalability to large devices; ability to resist hard environmental conditions, mobility of node and variation of nodes [14].

It is the WSN that plays a major part in enabling highly accurate sensor and actuation systems, in homes, buildings and surrounding spaces, by supplying a trusted, cheap and wide solution. Their tools can be used in current, as well as future, structures, without significant changes in the existing infrastructure[15].

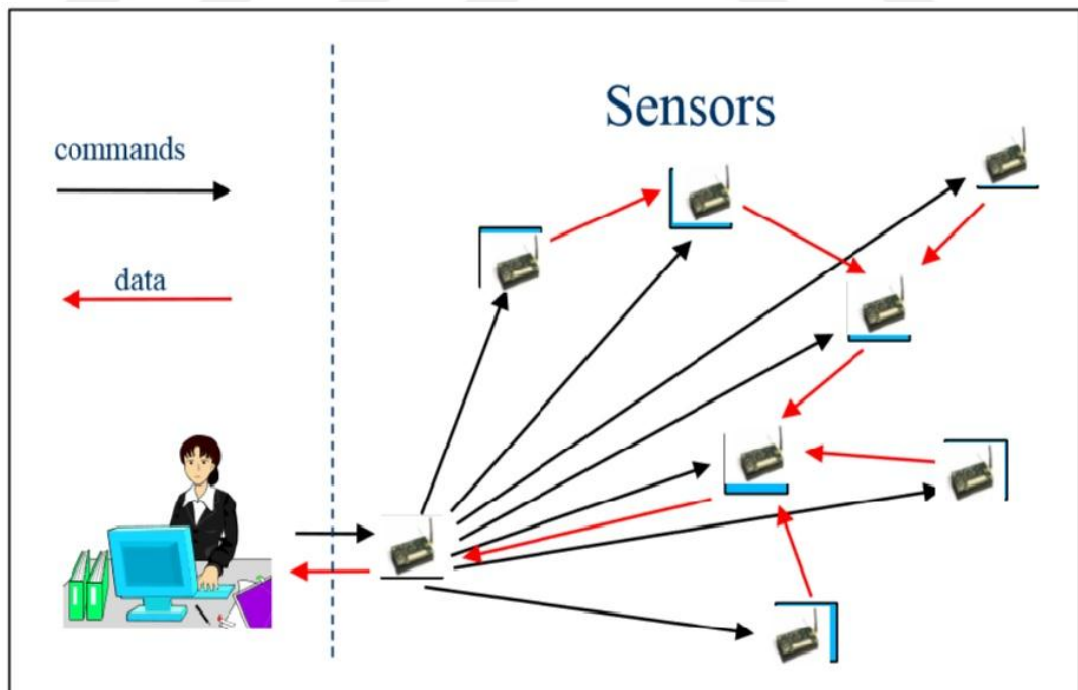


Figure 2.3 WSN Sensors.

2.3. The Internet of Things

The Internet of Things alludes to a system of items where everything is extraordinarily and generally addressable, distinguished and overseen by PCs and advanced mobile phones. It is a gathering of advancements that make it conceivable to interface things like sensors and actuators to the Internet (Figure 2.4) [16][17].

Internet of Things is known as an incorporated piece of the Future Internet and could be characterized as a dynamic worldwide system foundation with self-arranging capacities in view of standard and interoperable correspondence conventions where physical and virtual things have characters, physical characteristics and virtual identities, and utilize smart interfaces, and are flawlessly coordinated into the data network [18].



Figure 0.4 The Internet of Things image.

2.4. System Block Diagram

According to the design needs and desires, the system block diagram (Figure 2.5) is made. Our block diagram shows all the parts of the system and their functions. The project design follows the modular approach, using an Arduino Mega 2560 (Atmel 2560) microcontroller. The system is intended to enhance security, adaptability and effectiveness. The framework is planned to give ease in everyday life, and additionally spares power and human endeavor. This framework incorporates Arduino, sensors (like LPG gas, PIR, humidity and temperature), LCD show, LAN, 8 Relays channel, RFID, Keypad, smartphone and PC.

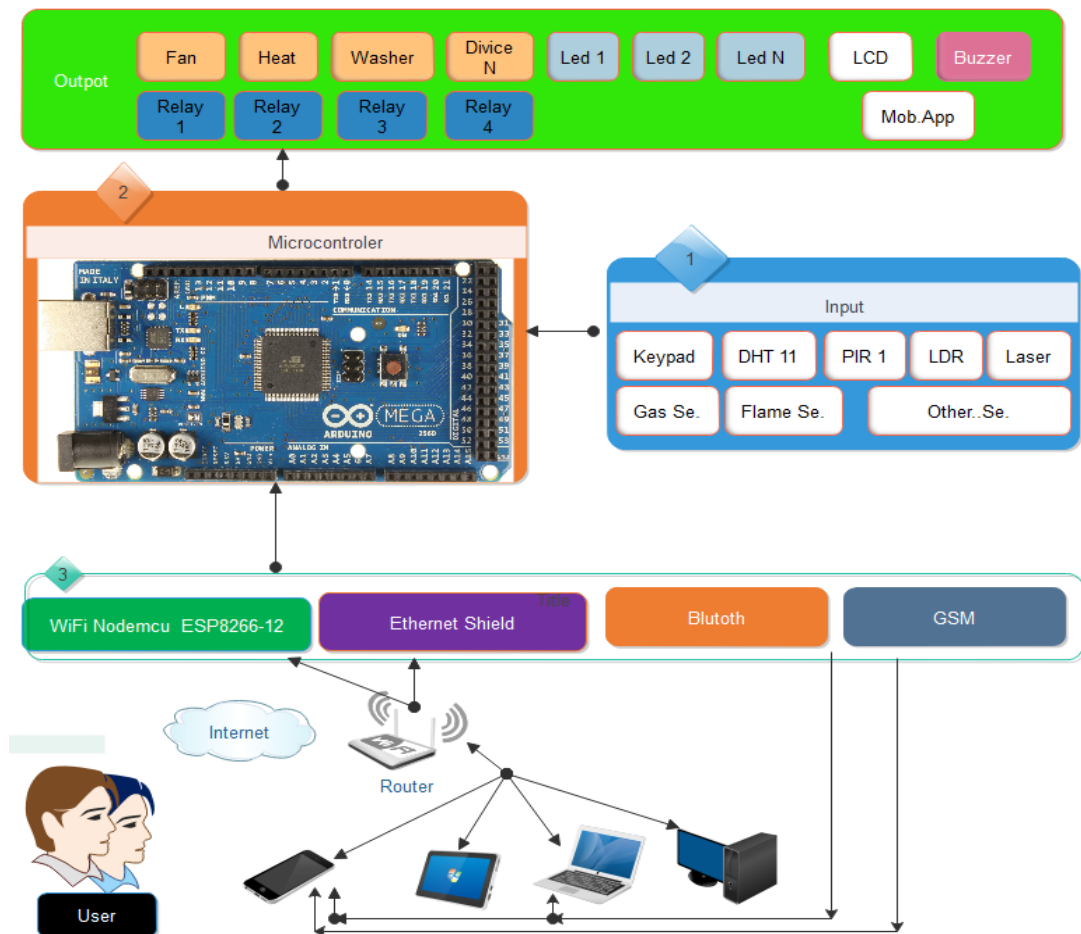


Figure 2.5 System Block Diagram

2.5. System Implementatinons

2.5.1. Project Flow

This section explains the steps that need to be undertaken in order to achieve the goal of the project (Figure 2.6).



Figure 2.6 Project Flow.

2.5.2. Hardware Implementation:

This includes PC, Laptop or Tablet, and Smart Phone, Arduino Mega 2560 (Figure 2.7), Arduino UNO R3 (Figure 2.8), Breadboard Circuit, Ethernet Shield, Router, Led, LCD for Arduino, LDR Sensor, RFID Card System, Motion sensor, Servomotors, Temperature sensor, GSM Modem, smoke sensor and LPG gas sensor.

2.5.3. Arduino Mega 2560

My project uses an Arduino MEGA2560 which is based on an ATmega2560 microprocessor (Figure 2.7).

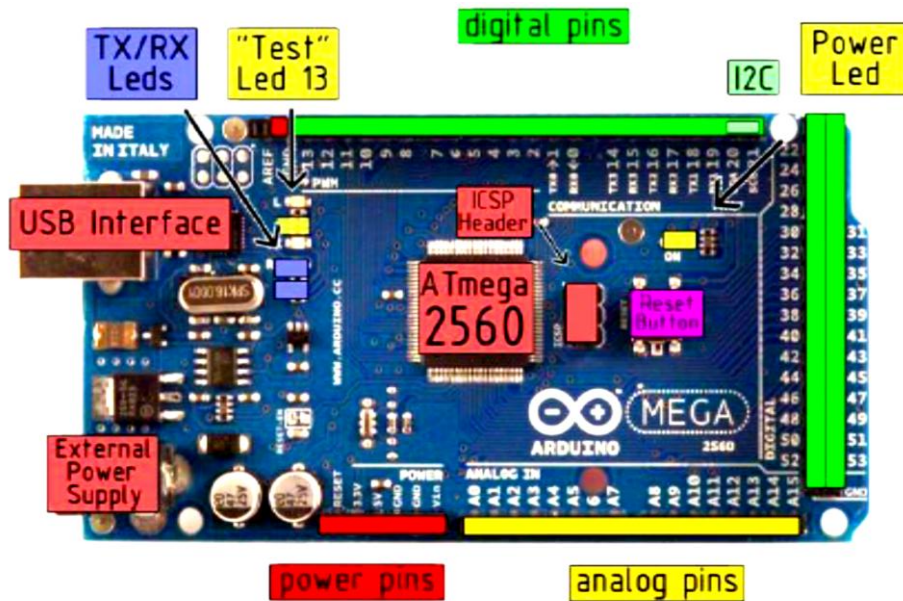


Figure 2.7 Arduino-Mega2560 Structure.

The Arduino MEGA2560 Microcontroller has been designed based on an ATmega 2560 microprocessor that runs at the speed of 16MHz, as shown in Table 2.1 below.

Table 2.1 Specifications of Arduino MEGA2560 Microprocessor.

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	54 (of which 15 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz
LED_BUILTIN	13
Length	101.52 mm
Width	53.3 mm
Weight	37 g

2.5.4. Arduino UNO R3 (Figure 2.8)



Figure 2.8 Arduino-UNO Structure.

The table below describes the technical specifications of Arduino Uno (Table2.2) [19].

Table 0.2. Specifications of Arduino Uno.

Technical specs

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

Topic: Arduino UNO Pinout Diagram (Figure 0-9) [20].

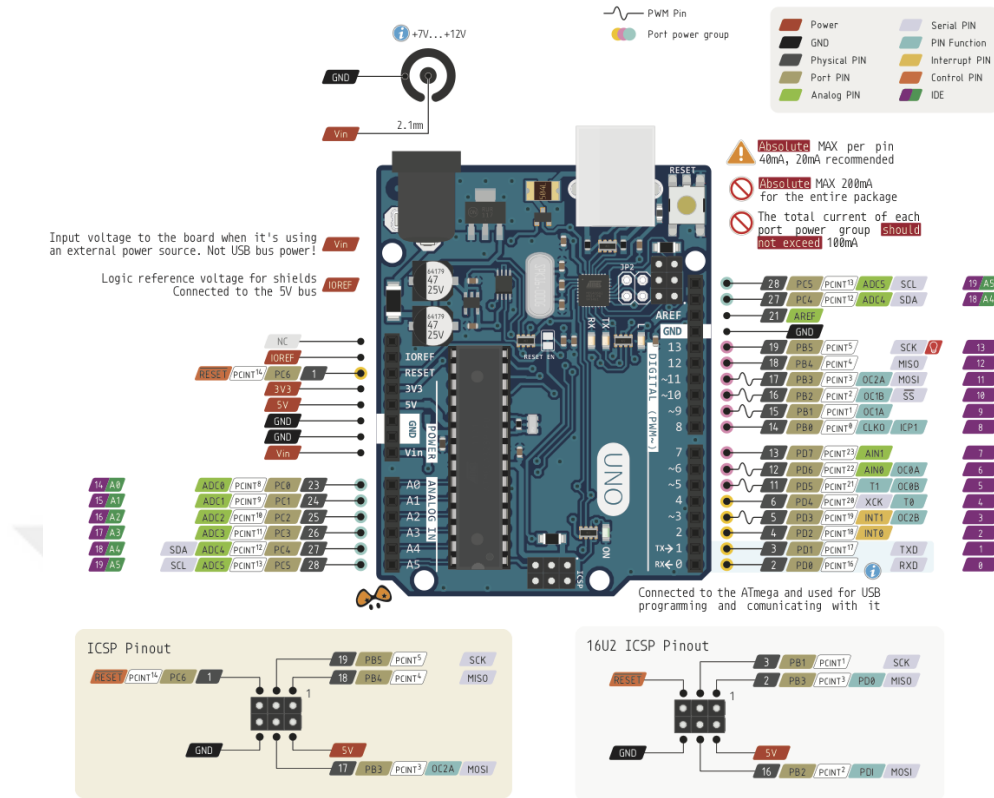
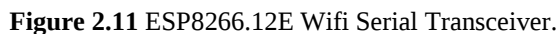


Figure 2.9 Arduino UNO Pinout Diagram.

2.5.5. WiFi Shield (ESP8266 WIFI SERIAL TRANSCEIVER):

The ESP8266 Serial-to-WiFi adapter has been widely adopted as a cost-effective solution for IoT and WiFi-capable devices. We used two types of ESP8266 in our project: Node MCU ESP8266-12E WIFI (Figure 2.10), (Figure 2.11) ,and ESP8266-01 WIFI [21][22].

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Table 0.4 Parameters Node MCU ESP8266-12E.

Categories	Items	Values
WiFi Paramters	Certificates	FCC/CE/TELEC/SRRC
	WiFi Protocles	802.11 b/g/n
	Frequency Range	2.4G-2.5G (2400M-2483.5M)
	Tx Power	802.11 b: +20 dBm
		802.11 g: +17 dBm
		802.11 n: +14 dBm
	Rx Sensitivity	802.11 b: -91 dbm (11 Mbps)
		802.11 g: -75 dbm (54 Mbps)
		802.11 n: -72 dbm (MCS7)
	Types of Antenna	PCB Trace, External, IPEX Connector, Ceramic Chip
Hardware Paramaters	Peripheral Bus	UART/SDIO/SPI/I2C/I2S/IR Remote Control
		GPIO/PWM
	Operating Voltage	3.0~3.6V
	Operating Current	Average value: 80mA
	Operating Temperature Range	-40°~125°
	Ambient Temperature Range	Normal temperature
	Package Size	5x5mm
	External Interface	N/A
Software Parameters	WiFi mode	station/softAP/SoftAP+station
	Security	WPA/WPA2
	Encryption	WEP/TKIP/AES
	Firmware Upgrade	UART Download / OTA (via network)
	Ssoftware Development	Supports Cloud Server Development / SDK for custom firmware development
	Network Protocols	IPv4, TCP/UDP/HTTP/FTP

MODULE ESP826-01 is a cheap, high quality WiFi module with potent on-board processing and storage capacities [24]. (Figure 2.12).

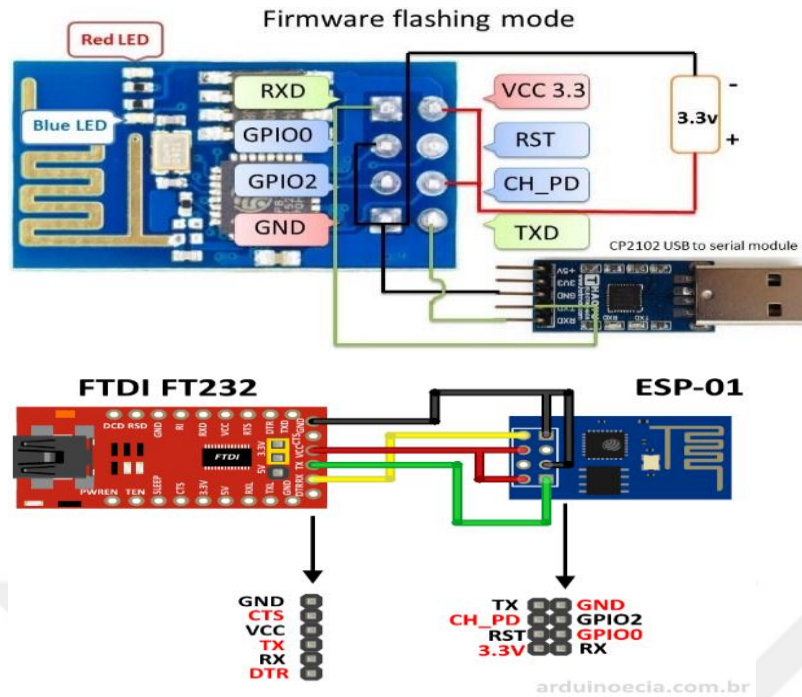


Figure 2.12 Top View of ESP8266-01+FTDI FT232.

The following table shows the difference between ESP8266 types (Table 2.4) [25].

Table 0.5 Difference between ESP8266 types.

Name	Active pins	Pitch	Form factor	LEDs	Antenna	Shielded?	dimensions (mm)	Notes
ESP-01	6	0.1"	2x4 DIL	Yes	PCB trace	No	14.3 x 24.8	
ESP-02	6	0.1"	2x4 castellated	No	U-FL connector	No	14.2 x 14.2	
ESP-03	10	2 mm	2x7 castellated	No	Ceramic	No	17.3 x 12.1	
ESP-04	10	2 mm	2x4 castellated	No	None	No	14.7 x 12.1	
ESP-05	3	0.1"	1x5 SIL	No	U-FL connector	No	14.2 x 14.2	
ESP-06	11	misc	4x3 dice	No	None	Yes	14.2 x 14.7	Not FCC approved
ESP-07	14	2 mm	2x8 pinhole	Yes	Ceramic + U-FL connector	Yes	20.0 x 16.0	Not FCC approved
ESP-08	10	2 mm	2x7 castellated	No	None	Yes	17.0 x 16.0	Not FCC approved
ESP-09	10	misc	4x3 dice	No	None	No	10.0 x 10.0	
ESP-10	3	2 mm?	1x5 castellated	No	None	No	14.2 x 10.0	
ESP-11	6	0.05"	1x8 pinhole	No	Ceramic	No	17.3 x 12.1	
ESP-12	14	2 mm	2x8 castellated	Yes	PCB trace	Yes	24.0 x 16.0	FCC and CE approved ^[12]
ESP-12-E	20	2 mm	2x8 castellated	Yes	PCB trace	Yes	24.0 x 16.0	
ESP-12-F	20	2 mm	2x8 castellated	Yes	PCB trace	Yes	24.0 x 16.0	FCC and CE approved. Improved antenna performance. 4MB Flash
ESP-13	16	1.5 mm	2x9 castellated	No	PCB trace	Yes	W18.0 x L20.0	Marked as "FCC". Shielded module is placed sideways, as compared to the ESP-12 modules.

2.5.6. Bluetooth HC-5

Bluetooth is a short field communication technology (less than 10 m) and is considered a low energy utilisation. It is not appropriate for all our demands. The information transmission rate is less than that of WI-FI, yet it is still beneficial for our application (720 Kb/s) (Figure 2.13) [26].

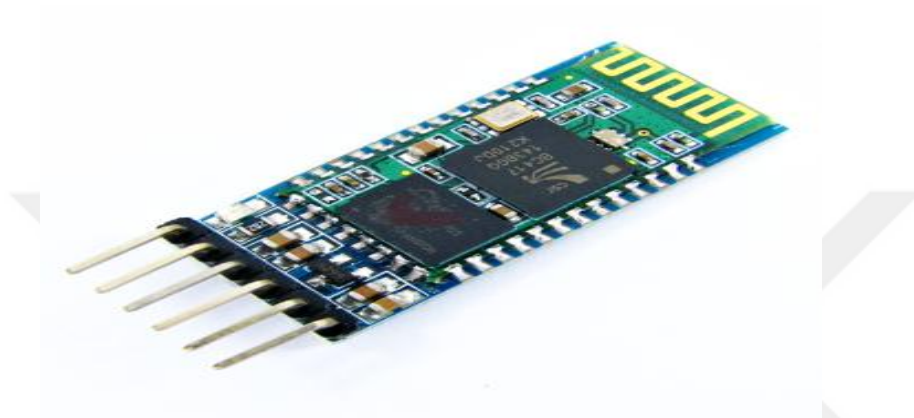


Figure 2.13 Bluetooth HC-5 device.

There are comparisons between WiFi and Bluetooth in several features [27].

Table 2.6 Comparisons between WiFi and Bluetooth.

Feature	WiFi	Bluetooth
Battery life time	Several hours	Several days
Complexity	High complexity	Complex
Nodes Number	32	7
Time for network communication	3 seconds	10 seconds
coverage	100m	10m
Extension	Roaming enable	no
Data Rate	11Mbps	1Mbps
Security	SSID	64bit, 128bit

2.5.7. SIM808 Module (GPS-GSM-GPRS):

This is a GSM, GPRS and GPS three-in-one limit module. In light of the latest GSM/GPS module SIM808 from SIMCOM, it supports GSM/GPRS Quad-Band framework and joins GPS innovation for satellite route (shipping). It is controlled by AT charge by methods for UART and sponsorships 3.3V and 5V clever level (Figure 2.14) [28].



Figure 2.14 SIM808 Module.

2.5.8. Ethernet Shield (W5100)

In our design, W5100 interface has been used (Figure 2.15) this uses 0.18 μm CMOS technology and has 16Kbytes of memory (TX/RX buffet) to supply a 10Mb/100Mb Ethernet association [29].

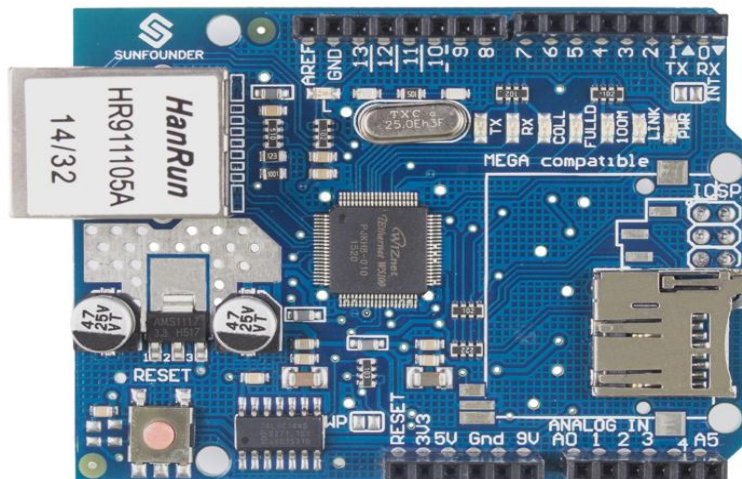


Figure 2.15 Ethernet shield.

2.5.9. LAN Cable (Local Area Network):

To get to the web in Arduino LAN connection is required. The LAN speed is considerably quicker than the wireless speed (Figure 2.16) [30].



Figure 2.16 LAN Cable.

2.5.10. LCD Display

LCD display is used to see the present status of the home devices and the sensors (password and temperature) (Figure 2.17).



Figure 2.17 LCD Display.

2.5.11. Sensors

The sensors used in this project include photo resistor (Figure 2.18), temperature and humidity sensors (DHT11) (Figure 2.19), flame sensor (Figure 2.20), Gas Sensor (MQ-2) (Figure 2.21) and Human Body Pyro electric Infrared Sensor (PIR) (Figure 2.22).

There are many distinctive gas sensors that recognize LPG, CO₂, methane and fire. The case given here utilizes the MQ2 sensor to distinguish air quality.



Figure 2.18 Photo resistor.



Figure 2.19 Humidity sensors (DHT11).



Figure 2.20 Flame sensor.



Figure 2.21 Gas Sensor (MQ-2).

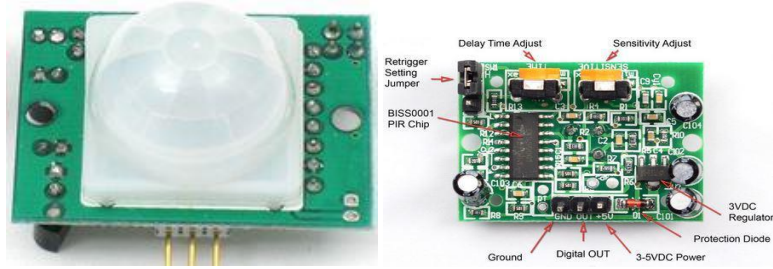


Figure 2.22 Human PIR Sensor (anterior and posterior views).

The following flowcharts show different sensors and their connection to the Arduino and how temperature, humidity and gases are detected (figure 2.23 and 2.24).

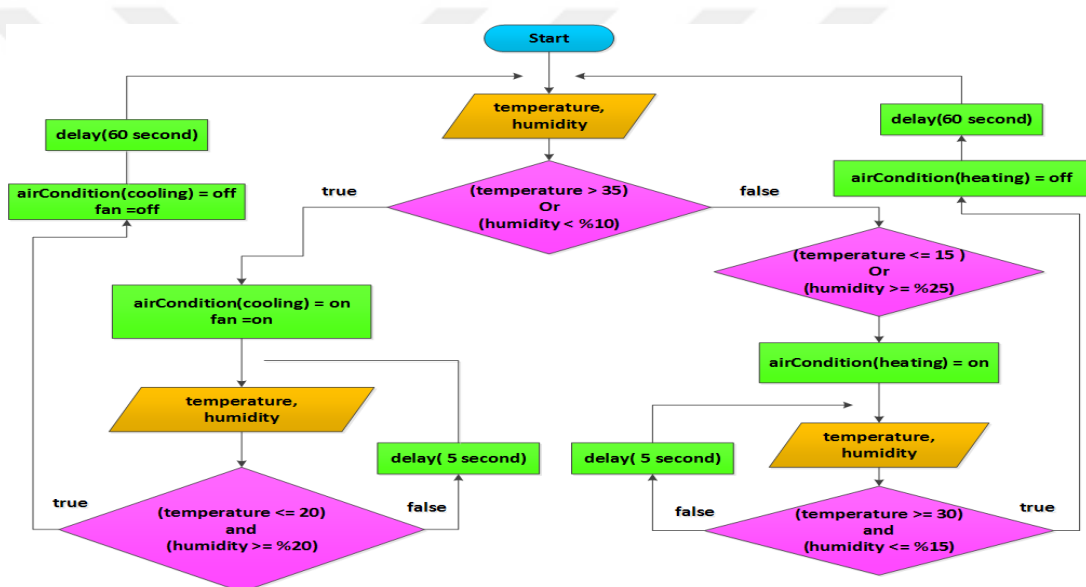


Figure 2.23 Flowchart of Temperature and Humidity sensors (DHT11).

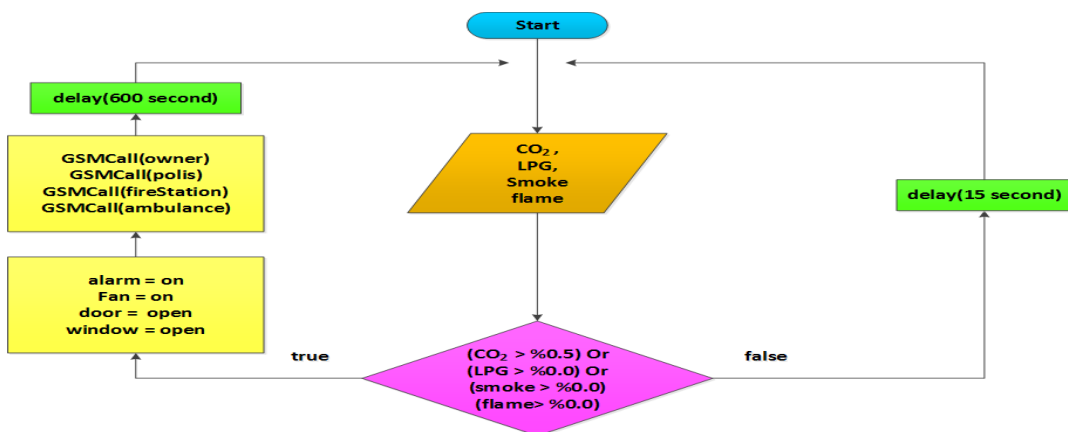


Figure 2.24 Flowchart of LPG gas sensor and Gas Sensor (MQ-2).

Human Body Pyroelectric Infrared Sensor (PIR): (Figure 2.25) feels any difference in IR radiation. In this manner, it could be utilised to distinguish movement. PIR's IC is BISS0001 Micro Power utilises low-energy CMOS technology. This sensor distinguishes the movement of an individual. As a human passes through this sensor, the background temperature (room temperature) will increase (to the body temperature) and in this manner the movement or human will be recognised [31]. This sensor may be used inside or outside the house. Outside the house: when the password (entered through a keypad) and/or RFID card (Figure 3.20) is used correctly, the buzzer (shooting) will stop, a green light will go on and the main door will be opened. When an incorrect password is entered or an RFID card is not used or wrongly used, the buzzer remains working, the red light will go on and the main door will remain closed. Inside the house, when the PIR sensor is on, if it recognises any motion the buzzer starts to work and the red light goes on. The device starts calling the saved mobile numbers (residents or police station).



Figure 2.25 RFID RC522.

The following flowcharts (Figure 2.26 and 2.27) show the sequence of detection of any motion by light and LASER, then alarming through sound (buzzer) and, PIR and GSM.

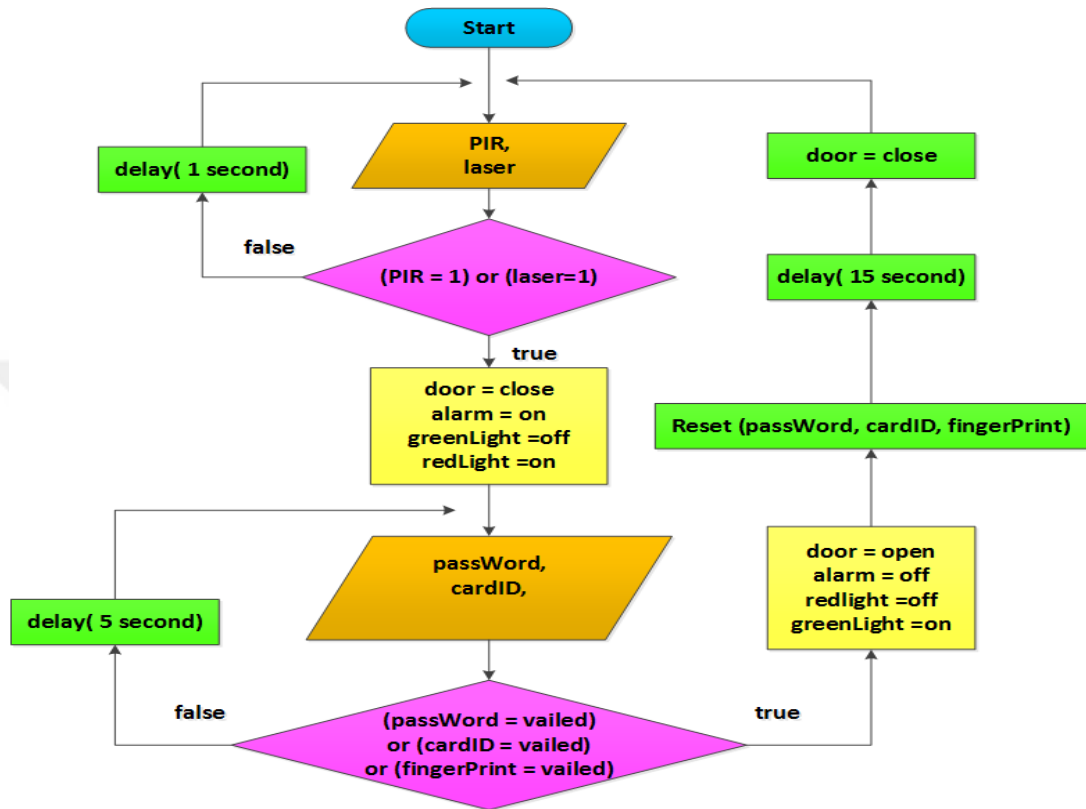


Figure 2.26 Flowchart of PIR and Laser.

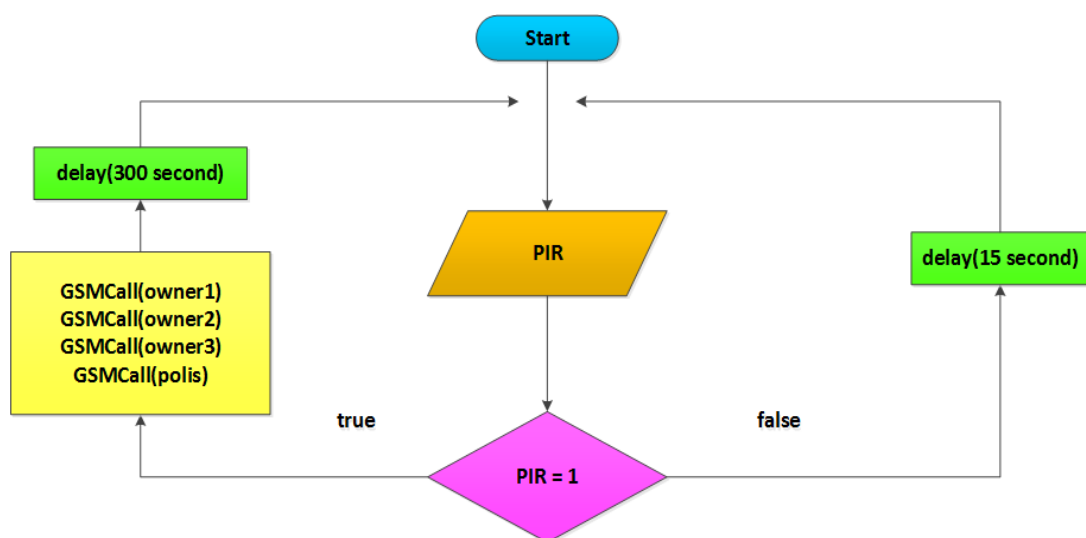


Figure 2.27 Flowchart of PIR.

2.5.12. Software Implementation - System Software Design

This part deals with the configuration of the software, program procedures and framework approaches used in programming the Arduinos in our smart home model. The software program roles are receiving information and orders, performing distinctive orders, controlling operational stations and supporting information input/output gates. We have attempted to offer general thoughts on program stream and usage (see flow charts). We divided our design into various parts, contingent upon the useful connection between these parts, to be dealt with easily and when a section or a piece is not working appropriately, it can be detected and treated.

Arduino IDE 1.6.3 Defining: it is an open source program. Codes can be written easily in this program. It is uploaded to the Arduino board easily, any of Uno and Mega. It can be downloaded via the following link <https://www.arduino.cc/en/Main/Software>.

The application created for this work (Arduino IDE 1.8.0) is responsible for the participation, communication and collaboration between the hardware and the portable PC or smart cell. It has been written in C language to follow the guidelines of coding for the project. WiFi Node MCU ESP8266-12E needs a software introduced inside Arduino IDE [32].

First we install the Arduino Software/IDE (Figure 2.28), then we open the Arduino program IDE (Figure 2.29), then select (File), where one can find the (Preferences) Dialog (Figure 2.30). Choose (Preferences), a (Settings) list will be opened, in "Additional Boards Manager URLs" add this line and click on "OK":

http://arduino.esp8266.com/stable/package_esp8266com_index.json " (Figure 2.31) then go to (tools again), from the list select the port number (Figure 2.32), after that choose the (board) (Figure 2.33), select (boards manager) (Figure 2.34) at the top. Select "ESP8266 Community Version 2.3.0" and install it (Figure 2.35) [33] [34].



Figure 2.28 Install the Arduino Software IDE.

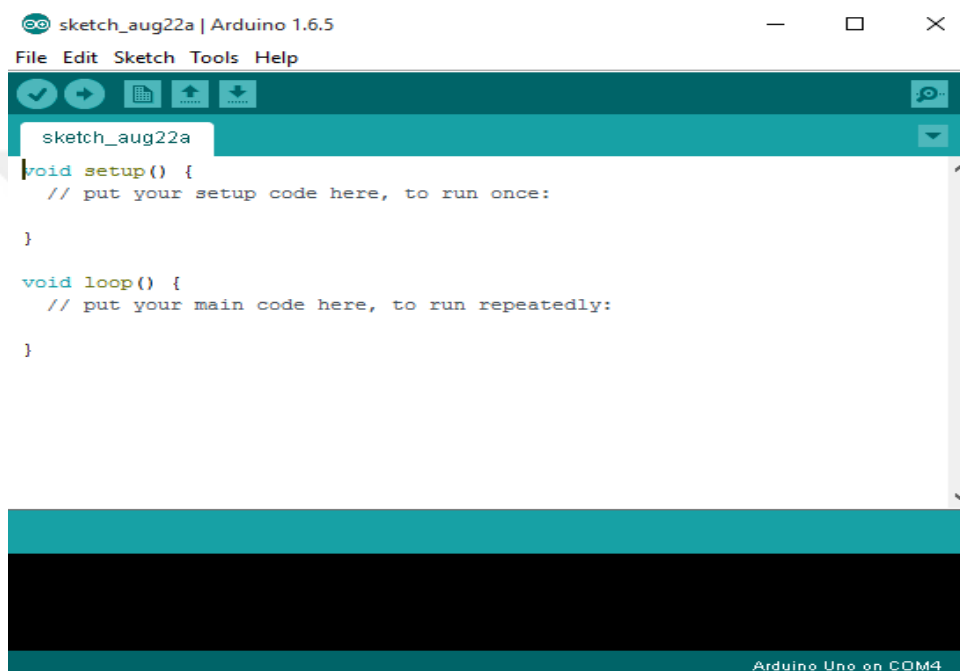


Figure 2.29 Open the Arduino program IDE.

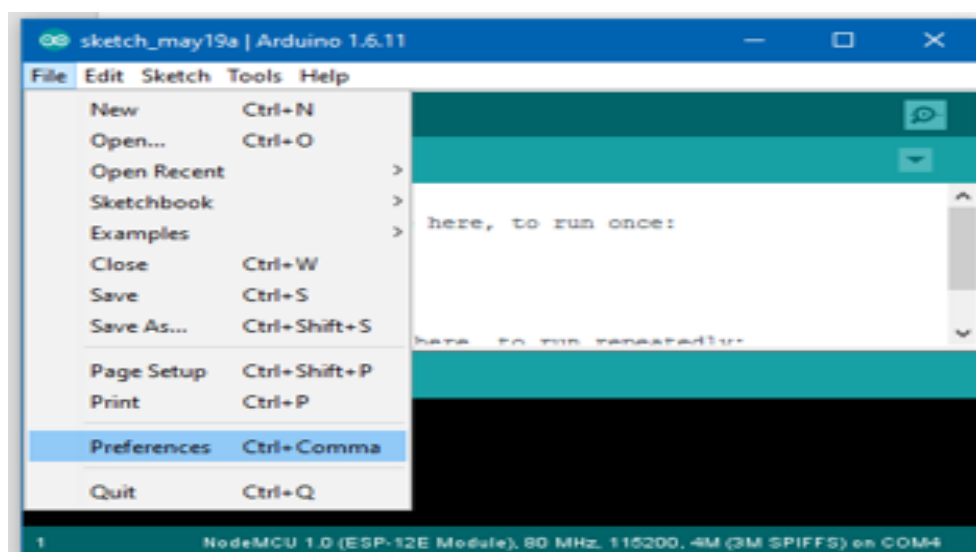


Figure 2.30 Select (Preferences) Dialog.

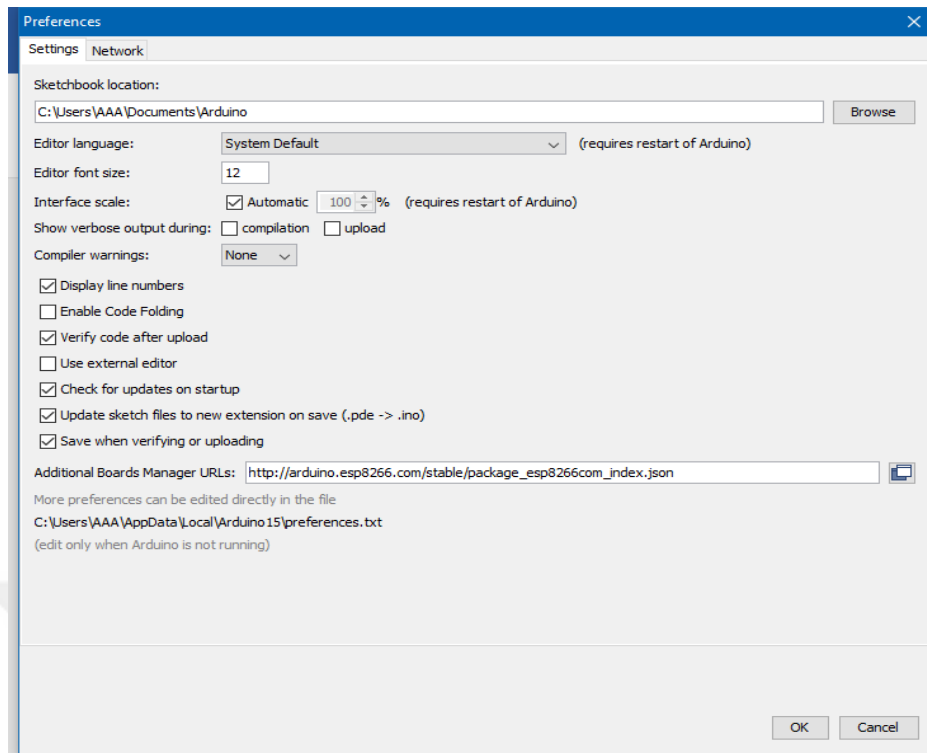


Figure 2.31 Settings the Arduino Board.

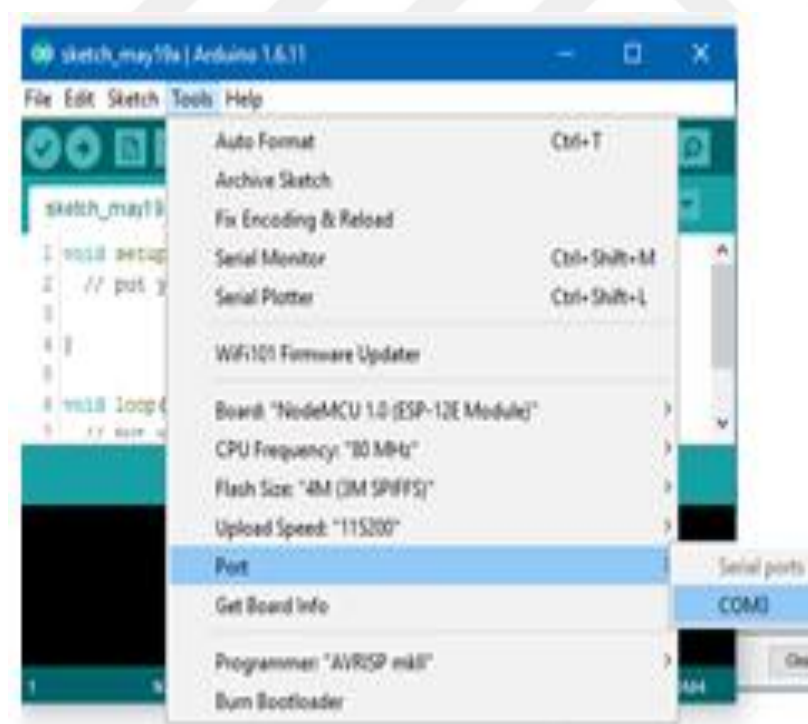


Figure 2.32 Select the port number.

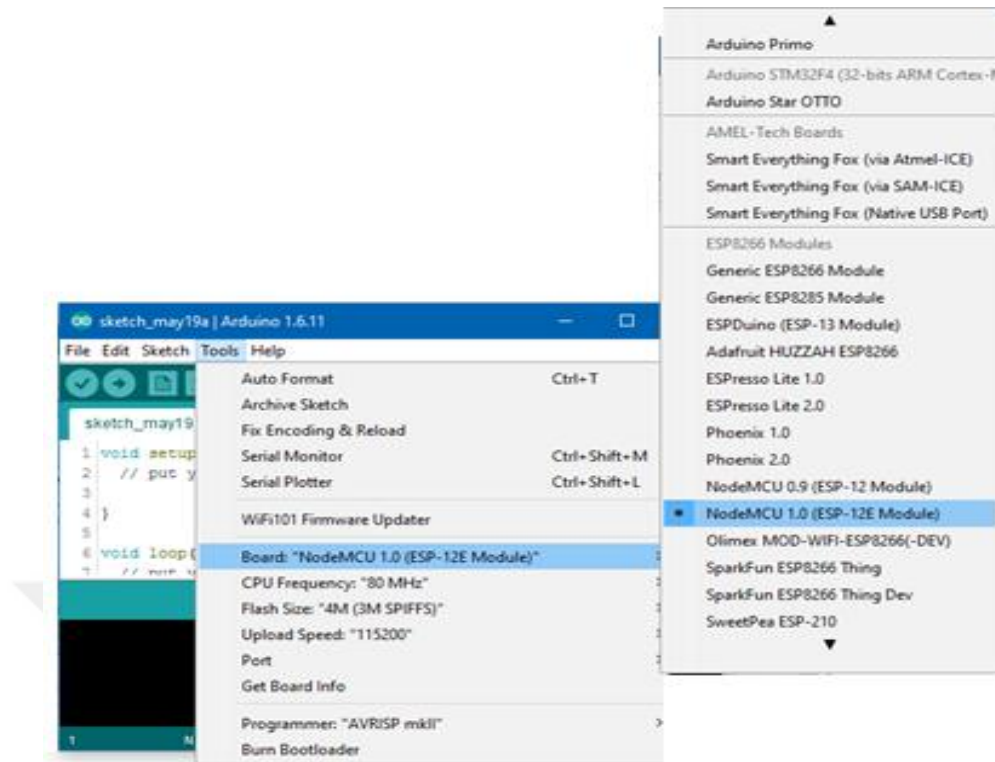


Figure 2.33 From the Tools choose (board).

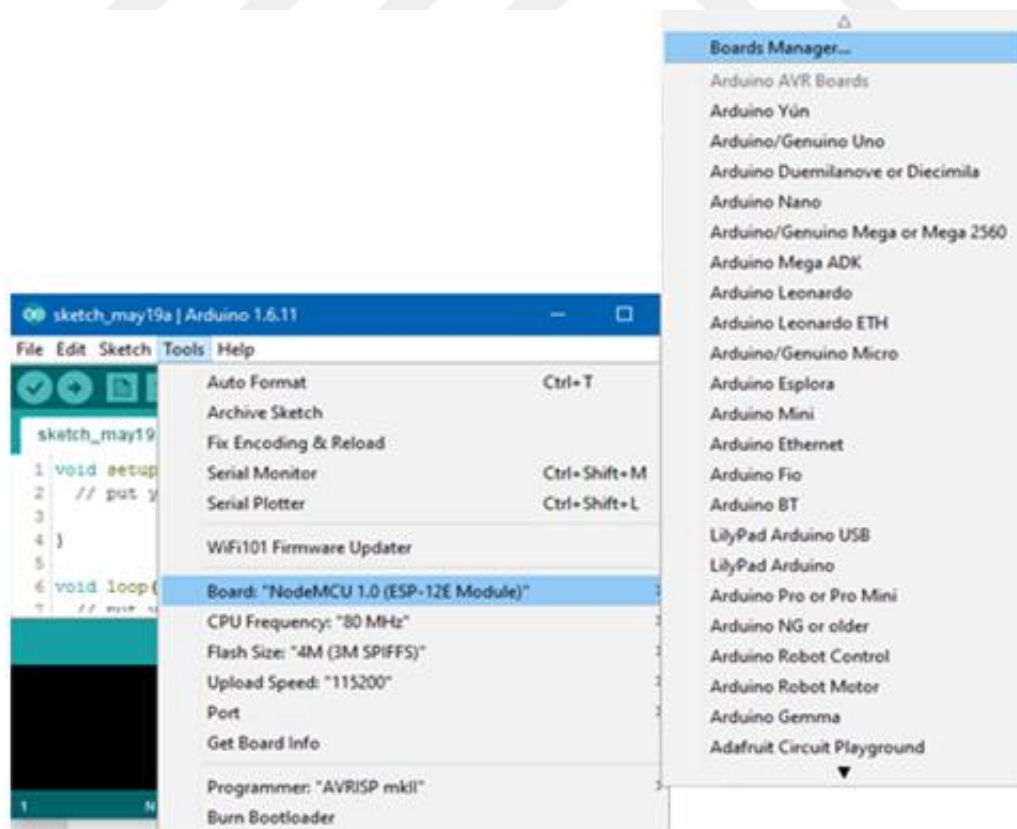


Figure 2.34 Select (boards manager) .

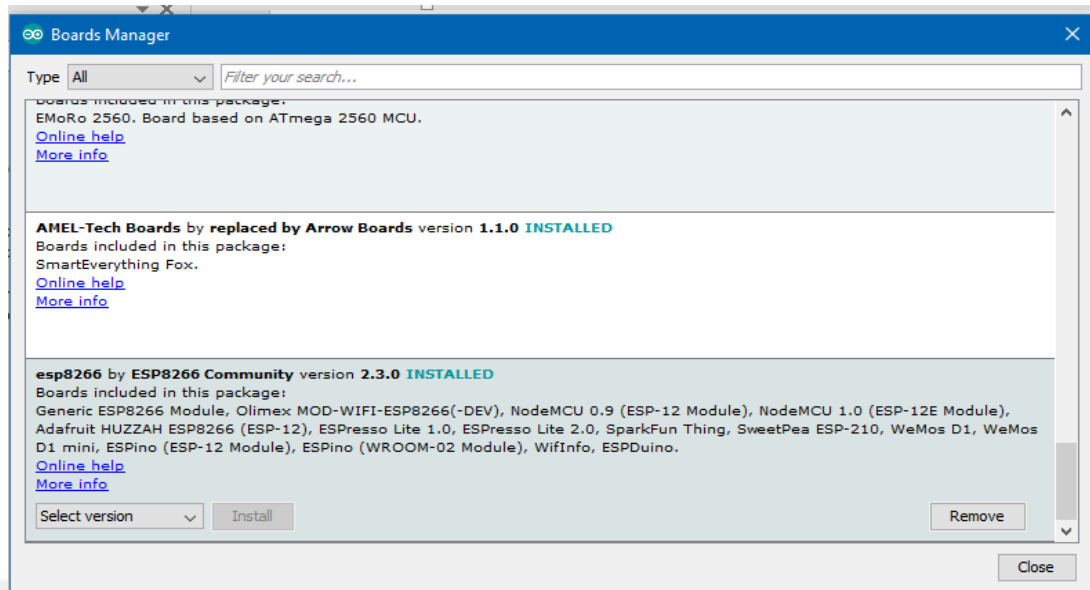


Figure 2.35 Select "ESP8266 Community Version 2.3.0" and install it .

To determine the type of the board, connect the Board to the PC, then select Device Manager in (my computer). One will see the serial ports in (other devices). Again, select (tools) and choose the COM number (=serial port). In the same list (i.e. tools), choose type of the board (e.g. Node MCU ESP8266-12E or Arduino Mega 2560).[35]

The technique used to outline this product is an upper to lower down organized programming plan. The ports must be defined and determined in the start of the program along with the installing of required libraries then entering the code then uploading, and after that saving the code by a name inside the Arduino`s memory.

After the port locations and definitions, the program initially calls various libraries, e.g. Serial Peripheral Interface (SPI) Library, Ethernet Library, Temperature and Humidity Library and RFID Library.

Our smart home system software involves programming the Arduino by C and C++ languages (utilising IDE accompanies the microcontroller itself), and Applications such as Arduino IDE 1.8.1 for windows10, ESP8266 WIFI control, Arduino WIFI control and Arduino Bluetooth control device for Android smartphones.

The application program is a NET based application. Entering an IP in the URL of the browser connects the devices to the ESP. The application programs are mindful of setup and arrangement, and keep up the entire smart home system utilising a database to keep log of smart home system parts, we utilize XML files to spare system log.

The Arduino programming is through utilising C and C++ languages. Utilising IDE accompanies the microcontroller itself. Arduino software collects information about events from associated sensors, then applies activity to devices and what is pre-programmed in the server.

The communication inside the house is through the following:

1. TP-Link Router that boosts wireless network throughout the home, broadcasting the WIFI that connects Node MCU ESP8266-12E, ESP8266-01 to smartphone and PC. The Router is also connected to the Ethernet shield via a cable (RJ-45), connecting it to an Arduino.

2. The GSM 808 communicates with a saved mobile number during any event that reaches an Arduino through any connected sensors.

When you are outside the home, the communication is through the **Internet**. Via **IoT** we can control home devices (e.g. lamps and TV) from far away.

The following table (Table 2.6) contains the parts of our project:

Table 0.7 Project parts.

No	Components	Sensors	Display	Wireless Technology	Other
1	PC	RFID Card System	LCD	WiFi ESP8266-01	Registers
2	Smart Mobile	LDR Sensor	Monitor	WiFi Node MCU	Coil
3	Tablet	Motion sensor		ESP8266-12EE	Switch
4	Arduino Mega	Infrared Remote		Bluetooth HC-5	Wire
5	2560	Control		IR	Transistor
6	Arduino UNO	Temperature node		Ethernet Shield	Breadboard Circuit
7	R3	Light control		Router	Led
8	GSM	Door alarm buzzer			buzzer
9	GPRS	Windows control			Servo motors
10		Smoke sensors			Solar panel tracking
11		Gas leakage			system
12		detection			
		Flame Sensor			
		Ultrasonic Sensor			

3. TO IMPLEMENT THIS PROJECT WE DIVIDED INTO SEVERAL PARTS

1. For ease of implementation.
2. To process the errors contained in the project.
3. To increase the pin used by the parts.
4. To solve the problem of energy saving.
5. To maintain the safety of the tools used.
6. Limited to the size of the Arduino board memory.
7. Easy detection of programming errors.

3.1. In this Section of the Project which is Specific to [IOT]

Step 1: It consists in the following parts [36]:

1. 1*Node MCU ESP8266-12E.
2. 1*Micro-USB-Data-Cable
3. 1*PIR Motion Sensor
4. 1*DHT11 Sensor (Humidity & Temperature)
5. 1*MQ2. Gas Sensors
6. 2*Push Button
7. 2*Resistors (220 ohm Used) // If can used 5mm LED
8. 1* 3 mm LED- Green
9. 1* 3 mm LED- Red
10. 1*Buzzer
11. 8*Jumper Wire (male + female) 20 cm
12. 1*Bread Board (Size 16,55 x 5,45 x 0.85 cm)
13. 1*Battery 9V
14. 1*Battery-9V-DC-Power-Cable

Step 2: To buy all the parts used in the project - from the following link:

- https://www.ebay.com/sch/items/?_nkw=esp-12e+nodemcu

Step 3: The following figure indicates the ways they are assembled together (Figure 3.1) and it performs the following tasks [37]:

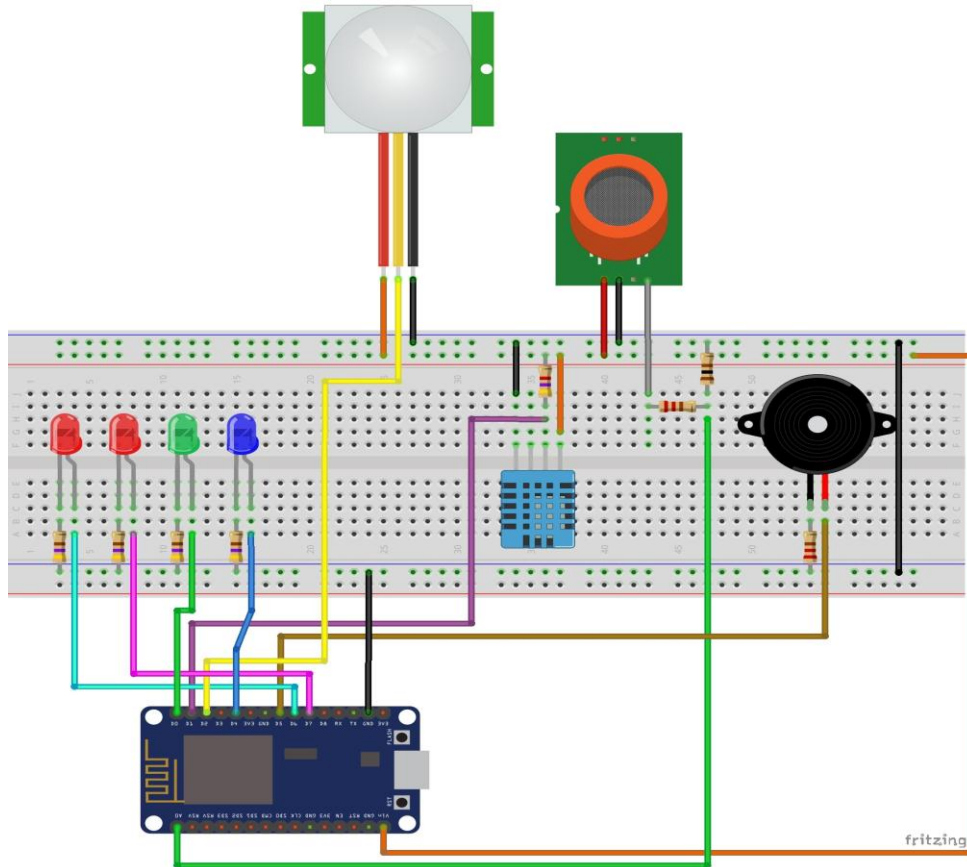


Figure 3.1 IOT with Node MCU ESP8266-12E Circuit.

Step 4: It is very necessary to import this library for the project to work the best, especially for the GitHub. It is added to the Arduino program [38]:

- <https://github.com/esp8266/Arduino>

Step 5: Then the code of the program is written. Then, the port and the Arduino type are determined and uploaded. Then, it is saved as (IOT).

Step 6: This is the program code at the end of project.

Step 7: The result of this section is shown in the following figure (figure 3.2, 3.3 and 3.4) [39].



Figure 3.2 ESP8266-12E WiFi Control



Figure 3.3 ESP8266-01 WiFi Control.

Implementation of Smart House Application Using Wireless Sensor Networks.

Name: Ismail Asaad Mohammed ID: 142129107

Supervisor: Assit Prof.Dr.Erkan DUMAN

Gas Sen.		Lead1	☐ ON	☐ OFF
Flame		Lead2	☐ ON	☐ OFF
Temperature		Lead3	☐ ON	☐ OFF
Humidity		Lead4	☐ ON	☐ OFF
CO ₂		FUN	☐ ON	☐ OFF

ELAZIG: 2017



Figure 3.4 Web Interface ESP8266-12E and ESP8266-01.

In the first section, in the practical part of this project, it is written in a practical step-by-step method to be easily understood by those who will read and use this project. The important and effective parts of this section are Node MCU ESP8266-12E and ESP8266-01 to construct the project, which is a smart home via WiFi and using IOT.

- ESP8266 features methodology of buying ESP8266
- Methodology of doing and using it.

3.1.1. An Entrance to ESP8266

Its price is around \$4 to \$10. It has many types, each with different features. For this project, Node MCU ESP8266-12E (Figure 2.11) and ESP8266-01 (Figure 2.12) are used. It is achieved easily. It can be used in larger projects to tie several devices and for controlling them. The Node MCU ESP8266-12E type is used the most. It is feasible in terms of running the project.

Note: If anyone wanted to use fewer pins then ESP8266-01 is a better option as it is smaller and cheaper (Figure 2.12).

Warning: It is worth pointing out that these pieces work at 3.3V. If the voltage is higher then the circuit is harmed with the possibility of defecting the entire system.

3.1.2. All types of Wi-Fi ESP8266 are shown in the figure below (Figure 3.5).

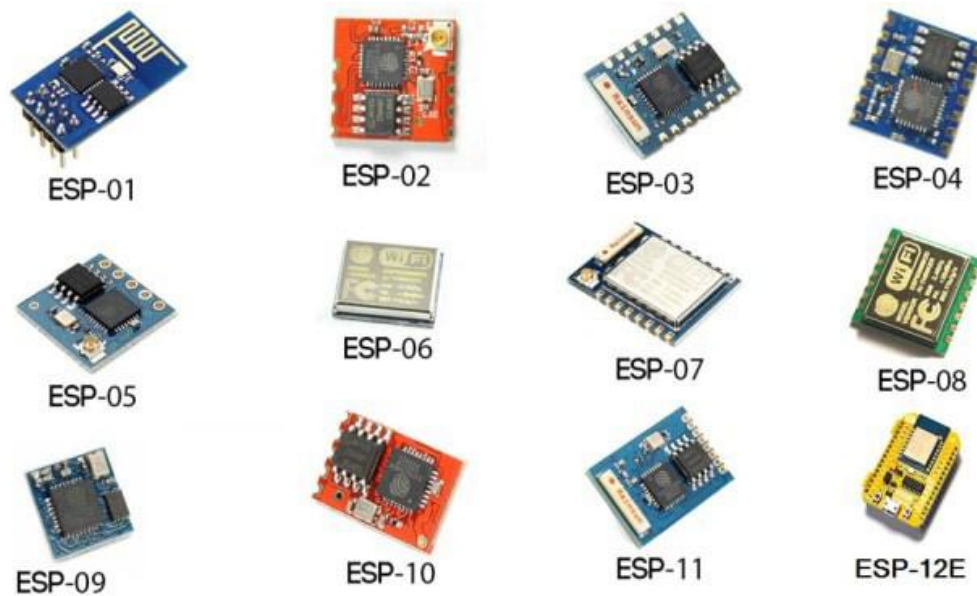


Figure 3.5 All types of Wi-Fi ESP8266.

3.1.3. In our project we used two types of Wi-Fi (ESP8266-01,12E):

First type: ESP8266-01 - it weighs much less, is small in size and has the fewest pins. It is used for no more than two devices. It is a bit hard to connect them. It runs at 3.3v, even in its programming.

Second type: Node MCU ESP8266-12E - it weighs more, is larger in size and has more pins. It is used for several devices. It is embedded on Breadboard.

3.1.4. Methods of ESP8266 Programming:

Two ways are most often used to program both types of WiFi Node MCU ESP8266-12E and ESP8266-01. In the first chapter, the methodology of its programming and the preparation to run it and install Code for it [40].

In section one: ESP8266-01 is described via the Arduino IDE program.

In section two: ESP8266 with Firmware. The first method is the most widely used, and we can easily get many examples from the Internet.

In section one ESP8266 with Arduino IDE 1.6.3 program: in this section the installation, arrangement and preparation of the program is explained to work with ESP8266.

It is easily installed into computers and it advances with various operating systems, such as Windows, Mac and Linux which is created with Java. It has plenty of examples to be used when needed. The libraries can be installed via GitHub to the program Arduino IDE.

3.1.5. The requirements for their operation

Installing Java in the PC when the PC lacks Java. The most updated version needs to be installed. It can be downloaded via the following link. <https://www.java.com/en/download/>

Install Arduino program, correctly. Then, install ESP8266 board as the following,

It is important to recognise each pin. In the following table, the GPIO pins explained which each one of them with the ESP8266-01 only there are 0,2 pins. But, in Node MCU ESP8266-12E there are 16 GPIO pins as input. The selected output works at 3.3v.

3.2. This section of the project is specific to [Ethernet Shield W5100]

Step 1: It consists in the following parts:

1. 1*Arduino (Mega-2560-R3)
2. 1*Ethernet Shield W5100
3. 1*RJ45 Cable (Ethernet Lan Network)
4. TP-LINK (Wireless N Router)
5. 1*DHT11 Sensor (Humidity & Temperature)
6. 1*MQ2. Gas Sensors
7. 2*Push Button
8. 2*Resistors (220 ohm Used) // If can used 5mm LED
9. 1* 3 mm LED- Green
10. 1* 3 mm LED- Red
11. 1*Buzzer
12. 8*Jumper Wire (male + female) 20 cm
13. 1*Bread Board (Size 16,55 x 5,45 x 0.85 cm)

14. 1*Battery 9V
15. 1*Battery-9V-DC-Power-Cable
16. 1*USB Cable

Step 2: The following figure indicates the ways they are assembled together (Figure 0-6) and it performs the following tasks:

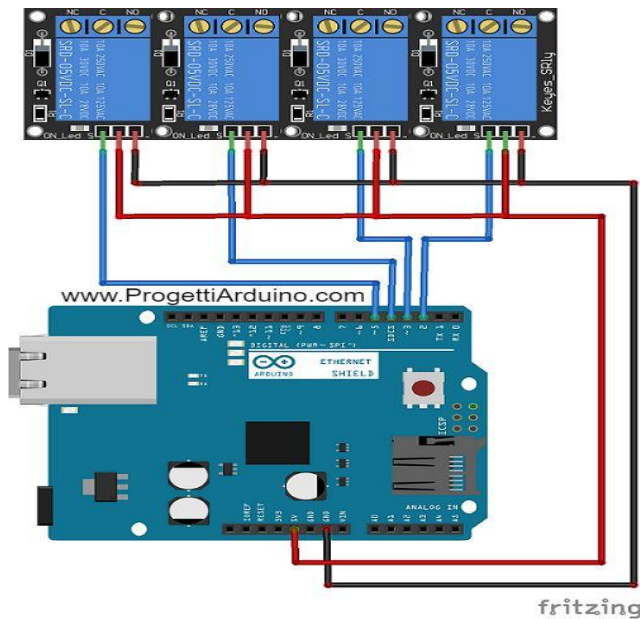


Figure 3.6 Ethernet Shield W5100.

Step 3: It is necessary to import this library for the project to work best, especially for the GitHub. It is added to the Arduino program:

- <https://www.arduino.cc/en/Reference/Ethernet>

Step 4: Then the code of the program is written. Then, the port and the Arduino type are determined and uploaded. Then, it is saved as (Ethernet).

Step 5: This is the program code at the end of the project.

3.3. This section of the project is specific to [Motion Detected]

Step 1: it consists in the following parts:

1. 1*Arduino UNO (R3 MEGA328P)
2. 1*SIM808 Development Board GSM GPRS GPS
3. 1*PIR Motion Sensor
4. 2*Push Button
5. 1* 3 mm LED- Green
6. 1* 3 mm LED- Red
7. 1*Buzzer
8. 8*Jumper Wire (male + female) 20 cm
9. 1*Battery 9V
10. 1*Battery-9V-DC-Power-Cable
11. 1*CIM Card Mini

Step 2: To buy all the parts used in the project - from the following link at the end of the project.

Step 3: The following figure indicates the ways they are assembled together (Figure 3.7) and it performs the following tasks:

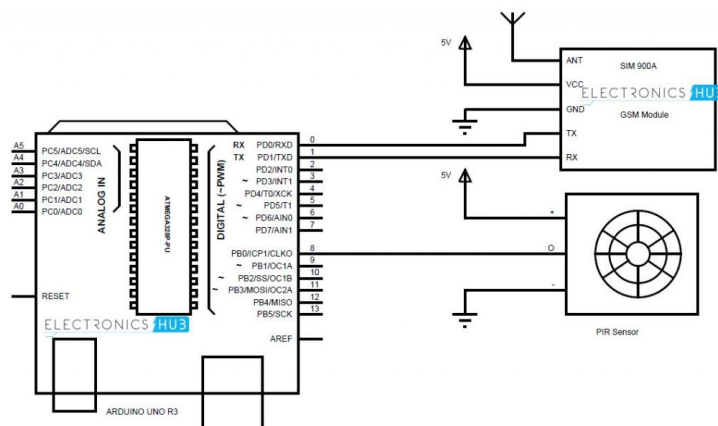


Figure 3.7 Motion Detected.

Step 4: It is necessary to import this library for the project to work best, especially for the GitHub. It is added to the Arduino program:

Step 5: Then the code of the program is written. Then, the port and the Arduino type are determined and uploaded. Then, it is saved as (Motion Detected).

Step 6: This is the program code at the end of project.

Step 7: The necessary library is achieved via this link.

Step 8: The result of this section is shown in the following figure.

3.4. This section of the project is specific to [Bluetooth HC-05]

Step 1: It consists in the following parts:

1. 1*Arduino (Mega-2560-R3)
2. 1*Bluetooth HC-05 (6 Pin Wireless)
3. 1*8-Channel-Relay-Board
4. 2*Resistors (220 ohm Used) // If can used 5mm LED
5. 1* 3 mm LED- Green , Red
6. 14*Jumper Wire (male + female) 20 cm
7. 1*Battery 9V
8. 1*Battery-9V-DC-Power-Cable
9. 1*USB Cable
10. Android Application

Step 2: To buy all the parts used in the project - from the following link from the end of the project.

Step 3: The following figure indicates the ways they are assembled together (Figure 3.8) and it performs the following tasks:

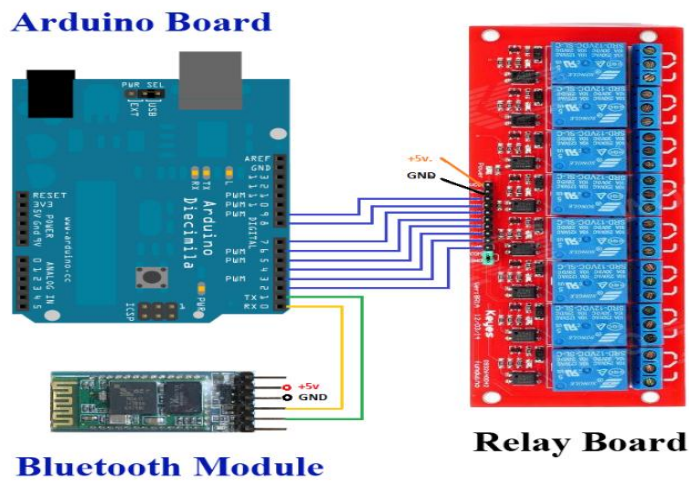


Figure 3.8 Bluetooth HC-05.

Connect pin the Bluetooth with the Arduino .

VCC – VCC

GND – GND

RXD – TX

TXD – RX

Download App in Play Store:

1. Install -Arduino Bluetooth Control Device (App. Free) (Figure 3.9) [41].



Figure 3.9 Arduino Bluetooth Control Device.

2. Open the Program (Figure 3.10).



Figure 3.10 Arduino Bluetooth Control.

3. Turn On Bluetooth.
4. Connects between mobile and the Bluetooth (Figure 3.11).

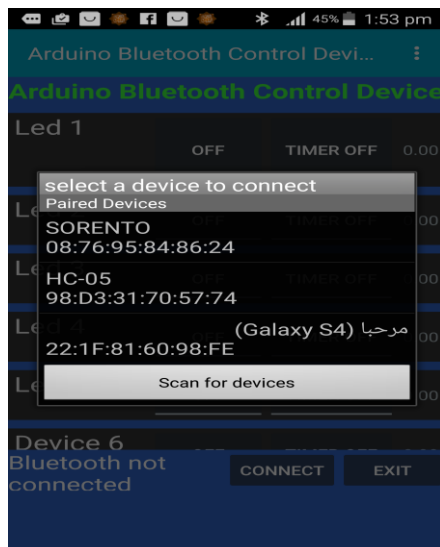


Figure 3.11 Connects mobile and Bluetooth.

5. Can be used to turn all the devices in the house on or off.
6. In the setting can to Change name your all devices (Figure 3.12).

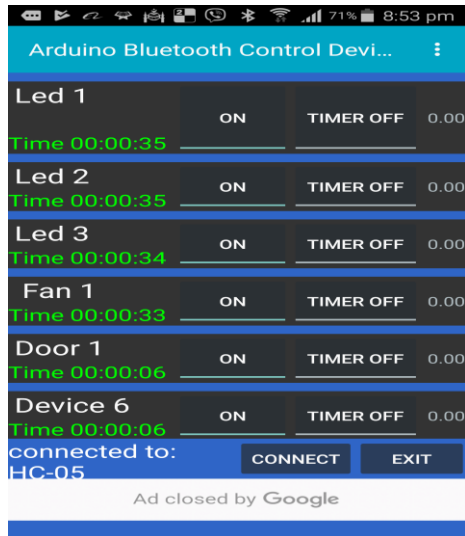


Figure 3.12 Setting can to Change name.

7. Can use Timer to turn all the devices in the house on or off.

Step 4: It is necessary to import this library for the project to work best, especially for the GitHub. It is added to the Arduino program:

Step 5 Then the code of the program is written. Then, the port and the Arduino type are determined and uploaded. Then, it is saved as (Bluetooth 5).

Step 6: This is the program code at the end of project.

Step 7: The result of this section is shown in the following figure (Figure 3.13).

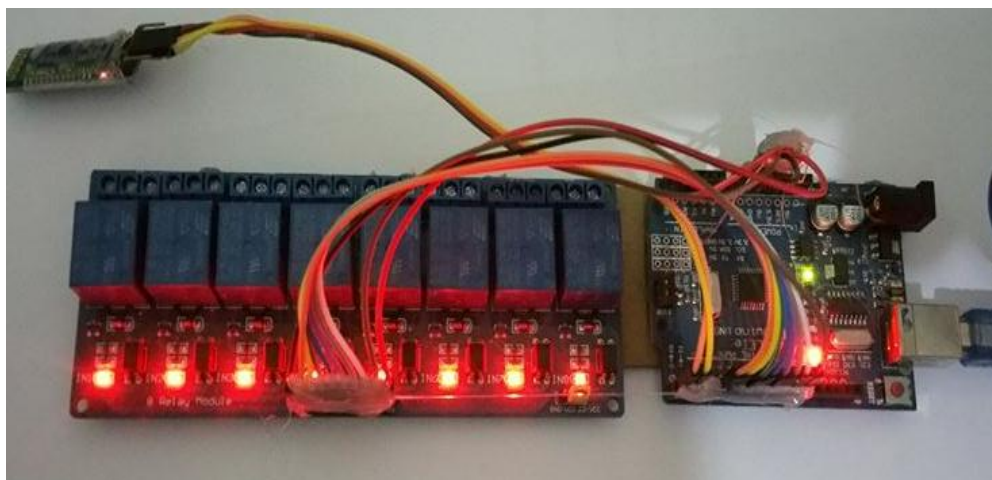


Figure 3.13 The result of this Bluetooth section.

Note:

- Use 3.3V DC Power to Bluetooth HC-5.
- Use 5V DC Power to Relay.

3.5. This section of the project is specific to [Control the Home]

Step 1: It consists of the following parts:

1. 1*Arduino (Mega-2560-R3)
2. 1*DHT11 Sensor (Humidity & Temperature)
3. 2*Push Button
4. 2*Resistors (10 Kohm Used) // used to LCD Low or Height Light
5. 1* 3 mm LED- Green
6. 1* 3 mm LED- Red
7. 1*Buzzer
8. 40*Jumper Wire (male + female) 20 cm
9. 1*Bread Board (Size 16,55 x 5,45 x 0.85 cm)
10. 1*Battery 9V
11. 1*Battery-9V-DC-Power-Cable
12. 1*USB Cable
13. 1*Laser
14. 1*LDR
15. 1*LCD
16. 1*RFID
17. 1*Keypad 4*4
18. 1*Relay 4 Channel

Step 2: To buy all the parts used in the project - from the following link at the end of the project.

Step 3: The following figure indicates the ways they are assembled together (Figure 3.14) and it performs the following tasks:

Step 4: It is necessary to import this library for the project to work best, especially for the GitHub. It is added to the Arduino program:

Step 5: Then the code of the program is written. Then, the port and the Arduino type is determined and uploaded. Then, it is saved as (Control the Home).

Step 6: This is the program code at the end of the project.

Step 7: The result of this section is shown in the following figure.

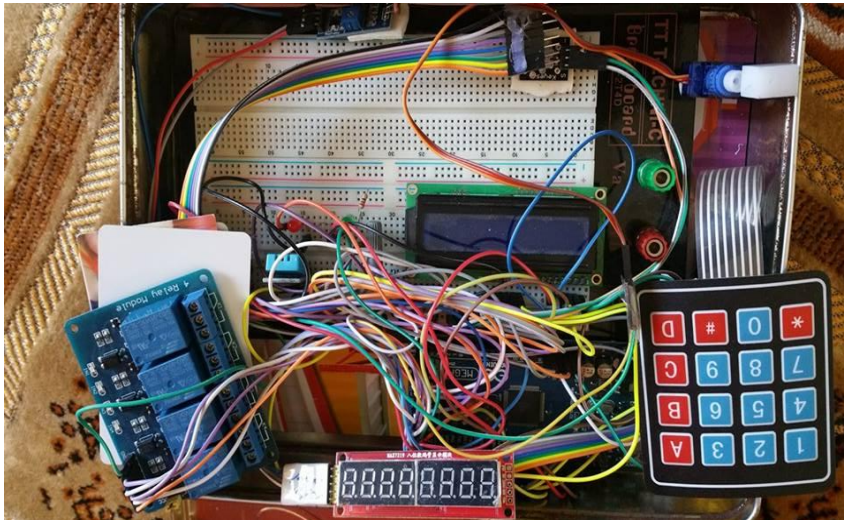


Figure 3.14 The result of this Control the Home.

3.6. This section of the project is specific to [Solar Tracker]

Step 1: It consists of the following parts:

1. 1*Arduino UNO R3
2. 2*Push Button
3. 4*Resistors (10 Kohm Used)
4. 4*LDR
5. 20*Jumper Wire (male + female) 20 cm
6. 1*Bread Board (Size 16,55 x 5,45 x 0.85 cm)

7. 1*Battery 9V
8. 1*Battery-9V-DC-Power-Cable
9. 1*USB Cable
10. 2*Servo Motors
11. 1* Solar panel

Step 2: To buy all the parts used in the project - from the following link at the end of the project.

Step 3: The following figure indicates the ways they are assembled together (Figure 3.15, 3.16) and it performs the following tasks:

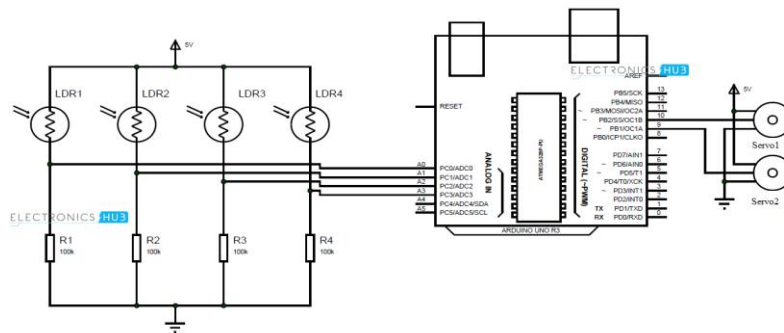


Figure 3.15 Solar Tracker.

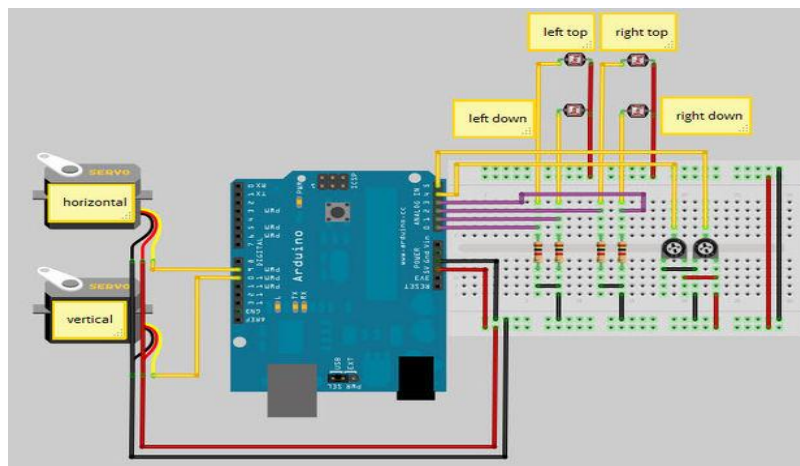


Figure 3.16 Solar Tracker.

Step 4: It is necessary to import this library for the project to work best, especially for the GitHub. It is added to the Arduino program:

- <https://github.com/arduino-libraries/Servo>

Step 5: Then the code of the program is written. Then, the port and the Arduino type are determined and uploaded. Then, it is saved as (Solar Tracker).

Step 6: This is the program code at the end of project.

Step 7: The result of this section is shown in the following figure (Figure 3.17).



Figure 3.17 Solar Tracker.

3.7. Note

1. For all parts: Make sure to download and correctly link the library from the following links:

- <https://github.com/search?utf8=%E2%9C%93&q=arduino+library&type=>
- <https://iot-playground.com/build>

2. To order and buy these parts from within Turkey, preferably from the following links:

- <https://www.direnc.net/>
- <http://www.robotistan.com/>

3. To find out the size of resistance we use this card (Figure 3.18):

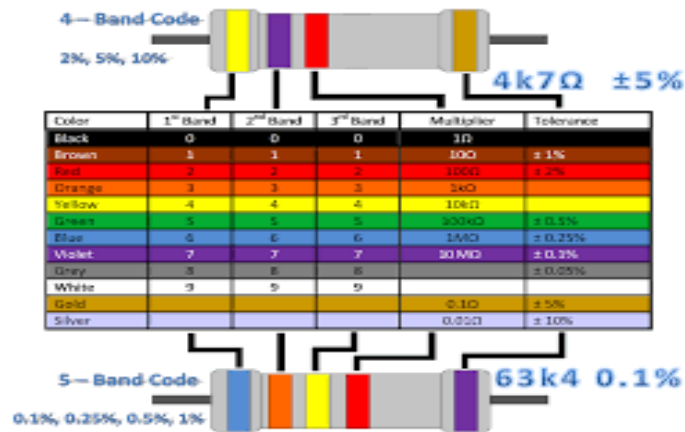


Figure 3.18 Find out the size of resistance.

4. EXPERIMENTAL RESULTS

The planned procedure in building the smart home was successfully applied using equipment such as: WiFi, Sensor, GSM and Arduino in order to operate and administer all the instruments properly.

- The house can detect any body approaching it through PIR or LDR and Laser.
- It can be operated using a personal password by using RFID or Keypad, which turns on a green light that can be seen in the LCD screen.
- After entering the Password or the RFID the door opens automatically and then closes.
- In cases of entering incorrect passwords or using the system incorrectly, a red light and a buzzer turn on to give warning. It enables the user to switch the lights on and off. It also works automatically by turning the indoor and outdoor lights on when it is dark and turning all of them off when there is daylight.
- It also enables the user to check the temperature and humidity in the house, as well as working sensitively to detect any strangers entering the house and the existence of any gas, CO₂, or fire. It also operates to take some necessary reactions and giving the user caution through their mobile phone, as well as operating ventilators and contacting related parties such as fire rescue services, police and ambulance.
- It is worth mentioning that the results can be accessed through web, smart phone and tablet using Bluetooth, WiFi, and IOT.

- The user can also be informed about the amount of water left in the roof storage tank. They can also stop water consumption at a certain point, which means controlling water consumption for the purpose of protecting it as an important national treasure.
- Reducing energy consumption, which is vital for the environment and the economy at the same time, as most of the equipment only works when necessary.
- The system is also able to draw and close all the curtains and drapes in the house.
- Using Bluetooth and IR the user is also able to turn on/off and use most of the house equipment.
- All the above-mentioned points facilitate their users in so many aspects which gives them comfort, protection, security and insurance.
- Eventually, by using Solar Tracking generation of light, we managed to obtain more powers of light. The system is able to search for light automatically in a horizontal and a vertical way

In short, this system is able to work with all its pieces through the internet properly and show the results, as well as performing the tasks using a computer, mobile phone or tablet. It also suggests different ways to activate and use the system properly.

5. CONCLUSION

- Nowadays, technology has developed in so many ways. In this respect, smart homes could be built considering the following important points:

1. Making sure they are strong and effective as well as being user friendly.
2. Considering security and safety aspects.
3. Making sure it costs little and is economic.
4. For the development of this project, the Solar Tracking generation of light is used to save more energy.
5. Building in a way which leads to less energy consumption and is environmentally friendly.
6. Making sure it is easy to develop as well as easy to mend.

- Smart home is able to connect a number of machines and sensors together and enables them to work properly and automatically. It also facilitates its users, especially disabled people.

- In this study, Smart Home Security is considered, so as to be applied properly. It suggests two different ways to connect it to internet, so that it can be used and observed from a distance. This can be achieved through the web by using a PC, laptop, smart phone and tablet after entering their special IP and connecting them together through WSN.

- The study also suggests using more than one type of wireless, such as IR, Bluetooth and WiFi, in the same project.

- In case of any unexpected incidents, such as strangers entering the house, the existence of fire, smoke, CO₂ gas, or gas exposure, etc. the project suggests building a relationship between the smart home, its user and related parties through GSM.

- The study also focuses on protecting the environment, reducing electrical energy consumption and avoiding the waste of water. These are the main points, as the mentioned sources are among the main issues in our country as well as being the primary daily needs that are not available these days.

- It is recommended to develop this project and connect it to Face Recognition and Voice Recognition, which aims to enhance the facility and provide more safety and security at the same time.

- It also considers children, patients and elderly people in order to provide them with better care, by observing and watching their movement, safety, body temperature, heart beats, etc. so that the system contacts the owner and ambulance services in any problematic situations.

Advantages of our System:

The implementation of a Smart House Application Using Wireless Sensor Networks was managed successfully as it was user friendly and cost effective, because of better flexibility via an android device through the web and a wider range of scalability. This system provided comfort, authentication and security.

Future Recommendations

1. Each component is better tested before using them, especially the relays for safety purposes.
2. Instead of WiFi, IR and Bluetooth modules, try LiFi technology which is 100 times faster than WiFi and which amplifies the signal for working at a greater distance.

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