A

Project Report

On

IOT BASED HOME AUTOMATION USING NODE MCU

Submitted in partial fulfillment of the requirement for the award of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

BY

S.PAVAN SAI KIRAN	**(21AM5A0407)**
D.RASOOL BEE	**(21AM5A0408)**
I.SANKHAR NARAYANA REDDY	**(20AM1A0475)**

Under the esteemed guidance of

Dr. D. RAGHUNATHA RAO, **M. Tech., Ph.D**

Associate Professor, Dept. of ECE

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SVR ENGINEERING COLLEGE

AYYALURUMETTANANDYAL–518503(A.P)

(Affiliated to JNTUA, Approved by AICTE, New Delhi, Accredited by NAAC of UGC & NBA of AICTE)

2020-2024

SVR ENGINEERING COLLEGE

Ayyaluru Metta, Nandyal-518503, NANDYAL (Dist.), A.P.

(Affiliated to JNTUA, Approved by AICTE, New Delhi, Accredited by NAAC of UGC & NBA of AICTE)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

This is to certify that the dissertation entitled **"IOT BASED HOME AUTOMATION USING Node MCU"** is the bonafide work done and submitted by

S.PAVAN SAI KIRAN (21AM5A0407)

D.RASOOL BEE (21AM5A0408)

I.SANKHAR NARAYANA REDDY (20AM1A0475)

In partial fulfillment of the requirement for the award of the degree of **Bachelor of Technology** in **Electronics and Communication Engineering** in the **SVR ENGINEERING COLLEGE (Affiliated to Jawaharlal Nehru Technological University Anantapuramu)** is a record of bonafide work carried out by them under our guidance and supervision.

Project Guide:

Dr. D. RAGHUNATHA RAO, M. Tech., Ph. D

Associate Professor

Dept. of ECE

SVREC

Head of the Department:

Dr. G. LAKSHMINARAYANA, M. Tech., Ph. D

Professor & HOD

Dept. of ECE

SVREC

EXTERNAL EXAMINER

DECLARATION

We hereby declare that the project report entitled "IOT BASED HOME AUTOMATION USING Node MCU ''is carried out by us during the academic year 2023–2024 in partial fulfillment of the award of Bachelor of Technology in Electronics and communication Engineering from SVR Engineering College affiliated to Jawaharlal Nehru Technological University Anantapuram. We have not submitted the same to any other university organization for the award of any other degree.

S.PAVAN SAI KIRAN (21AM5A0407)

D.RASOOL BEE (21AM5A0408)

I.SANKHAR NARAYANA REDDY (20AM1A0475)

ACKNOWLEDGEMENT

We earnestly take the responsibility to acknowledge the following distinguished personalities who graciously allowed us to carryout project work successfully.

We express deep gratitude to our guide **Dr.D.RAGHUNTHA RAO,** **M.Tech, Ph.D** Associate Professor, Department of ECE, **S.V.R Engineering College,** for the guidance and for his incessant help and encouragement throughout the course of the project work. His friendly and informal talks helped us to work under excellent working conditions.

We would like to express our gratitude to project coordinator **Dr.D.RAGHUNATHA RAO**, **M.Tech, Ph.D** Associate Professor, in the Department of ECE, **S.V.R Engineering College,** for his encouragement throughout the course.

We are extremely thankful to the Head of the Department of ECE, **Dr. G. LAKSHMI NARAYANA** **M.Tech, Ph.D**, **S.V.R Engineering College,** for the encouragement and assistance provided to us, which contributed to the successful completion of this project.

We are thankful to our Principal **Dr. P.MALLIKARJUNA REDDY** **M.Tech, Ph.D** who has encouraged and motivated us to complete the project by providing all necessary facilities to carry out the work in the college.

We are thankful to our honorable chairman **Sri S.V.RAMIREDDY** & honorable Managing Director **Sri S.DINESH REDDY** for providing good faculty and for their moral support throughout the course.

We would like to thank all teaching and non-teaching members of the ECE Department for their generous help in various ways for the completion of this thesis.

They have been great sources of inspiration to us and wet hank them from the bottom of our heart.

S.PAVAN SAI KIRAN (21AM5A0407)

D.RASOOL BEE (21AM5A0408)

I.SANKHAR NARAYANA REDDY (20AM1A0475)

Vision and Mission of the institute

Vision

To produce competent engineering graduates & managers with a strong base of technical &managerial knowledge and the complementary skills needed to be successful professional engineers & managers.

Mission

To fulfill the vision by imparting quality technical & management education to the aspiring students by creating effective teaching/learning environment and providing the state of the art infrastructure and resources.

Vision and Mission of the Department

Vision

To produce highly skilled, creative and competitive Electronics and Communication Engineers to meet the emerging needs of the society.

Mission

- Impart core knowledge and necessary skills in Electronics and Communication Engineering through innovative teaching and learning.
- In calculate critical thinking, ethics, lifelong learning and creativity needed for industry and society.
- Cultivate the students with all-round competencies, for career, higher education and self-employability.

Program Educational Objectives (PEOs)

- **PEO1:** Graduates apply their knowledge of mathematics and science to identify, analyze and solve problems in the field of Electronics and develops communication systems.
- **PEO2:** Graduates embody a commit mentor of essential ethics, diversity and social awareness in their professional career.
- **PEO3**: Graduates exhibit a desire for life-long learning through technicaltraining and professional activities.

Program Specific Outcomes (PSOs)

- **PSO1:** Apply the fundamental concepts of electronics and communication engineering to design a variety of components and systems for applications including signal processing ,image processing, communication, networking, embedded systems, VLSI and control system.
- **PSO2:** Select and apply cutting-edge engineering hardware and software tools to solve complex Electronics and Communication Engineering problems.

SVR ENGINEERING COLLEGE	
DEPARTMENT	**ELECTRONICS AND COMMUNICATION ENGINEERING**
PROGRAM OUTCOME ATTAINMENT	
PO 1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety and the cultural, societal, and environmental considerations.
PO 4	Ability arch literature , use research methods to execute project and synthesize the problem to provide valid conclusions.
PO 5	Create, select, and apply appropriate techniques, resources ,and modern engineering and IT tools including prediction and modeling to complex engineering activitieswith an understanding of the limitations.
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of and need for sustainable development.
PO 8	Apply ethical principles and commit of professional ethics and responsibilities and norms of the engineering practice.
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and given receive instructions.
PO11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi disciplinary environments.
PO 12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO 1	Apply the fundamental concepts of electronics and communication engineering to design a variety of components and systems for applications including signal processing,imageprocessing,communication,networking,embeddedsystems ,VLSI and control system.
PSO 2	Identify indigenous processes and components for producing high quality, compact, energy efficient and eco-friendly solutions prices.

TITLE	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO1 2	PSO1	PSO2
IOT BASED HOMEAUTOMATION USING Node MCU	3	3	2	2	2	2	1	1	2	2	2	3	3	3

INDEX

ABSTRACT

Home automation refers to the automatic and electronic control of household features, activity, and appliances. In simple terms, it means you can easily control the utilities and features of your home via the Internet to make life more convenient and secure, and even spend less on household bills.

Home automation can be used for maintaining hassle free living conditions within a home. Because of its ability to ensure security and ease in access, home automation is gaining more popularity day by day. This project proposes IOT based smart home application used to remotely control the home appliances using NODE MCU. In the system Raspberry will be interfaced with relay module and SMART HOME android application installed on the smartphone.

It highlights the availability of a mobile app or web interface for convenient control and monitoring of home devices.

SOFTWARE

1. ARDUINO IDE
2. EMBEDDED C

HARDWARE

1. NODE MCU
2. ARDUINO
3. LCD
4. RELAYS
5. BULB
6. DC FAN
7. Adaptor(12v)
8. AC-CARD

1. INTRODUCTION

1.1. INTRODUCTION TO THE PROJECT

In today's fast changing world, everything is becoming compact, portable and mobile. The mobile handsets for communication are the biggest advancement in the area. These have made our lives much simpler and connected. Today almost everyone is familiar with its usage, and is able to draw advantage from it.

The technologies for mobile communication have been ever evolving. Each had their share of pro's and con's. The Wi-Fi ESP8266 represents the second generation of mobile communications. It is a digital telephony system, used in most parts of the world, starting from Finland in 1991 till now, with more than 690 mobile networks providing Wi-Fi services across 213 countries.

The project aims at designing an advanced home automation system using normal web server and Wi-Fi technology. The devices can be switched ON/OFF and sensors can be read using a Personal computer (PC) through Wi-Fi. Automation is the most frequently spelled term in the field of electronics. The hunger for automation brought many revolutions in the existing technologies. These had greater importance than any other technologies due to its user-friendly nature. These can be used as a replacement of the existing switches in home which produces sparks and also results in fire accidents in few situations. Considering the advantages of Wi-Fi an advanced automation system was developed to control the appliances in the house. Wi-Fi (Short for Wireless Fidelity) is a wireless technology that uses radio frequency to transmit data through the air. Wi-Fi has initial speeds of 1mbps to 2mbps. Wi-Fi transmits data in the frequency band of 2.4 GHz. It implements the concept of frequency division multiplexing technology. Range of Wi-Fi technology is 40-300 feet. The controlling device for the automation in the project is a arduino UNO. The data sent from PC over Wi-Fi will be received by Wi-Fi module connected to arduino UNO. Arduino UNO reads the data and decides the switching action of electrical devices connected to it through relays.

OBJECTIVE OF PROJECT

1. The goal of this project is to develop a home automation system that gives the user complete control over all remotely controllable aspects of his or her home.
2. The automation system will have the ability to be controlled from a central host PC, the internet, and also remotely accessed via a pocket PC with a windows mobile based application.

1.2 MOTIVATION

As an engineering student a project is required as part of the final year work. The project chosen is the activation of Home Automation via mobile technology. This was selected because of incorporating mobile technology with controlling of appliances which we believe is the next important step to realize the Home Automation. The comfort of being able to take control of devices from one particular location has become imperative as it saves a lot of time and effort.

1.3 PROBLEM STATEMENT

Technology has advanced so much in the last decade or two that it has made life more efficient and comfortable. The comfort of being able to take control of devices from one particular location has become imperative as it saves a lot of time and effort. There for there arises a need to do so in a systematic manner which we have tried to implement with our system. The system we have proposed is an extended approach to automating a control system. The application of our system comes in handy when people who forget to do simple things such as turn ON or OFF devices at their home or in their office, they can now do so without their presence by the transmission of a simple text message from their mobile phone.

2. LITERATURE REVIEW

There are many definitions of home automation available in the literature. The Paper [4] considers the problems with the implementation of home automation systems. Furthermore the possible solutions are devised through various ISSN (Print) : 2320 – 3765 ISSN (Online): 2278 – 8875 International Journal of advanced research in Electrical, Electronics and Instrumentation Engineering (An ISO 3297: 2007 Certified Organization) Vol. 3, Issue 9, September 2014 10.15662/ijareeie.2014.0309042 Copyright to IJAREEIE www.ijareeie.com 12122 network technologies. Several issues affecting home automation systems such as lack of robustness, compatibility issue and acceptability among the old and disabled people are discussed. [5] Present a design and implementation of SMS based control for monitoring systems. The paper has three modules involving sensing unit for monitoring the complex applications. A microcontroller works as processing unit and a communication module that uses GPRS modem or cell phone via serial port RS-232. The SMS is used for status reporting such as power failure. The paper [6] explores primary health-care management for the rural population. A solution proposes the use of the mobile web-technologies providing the PHC services to the rural population.

The system involves the use of SMS and cell phone technology for information management, transactional exchange and personal communication.

[7] Propose remote monitoring through mobile phone involving the use of spoken commands. The spoken commands are generated and sent in the form of text SMS to the control system and then the microcontroller on the basis of SMS takes a decision of a particular task. [8] Focuses on the controlling of home appliances remotely and providing security when the user is away from the place. The system is SMS based and uses wireless technology to revolutionize the standards of living. This system provides ideal solution to the problems faced by home owners in daily life. The system is wireless therefore more adaptable and cost-effective. The HACS system provides security against intrusion as well as automates various home appliances using SMS. The system uses Wi-Fi technology thus providing ubiquitous access to the system for security and automated appliance control. [9] Describes how to manage and control home appliances using mobile phone, people can use this system to do things in their home from a far place before they reach home. To control an appliance the user sends a command in form of SMS from his/her mobile phone to a computer which is connected to the appliance, once the message is received the computer will send the command to a microcontroller for controlling the appliance appropriately. [10] Propose the system uses

LPC2148 as a central microcontroller and it allows remote control of different appliances through SMS messages.

As the use of Wi-Fi for telephony becomes more widespread, it is inevitable that costs will be driven lower, and it is also inevitable that this medium for the transfer of telemetry data will become very important to the electricity supply industry [12] in the next few years. One major issue which will require to be addressed as this development takes place is the security protection of data being transferred, particularly in the radio link paths of the network.[7] Li Kaicheng, Liu Jianfeng, Yue Congyuan, Zhang Ming: (Jun 2008) A power load management system[5] based on ARM-7 microcontroller and Wi-Fi is presented in this paper. The proposed system consists of electronic KWH meter, intelligent management terminal (IMT) and management centre. The intelligent terminal is sued to acquire information from KWH meter, control the energy-consuming device and communicate with management centre via Wi-Fi network. How to implement the IMT by using ARM-7 microcontroller and Wi-Fi telecommunication module is discussed in detail. Also the software design of the terminal with high performance embedded real-time operating system muC/OS-II is presented in this paper.[8]

THEORETICAL BACKGROUND Wi-Fi (Global system for mobile communications: originally from GROUPE special mobile) is the most popular standard for mobile phones in the world. Its promoter, the Wi-Fi association, estimates that 80% of the global mobile market uses the standard. Wi-Fi is used by over 3 billion people across more than 212 countries and territories.

Its ubiquity makes international roaming very common between mobile phone operators enabling subscribers to use their phones in many parts of the world. Wi-Fi differs from its predecessors in that both signaling and speech channels are digital, and thus is considered a second generation (2G) mobile phone system . This has also meant that data communication was easy to build into the system.

When people think about home automation, most of them may imagine living in a smart home: One remote controller for every household appliance, cooking the rice automatically, starting air conditioner automatically, heating water for bath automatically and shading the window automatically when night coming. To some extent home automation equals to smart home. They both bring out smart living condition and make our life more convenient and fast. Review of foreign studies : In their paper, Tan, Lee and Soh (2002) proposed the development

of an internet-based system to allow monitoring of important process variables from a distributed control system (DCS). This paper proposes hardware and software design considerations which enable the user to access the process variables on the DCS, remotely and effectively Potamitis, Georgila, Fakotakis, and Kokkinakis, G. (2003) suggested the use of speech to interact remotely with the home appliances to perform a particular action on behalf of the user. The approach is inclined for people with disability to perform real-life operations at home by directing appliances through speech. Voice separation strategy is selected to take appropriate decision by speech recognition In the year 2006, S. M. Anamul Haque,S. M. Kamruzzaman and Md. Ashraful Islam proposed a system entitled "A system for smart- home control of appliances based on time and speech interaction" that controls the home appliances using the personal computer. This system is developed by using the visual basic 6.0 as programming language and Microsoft voice engine tools for speech recognition purpose. Appliances can be either controlled by timer or by voice command. 14 Ciubotaru- Petrescu, Chiciudean, Cioarga, and Stanescu (2006) present a design and implementation of SMS based control for monitoring systems. The paper has three modules involving sensing unit for monitoring the complex applications. A processing unit, that is microcontroller and a communication module that uses GPRS modem or cell phone via serial port RS-232. The SMS is used for status reporting such as power failure. Jawarkar, Ahmed, Ladhake, and Thakare (2008) propose remote monitoring through mobile phone involving the use of spoken commands. The spoken commands are generated and sent in the form of text SMS to the control system and then the microcontroller on the basis of SMS takes a decision of a particular task. Prof. Era Johri Dept. Of Information And Technology K.J.Somaiya College Of Engineering VIDYAVIHAR, MUMBAI "Remote Controlled Home Automation Using Android Application via Wi-Fi Connectivity".

3. INTRODUCTION ABOUT EMBEDDED SYSTEMS

3.1 EMBEDDED SYSTEMS

An embedded system is a combination of software and hardware to perform a dedicated task. Some of the main devices used in embedded products are microprocessors and microcontrollers. Microprocessors are commonly referred to as general purpose processors as they simply accept the inputs, process it and give the output. In contrast, a microcontroller not only accepts the data as inputs but also manipulates it, interfaces the data with various devices, controls the data and thus finally gives the result.

3.1.1. INTRODUCTION OF EMBEDDED SYSTEM

An embedded system is a combination of computer hardware and software, and perhaps additional mechanical or other parts, designed to perform a specific function. A good example is the microwave oven. Almost every household has one, and tens of millions of them are used every day, but very few people realize that a processor and software are involved in the preparation of their lunch or dinner.

This is in direct contrast to the personal computer in the family room. It too is comprised of computer hardware and software and mechanical components (disk drives, for example). However, a personal computer is not designed to perform a specific function rather; it is able to do many different things. Many people use the term general-purpose computer to make this distinction clear. As shipped, a general-purpose computer is a blank slate; the manufacturer does not know what the customer will do wish it. One customer may use it for a network file server another may use it exclusively for playing games, and a third may use it to write the next great american novel.

Frequently, an embedded system is a component within some larger system. For example, modern cars and trucks contain many embedded systems. One embedded system

controls the anti-lock brakes, other monitors and controls the vehicle's emissions, and a third displays information on the dashboard.

In some cases, these embedded systems are connected by some sort of a communication network, but that is certainly not a requirement.

At the possible risk of confusing you, it is important to point out that a general-purpose computer is itself made up of numerous embedded systems. For example, my computer consists of a keyboard, mouse, video card, modem, hard drive, floppy drive, and sound card-each of which is an embedded system. Each of these devices contains a processor and software and is designed to perform a specific function. For example, the modem is designed to send and receive digital data over analog telephone line. That's it and all of the other devices can be summarized in a single sentence as well.

3.1.2. OVERVIEW OF EMBEDDED SYSTEM

Every embedded system consists of custom-built hardware built around a central processing unit (CPU). This hardware also contains memory chips onto which the software is loaded. The software residing on the memory chip is also called the ‘firmware’.

The same architecture is applicable to any computer including a desktop computer. However, there are significant differences. It is not compulsory to have an operating system in every embedded system. For small appliances such as remote control units, air conditioners, toys etc., there is no need foran operating system and you can write only the software specific to that application.

For applications involving complex processing, it is advisable to have an operating system. In such a case, you need to integrate the application software with the operating system and then transfer the entire software on to the memory chip. Once the software is transferred to the memory chip, the software will continue to run for a long time you don’t need to reload new software. Now, let us see the details of the various building blocks of the hardware of an embedded system. As shown in Fig. the building blocks are:

a. Central processing unit (CPU)
b. Memory (Read-only memory and random access memory)
c. Input devices
d. Output devices
e. Communication interfaces

f. Application-specific circuitry

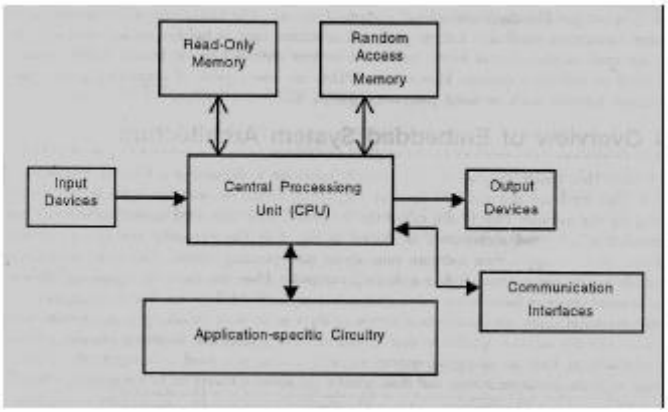


Fig: 3.1 Building blocks of the hardware of an embedded system

- **CENTRAL PROCESSING UNIT (CPU)**

The Central processing unit (processor, in short) can be any of the following: microcontroller, microprocessor or digital signal processor (DSP). A micro-controller is a low-cost processor. Its main attraction is that on the chip itself, there will be many other components such as memory, serial communication interface, analog to digital converter etc.

So, for small applications, a micro-controller is the best choice as the number of external components required will be very less. On the other hand, microprocessors are more powerful, but you need to use many external components with them. DSP is used mainly for applications in which signal processing is involved such as audio and video processing.

- **MEMORY**

The memory is categorized as Random Access Memory (RAM) and Read Only Memory (ROM). The contents of the RAM will be erased if power is switched off to the chip, whereas ROM retains the contents even if the power is switched off. So, the firmware is stored in the ROM. When power is switched on, the processor reads the ROM the program is program is executed.

- **INPUT DEVICES**

Unlike the desktops, the input devices to an embedded system have very limited capability. There will be no keyboard or a mouse, and hence interacting with the embedded system is no easy task. Many embedded systems will have a small keypad you press one key to give a specific command. A keypad may be used to input only the digits.

Many embedded systems used in process control do not have any input device for user interaction; they take inputs from sensors or transducers produce electrical signals that are in turn fed to other systems.

- **OUTPUT DEVICES**

The output devices of the embedded systems also have very limited capability. Some embedded systems will have a few light emitting diodes (LEDs) to indicate the health status of the system modules, or for visual indication of alarms. A small liquid crystal display (LCD) may also be used to display some important parameters.

- **COMMUNICATION INTERFACES**

The embedded systems may need to, interact with other embedded systems at they may have to transmit data to a desktop. To facilitate this, the embedded systems are provided with one or a few communication interfaces such as RS232, RS422, RS485, universal serial bus (USB), IEEE 1394, ethernet etc.

- **APPLICATION-SPECIFIC CIRCUITRY**

Sensors, transducers, special processing and control circuitry may be required fat an embedded system, depending on its application. This circuitry interacts with the processor to carry out the necessary work. The entire hardware has to be given power supply either through the 230 volts main supply or through a battery. The hardware has to design in such a way that the power consumption is minimized.

4. DESIGN OF HARDWARE

This chapter briefly explains about the hardware implementation of controlling and distribution of prepaid electrical services using wsn. It discuss the circuit diagram of each module in detail.

Node MCU

Node MCU is a low-cost open source iot platform. It initially included firmware which runs on the ESP8266 Wi-Fi soc from espress if systems, and hardware which was based on the ESP-12 module. Later, support for the ESP32 32-bit MCU was added.

Overview

Node MCU is an open source firmware for which open source prototyping board designs are available.The name "node MCU" combines "node" and "MCU"(micro- controller unit).Strictly speaking, the term "node MCU" refers to the firmware rather than the associated development kits.Both the firmware and prototyping board designs are open source.

The firmware uses the lua scripting language. The firmware is based on the elua project, and built on the espress if Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson and SPIFFS.Due to resource constraints, users need to select the modules relevant for their project and build a firmware tailored to their needs. Support for the 32-bit ESP32 has also been implemented.

The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on breadboards. The design was initially based on the ESP-12 module of the ESP8266, which is a Wi-Fi soc integrated with a Tensilica Xtensa LX106 core, widely used in iot applications (see related projects).

Types

There are two available versions of node MCU as version 0.9 & 1.0 where the version 0.9 contains **ESP-12** and version 1.0 contains **ESP-12E** where E stands for "Enhanced". History

Node MCU was created shortly after the ESP8266 came out. On December 30, 2013, Espressif systems began production of the ESP8266.[12] node MCU started on 13 Oct 2014, when Hong

committed the first file of node MCU -firmware to git hub.Two months later, the project expanded to include an open-hardware platform when developer Huang R committed the gerber file of an ESP8266 board, named devkit v0.9. Later that month, Tuan PM ported MQTT client library from contiki to the ESP8266 soc platform, and committed to node MCU project, then node MCU was able to support the MQTT iot protocol, using lua to access the MQTT broker. Another important update was made on 30 Jan 2015, when Devsaurus ported the u8glib to the node MCU project enabling node MCU to easily drive LCD, Screen, OLED, even VGA displays.

In the summer of 2015 the original creators abandoned the firmware project and a group of independent contributors took over. By the summer of 2016 the node MCU included more than 40 different modules.

Related projects

ESP8266 Arduino Core

As Arduino.cc began developing new MCU boards based on non-AVR processors like the ARM/SAM MCU used in the arduino IDE, they needed to modify the arduino IDE so it would be relatively easy to change the IDE to support alternate tool chains to allow arduino C/C++ to be compiled for these new processors. They did this with the introduction of the board manager and the SAM Core. A "core" is the collection of software components required by the board manager and the arduino IDE to compile an arduino C/C++ source file for the target MCU's machine language. Some ESP8266 enthusiasts developed an arduino core for the ESP8266 Wi-Fi soc, popularly called the "ESP8266 Core for the arduino IDE".This has become a leading software development platform for the various ESP8266-based modules and development boards, including node mcus.

4.9. POWER SUPPLY

The power supplies are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function. A d.c power supply which maintains the output voltage constant irrespective of a.c mains fluctuations or load variations is known as “Regulated D.C power supply”.

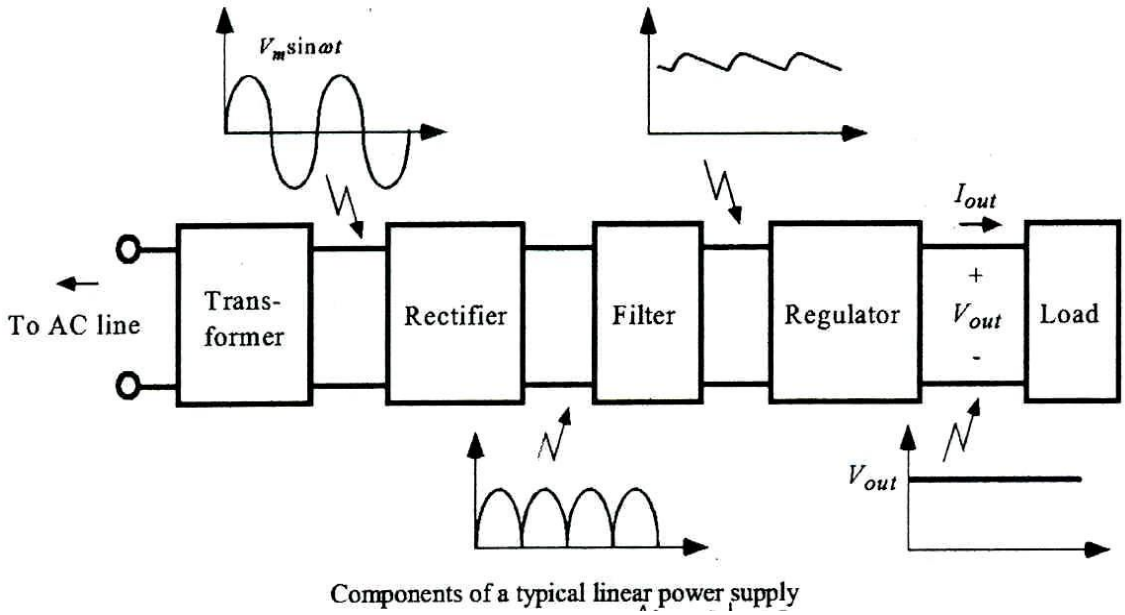


Fig:4.4. Block Diagram of Power Supply

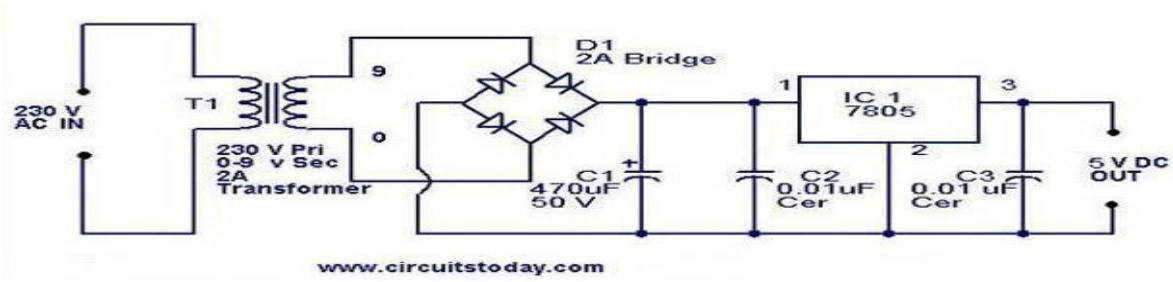


Fig:4.5. Schematic Diagram of Power Supply

4.9.1. TRANSFORMER

A transformer is an electrical device which is used to convert electrical power from one Electrical circuit to another without change in frequency.

When AC is applied to the primary winding of the power transformer it can either be stepped down or up depending on the value of DC needed. In our circuit the transformer of 230v/12-0-12v is used to perform the step down operation where a 230V AC appears as 12V AC across the secondary winding.

4.9.2. RECTIFIER

A circuit which is used to convert AC to D C is known as rectifier. The process of conversion AC to DC is called rectification.

Bridge Rectifier

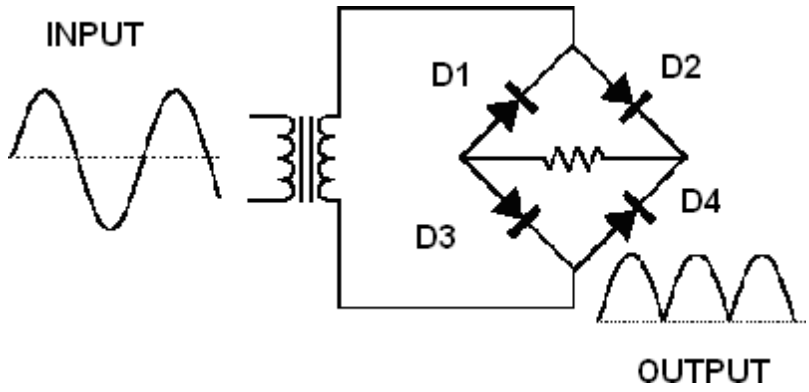


Fig: 4.6 Bridge Rectifier

OPERATION

During positive half cycle of secondary, the diodes D2 and D3 are in forward biased while D1 and D4 are in reverse biased. During negative half cycle of secondary voltage, the diodes D1 and D4 are in forward biased while D2 and D3 are in reverse biased.

4.9.3. FILTER

A Filter is a device which removes the ac component of rectifier output but allows the d.c component to reach the load. We have seen that the ripple content in the rectified output of half wave rectifier is **121%** or that of full-wave or bridge rectifier or bridge rectifier is **48%** such high percentages of ripples is not acceptable for most of the applications. Ripples can be removed by one of the following methods of filtering. A capacitor, in parallel to the load, provides an easier by –pass for the ripples voltage though it due to low impedance. At ripple frequency and leave the d.c.to appears the load.

4.9.4. VOLTAGE REGULATOR

As the name itself implies, it regulates the input applied to it. A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. In this project, power supply of 5V and 12V are required. In order to obtain these voltage levels,7805 and 7812 voltage regulators are to be used. The first number 78 represents positive supply and the numbers 05,12 represent the required output voltage.

4.10. Wi-Fi

4.10.1. INTRODUCTION

Wi-Fi (Global system for mobile communications) is an open, digital cellular technology used for transmitting mobile voice and data services.The idea of Wi-Fi was developed at Bell Laboratories in 1970. It is widely used mobile communication system in the world. Wi-Fi operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands.

Wi-Fi system was developed as a digital system using time division multiple access (TDMA) technique for communication purpose. The digital system has an ability to carry 64 kbps to 120 Mbps of data rates.

A Wi-Fi modem is a device which can be either a mobile phone or a modem device which can be used to make a computer or any other processor communicate over a network. It can be connected to a computer through serial, USB or Bluetooth connection.A Wi-Fi modem can also be a standard Wi-Fi mobile phone with the appropriate cable and software driver to connect to a serial port or USB port on your computer.

Wi-Fi module is used to establish communication between a computer and a Wi-Fi system. Global packet radio service (GPRS) is an extension of Wi-Fi that enables higher data transmission rate.

4.10.2. INTERFACE Wi-Fi WITH PC

Wi-Fi module consists of a Wi-Fi modem assembled together with power supply circuit and communication interfaces (like RS-232, USB, etc) for computer. The MODEM is the soul of such modules.

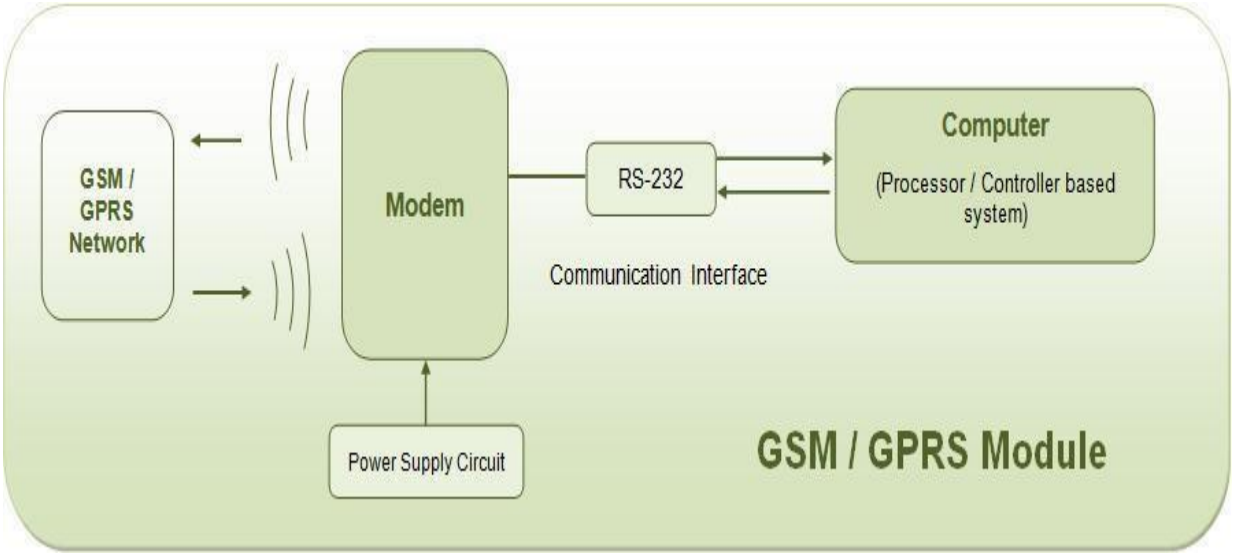


Fig: 4.7. Interface Wi-Fi with PC

4.10.3. MOBILE TELEPHONY STANDARDS

❖ **First Generation of Mobile Networks (1G)**

The first generation of mobile telephony (written **1G**) operated using analog communications and portable devices that were relatively large. It used primarily the following standards:

- **AMPS** (Advanced mobile phone system), which appeared in 1976 in the United States, was the first cellular network standard. It was used primarily in the Americas, Russia and Asia. This first-generation analogue network had weak security mechanisms which allowed hacking of telephones lines.
- **TACS** (Total Access Communication System) is the european version of the AMPS model. Using the 900 MHz frequency band, this system was largely used in england and then in Asia (Hong-Kong and Japan).

- **ETACS** (Extended total access communication system) is an improved version of the TACS standard developed in the United Kingdom that uses a larger number of communication channels.

The first-generation cellular networks were made obsolete by the appearance of an entirely digital second generation.

❖ **Second Generation of Mobile Networks (2G)**

The second generation of mobile networks marked a break with the first generation of cellular telephones by switching from analogue to digital. The main 2G mobile telephony standards are:

- Wi-Fi (Global System for Mobile communications) is the most commonly used standard in europe at the end of the 20th century and supported in the united states. This standard uses the 900 MHz and 1800 MHz frequency bands in europe. In the united states, however, the frequency band used is the 1900 MHz band. Portable telephones that are able to operate in europe and the united states are therefore called **tri-band**.
- **CDMA** (Code Division Multiple Access) uses a spread spectrum technique that allows a radio signal to be broadcast over a large frequency range.
- T**DMA** (Time division multiple access) technique relies on assigning different time slots to each user on the same frequency. It can easily adapt to data transmission and voice communication and can carry 64kbps to 120Mbps of data rate.

❖ **Third Generation of Mobile Networks (3G)**

The IMT-2000 (International Mobile Telecommunications for the year 2000) specifications from the International telecommunications union (ITU) defined the characteristics of **3G** (third generation of mobile telephony). The most important of these characteristics are:

1. High transmission data rate.
2. 144 Kbps with total coverage for mobile use.
3. 384 Kbps with medium coverage for pedestrian use.
4. 2 Mbps with reduced coverage area for stationary use.
5. World compatibility.
6. Compatibility of 3rd generation mobile services with second generation networks.

3G offers data rates of more than 144 Kbit/s, thereby allowing the access to multimedia uses such as video transmission, video-conferencing or high-speed internet access.

3G networks use different frequency bands than the previous networks: 1885-2025 MHz and 2110-2200 MHz.

The main 3G standard used in Europe is called **UMTS** (Universal Mobile Telecommunications System) and uses **WCDMA** (Wideband Code Division Multiple Access) encoding. UMTS technology uses 5 MHz bands for transferring voice and data, with data rates that can range from 384 Kbps to 2 Mbps. **HSDPA** (High Speed Downlink Packet Access) is a third generation mobile telephony protocol, (considered as "3.5G"), which is able to reach data rates on the order of 8 to 10 Mbps.

4.10.4. Wi-Fi STANDARDS

Wi-Fi uses narrowband TDMA, which allows eight simultaneous calls on the same radio frequency. There are three basic principles in multiple access, FDMA (Frequency Division Multiple Access), TDMA (Time Division Multiple Access), and CDMA (Code Division Multiple Access). All three principles allow multiple users to share the same physical channel. But the two competing technologies differ in the way user sharing the common resource.

TDMA allows the users to share the same frequency channel by dividing the signal into different time slots. Each user takes turn in a round robin fashion for transmitting and receiving over the channel. Here, users can only transmit in their respective time slot

CDMA uses a spread spectrum technology that is it spreads the information contained in a particular signal of interest over a much greater bandwidth than the original signal. Unlike TDMA, in CDMA several users can transmit over the channel at the same time.

4.10.5. ARCHITECTURE OF Wi-Fi NETWORK

In a Wi-Fi network, the user terminal is called a **mobile station**. A mobile station is madeup of a **SIM** (Subscriber Identity Module) card allowing the user to be uniquely identified and a mobile terminal. The terminals (devices) are identified by a unique 15-digit identification number called **IMEI** (International Mobile Equipment Identity). Each SIM card also has a unique (and secret) identification number called **IMSI** (International Mobile Subscriber Identity). This code can be protected using a 4-digit key called a PIN code.

Communications occur through a radio link (air interface) between a mobile station and a base station.

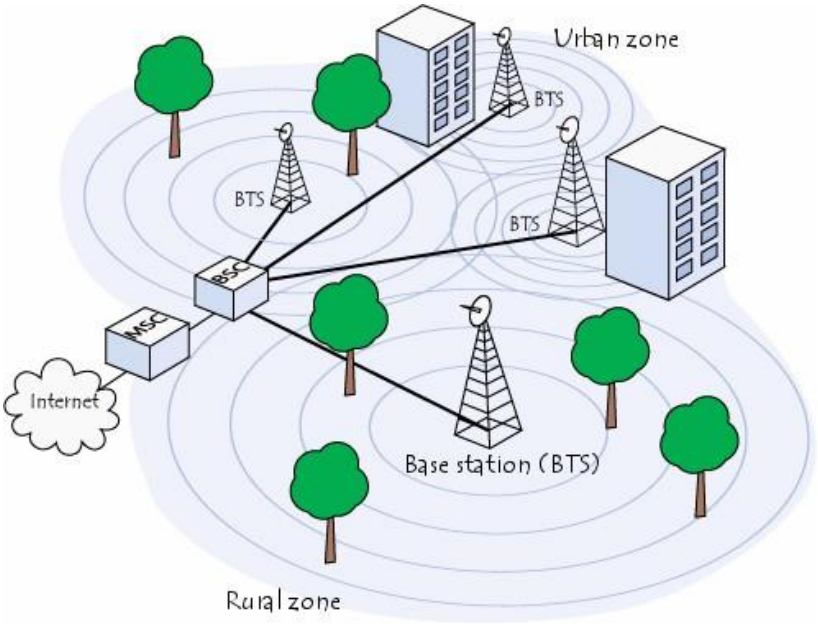


Fig:4.8. Architecture of the Wi-Fi network

- **A Mobile Station:** It is the mobile phone which consists of the transceiver, the display and the processor and is controlled by a SIM card operating over the network.
- **Base Station Subsystem:** It acts as an interface between the mobile station and the network subsystem. It consists of the base transceiver station which contains the radio transceivers and handles the protocols for communication with mobiles. It also consists of the base station controller which controls the base transceiver station and acts as a interface between the mobile station and mobile switching centre.
- **Network Subsystem:** It provides the basic network connection to the mobile stations. The basic part of the network subsystem is the mobile service switching centre which provides access to different networks like ISDN, PSTN etc. It also consists of the home location register and the visitor location register which provides the call routing and roaming capabilities of WI-FI. It also contains the equipment identity register which maintains an account of all the mobile equipments wherein each mobile is identified by its own IMEI number. IMEI stands for international mobile equipment identity.

4.10.6. Features of Wi-Fi Module

A WI-FI/GPRS MODEM can perform the following operations:

1. Receive, send or delete SMS messages in a SIM.
2. Read, add, search phonebook entries of the SIM.
3. Make, receive or reject a voice call.

The MODEM needs AT commands, for interacting with processor or controller, which are communicated through serial communication. These commands are sent by the controller/processor. The MODEM sends back a result after it receives a command. Different AT commands supported by the MODEM can be sent by the processor/controller/computer to interact with the Wi-Fi.

A Wi-Fi modem is one of the wireless modem that is devised to work with a Wi-Fi wireless network. It works with the same frequency of Wi-Fi wireless network.

4.10.7. AT COMMANDS

The Wi-Fi modem requires a SIM card from a wireless carrier in order to operate. As mentioned in earlier sections of this SMS tutorial, computers use AT commands to control modems. Some AT commands are list below.

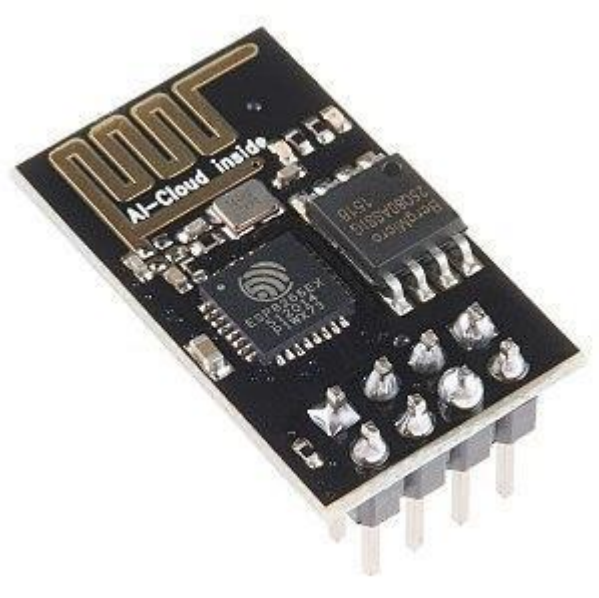
- ATD (Dial)
- ATA (Answer)
- ATH (Hook control)
- ATO (Return to online data state)
- AT+CMGS (Send SMS message)
- AT+CMSS (Send SMS message from storage)
- AT+CMGL (List SMS messages)
- AT+CMGR (Read SMS messages).

In addition to the standard AT commands, Wi-Fi modems support an extended set of AT commands. These extended AT commands are defined in the Wi-Fi standards. With the extended AT commands, you can do things like:

- Reading, writing and deleting SMS messages.
- Sending SMS messages.

- Monitoring the signal strength.
- Monitoring the charging status and charge level of the battery.
- Reading, writing and searching phone book entries.

ESP8266



ESP-01 module by Ai-Thinker

Manufacturer	Espressif Systems
Type	32-bit microcontroller
CPU	@ 80 MHz (default) or 160 MHz
Memory	32 KiB instruction, 80 KiB user data
Input	16 GPIO pins
Power	3.3 V DC

ESP8266 WI-FI

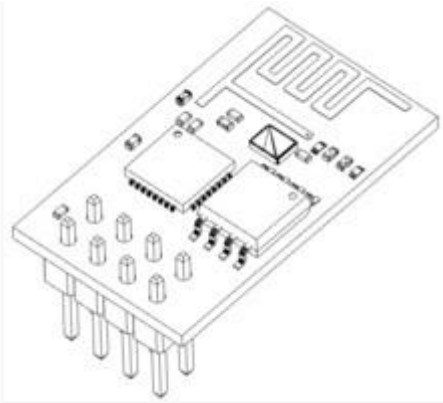
The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability produced by Shanghai-based chinese manufacturer espress if systems.[1]

The chip first came to the attention of western makers in August 2014 with the ESP-01 module, made by a third-party manufacturer, Ai-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. However, at the time there was almost no English-language documentation on the chip and the commands it accepted.[2] The very low price and the fact that there were very few external components on the module which suggested that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, chip, and the software on it, as well as to translate the chinese documentation.[3]

The ESP8285 is an ESP8266 with 1 MiB of built-in flash, allowing for single-chip devices capable of connecting to Wi-Fi.[4]

The successor to these microcontroller chips is the ESP32.

Features



ESP-01 wireframe.

- Processor: L106 32-bit RISC microprocessor core based on the Tensilica Xtensa Diamond Standard 106Micro running at 80 MHz†
- Memory:
  - 32 KiB instruction RAM
  - 32 KiB instruction cache RAM
  - 80 KiB user data RAM

- 16 KiB ETS system data RAM
- External QSPI flash: up to 16 MiB is supported (512 KiB to 4 MiB typically included)
- IEEE 802.11 b/g/n Wi-Fi
  - Integrated TR switch, balun, LNA, power amplifier and matching network
  - WEP or WPA/WPA2 authentication, or open networks
- 16 GPIO pins
- SPI
- I²C (software implementation)[5]
- I²S interfaces with DMA (sharing pins with GPIO)
- UART on dedicated pins, plus a transmit-only UART can be enabled on GPIO2
- 10-bit ADC (successive approximation ADC)

Both the CPU and flash clock speeds can be doubled by overclocking on some devices. CPU can be run at 160 MHz and flash can be sped up from 40 MHz to 80 MHz. Success varies chip to chip.

SDKs

In late October 2014, espress if systems released a software development kit (SDK) that allowed the chip to be programmed, removing the need for a separate microcontroller. Since then, there have been many official SDK releases from Espress if maintains two versions of the SDK – one that is based on FreeRTOS and the other based on callbacks.

An alternative to espress if's official SDK is the open source ESP-Open-SDK that is based on the GCC toolchain. ESP8266 uses the Cadence Tensilica L106 microcontroller and the GCC toolchain is open-sourced and maintained by Max Filippov.Another alternative is the "Unofficial Development Kit" by Mikhail Grigorev.

Other SDKs (mostly open source) include:

- NodeMCU – A lua-based firmware.
- Arduino – A C++ based firmware. This core enables the ESP8266 CPU and its Wi-Fi components to be programmed like any other arduino device. The ESP8266 arduino core is available through github.
- PlatformIO (https://platformio.org/platforms/espressif8266) – A cross-platform IDE and unified debugger which sits on top of arduino code and libraries.

- MicroPython – A port of MicroPython (an implementation of python for embedded devices)to the ESP8266 platform.
- ESP8266 BASIC – An open source basic interpreter specifically tailored for the internet of things. Self hosting browser based development environment.
- Zbasic for ESP8266 – A subset of microsoft's widely used visual basic 6 which has been adapted as a control language for the ZX microcontroller family and the ESP8266.
- Espruino – An actively maintained JavaScript SDK and firmware, closely emulating Node.js. Supports a few MCUs, including the ESP8266.
- Mongoose OS – An open source operating system for connected products. Supports ESP82666 and ESP32. Develop in C or JavaScript.
- ESP-Open-SDK – Free and open (as much aspossible) integrated SDK for ESP8266/ESP8285 chips.
- ESP-Open-RTOS – Open source free RTOS-based ESP8266 software framework.
- Zerynth – IoT framework that allows programming ESP8266 and other microcontrollers using Python.

Espressif modules

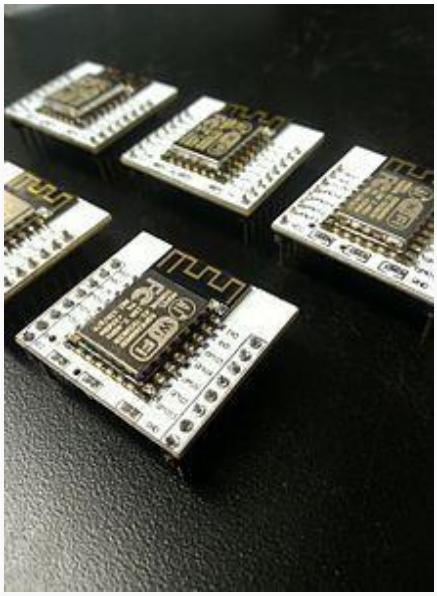
This is the series of ESP8266-based modules made by Espressif:

Name	Active pins	Pitch	Form factor	LEDs	Antenna	Shielded	Dimensions (mm)	Notes
ESP-WROOM-02	18	1.5 mm	2×9 castellated	No	PCB trace	Yes	18 × 20	FCC ID 2AC7Z-ESPWROOM02.
ESP-WROOM-	18	1.5 M	2×9 castell	No	PCB trace	Yes	18 × 20	FCC ID 2AC7Z-ESPWROO

02D[15]		M	ated					M02D. Revision of ESP-WROOM-02 compatible with both 150-mil and 208-mil flash memory chips.
ESP-WROOM-02U[15]	18	1.5 mm	2×9 castellated	No	U.FL socket	Yes	18 × 20	Differs from ESP-WROOM-02D in that includes an U.FL compatible antenna socket connector.
ESP-WROOM-S2[16]	20	1.5 mm	2×10 castellated	No	PCB trace	Yes	16 × 23	FCC ID 2AC7Z-ESPWROOMS2.

In the table above (and the two tables which follow), "active pins" include the GPIO and ADC pins with which you can attach external devices to the ESP8266 MCU. The "Pitch" is the space between pins on the ESP8266 module, which is important to know if you are going to breadboard the device. The "Form factor" also describes the module packaging as "2 × 9 DIL", meaning two rows of 9 pins arranged "Dual In Line", like the pins of DIP ICs. Many ESP-xx modules include a small on-board LED which can be programmed to blink and thereby indicate activity. There are several antenna options for ESP-xx boards including a trace antenna, an on-board ceramic antenna, and an external connector which allows you to attach an external Wi-Fi antenna. Since Wi-Fi communications generates a lot of RFI (Radio Frequency Interference), governmental bodies like the FCC like shielded electronics to minimize interference with other devices. Some of the ESP-xx modules come housed within a metal box with an FCC seal of approval stamped on it. First and second world markets will likely demand FCC approval and shielded Wi-Fi devices.

Ai-Thinker modules



Ai-Thinker ESP8266 modules (ESP-12F, black color) soldered to breakout boards (whitecolor)

These are the first series of modules made with the ESP8266 by the third-party manufacturer Ai-Thinker and remain the most widely available. They are collectively referred to as "ESP-xx modules". To form a workable development system they require additional components, especially a serial TTL-to-USB adapter (sometimes called a USB-to-UART bridge) and an external 3.3 volt power supply. Novice ESP8266 developers are encouraged to consider larger

ESP8266 Wi-Fi development boards like the NodeMCU which includes the USB-to-UART bridge and a Micro-USB connector coupled with a 3.3 volt power regulator already built into the board. When project development is complete, these components are not needed anymore and it can be considered using these cheaper ESP-xx modules as a lower power, smaller footprint option for production runs.

Flash in notes; "512 KiB Flash" indicates for that & the ones after unless mentioned ie "(1 MiB)" in () means just this one)

Name	Active pins	Pitch	Form factor	LEDs	Antenna	Shielded	Dimensions (mm)	Notes
ESP-01	6	0.1 in	2×4 DIL	Yes	PCB trace	No	14.3 × 24.8	512 KiB Flash
ESP-01S	6	0.1 in	2×4 DIL	Yes	PCB trace	No	14.4 × 24.7	(1 MiB Flash)
ESP-01M	16	1.6 mM	2×9 edge connector	No	PCB trace	Yes	18.0 × 18.0	Uses ESP8285 (1 MiB built-in flash)
ESP-02	6	0.1 in	2×4 castell	No	U.FL socket	No	14.2 × 14.2	

Name	Active pins	Pitch	Form factor	LEDs	Antenna	Shielded	Dimensions (mm)	Notes
			ated					
ESP-03	10	2 mm	2×7 castellated	No	Ceramic	No	17.3 × 12.1	
ESP-04	10	2 mm	2×4 castellated	No	None	No	14.7 × 12.1	
ESP-05	3	0.1 in	1×5 SIL	No	U.FL socket	No	14.2 × 14.2	
ESP-06	11	various	4×3 dice	No	None	Yes	14.2 × 14.7	Not FCC approved.
ESP-07	14	2 mm	2×8 pinhole	Yes	Ceramic + U.FL socket	Yes	20.0 × 16.0	Not FCC approved.

Name	Active pins	Pitch	Form factor	LEDs	Antenna	Shielded	Dimensions (mm)	Notes
ESP-07S	14	2 mm	2×8 pinhole	No	U.FL socket	Yes	17.0 × 16.0	FCC and CE approved.
ESP-08	10	2 mm	2×7 castellated	No	None	Yes	17.0 × 16.0	Not FCC approved.
ESP-09	10	various	4×3 dice	No	None	No	10.0 × 10.0	
ESP-10	3	2 mm	1×5 castellated	No	None	No	14.2 × 10.0	
ESP-11	6	1.27 Mm	1×8 pinhole	No	Ceramic	No	17.3 × 12.1	
ESP-12	14	2 mm	2×8 castell	Yes	PCB trace	Yes	24.0 × 16.0	FCC and CE approve

Name	Active pins	Pitch	Form factor	LEDs	Antenna	Shielded	Dimensions (mm)	Notes
			ated					d.[18]
ESP-12E	20	2 mm	2×8 castellated	Yes	PCB trace	Yes	24.0 × 16.0	4 MiB flash.
ESP-12F	20	2 mm	2×8 castellated	Yes	PCB trace	Yes	24.0 × 16.0	FCC and CE approved. Improved antenna performance. 4 MiB flash.
ESP-12S	14	2 mm	2×8 castellated	Yes	PCB trace	Yes	24.0 × 16.0	4 MiB flash. FCC approved.[19]

Name	Active pins	Pitch	Form factor	LEDs	Antenna	Shielded	Dimensions (mm)	Notes
ESP-13	16	1.5 mm	2×9 castellated	No	PCB trace	Yes	W18.0 × L20.0	Marked as ″FCC″. Shielded module is placed sideways, as compared to the ESP-12 modules.
ESP-14	22	2 mm	2×8 castellated +6	No	PCB trace	Yes	24.3 × 16.2	

4.11. RELAYS

Relays are simple switches which are operated both electrically and mechanically. Relays consist of a n electromagnet and also a set of contacts. The switching mechanism is carried out with the help of the electromagnet. The main operation of a relay comes in places where only a low-power signal can be used to control a circuit. It is also used in places where only one signal can be used to control a lot of circuits.

4.11.1. Relay Design

There are only four main parts in a relay. They are

- Electromagnet
- Movable armature
- Switch point contacts
- Spring

4.11.2. Pole and Throw

Relays have the exact working of a switch. So, A relay is said to switch one or more poles. Each pole has contacts that can be thrown in mainly three ways. They are

- **Normally Open Contact (NO)** – NO contact is also called a make contact. It closes the circuit when the relay is activated. It disconnects the circuit when the relay is inactive.
- **Normally Closed Contact (NC)** – NC contact is also known as break contact. This is opposite to the NO contact. When the relay is activated, the circuit disconnects. When the relay is deactivated, the circuit connects.
- **Change-over (CO)** – This type of contacts are used to control two types of circuits. They are used to control a NO contact and also a NC contact with a common terminal.

4.11.3. Relay Basics

The basics for all the relays are the same. Take a look at a 4 – pin relay shown below. The pins 1, 3 represents the control circuit and 2, 4 represents the load circuit.

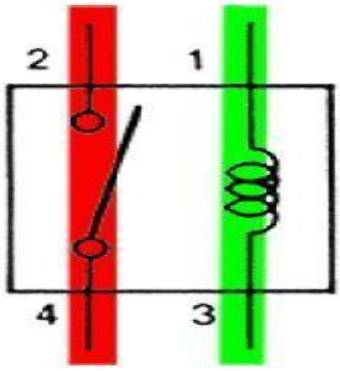


Fig: 4.11. Relay circuit

- **Energized Relay (ON)**

As shown in the circuit, the current flowing through the coils represented by pins 1 and 3 causes a magnetic field to be aroused. This magnetic field causes the closing of the pins 2 and 4. Thus, when the relay in energized the current flow will be through the pins 2 and 4.

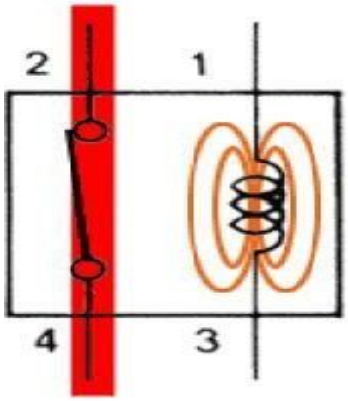
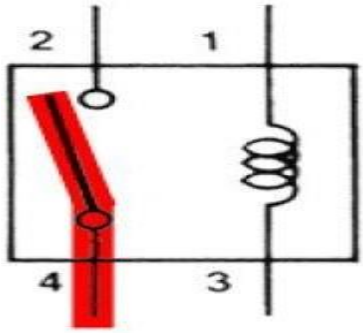


Fig: 4.12. Energized Relay (ON)

- **De – Energized Relay (OFF)**

As soon as the current flow stops through pins 1 and 3, the switch opens and thus the open circuit prevents the current flow through pins 2 and 4. Thus the relay becomes de-energized and thus in off position.

Fig: 4.13. De-Energized Relay (OFF)



In simple, when a voltage is applied to pin 1, the electromagnet activates, causing a magnetic field to be developed, which goes on to close the pins 2 and 4 causing a closed circuit. When there is no voltage on pin 1, there will be no electromagnetic force and thus no magnetic field. Thus the switches remain open.

4.11.4. RELAY TYPES:

- **Single Pole Single Throw (SPST)** – This type of relay has a total of four terminals. Out of these two terminals can be connected or disconnected. The other two terminals are needed for the coil.
- **Single Pole Double Throw (SPDT)** – This type of a relay has a total of five terminals. Out f these two are the coil terminals. A common terminal is also included which connects to either of two others.
- **Double Pole Single Throw (DPST)** – This relay has a total of six terminals. These terminals are further divided into two pairs. Thus they can act as two SPST's which are actuated by a single coil. Out of the six terminals two of them are coil terminals.

- **Double Pole Double Throw (DPDT)** – This is the biggest of all. It has mainly eight relay terminals. Out of these two rows are designed to be change over terminals. They are designed to act as two SPDT relays which are actuated by a single coil.

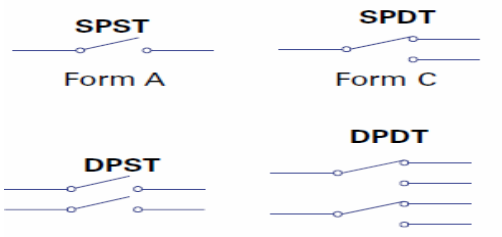


Fig: 4.14. Relay types

4.15. LCD:

A model described here is for its low price and great possibilities most frequently used in practice. It is based on the HD44780 microcontroller (Hitachi) and can display messages in two lines with 16 characters each. It displays all the alphabets, Greek letters, punctuation marks, mathematical symbols etc. In addition, it is possible to display symbols that user makes up on its own. Automatic shifting message on display (shift left and right), appearance of the pointer, backlight etc. are considered as useful characteristics.

Fig: 4.17. LCD

4.15.1. PINS FUNCTIONS:

There are pins along one side of the small printed board used for connection to the microcontroller. There are total of 14 pins marked with numbers (16 in case the background light is built in). Their function is described in the table below:

Function	Pin Number	Name	LogicState	Description
Ground	1	Vss	-	0V
Power supply	2	Vdd	-	+5V
Contrast	3	Vee	-	0 –Vdd
Control of operating	4	RS	0 1	D0 – D7 are interpreted as commands D0 – D7 are interpreted as data
	5	R/W	0 1	Write data (from controller to LCD) Read data (from LCD To controller)
	6	E	0 1 From 1 to 0	Access to LCD Disabled Normal operating Data/commands are transferred to LCD
Data / commands	7	D0	0/1	Bit 0 LSB
	8	D1	0/1	Bit 1
	9	D2	0/1	Bit 2
	10	D3	0/1	Bit 3
	11	D4	0/1	Bit 4
	12	D5	0/1	Bit 5
	13	D6	0/1	Bit 6
	14	D7	0/1	Bit 7 MSB

LCD SCREEN

LCD screen consists of two lines with 16 characters each. Each character consists of 5x7 dot matrix. Contrast on display depends on the power supply voltage and whether messages are displayed in one or two lines. For that reason, variable voltage 0-Vdd is applied on pin marked as Vee. Trimmer potentiometer is usually used for that purpose. Some versions of displays have built in backlight (blue or green diodes). When used during operating, a resistor for current limitation should be used (like with any LE diode).

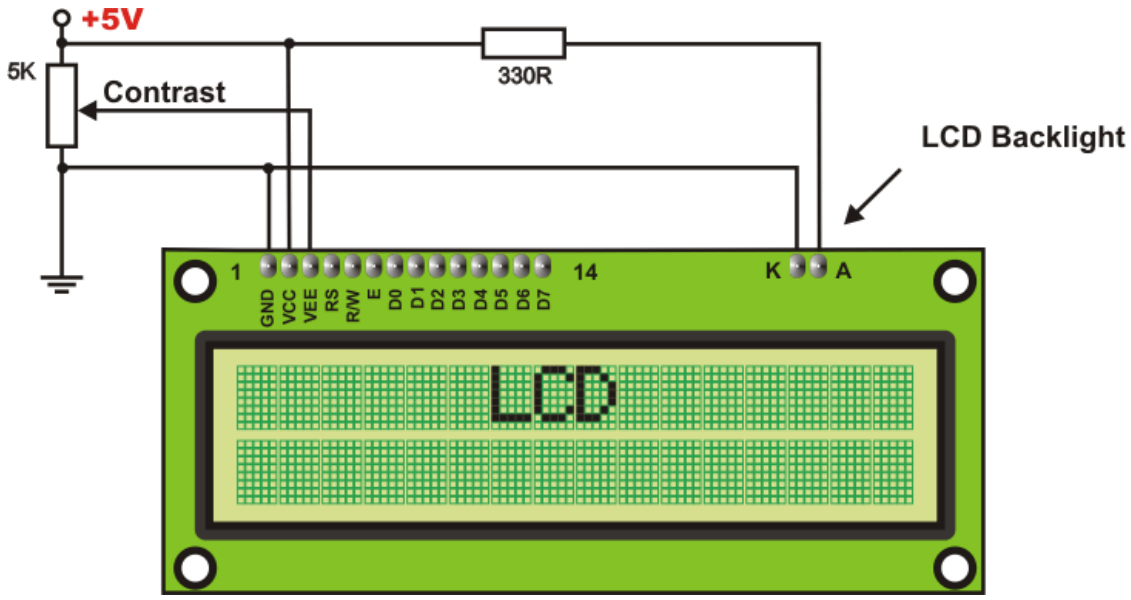


Fig: 4.18.LCD Screen Circuit Diagram

LCD Basic Commands

All data transferred to LCD through outputs D0-D7 will be interpreted as commands or as data, which depends on logic state on pin RS: RS = 1 - Bits D0 - D7 are addresses of characters that should be displayed. Built in processor addresses built in “map of characters” and displays corresponding symbols. Displaying position is determined by DDRAM address. This address is either previously defined or the address of previously transferred character is automatically incremented. RS = 0 - Bits D0 - D7 are commands which determine display mode. List of commands which LCD recognizes are given in the table below

Command	RS	RW	D7	D6	D5	D4	D3	D2	D1	D0	Execution Time
Clear display	0	0	0	0	0	0	0	0	0	1	1.64mS
Cursor home	0	0	0	0	0	0	0	0	1	x	1.64mS
Entry mode set	0	0	0	0	0	0	0	1	I/D	S	40uS
Display on/off control	0	0	0	0	0	0	1	D	U	B	40uS
Cursor/Display Shift	0	0	0	0	0	1	D/C	R/L	x	x	40uS
Function set	0	0	0	0	1	DL	N	F	x	x	40uS
Set CGRAM address	0	0	0	1	CGRAM address						40uS
Set DDRAM address	0	0	1	DDRAM address							40uS
Read “BUSY” flag (BF)	0	1	BF	DDRAM address							-

Table 4.3:Basic Commands Of LCD

5. DESIGN OF SOFTWARE

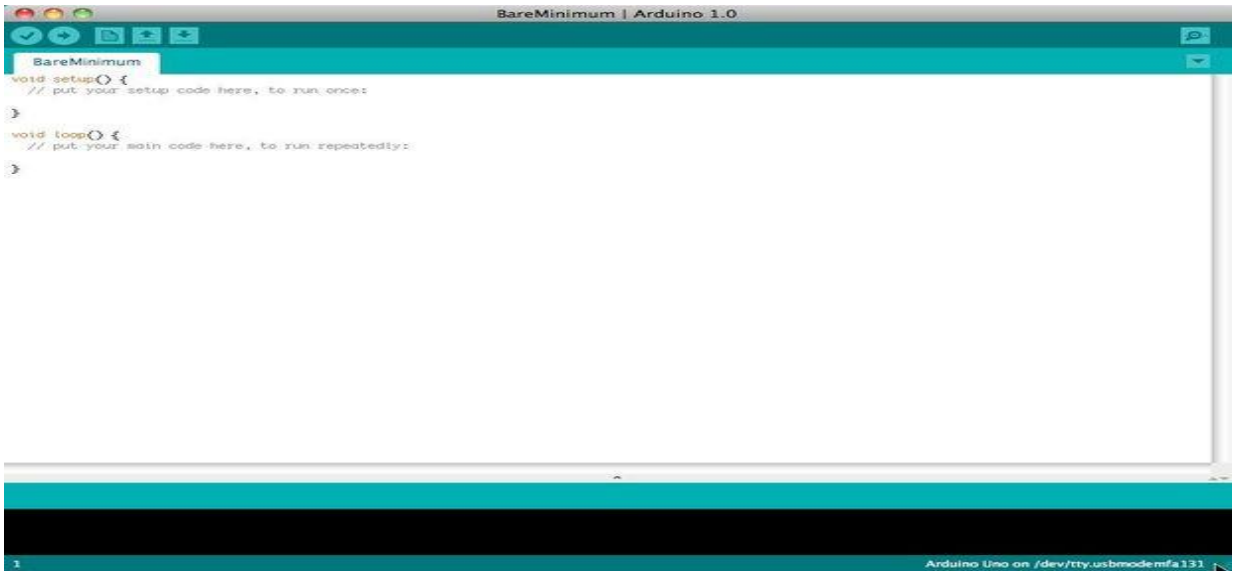
5.1. INTRODUCTION TO ARDUINO IDE SOFTWARE:

This is free software (evaluation version) which solves many of the pain points for an embedded system developer. This software is an integrated development environment (IDE), which integrated text editor to write program, a compiler and it will convert your source code into HEX file. Here is simple guide to start working with arduino IDE Vision which can be used for:

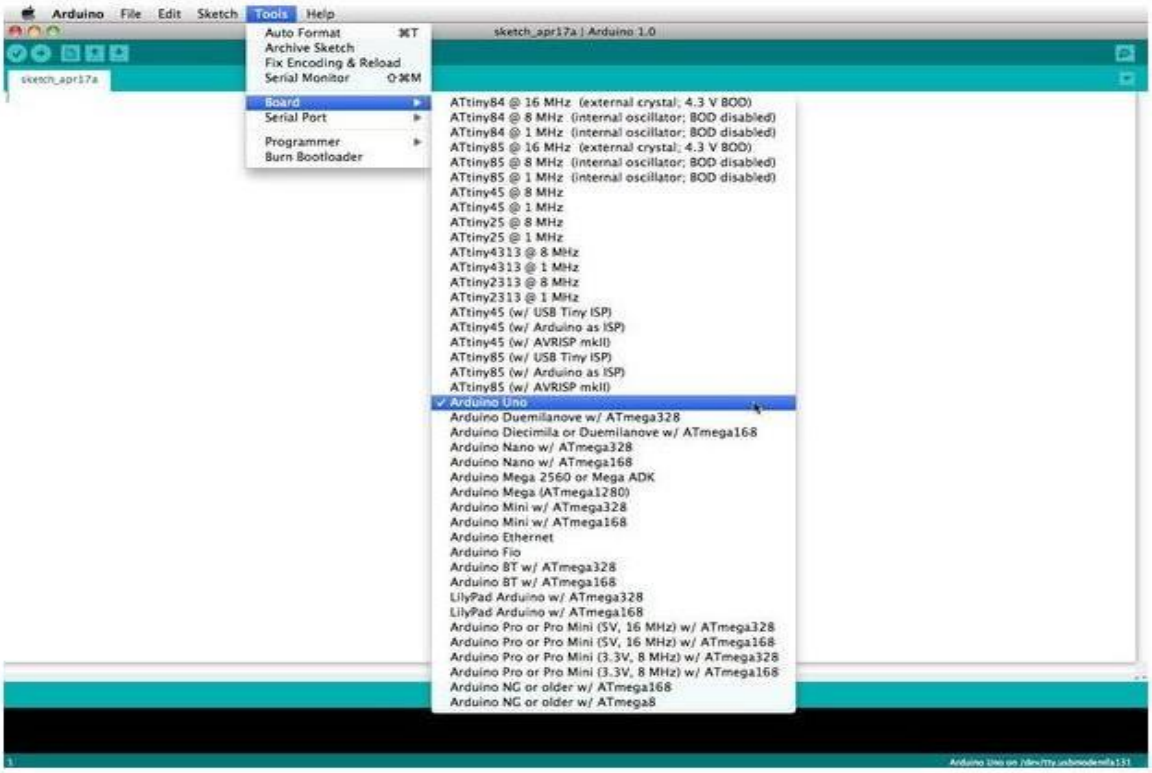
- Writing programs in arduino IDE
- Compiling and assembling programs
- Debugging programs

5.2. SOFTWARE STEPS:

Before you can start doing anything with the arduino, you need to download and install the arduino IDE (integrated development environment).



After the opening IDE the settings are changed in order to connect to the Arduino.



Before you can start doing anything in the arduino programmer, you must set the board-type and serialport.

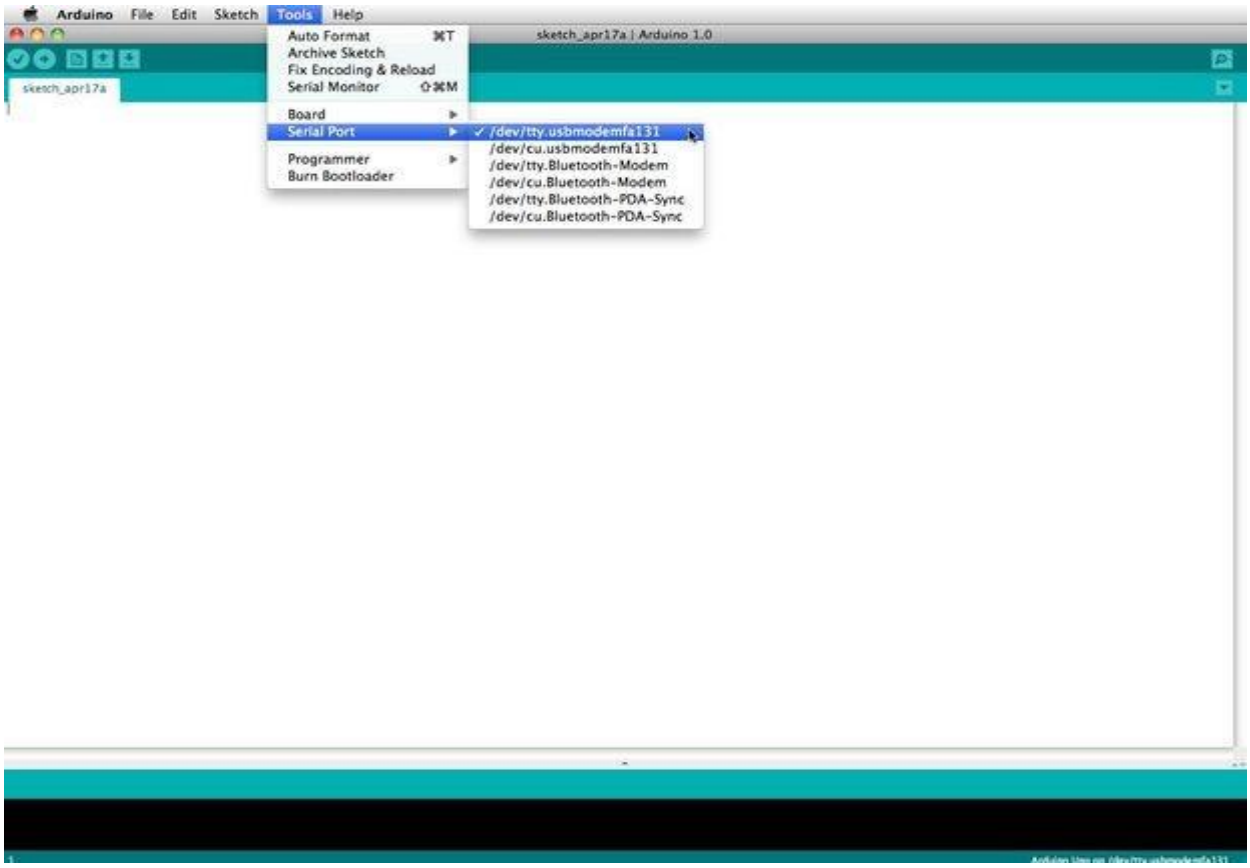
To set the board, go to the following:

Tools --> Boards

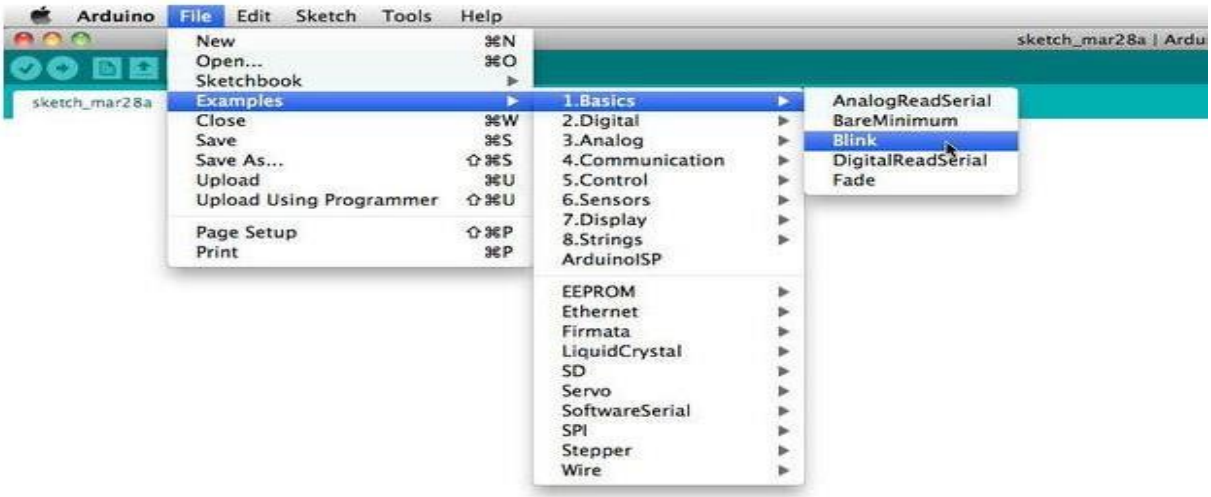
Select the version of board that you are using. Since I have an arduino Uno plugged in, I obviously selected "Arduino Uno."

To set the serial port, go to the following:

Tools --> Serial Port



Arduino programs are called sketches. The Arduino programmer comes with a ton of example sketches preloaded. This is great because even if you have never programmed anything in your life, you can load one of these sketches and get the Arduino to do something.

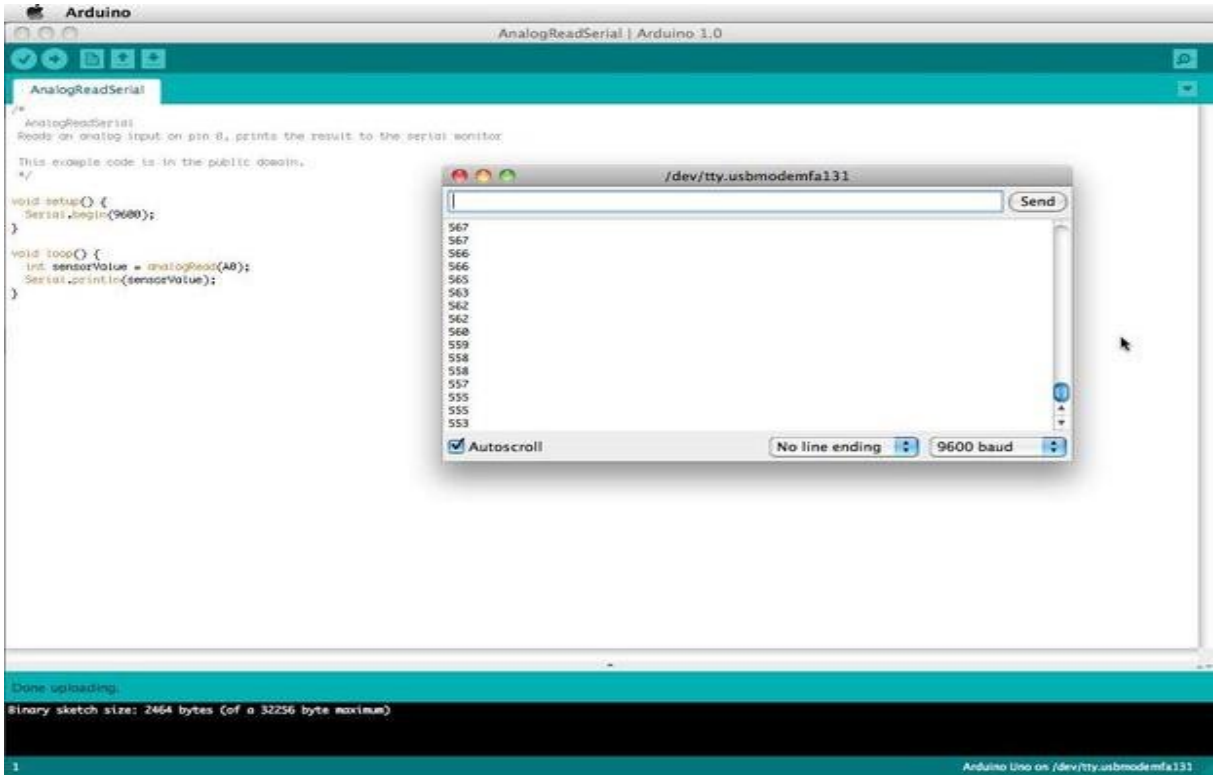


The serial monitor allows your computer to connect serially with the Arduino. This is important because it takes data that your Arduino is receiving from sensors and other devices and displays it in real-time on your computer. Having this ability is invaluable to debug your code and understand what number values the chip is actually receiving. For instance, connect center sweep (middle pin) of a potentiometer to A0, and the outer pins, respectively, to 5v and ground. Next upload the sketch shown below:

File --> Examples --> 1.Basics --> Analog Read Serial

Click the button to engage the serial monitor which looks like a magnifying glass. You can now see the numbers being read by the analog pin in the serial monitor. When you turn the knob the numbers will increase and decrease.

The numbers will be between the range of 0 and 1023. The reason for this is that the analog pin is converting a voltage between 0 and 5V to a discreet number.

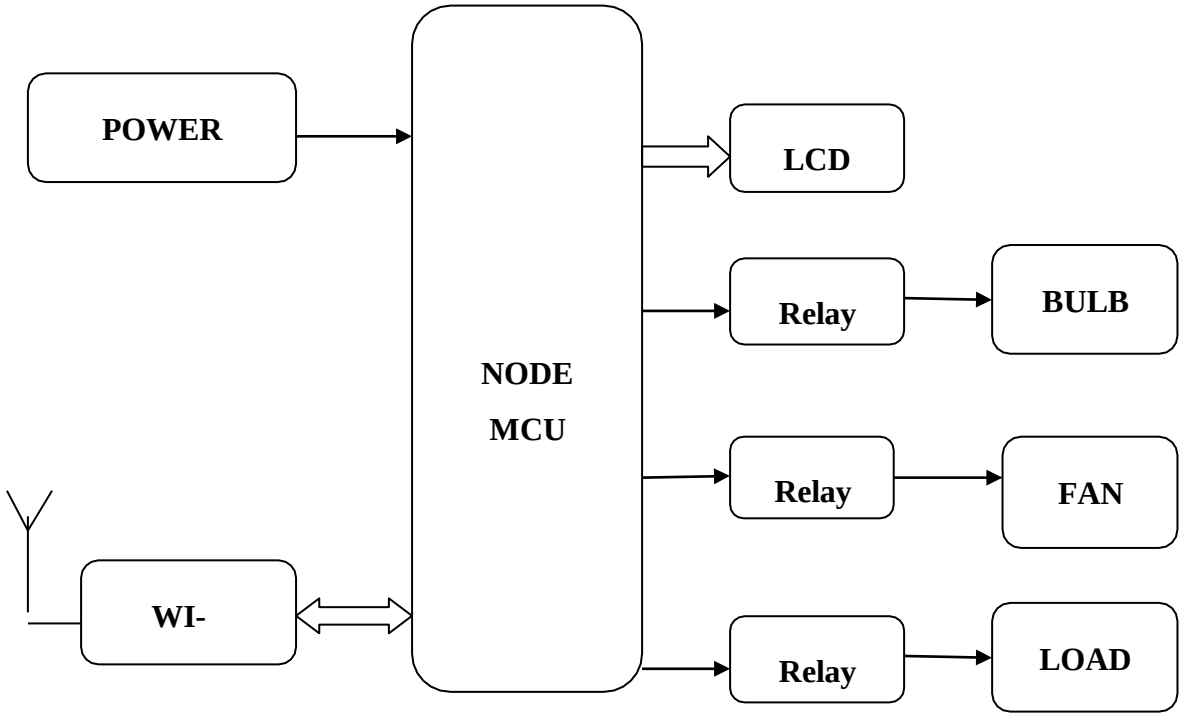


CHAPTER 6

PROJECT DESCRIPTION

This chapter deals with working and circuits of "EMBEDDED SYSTEM FOR HOME AUTOMATION USING SMS". It can be simply understood by its block diagram &circuit diagram.

6.1. BLOCK DIAGRAM



3.5. SOFTWARE REQUIREMENTS

- ARDUINO

3.6. HARDWARE REQUIREMENTS

- NODE MCU
- WI-FI
- LCD
- Power Supply
- AT command supporting Wi-Fi mobile phone
- Relays
- Bulbs

6.2. WORKING

The idea behind this project is to use the existing Wi-Fi infrastructure. So, all the operations involve the Wi-Fi system also. As we send any SMS, it goes through the Wi-Fi system. Any sent SMS can be received if we use a SIM card and Wi-Fi module. To operate any Wi-Fi modem, we have to use the AT commands to operate them. For example, if any SMS arrives the Wi-Fi modem sends the serial data in ASCII format. We can read these dataif we connect the modem with the serial port of the microcontroller at the baud rate of 9600. As the microcontroller comes to know that a SMS has been arrived, it can sent a proper AT command to read the SMS. The reading of SMS returns the mobile no of sender, the time and much more information. We have to select the SMS part of the message. The starting string of the SMS is used as the password. As the password is matched, then the SMS arrival is assumed to be valid by the microcontroller otherwise, it ignores the SMS. If the SMS is valid the controller enable respective relay then the load will be on and the status will be displayed on LCD. Working of "EMBEDDED SYSTEM FOR HOME AUTOMATION USING SMS" is very simple.

6.4. FLOW CHART

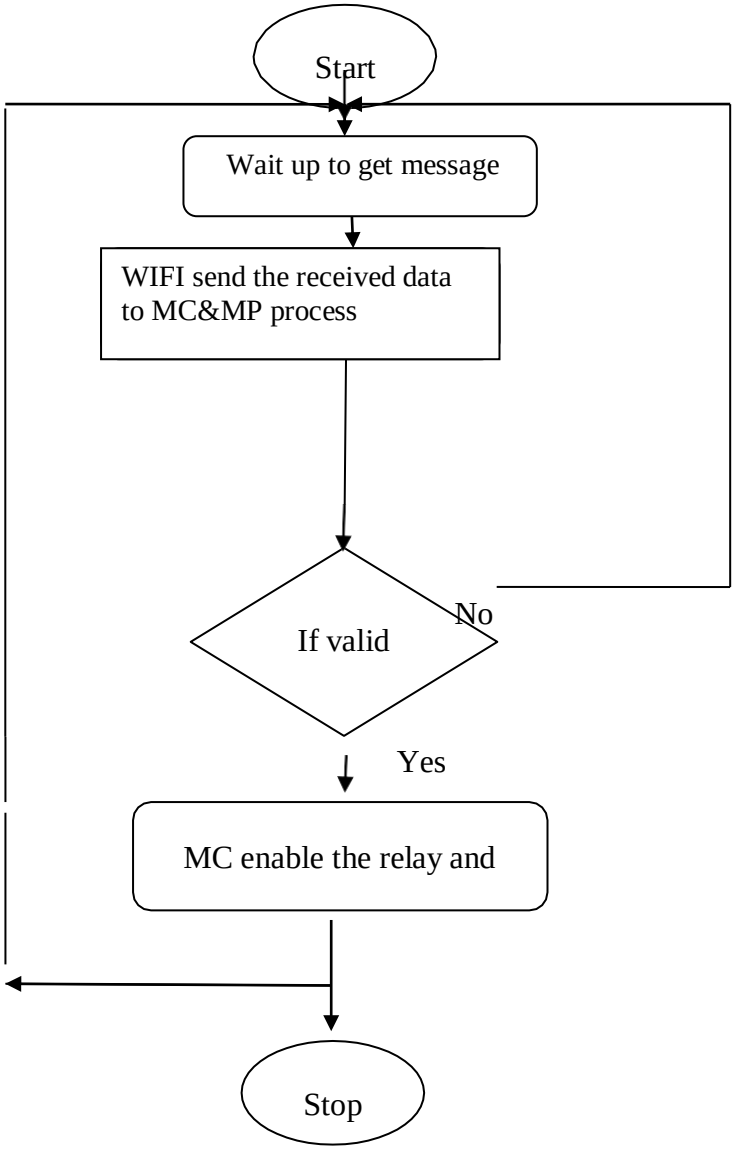
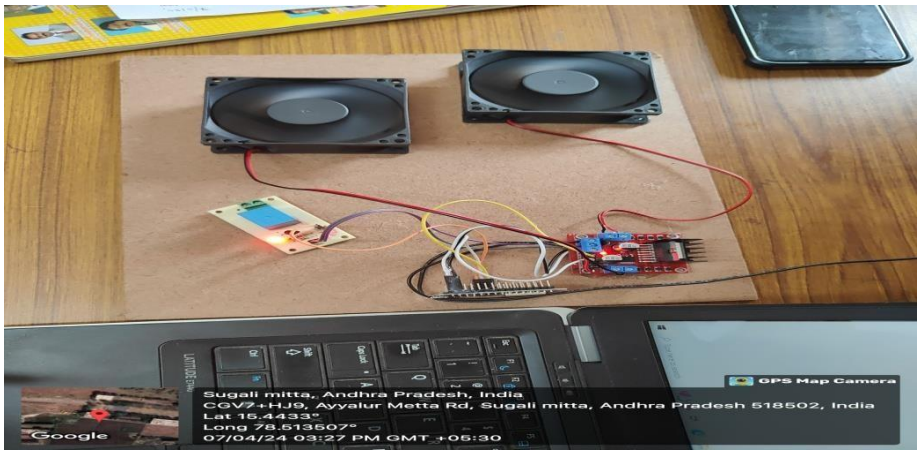
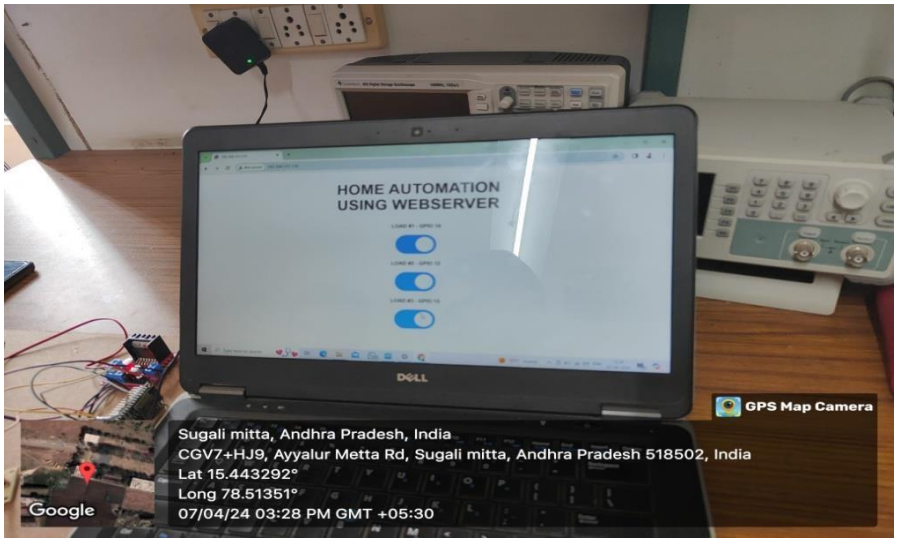


Fig: 3.3. Flow chart





For an IoT-based home automation project using Node MCU, you can have several output points to control different devices in your home. Here are a few common examples:

1. Lights: You can connect Node MCU to relay modules or solid-state relays (SSRs) to control the on/off state of lights in different rooms or areas of your home.

2. Fans: Similar to lights, you can use relay modules or SSRs to control the speed or on/off state of fans in your home.

ADVANTAGES

- Convenience
- Energy efficiency
- Increased security
- Customization and personalization
- Integration and compatibility
- Remote monitoring and notifications
- Cost savings

DISADVANTAGES

- Reliability and connectivity
- Initial setup and learning curve
- Compatibility limitations
- Privacy and security concerns

APPLICATIONS

- Smart lighting
- Energy management
- Security and surveillance
- Climate control
- Appliance control
- Home entertainment

RESULT

The model is working as per design and every process is done in a similar manner.For an IoT-based home automation project using NodeMCU, you can have several output points to control different devices in your home. Along with an exponential growth in connected devices,each thing inIoT communicates packets of dta that require reliable connectivity, storage,and security.

CHAPTER 7

CONCLUSION

This project presents the design and the implementation of an interactive home automation system with the node mcu, the internet accessibility and the speech features. The Internet provides access the full features of the system through an interactive web interface. As the mobility in the world increases, the need to control home from remote locations also increases. The monopolistic power distribution market in Asia is gradually transforming into a competitive marketplace. This system implementation is easy to implement wherever we feel necessary especially in the places like rural areas. The Wi-Fi is an excellent choice for this due to its extensive coverage. Since SMS is a text based protocol, even the most basic Wi-Fi systems can have an access to the status of the devices or make changes on these states. The speech makes the system an excellent choice for the motion disabled.

CHAPTER 8

FUTURE SCOPE

In the future, IoT-based home automation using Node MCU ESP8266 has a lot of exciting potential. We can expect even smarter and more personalized systems that integrate with AI and machine learning. Security features will be enhanced to protect user data and ensure the safety of connected devices. The IoT ecosystem will continue to expand, with more devices and technologies being integrated into home automation systems. Interoperability and standardization will make it easier to connect and manage different IoT devices. Energy optimization and sustainability will be prioritized, and voice and gesture control will become even more intuitive. The future of IoT-based home automation is bright and full of possibilities.

REFERENCES

1. A. Alheraish, "Design and Implementation of Home Automation System" IEEE transactions on consumer electronics, Vol. 50, No. 4, pp. 1087-1092, November 2004.
2. Beh Kok Sang, Abdul Rahman Bin Ramli, V. Prakash, Syed Abdul Rahman Bin Syed Mohamed, "SMS Gateway Interface - Remote monitoring and controlling via Wi-Fi SMS" 4th National conference on telecommunication technology proceedings, Shah Alam, Malaysia, pp. 84 - 87, 2002.
3. Theodoros Giannakopoulos, Nicolas - Alexander Tatlas, Todor Ganchev and Ilyas Potamitis, "A Practical, real-time speech-driven home automation front-end" IEEE Transactions on Consumer Electronics, Vol. 51, No. 2, pp. 514-523, May 2005.
4. Hua Jiang, Zhenduo Han, Peter Scucces, Sean Robidoux, and Ying Sun, "Voice-activated environmental control system for persons with disabilities" , IEEE xplore, pp. 167 - 168, 2000.
5. K. Tan, T. Lee and C. Yee Soh, "Internet-based monitoring of distrubuted control systems-an undergraduate experiment", IEEE transactions on education, Vol. 45, No.2, May 2002.
6. Chi Chung Ko, Ben M. Chen, Shaoyan Hu, Vikram Ramakrishnan, Chang Dong Cheng, Yuan Zhuand and Jiaping Chen, "A Web-Based Virtual Laboratory on a frequency modulation experiment", IEEE Transactions on Systems, Man and cybernetics-Part C: Applications and reviews, Vol. 31, No. 3, pp. 295-303, August 2001.
7. N. Swamy, O. Kuljaca and F. Lewis, "An internet-based educational control systems lab using Net-meeting", IEEE transaction on education, Vol. 45, No. 2, pp. 145-151, May 2002.
8. P. Lin and H.Broberg, "HVAC Applications", IEEE industry applications magazine, pp. 49-54, January 2002.
9. A. R. Al-Ali and M. AL-Rousan, "Java-Based Home Automation System" , IEEE transactions on consumer electronics, Vol. 50, No. 2, pp. 498-594, May 2004.

10. Ali Ziya Alkar and Umit Buhur, "An Internet Based Wireless Home Automation System for Multifunctional Devices", IEEE transactions on consumer electronics, Vol. 51, No. 4, pp. 1169-1174, november 2005.