A

Project Report

On

IOT BASED FIRE DEPARTMENT ALERTING SYSTEM

Submitted in partial fulfillment of the requirement for the award of

BACHELOR OF TECHNOLOGY

In

ELECTRONICS AND COMMUNICATION ENGINEERING

By

S.MD. MUSTAFA (21AM5A0405)

S.PUJITHA (20AM1A0461)

K.SRAVANI (21AM5A0410)

Under the esteemed guidance of

Mr. T.JAYASIMHA ***M. Tech***

ASSISTANT PROFESSOR

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SVR ENGINEERING COLLEGE

AYYALURU METTA NANDYAL– 518 503 (A.P)

(Affiliated to JNTU Anantapur, 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 JNTU Anantapur, Approved by AICTE, New Delhi)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

This is to certify that the dissertation entitled **"IOT BASED FIRE DEPARTMENT ALERTING SYSTEM"** is the bonafide work done and submitted by

S.MD.MUSTAFA (21AM5A0405)

S.PUJITHA (20AM1A0461)

K.SRAVANI (21AM5A0410)

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 Anantapur)** is a record of bonafide work carried out by them under our guidance and supervision.

The results embodied in this thesis have not been submitted to any other university or institute for the award of any degree.

Project Guide:

Mr.T.JAYASIMHA M.Tech

Assistant Professor

Dept. of ECE

SVREC

Head of the Department:

Dr.G.LAKSHMI NARAYANA M.Tech, Ph.D

Professor & HOD

Dept. of ECE

SVREC

EXTERNAL EXAMINER

DECLARATION

We hereby declare that the project report entitled "IOT BASED FIRE DEOARTMENT ALERTING SYSTEM" 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 Anantapur. We have not submitted the same to any other university or organization for the award of any other degree.

S.MD.MUSTAFA (21AM5A0405)

S.PUJITHA (20AM1A0461)

K.SRAVANI (21AM5A0410)

ACKNOWLEDGEMENT

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

We express deep gratitude to our guide **Mr.T.JAYASIMHA,** Assistant 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 towork under excellent working conditions.

We would like to express our gratitude to project coordinators **D.RAGUNATH RAO,** 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, 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** 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.RAMI REDDY** & 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 we thank them from the bottom of our heart.

S.MD.MUSTAFA (21AM5A0405)

S.PUJITHA (20AM1A0461)

K.SRAVANI (21AM5A0410)

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 Studentsby 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.
- Inculcate 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 develop sophisticated communication systems.

PEO2: Graduates embody a commitment to professional ethics, diversity and social awareness in their professional career.

PEO3: Graduates exhibit a desire for life-long learning through technical training 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	
DEPT.	**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 to review research 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 activities with 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 to professional ethics and responsibilities andnorms 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 communityand with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	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, tomanage projects and in multidisciplinary 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 communicationengineering to design a variety of components and systems for applications including signal processing, image processing, communication, networking, embedded systems, VLSI and control system.
PSO 2	Identify indigenous processes and components for producing high quality,compact, energy efficient and eco-friendly solutions at affordable prices.

TITLE	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
IOT BASED FIRE DEPARTMENT ALERTING SYSTEM	3	3	2	3	3	2	3	1	2	3	2	2	3	3

ABSTRACT

A Large destructive fire that spread over a forest or area of woodland is a Forest fire that causes loss of humungousamount of Property, Wildlife, Ecosystem and Economy. The project is focused on creating a permanent solution for this problem. It consists of an integrated IoT based system to detect, monitor and solve the issue without any manual involvement. The system consists of regular monitoring of the forest area with the help of cloud computingand analysis of the root cause of the fire. The system uses the latest Microcontroller, Wi-Fi communication and precision sensors such that there is no error in this part. The system also provides a quick response system so the fire can be controlled at the earliest stage.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES **Page No.**

IOT BASED FIRE DEPARTMENT ALERTING SYSTEM

CHAPTER 1

INTRODUCTION TO INTERNET OF THINGS

1.1 Introduction To Internet Of Things :

Internet of Things (IoT) is a network of physical objects or people called “things” that are embedded with software, electronics, network, and sensors that allows these objects to collect and exchange data. The goal of IoT is to extend to internet connectivity from standard devices like computer, mobile, tablet to relatively dumb devices like a toaster.

IoT makes virtually everything “smart,” by improving aspects of our life with the power of data collection, AI algorithm, and networks. The thing in IoT can also be a person with a diabetes monitor implant, an animal with tracking devices, etc.

1.2 How the Internet of Things Works :

The entire IoT process starts with the devices themselves like smartphones, smartwatches, electronic applianceslike TV, Washing Machine which helps you to communicate with the IoT platform.

The four fundamental components of an IoT system:

1.2.1 Sensors/Devices :

Sensors or devices are a key component that helps you to collect live data from the surrounding environment. All this data may have various levels of complexities. It could be a simple temperature monitoring sensor, or it may be in the form of the video feed.

A device may have various types of sensors which performs multiple tasks apart from sensing. For example, Amobile phone is a device which has multiple sensors like GPS, camera but your smartphone is not able to sense these things.

1.2.2 Connectivity :

All the collected data is sent to a cloud infrastructure. The sensors should be connected to the cloud using various mediums of communications. These communication mediums include mobile or satellite networks, Bluetooth, WI-FI, WAN, etc.

1.2.3 Data Processing :

Once that data is collected, and it gets to the cloud, the software performs processing on the gathered data. This process can be just checking the temperature, reading on devices like AC or heaters. However, it cansometimes also be very complex like identifying objects, using computer vision on video.

1.2.4 User Interface :

The information needs to be available to the end-user in some way which can be achieved by triggeringalarms on their phones or sending them notification through email or text message. The user sometimes might need an interface which actively checks their IoT system. For example, the user has a camera installed in his home. He wants to access video recording and all the feeds with the help of a web server.

However, it's not always one-way communication. Depending on the IoT application and complexity of the system, the user may also be able to perform an action which may create cascading effects.

1.3 IoT Architecture :

The IoT architecture depends upon different application areas of the Internet of Things, and it works as per the design. There is no standard defined architecture of IoT. It completely depends upon its functionality and implementation in different sectors. The below diagram shows a basic process flow of IoT.

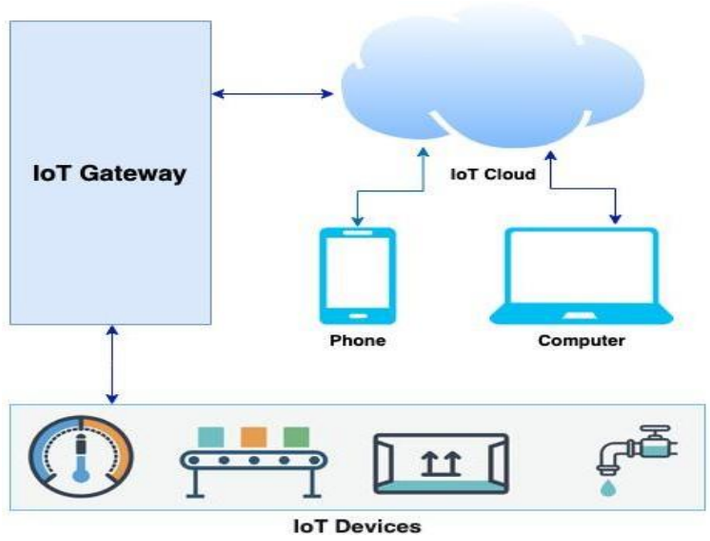

Fig 1.1: IoT Architecture

The IoT system combines many smart devices and the cloud platform to which they are all connected.The IoT system operates on several levels:

- Hardware can be wireless sensors or actuators. They react with the environment and make the data they collect available for analysis. For example, you can use them to switch off a light when the sun rises.
- IoT Gateway connects to the sensors and actuators, which compiles all their data. It then converts it into digital form and routes over the network by the internet gateway
- Cloud infrastructure, which handles storage and processing of the data received. This is the preferred storage method in IoT implementations.
- The application controls IoT devices on the user side (for smartphones, tablets, or PCs).

1.4 IoT Communication Protocols :

IoT protocols are being used to transfer data from devices to other IoT-powered devices. IoT protocols ensurethat the information that is sent from one device is received effectively by the next device which is part of theconnected environment.

We are listing here the top IoT communication protocols involved in the Internet of Things devices and applications.

1.4.1 Wi-Fi :

Wireless Fidelity (Wi-Fi) is the most popular for wireless local area networks. WiFi enables powerful communication between connected devices. It is applicable for indoor applications andhome automation. (Range: 100 to 250 ft)

1.4.2 Bluetooth :

Bluetooth is one of the most important IoT network protocols. Nowadays the new Bluetooth Low-Energy (BLE) is what IoT companies are using for different consumer product markets.

Bluetooth can be useful in smartphones, tablets, smartwatches, and media players. Bluetooth is more useful while transferring information between two or more devices that are near each other.

1.4.3 ZigBee :

Zigbee is an open global standard for wireless technology. It uses low-power digital radio signalsfor personal area networks. Zigbee has lower power consumption, high security, and has a longer range of communication. Zigbee can reach 200 meters whereas Bluetooth can reach 100 meters.

1.4.4 LoRa :

Long Range Wide Area Network (LoRaWAN) is a long-range radio-wide area network that provides low-cost mobile security to IoT and industrial applications. It has the ability to communicate inlong-range with low power consumption and supports a large network of millions of devices.

1.4.5 Z-Wave :

Z-Wave is a radio frequency based low-power consuming communication protocol and like Zigbee, it is based on IEEE 802.15.4 standard. The operating frequency of the Z-Wave communication protocol is 900 MHz, and the range is around 30–100 meters

This low-power radio frequency communication protocol is designed for home automation systems and electronic devices such as lamp controllers and sensors. Its data rate ranges approximately from 40kbps to 100kbps.

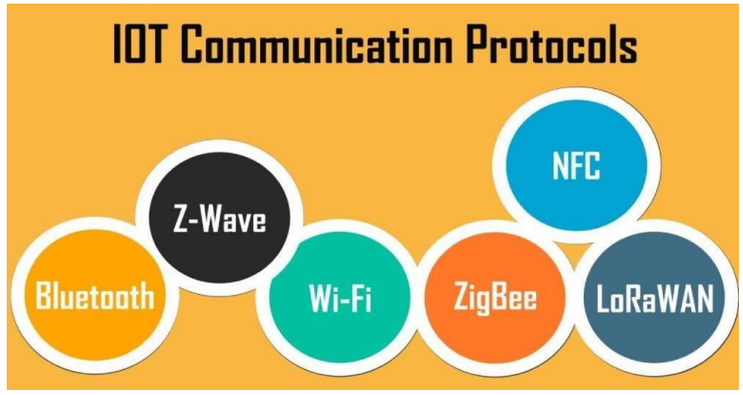

Fig 1.2: IOT Communication Protocols

1.5 IoT Cloud :

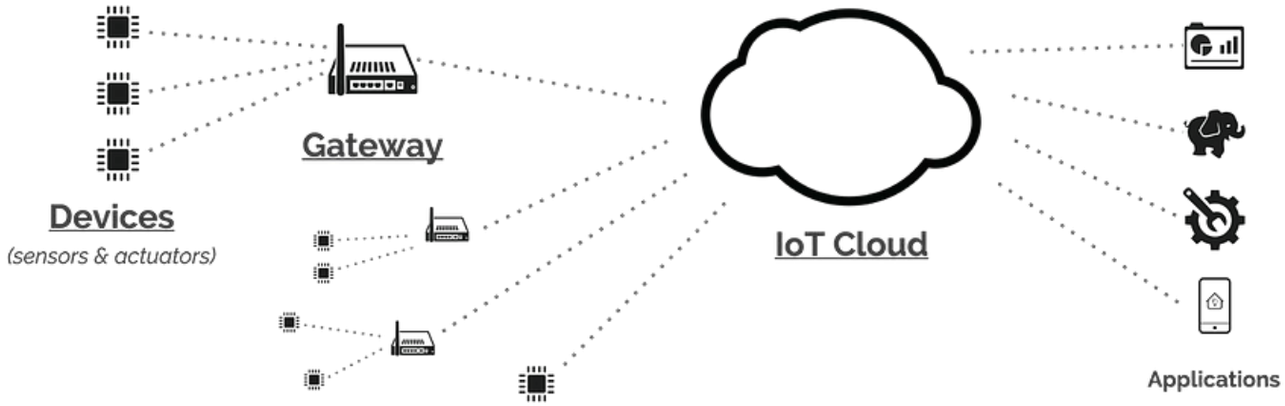

Fig 1.3: IoT Cloud

An IoT cloud is a huge network that supports IoT devices and applications. This is a platform that stores and processes IoT data. IoT cloud consumes large volumes of data generated by devices, sensors and then starts actions for real-time responses.

The sensors/devices from the IoT system talk to the cloud through some connectivity. The software starts processing the data and starts sending alerts. It can also turn the devices on and off based on the settings donewithin the application.

IoT clouds offer an efficient and scale-able model for delivering the configuration and services. Businesses with limited resources can opt for a demand solution of IoT cloud.

1.6 Benefits Of IoT :

Looking at the big picture of IoT benefiting any business, the organizations can expect things like:

- **Enhancing Productivity**: Increased automation with connected devices performs various operationsin a shorter duration. This leads to higher productivity
- **Customer behavior understanding and Analysis**: IoT helps identify the customers' behavioral patterns. It is useful in establishing better customer relationships and engagement strategies.
- **Precise monitoring and alert generatio**n: Ensures the reduction in errors

- **Real-time Analytics and Reporting**: helps to identify grey areas and take the right measures towards the solution.
- Reduced risk of system failure due to low human intervention
- **Improved Quality Control mechanism**: Increase quality control in the product life cycle.
- **Real-time decision making**: the customer behavior patterns help in sustaining the target audience. It leads to marketing and building brand loyalty.

1.7 Challenges in IoT :

Even though IoT has many benefits, there are certain challenges IoT has. Listed below are a few of the challenges:

- Creating a culture of technology within the organization is a prerequisite to start the use of IoT.
- Organizations need to invest in the following to enable effective use of IoT:
- **Investment in sensors** : Sensors cost high and need maintenance as well.
- **Data analytics :** Data analytics tools are required to identify patterns/sequences to arrive at a conclusion
- **Network investment** : Heavy cost is involved in building the network for IoT
- **System integration** : A lot of integration activity is involved in getting the IoT devices integratedwith the system
- **Security** : Security is one of the most important aspects which needs to be considered for preserving customer data
- Compatibility and Interoperability of Different IoT systems are also concern factors.
- Getting all the connected devices on one platform needs formalization
- Network challenges will always remain a crucial factor as the Internet is still not available everywhereat the same speed.
- Big Data in itself is so massive that combining it with IoT possesses a great challenge.

1.8 Top 10 IoT Application Areas :

Out of the 1,414 public enterprises, IoT projects identified, manufacturing / Industrial are most common (22%)followed by the Transportation / Mobility (15%) and Energy IoT projects (14%).

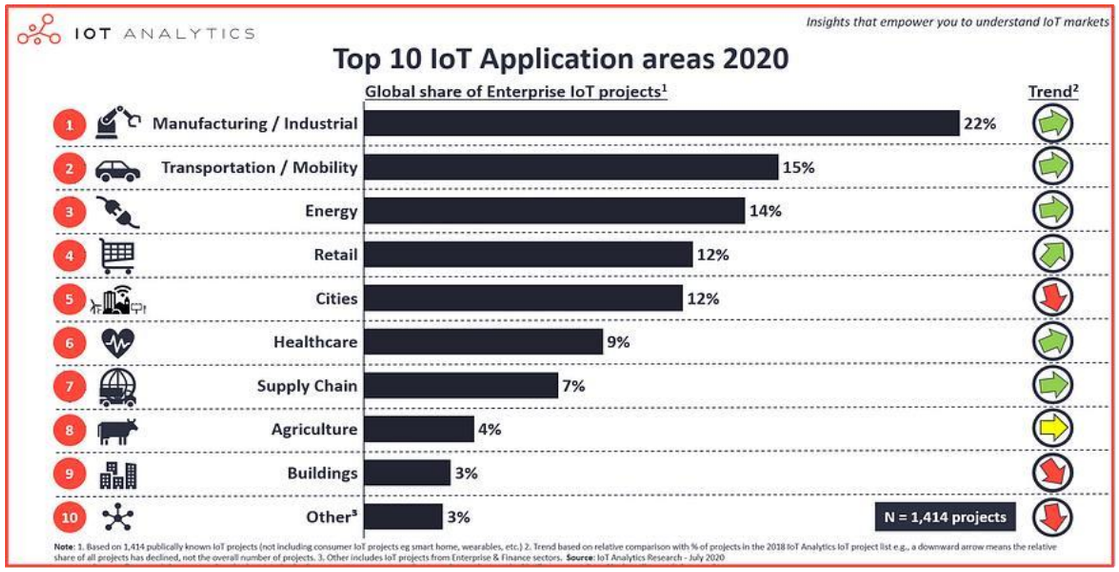

Fig 1.4: IoT Application Areas

For example, IoT is used for Home Automation. This is the ability to control domestic appliances by internet-connected systems. It may include controlling all lights, motion sensors, contact sensors of your home.

Using smart home IoT solutions, you can get the best level of control over your household. You can remotely switch on and off appliances and control the full range of functionality using mobile or web applications.

Listed below are some of the basic steps you need to follow in order to get started with the IoT project.

- The project team needs to understand the problems the customer to install IoT.
- Create a business model around connectivity which will justify the recurring cost.
- We need to understand whether preventive or predictive maintenance activity needs an IoT. Also, whether it is for asset tracking, environmental monitoring, automatic refilling, etc.
- We need to research the best IoT platforms, tools, and applications that could help us install an IoT product.

- We should examine the below mentioned things for solutions for an IoT product:

  - Hardware

  - Device management

  - Connectivity

  - Method of connectivity

  - Geographical coverage

  - Type of Service

- To summarize, including an IoT project in a business, we need to understand how the technology works and what it can do for your business.
- A unique set of IoT applications and tools can serve specific industries. The IoT technical partner will help us determine the particular needs better by defining our expectations. This will be useful in avoiding the pitfalls faced by companies that attempt IoT deployment on their own.

1.9 IoT Testing Challenges :

Here are the few common challenges which the QAs can face while testing the IoT products:

- Gadgets involved in IoT might not be available every time.
- It requires a lot of effort and is difficult to replicate the actual environment.
- Large effort among many teams to get the right test data.
- Due to device fragmentation, it is a challenge to build an IoT that can work across a wide range of devices. Presence of different brands, models, OS, versions of the OS, screen sizes, resolutions, and other elements.
- Many IoT communications protocols are present in the market to test the interaction with controllers and each other.
- Compatibility factor
- Security challenges

- Network and cloud availability: Network and clouds play an important role in IoT systems. It is a challenge to test the data at faster speeds. Testing IoT architecture on all kinds of network connectivity and speed is crucial.

For testers to overcome the above challenges, they must focus on a good testing approach. It is important to follow the structured requirements, comprehensive test plan.

1.10 Testing strategy for IoT :

IoT testing validates an IoT device's functionality, performance, security, and connected clouds. It is important to verify that your IoT devices can send sensitive information before bringing your product to market. Various types of testing help to ensure proper test coverage:

- **IoT Device functionality testing**: Done on both application and hardware to ensure that the device works as expected.
- **Sensor-protocol compatibility testing**: Test various IoT protocols like WiFi, Bluetooth, for device compatibility
- **Device security testing**: Verify that IoT devices are free from any threats, vulnerabilities, or risks. This includes checking device authentication, data collection, data transmission, device software, andmore. This testing will make ensure data protection and encryption
- **Performance Testing**: collect information on the response time and reliability of product features. Testers can check the performance of the devices with various IoT performance testing tools available in the market. It will ensure the expected performance of the IoT device under normalcircumstances.
- **Network Connectivity testing**: To check efficient and smooth connectivity across the connected network. This includes Device-to-Device connectivity and Device-to-Cloud connectivity testing.
- **Upgrade testing**: The upgrade testing is to check that the devices are working after the firmware upgrade, cloud updates

IoT devices must need large testing before releasing products to the market. The team can streamline IoT testing by adding the above testing practices to your development cycle.

CHAPTER 2

LITERATURE SURVEY

In recent years, there has been significant progress in fire detection and prevention technologies, especially in the domains of industrial and forest fire safety. Various research endeavors have focused on enhancing the effectiveness and efficiency of fire alarm systems, utilizing a combination of hardware and software solutions.

Ahmed Imteaj et al. developed a fire detection system for factories employing Raspberry Pi3, incorporating temperature, flame, and smoke sensors. The system boasts a remarkable extinguishing capability, quelling fires within 20 seconds by leveraging the air-conditioning infrastructure.

Abhinav Kumar et al. proposed a forest fire detection system utilizing Raspberry Pi interfaced with temperature and smoke sensors, bolstered by IoT technology for remote monitoring via a dedicated webpage named "Fire Security System." Additionally, standalone sensor boxes equipped with various sensors have been proposed for deployment throughout forest areas, although periodic data updates have been noted as a limitation.

Arun Ganesh et al. introduced a satellite-based fire detection system leveraging MODIS (Moderate Resolution Imaging Spectroradiometer) data for forest fire detection. However, the system's long scanning cycle poses a challenge in achieving real-time monitoring. Ahmad AA Alkhatib et al. proposed a distributed wireless sensor network for forest fire detection, aiming to establish a self-organized and robust network. Nevertheless, challenges related to sensor node failures have been identified.

CHAPTER 3

BLOCK DIAGRAM & HARDWARE DESCRIPTION

3.1. Block Diagram :

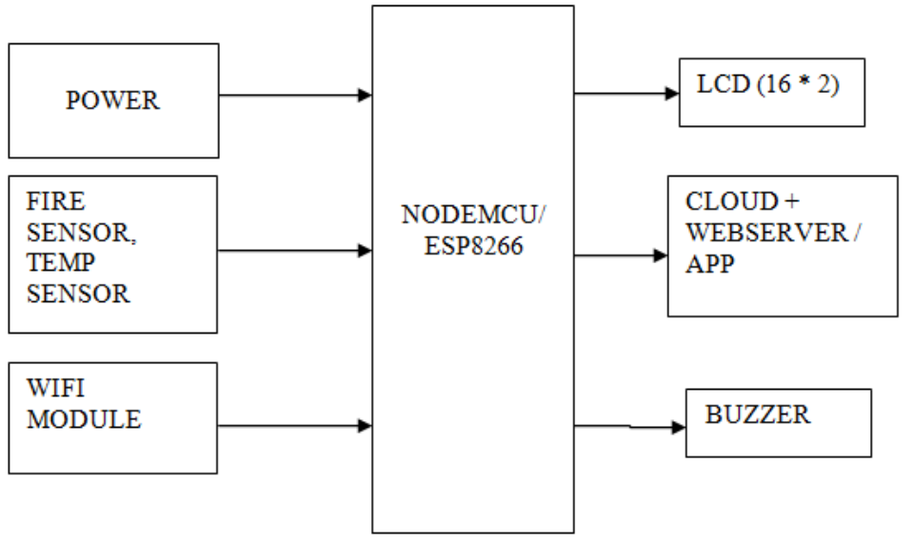

Fig:3.1 Block diagram of project

3.2 POWER SUPPLY :

All digital circuits require regulated power supply. In this article we are going to learn how to get a regulated positive supply from the mains supply.

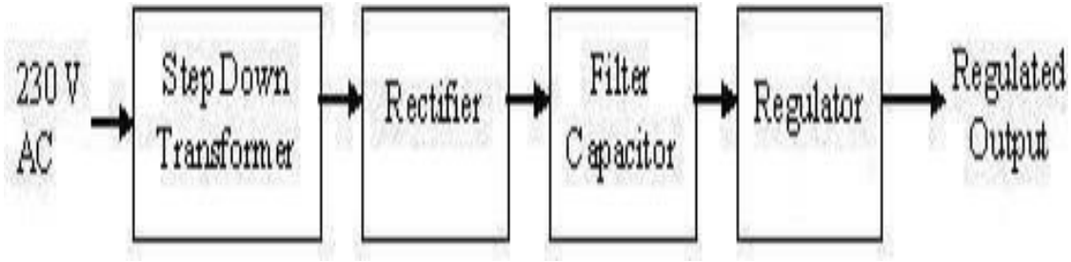

Fig 3.2.1: The basic block diagram of a fixed regulated power supply

Let us go through each block.

Transformer:

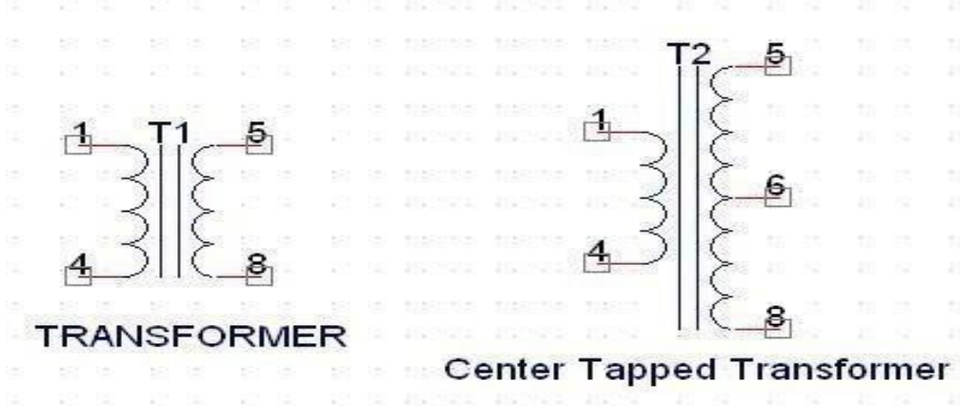

Fig 3.2.2: Different Types of Transformers

A transformer consists of two coils also called as "*WINDINGS*" namely *PRIMARY & SECONDARY.* They are linked together through inductively coupled electrical conductors also called as CORE. A changing current in the primary causes a change in the Magnetic Field in the core & this in turn induces an alternating voltage in the secondary coil. If load is applied to the secondary then an alternating current will flow through the load. If we consider an ideal condition then all the energy from the primary circuit will be transferred to the secondary circuit through the magnetic field.

$$P_{primary} = P_{secondary}$$

So,

$$I_pV_p = I_sV_s$$

The secondary voltage of the transformer depends on the number of turns in the Primary as well as in the secondary.

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

Rectifier:

A rectifier is a device that converts an AC signal into DC signal. For rectification purpose we use a diode, a diode is a device that allows current to pass only in one direction i.e. when the anode of the diode is positive with respect to the cathode also called as forward biased condition & blocks current in the reversed biased condition.

Rectifier can be classified as follows:

Half Wave Rectifier:

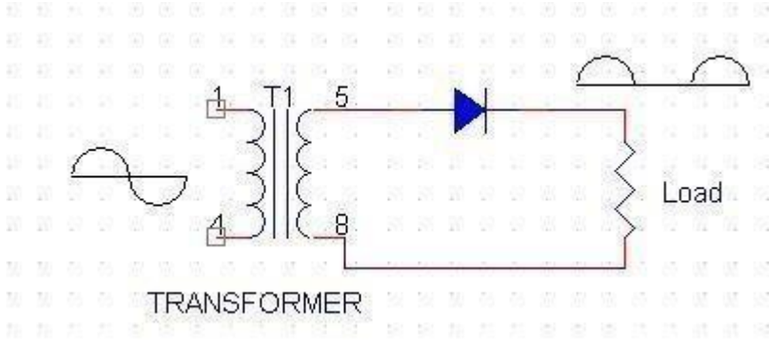

Fig 3.2.3: Half Wave Rectifier

This is the simplest type of rectifier as you can see in the diagram a half wave rectifier consists of only one diode. When an AC signal is applied to it during the positive half cycle the diode is forward biased & current flows through it. But during the negative half cycle diode is reverse biased & no current flows through it. Since only one half of the input reaches the output, it is very inefficient to be used in power supplies.

Full wave Rectifier:

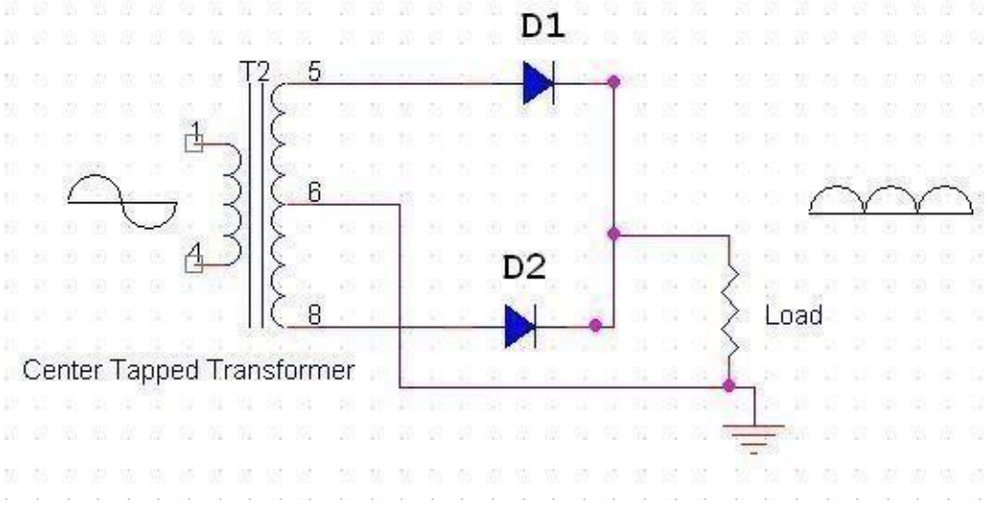

Fig 3.2.4: Full Wave Rectifier

Half wave rectifier is quite simple but it is very inefficient, for greater efficiency we would like to use both the half cycles of the AC signal. This can be achieved by using a center tapped transformer i.e. we would have to double the size of secondary winding & provide connection to the center. So during the positive half cycle diode D1 conducts & D2 is in reverse biased condition. During the negative half cycle diode D2 conducts & D1 is reverse biased. Thus we get both the half cycles across the load. One of the disadvantagesof Full Wave Rectifier design is the necessity of using a center tapped transformer, thus increasing the size& cost of the circuit. This can be avoided by using the Full Wave Bridge Rectifier.

Bridge Rectifier :

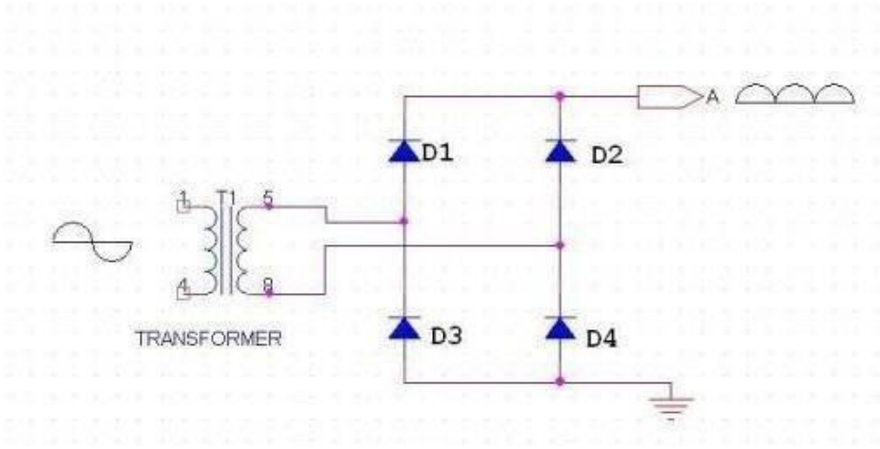

Fig 3.2.5: Bridge Rectifier

As the name suggests it converts the full wave i.e. both the positive & the negative half cycle into DC thus it is much more efficient than Half Wave Rectifier & that too without using a center tapped transformer thus much more cost effective than Full Wave Rectifier.Full Bridge Wave Rectifier consists of four diodes namely D1, D2, D3 and D4. During the positive half cycle diodes D1 & D4 conduct whereas in the negativehalf cycle diodes D2 & D3 conduct thus the diodes keep switching the transformer connections so we get positive half cycles in the output.

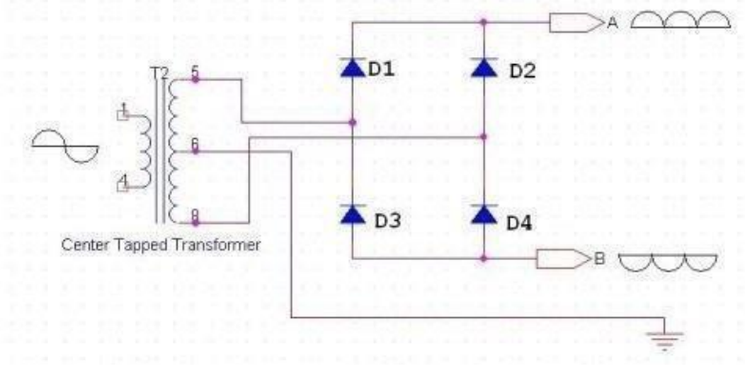

Fig 3.2.6: Center Tapped Bridge Rectifier

If we use a center tapped transformer for a bridge rectifier we can get both positive & negativehalf cycles which can thus be used for generating fixed positive & fixed negative voltages.

Filter Capacitor:

Even though half wave & full wave rectifier give DC output, none of them provides a constant output voltage. For this we require to smoothen the waveform received from the rectifier. This can be done by usinga capacitor at the output of the rectifier this capacitor is also called as "FILTER CAPACITOR" or "SMOOTHING CAPACITOR" or "RESERVOIR CAPACITOR". Even after using this capacitor a small amount of ripple will remain.We place the Filter Capacitor at the output of the rectifier the capacitor will chargeto the peak voltage during each half cycle then will discharge its stored energy slowly through the load while the rectified voltage drops to zero, thus trying to keep the voltage as constant as possible.

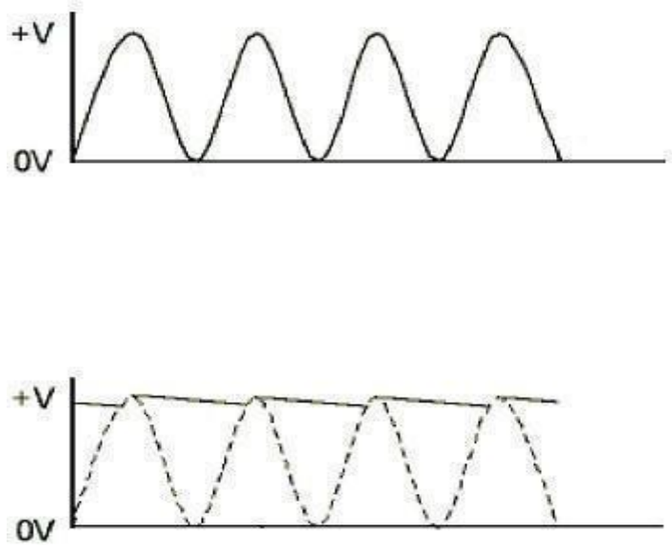

Fig 3.2.7: Capacitor Output Voltage

If we go on increasing the value of the filter capacitor then the Ripple will decrease. But then the costingwill increase. The value of the Filter capacitor depends on the current consumed by the circuit, the frequency of the waveform & the accepted ripple.

$$C = \frac{V_r F}{I}$$

Where,

Vr = accepted ripple voltage.(should not be more than 10% of thevoltage)I

= current consumed by the circuit in Amperes.

F = frequency of the waveform. A half wave rectifier has only one peak in one cycle so F=25hz

Where as a full wave rectifier has Two peaks in one cycle so F=100hz.

Voltage Regulator:

A Voltage regulator is a device which converts varying input voltage into a constant regulated output voltage. Voltage regulator can be of two types

- Linear Voltage Regulator Also called as Resistive Voltage regulator because they dissipate the excessive voltage resistively as heat.
- Switching Regulators They regulate the output voltage by switching the Current ON/OFF very rapidly. Since their output is either ON or OFF it dissipates very low power thus achieving higher efficiency as compared to linear voltage regulators. But they are more complex & generate high noise due to their switching action. For low level of output power switching regulators tend to be costly but for higher output wattage they are much cheaper than linear regulators.

The most commonly available Linear Positive Voltage Regulators are the 78XX series where the XX indicates the output voltage. And 79XX series is for Negative Voltage Regulators.

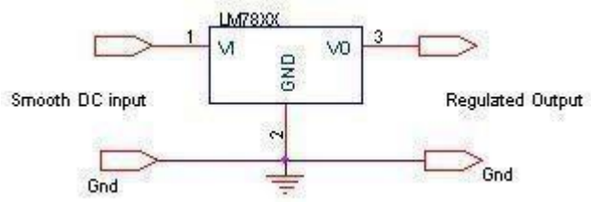

Fig 3.2.8: Voltage Regulator

After filtering the rectifier output the signal is given to a voltage regulator. The maximum input voltage that can be applied at the input is 35V.Normally there is a 2-3 Volts drop across the regulator so the input voltage should be at least 2-3 Volts higher than the output voltage. If the input voltage gets below the Vmin of the regulator due to the ripple voltage or due to any other reason the voltage regulator will not be able to produce the correct regulated voltage.

3.3. LED (LIGHT EMITTING DIODE) :

Fig 3.3.1: LED (RGB)

A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p–n junction diode that emits light when activated. When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. LEDs are typically small (less than 1 mm^2) and integrated optical

components may be used to shape the radiation pattern. Appearing as practical electronic components in 1962, the earliest LEDs emitted low- intensity infrared light. Infrared LEDs are still frequently used as transmitting elements in remote-control circuits, such as those in remote controls for a wide variety of consumer electronics. The first visible-light LEDs were also of low intensity and limited to red. Modern LEDs are available across the visible, ultravoilet, and infrared wavelengths, with very high brightness.

Table 1: LED Color-Wavelength Range

Color	Wavelength range (nm)	Typical efficiency coefficient	Typical efficacy (lm/W)
Red	$620 < \lambda < 645$	0.39	72
Red-orange	$610 < \lambda < 620$	0.29	98
Green	$520 < \lambda < 550$	0.15	93
Cyan	$490 < \lambda < 520$	0.26	75
Blue	$460 < \lambda < 490$	0.35	37

WORKING:

A P-N junction can convert absorbed light energy into a proportional electric current. The same process is reversed here (i.e. the P-N junction emits light when electrical energy is applied to it). This phenomenon is generally called electroluminescence, which can be defined as the emission of light from a semiconductor under the influence of an electric field. The charge carriers recombine in a forward-biased P-N junction as the electrons cross from the N-region and recombine with the holes existing in the P-region. Free electrons are in the conduction band of energy levels, while holes are in the valence energy band. Thus the energy level of the holes is less than the energy levels of the electrons. Some portion of the energy must be dissipated to recombine the electrons and the holes. This energy is emitted in the form of heat and light.

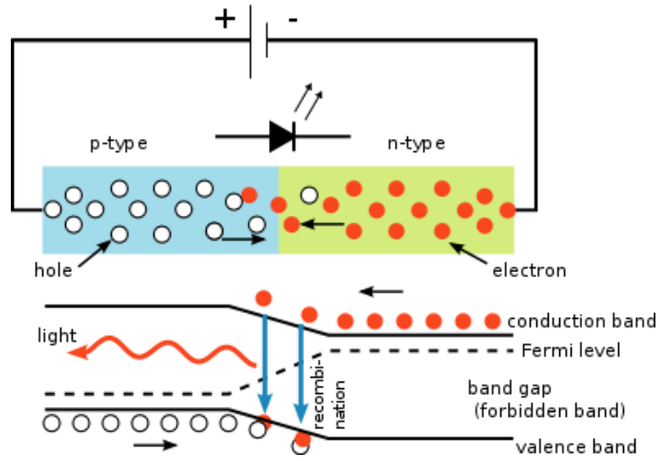

Fig 3.3.2 : Working of LED

The simplest circuit to drive an LED consists of a voltage source and two components connected in series with a resistor sometimes called the ballast resistor, and an LED. Optionally, a switch may be introduced to open and close the circuit. Although simple, this circuit is not the most energy efficient circuit to drive an LED, since energy is lost in the resistor. More complicated circuits improve the energy efficiency.

3.4 ESP-01 Wi-Fi Module :

The ESP-01 WiFi module, meticulously crafted by Espressif Systems, is based on the ESP8266 core processor and utilizes the advanced Tensilica L106 ultra-low power 32-bit micro MCU. It surpasses the boundaries of traditional microcontrollers, offering special features including a 16-bit simplified mode, support for dual main frequencies of 80 MHz and 160 MHz, integrated RTOS, and a complete WiFi networking suite (MAC/BB/RF/PA/LNA).

A notable feature of the ESP-01 is its integrated antenna, allowing for robust WiFi communication capabilities directly, eliminating the need for an external auxiliary antenna.

Beyond impressive hardware specs, the ESP-01 module also adheres to the IEEE802.11 b/g/n wireless protocol and includes a comprehensive TCP/IP protocol stack. This multifunctionality aids in integrating networking features into various devices (from smart home gadgets and sensors to broader applications), thereby enhancing device connectivity and functionality. Moreover, the ESP-01 can serve as an independent network controller, expanding the horizons of IoT innovation.

Fig 3.4.1: ESP-01

Functions and Features of ESP-01 :

- The ESP-01 follows the 802.11 b/g/n standard and performs excellently in 2.4 GHz WiFi communication, making it suitable for a range of wireless networking applications from smart homes to industrial automation.
- At its core is the Tensilica L106 ultra-low power 32-bit micro MCU. It is adaptable to 80 MHz and 160 MHz power frequencies and also integrates an RTOS for synchronous multitasking management. Moreover, the ESP-01 is equipped with a 10-bit high precision ADC for accurate analog signal processing.
- In the 802.11b mode, the ESP-01 provides a +20 dBm output power, ensuring effective signal transmission and improves data transmission efficiency through A-MPDU, A-MSDU aggregation, and a 0.4 μs guard interval. WPA/WPA2 protocols enhance security, and firmware updates are simplifiedthrough AT remote and cloud OTA upgrade features.

- The ESP-01 supports STA/AP/STA+AP modes and smart configuration for flexible network connections, simplifying connections with Android and iOS devices. An abundance of interfaces, including HSPI, UART, I2C, I2S, IR remote control, PWM, and GPIO, enrich device interconnect options.

- The ESP-01 excels in power management with a deep sleep mode consuming only 10 µA of current and a shutdown current of less than 5 µA. It is capable of waking up, connecting, and transmitting packets in just 2 milliseconds, optimizing energy use while maintaining fast responsiveness. Standby power consumption remains below 1.0mW (DTIM3), indicating low power consumption even in standby mode.

ESP-01 Module Pins and Functions :

- **VCC (3.3V)** - This is the power supply pin. The ESP-01 module requires a 3.3V power supply. Ensure stable voltage and sufficient current for normal module operation.

- **GND (Ground)** - This is the ground pin, used to connect the power supply's ground line, ensuring circuit grounding.

- **TXD (Transmit Data)** - The TXD pin is used to send data, transmitting data from the module to an external device, usually a microcontroller or another serial device.

- **RXD (Receive Data**) - The RXD pin is used to receive data, transferring data sent by an external deviceto the ESP-01 module for processing and parsing.

- **GPIO0 (General Purpose Input/Output 0)** - This is general-purpose input/output pin 0, which can be connected to external circuits for digital input or output operations. At startup, the state of GPIO0 can also be used for different boot mode selections.

- **GPIO2 (General Purpose Input/Output 2**) - Similar to GPIO0, GPIO2 is a general-purpose input/output pin, which can be used for external device connections.

- **CH_PD (Chip Power-Down)** - This is the module's power control pin. By controlling CH_PD, the module can enter low power modes or normal operation modes.

- **RST (Reset)** - The RST pin is used to reset the ESP-01 module. Pulling the RST pin low (usually to ground) will reboot the module.

- **EN (Enable)** - The EN pin is used to enable or disable the ESP-01 module. The ability to remotely enable or disable the module can be achieved by controlling the EN pin.

- **ADC (Analog-to-Digital Converter)** - The ADC pin allows for the connection of analog sensors or voltage sources for conversion and reading of analog signals.

- **GPIO15 (General Purpose Input/Output 15)** - This is another general-purpose input/output pin, used for various digital input or output tasks.

- **GPIO13, GPIO12, GPIO14** - These pins are also general-purpose input/output pins, used to extend the ESP-01 module's digital input/output capabilities.

- **GPIO4, GPIO5, GPIO16** - These pins are also general-purpose input/output pins, useful for connecting external devices or extending functionalities.

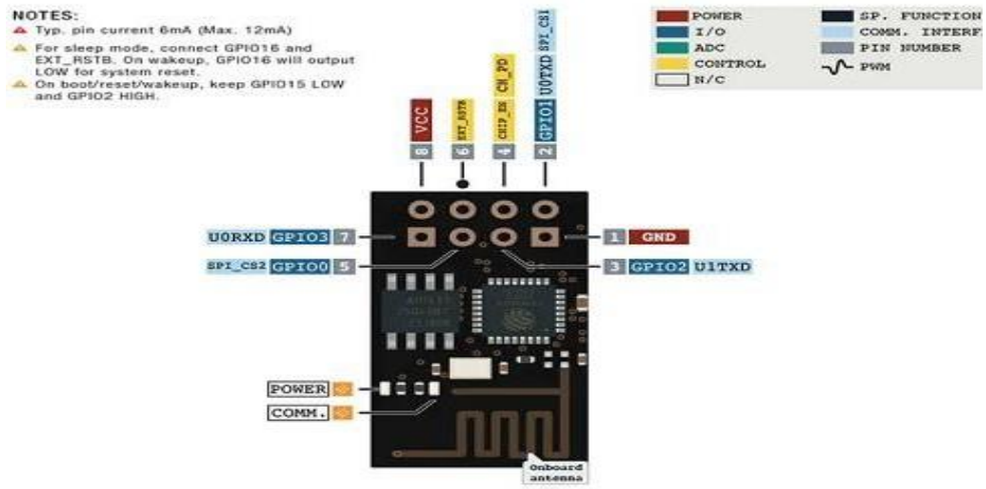

Fig 3.4.2: ESP-01 Pin Configuration

Applications of ESP-01 :

- **Wireless Computer Peripherals:** The ESP-01 module can be used to create wireless keyboards, mice, and even drawing pads. By connecting to a computer or tablet, users can achieve wireless control, whichis beneficial for tasks like presentations, media control, and game control. The ESP-01's quick response and stability make it an ideal choice.

- **Wireless Game Controllers:** The ESP-01 module can be used with buttons, joysticks, and sensors to create wireless game controllers. This allows players to enjoy gaming experiences without the limitations of wired connections. Low latency and high stability are important considerations for game controller design, and the ESP-01 meets these requirements.

- **Wireless Audio:** For audio applications, the ESP-01 can be used to build wireless audio transmission systems. It can transmit audio data from one device to another, such as streaming music from asmartphone to a Bluetooth speaker or headphones. This provides users with greater flexibility and more freedom in the layout of audio equipment.

- **Remote Control:** A typical application of the ESP-01 is remote control. It can be used to control TVs, home theater systems, projectors, and various devices. By pairing with an infrared emitter or other communication interfaces, the ESP-01 can achieve remote control capabilities, integrating multiple remotes into one smart remote, enhancing the user experience.

- **Home Automation:** The ESP-01 module has a wide range of applications in home automation. It can be used to control lights, temperature, security systems, and more. By working with sensors and actuators, the ESP-01 can create a smart home control center, allowing users to easily control and monitor home devices through a phone or computer.

- **Toys:** The ESP-01 is also widely applied in toy design. From remote-controlled planes to smart dolls, the ESP-01 module can add wireless control and interaction capabilities to toys. This offers manufacturers innovative possibilities and makes toys more attractive.

3.5 Liquid Crystal Display (LCD) :

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

Fig 3.5.1: 16X2 LCD

LCD 16×2 Pin Diagram

The 16×2 LCD pinout is shown below.

- Pin1 (Ground/Source Pin): This is a GND pin of display, used to connect the GND terminal of the microcontroller unit or power source.
- Pin2 (VCC/Source Pin): This is the voltage supply pin of the display, used to connect the supply pin of the power source.
- Pin3 (V0/VEE/Control Pin): This pin regulates the difference of the display, used to connect a changeable POT that can supply 0 to 5V.
- Pin4 (Register Select/Control Pin): This pin toggles among command or data register, used to connect a microcontroller unit pin and obtains either 0 or 1(0 = data mode, and 1 = command mode).
- Pin5 (Read/Write/Control Pin): This pin toggles the display among the read or writes operation, and it is connected to a microcontroller unit pin to get either 0 or 1 (0 = Write Operation, and 1 = Read Operation).
- Pin 6 (Enable/Control Pin): This pin should be held high to execute Read/Write process, and it is connected to the microcontroller unit & constantly held high.

- Pins 7-14 (Data Pins): These pins are used to send data to the display. These pins are connected in two- wire modes like 4-wire mode and 8-wire mode. In 4-wire mode, only four pins are connected to the microcontroller unit like 0 to 3, whereas in 8-wire mode, 8-pins are connected to microcontroller unit like 0 to 7.
- Pin15 (+ve pin of the LED): This pin is connected to +5V
  Pin 16 (-ve pin of the LED): This pin is connected to GND.

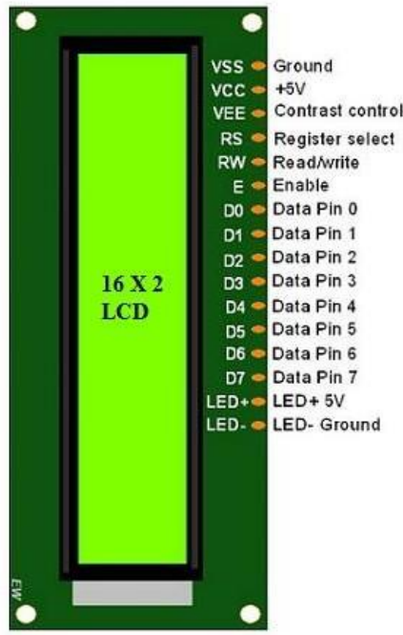

Fig 3.5.2: LCD-16×2-pin-diagram

Features of LCD 16x2 :

The features of this LCD mainly include the following.

- The operating voltage of this LCD is 4.7V-5.3V
- It includes two rows where each row can produce 16-characters.
- The utilization of current is 1mA with no backlight

- Every character can be built with a 5×8 pixel box
- The alphanumeric LCDs alphabets & numbers
- Is display can work on two modes like 4-bit & 8-bit
- These are obtainable in Blue & Green Backlight
- It displays a few custom generated characters

Registers of LCD :

A 16×2 LCD has two registers like data register and command register. The RS (register select) is mainly used to change from one register to another. When the register set is '0', then it is known as command register. Similarly, when the register set is '1', then it is known as data register.

Command Register :

The main function of the command register is to store the instructions of command which are given to the display. So that predefined tasks can be performed such as clearing the display, initializing, set the cursor place, and display control. Here commands processing can occur within the register.

Data Register :

The main function of the data register is to store the information which is to be exhibited on the LCD screen.Here, the ASCII value of the character is the information which is to be exhibited on the screen of LCD. Whenever we send the information to LCD, it transmits to the data register, and then the process will be starting there. When register set =1, then the data register will be selected.

16×2 LCD Commands :

The commands of LCD 16X2 include the following.

- For Hex Code-01, the LCD command will be the clear LCD screen
- For Hex Code-02, the LCD command will be returning home
- For Hex Code-04, the LCD command will be decrement cursor

- For Hex Code-06, the LCD command will be Increment cursor
- For Hex Code-05, the LCD command will be Shift display right
- For Hex Code-07, the LCD command will be Shift display left
- For Hex Code-08, the LCD command will be Display off, cursor off
- For Hex Code-0A, the LCD command will be cursor on and display off
- For Hex Code-0C, the LCD command will be cursor off, display on
- For Hex Code-0E, the LCD command will be cursor blinking, Display on
- For Hex Code-0F, the LCD command will be cursor blinking, Display on
- For Hex Code-10, the LCD command will be Shift cursor position to left
- For Hex Code-14, the LCD command will be Shift cursor position to the right
- For Hex Code-18, the LCD command will be Shift the entire display to the left
- For Hex Code-1C, the LCD command will be Shift the entire display to the right
- For Hex Code-80, the LCD command will be Force cursor to the beginning (1st line)
- For Hex Code-C0, the LCD command will be Force cursor to the beginning (2nd line)
- For Hex Code-38, the LCD command will be 2 lines and 5×7 matrix

3.6 Buzzer :

An audio signaling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered throughDC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs,it can generate different sounds like alarm, music, bell & siren.

Fig 3.6.1: Buzzer Pin Configuration

The **pin configuration of the buzzer** is shown below. It includes two pins namely positive and negative.The positive terminal of this is represented with the '+' symbol or a longer terminal. This terminal is powered through 6Volts whereas the negative terminal is represented with the '-'symbol or short terminal and it is connected to the GND terminal.

Specifications :

- Color is black
- The frequency range is 3,300Hz
- Operating Temperature ranges from – 20° C to +60°C
- Operating voltage ranges from 3V to 24V DC
- The sound pressure level is 85dBA or 10cm
- The supply current is below 15mA

Types of Buzzer :

A buzzer is available in different types which include the following.

- Piezoelectric
- Electromagnetic
- Mechanical
- Electromechanical
- Magnetic

Piezoelectric :

As the name suggests, the piezoelectric type uses the piezoelectric ceramic's piezoelectric effect & pulse current to make the metal plate vibrate & generate sound. This kind of buzzer is made with a resonance box, multi resonator, piezoelectric plate, housing, impedance matcher, etc. Some of the buzzers are also designed with LEDs.

The multi resonator of this mainly includes ICs and transistors. Once the supply is given to this resonator, it will oscillate and generates an audio signal with 1.5 to 2.kHz. The impedance matcher will force the piezoelectric plate to produce sound.

Electromagnetic :

This type of buzzer is made with a magnet, solenoid coil, oscillator, housing, vibration diaphragm, and magnet. Once the power supply is given, the oscillator which produces the audio signal current will supply throughout the solenoid coil to generate a magnetic field.

Sometimes, the vibration diaphragm will vibrate & generates sound under the magnet & solenoid coil interaction. The frequency range of this ranges from 2 kHz to 4kHz.

Mechanical :

These types of buzzers are subtypes of electromagnetic, so the components used in this type are also similar. But the main difference is that the vibrating buzzer is placed on the outside instead of the inside.

Electromechanical :

The designing of these types of buzzers can be done with a bare metal disc & an electromagnet. The working principle of this is similar to magnetic and electromagnetic. It generates sound throughout the disc movement & magnetism.

Magnetic:

Like a piezo type, magnetic is also used to generate a sound but they are different due to core functionality. The magnetic type is more fixed as compared to the piezo type because they work through a magnetic field. Magnetic buzzers utilize an electric charge instead of depending on piezo materials to generate a magnetic field, after that it permits another element of the buzzer to vibrate & generate sound.

The applications of magnetic buzzers are similar to the piezo type in household devices, alarms such as watches, clocks & keyboards

Working Principle :

The working principle of a buzzer depends on the theory that, once the voltage is given across a piezoelectric material, then a pressure difference is produced. A piezo type includes piezo crystals among two conductors. Once a potential disparity is given across these crystals, then they thrust one conductor & drag the additionalconductor through their internal property. So this continuous action will produce a sharp sound signal.

How to use a Buzzer? :

A buzzer is an efficient component to include the features of sound in our system or project. It is an extremely small & solid two-pin device thus it can be simply utilized on breadboard or PCB. So in most applications, this component is widely used.

There are two kinds of buzzers commonly available like simple and readymade. Once a simple type is power-driven then it will generate a beep sound continuously. A readymade type looks heavier & generates aBeep. Beep. Beep. This sound is because of the internal oscillating circuit within it.

This buzzer uses a DC power supply that ranges from 4V – 9V. To operate this, a 9V battery is used but it is suggested to utilize a regulated +5V/+6V DC supply. Generally, it is connected through a switching circuitto switch ON/OFF the buzzer at the necessary time interval.

Advantages :

- Simply Compatible
- Frequency Response is Good
- Size is small
- Energy Consumption is less
- The Range of Voltage usage is Large
- Sound Pressure is high

Disadvantages :

- Controlling is a little hard
- Generates Annoying Sound
- Training is necessary to know how to repair the condition without just turning off.

Applications :

- Communication Devices
- Electronics used in Automobiles
- Alarm Circuits
- Portable Devices
- Security Systems
- Timers
- Household Appliances
- Sporting Events
- Game shows

3.7 Flame Sensor :

A **flame detector** is a sensor designed to detect and respond to the presence of a flame or fire, allowing **flame detection**. Responses to a detected flame depend on the installation, but can include sounding an alarm, deactivating a fuel line (such as a propane or a natural gas line), and activating a fire suppression system. When used in applications such as industrial furnaces, their role is to provide confirmation that the furnace is working properly; in these cases they take no direct action beyond notifying the operator or control system. A flame detector can often respond faster and more accurately than a smoke or heat detector due to the mechanisms it uses to detect the flame.

Types Of Flame Sensors :

1. Optical flame detectors :

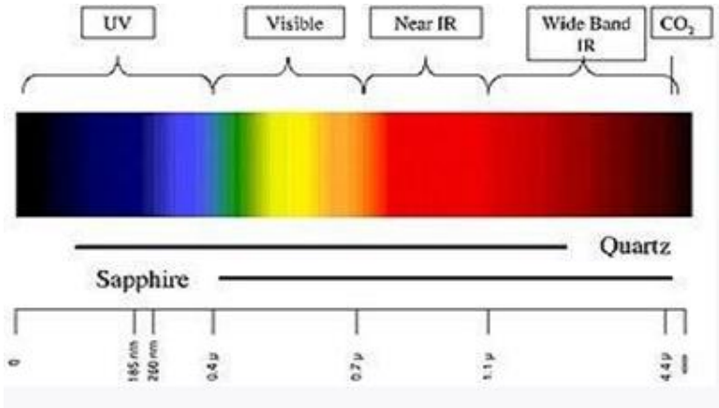

Fig 3.7.1 : Wavelength spectrum

Ultraviolet detector :

Ultraviolet (UV) detectors work by detecting the UV radiation emitted at the instant of ignition. While capableof detecting fires and explosions within 3–4 milliseconds, a time delay of 2–3 seconds is often included to minimize false alarms which can be triggered by other UV sources such as lightning, arc welding, radiation, and sunlight. UV detectors typically operate with wavelengths shorter than 300 nm to minimize the effects of natural background radiation. The solar blind UV wavelength band is also easily blinded by oily contaminants

Near IR array :

Near infrared (IR) array flame detectors (0.7 to 1.1 µm), also known as visual flame detectors, employ flame recognition technology to confirm fire by analyzing near IR radiation using a charge-coupled-device (CCD). A near infrared (IR) sensor is especially able to monitor flame phenomena, without too much hindrance from water and water vapour. Pyroelectric sensors operating at this wavelength can be relatively cheap. Multiple channelor pixel array sensors monitoring flames in the near IR band are arguably the most reliable technologies available for detection of fires. Light emission from a fire forms an image of the flame at a particular instant.

Infrared :

Infrared (IR) or wideband infrared (1.1 µm and higher) flame detectors monitor the infrared spectral band for specific patterns given off by hot gases. These are sensed using a specialized fire-fighting thermal imaging camera (TIC), a type of thermographic camera. False alarms can be caused by other hot surfaces and background thermal radiation in the area. Water on the detector's lens will greatly reduce the accuracy of the detector, as will exposure to direct sunlight. A special frequency range is 4.3 to 4.4 µm. This is a resonance frequency of CO_2. During burning of a hydrocarbon (for example, wood or fossil fuels such as oil and natural gas) much heat and CO_2 is released. The hot CO_2 emits much energy at its resonance frequency of 4.3 µm. This causes a peak in the total radiation emission and can be well detected.

Moreover, the "cold" CO_2 in the air is taking care that the sunlight and other IR radiation is filtered. This makes the sensor in this frequency "solar blind"; however, sensitivity is reduced by sunlight. By observing the flicker frequency of a fire (1 to 20 Hz) the detector is made lesssensitive to false alarms caused by heat radiation, for example caused by hot machinery. A severe disadvantage is that almost all radiation can be absorbed by water or water vapour; this is particularly valid for infrared flame detection in the 4.3 to 4.4 µm region. From approx. 3.5 µm and higher the absorption by water or ice is practically 100%. This makes infrared sensors for use in outdoor applications very unresponsive to fires. The biggest problem is our ignorance; some infrared detectors have an (automatic) detector window self test, but this self test only monitors the occurrence of water or ice on the detector.

A salt film is also harmful, because salt absorbs water. However, water vapour, fog or light rain also makes the sensor almost blind, without the user knowing. The cause is similar to what a fire fighter does if he approaches a hot fire: he protects himself by means of a water vapour screen against the enormous infrared heat radiation. The presence of water vapor, fog, or light rain will then also "protect" the monitor causing it to not see the fire. Visible light will, however be transmitted through the water vapour screen, as can easily been seen by the fact that a human can still see the flames through the water vapour screen.

Infrared thermal cameras :

MWIR infrared (IR) cameras can be used to detect heat and with particular algorithms can detect hot-spots withina scene as well as flames for both detection and prevention of fire and risks of fire. These cameras can be used in complete darkness and operate both inside and outside.

UV/IR :

These detectors are sensitive to both UV and IR wavelengths, and detect flame by comparing the threshold signal of both ranges. This helps minimize false alarms.

IR/IR flame detection:

Dual IR (IR/IR) flame detectors compare the threshold signal in two infrared ranges. Often one sensor looks at the 4.4 micrometer carbon dioxide (CO2), while the other sensor looks at a reference frequency. Sensing the CO2 emission is appropriate for hydrocarbon fuels; for non-carbon based fuels, e.g., hydrogen, the broadband water bands are sensed.

IR3 flame detection:

Multi-infrared detectors make use of algorithms to suppress the effects of background radiation (blackbody radiation), again sensitivity is reduced by this radiation.

Triple-IR flame detectors compare three specific wavelength bands within the IR spectral region and their ratio to each other. In this case one sensor looks at the 4.4 micrometer range while the other sensors look at reference wavelengths both above and below 4.4. This allows the detector to distinguish between non-flame IR sources and actual flames which emit hot CO2 in the combustion process. As a result, both detection range and

immunity to false alarms can be significantly increased. IR3 detectors can detect a $0.1m^2$ ($1 ft^2$) gasoline pan fire at up to 65 m (215 ft) in less than 5 seconds. Triple IRs, like other IR detector types, are susceptible to blinding by a layer of water on the detector's window.

Most IR detectors are designed to ignore constant background IR radiation, which is present in all environments. Instead they are designed to detect suddenly changing or increasing sources of the radiation. When exposed to changing patterns of non-flame IR radiation, IR and UV/IR detectors become more prone to false alarms, while IR3 detectors become somewhat less sensitive but are more immune to false alarms.

2. Other types :

Ionization current flame detection:

Fig 3.7.2 : Ionization Flame detectors

The intense ionization within the body of a flame can be measured by means by the phenomena of Flame Rectification whereby an AC current flows more easily in one direction when a voltage is applied. This current canbe used to verify flame presence and quality.

Such detectors can be used in large industrial process gas heaters and are connected to the flame control system. They usually act as both flame quality monitors and for flame failure detection. They are also common in a variety of household gas furnaces and boilers.

Thermocouple flame detection:

Thermocouples are used extensively for monitoring flame presence in combustion heating systems and gas cookers. A common use in these installations is to cut off the supply of fuel if the flame fails, in order to prevent unburned fuel from accumulating. These sensors measure heat and therefore are commonly used to determinethe *absence* of a flame. This can be used to verify the presence of a Pilot flame.

Applications :

- Hydrogen stations.
- Gas-fueled cookers
- Industrial heating and drying systems
- Domestic heating systems
- Industrial gas turbines

3.8 DHT11 SENSOR

The **DHT11** is a commonly used **Temperature and humidity sensor that** comes with a dedicated NTC tomeasure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data.

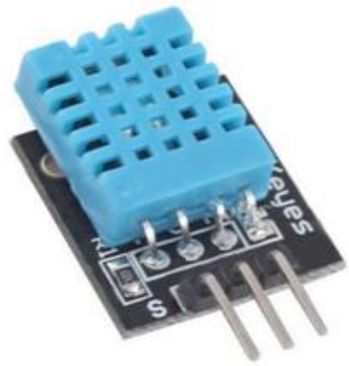

Fig 3.8.1 : DHT-11 Sensor

DHT11 Pinout Configuration:

For DHT11 Sensor:

Table 2 : DHT11 Sensor Pinout

No	Pin name	Description
1	VCC	Power supply 3.5V to 5.5V
2	DATA	Outputs both Temperature and Humidity through serial Data
3	NC	No Connection and hence not used
4	GROUND	Connected to the ground of the circuit

DHT11 Specifications:

- Operating Voltage: 3.5V to 5.5V
- Operating current: 0.3mA (measuring) 60uA (standby)
- Output: Serial data
- Temperature Range: 0°C to 50°C
- Humidity Range: 20% to 90%
- Resolution: Temperature and Humidity both are 16-bit
- Accuracy: ±1°C and ±1%

How to use DHT11 Sensor :

The DHT11 Sensor is factory calibrated and outputs serial data and hence it is highly easy to set it up. The connection diagram for this sensor is shown below.

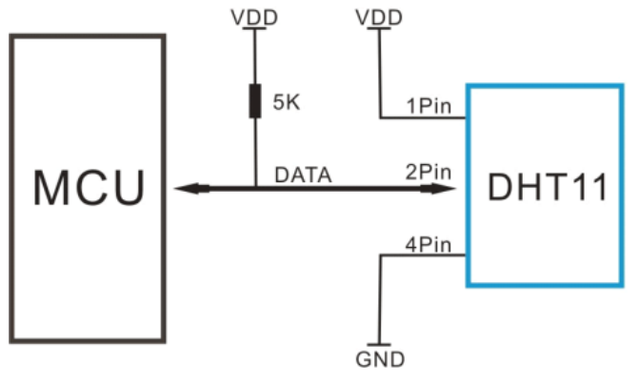

Fig 3.8.2 : DHT11 Working

you can see the data pin is connected to an I/O pin of the MCU and a 5K pull-up resistor is used. This data pinoutputs the value of both temperature and humidity as serial data. If you are trying to interface DHT11 with Arduino then there are ready-made libraries for it which will give you a quick start.If you are trying to interface it with some other MCU, then the datasheet given below will come in handy.

The output given out by the data pin will be in the order of 8bit humidity integer data + 8bit the Humidity decimal data +8 bit temperature integer data + 8bit fractional temperature data +8 bit parity bit. To request the DHT11 moduleto send these data the I/O pin has to be momentarily made low and then held high as shown in the timing diagram below.

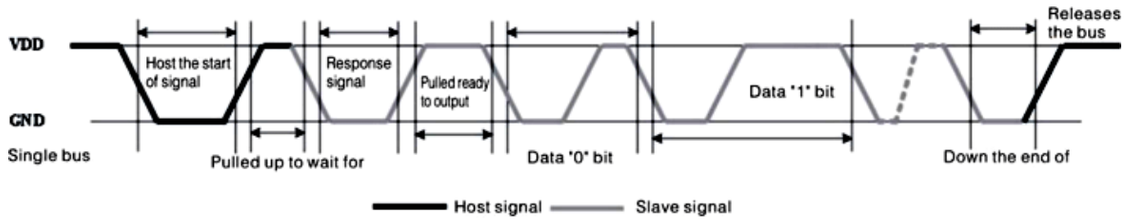

Fig 3.8.3 : Timing Diagram of DHT11.

Applications:

- Measure temperature and humidity
- Local Weather station
- Automatic climate control
- Environment monitoring

CHAPTER 4

CONTROLLER

4.1 Node MCU :

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 Ex press 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.

Key features of the Node MCU include:

1. Easy Programming: Node MCU can be programmed using Lua scripting language, which is simple andeasy to learn.
2. Wi-Fi Connectivity: It has built-in Wi-Fi capabilities, allowing your projects to connect to the internet andinteract with other devices.
3. GPIO Support: Node MCU has General Purpose Input/Output (GPIO) pins that can be used to connect andcontrol external hardware components.

4. Development Environment: It provides a development environment that includes a firmware Flashing tooland a serial port communication tool.
5. Open-Source: Node MCU is open-source, which means its design and code are freely available for anyoneto modify and improve.

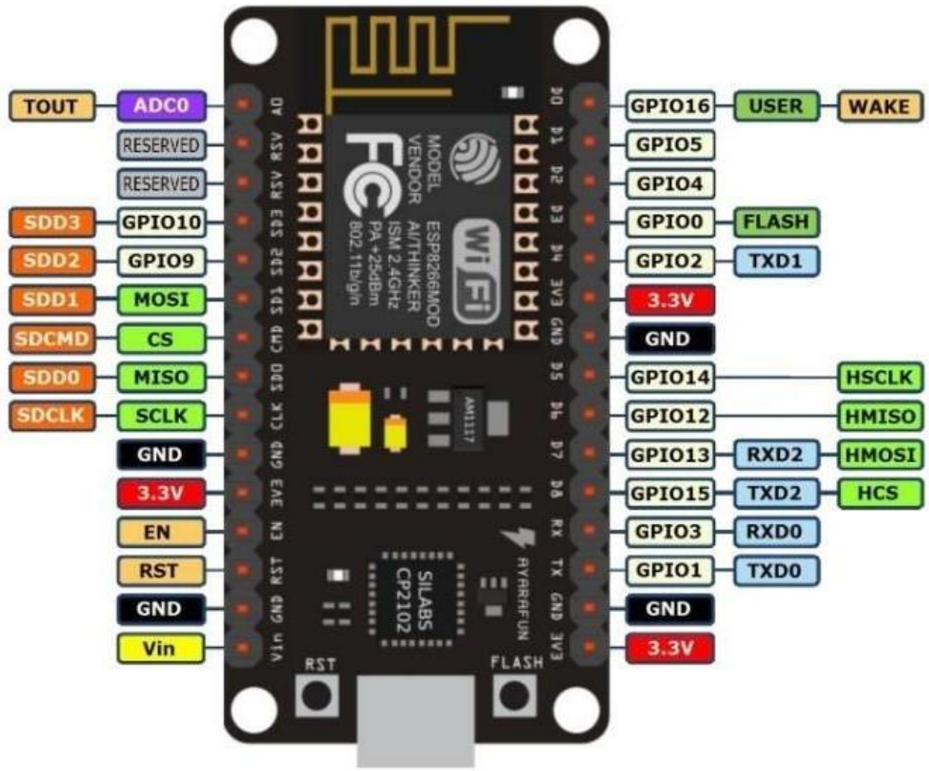

Fig:4.1 Pinout of Node MCU ESP8266

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 Due, they needed to modify the ARDUINO IDE so it would be relatively easy to change the IDE to support alternate toolchains 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 WiFi 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.

4.2 HISTORY :

Node MCU was created shortly after the ESP8266 came out. On December 30, 2013, ESPRESSIF systems began production of the ESP8266. Node MCU started on 13 Oct 2014, when Hong committed the first file of Node MCU- firmware to GitHub. 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.

4.3 HARDWARE:

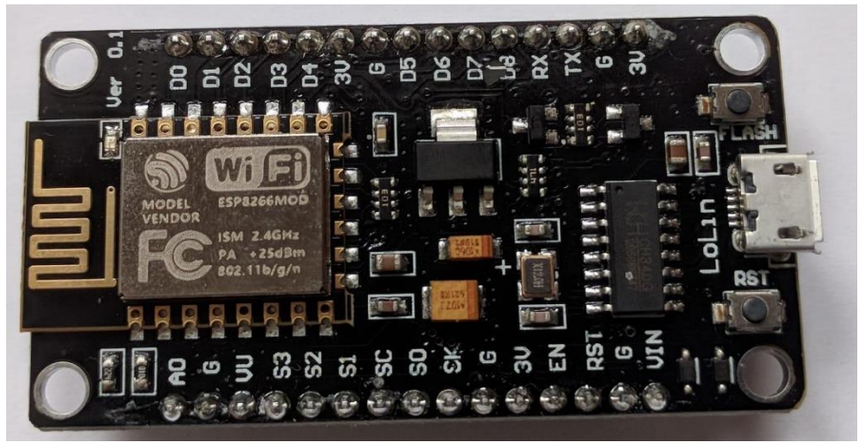

Fig 4.3: ESP8266 NODE MCU

The Node MCU development board is based on the ESP8266 WiFi module and provides a convenient platform for building IoT (Internet of Things) projects. Here are some key hardware features of the Node MCU board:

1. **ESP8266 Module**: The core of the Node MCU board is the ESP8266 WiFi module, which features a 32-bit Tensilica microcontroller running at 80MHz (or overclocked to 160MHz) and integrated WiFi connectivity.
2. **USB-to-Serial Converter**: The Node MCU board includes a USB-to-Serial converter chip (typically the CH340 or CP2102) that allows you to program the ESP8266 module and communicate with it over USB.
3. **Power Supply**: The Node MCU board can be powered via the USB port or an external power source connected to the VIN pin. It operates at 3.3V and has a built-in voltage regulator to provide a stable power supply to the ESP8266 module.
4. **GPIO Pins**: The Node MCU board provides several GPIO (General Purpose Input/Output) pins that can be used for digital input/output, analog input, and various other functions. The number of GPIO pins varies depending upon requirements the specific Node MCU board version.
5. **Reset and Flash Buttons**: The Node MCU board typically includes a reset button and a flash button. The reset button can be used to reset the ESP8266 module, while the flash button is used to put the module into bootloader mode for firmware flashing.

6. **LEDs**: Some Node MCU boards include onboard LEDs that can be used for indicating the board's status or for general purpose use in your projects.
7. **Additional Features**: Depending on the specific Node MCU board version, there may be additional features such as voltage level shifters, additional power pins, or onboard sensors.

4.4 SOFTWARE DEVLOPMENT

A program for NODE MCU may be written in any programming language for a compiler that produces binary machine code for the target processor. Atmel provides a development environment for their microcontrollers, AVR Studio and the newer Atmel Studio.

The ESP8266 project provides the Arduino integrated development environment (IDE), which is a cross-platform application written in the programming language Java. It originated from the IDE for the languages *Processing* and *Wiring*. It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, brace matching, and syntax highlighting, and provides simple *one-click* mechanisms to compile and upload programs to an Arduino board. It also contains a message area, a text console, a toolbar with buttons for common functions and a hierarchy of operation menus.

A program written with the IDE for Arduino is called a *sketch*.[40] Sketches are saved on the development computer as text files with the file extension *.ino*. Arduino Software (IDE) pre-1.0 saved sketches with the extension *.pde*. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which providesmany common input and output procedures. User-written code only requires two basic functions, for startingthe sketch and the main program loop, that are compiled and linked with a program stub *main()* into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution, encoding that is loaded into the Arduino board by a loader program in the board's

Applications

- Xoscillo, an open-source oscilloscope
- Arduinome, a MIDI controller device that mimics the Monome
- OBDuino, a trip computer that uses the on-board diagnostics interface found in most modern cars
- Ardupilot, drone software and hardware
- Gameduino, an Arduino shield to create retro 2D video games
- Arduino Phone, a do-it-yourself cellphone
- Water quality testing platform
- Automatic titration system based on Arduino and stepper motor
- Low cost data glove for virtual reality applications
- Impedance sensor system to detect bovine milk adulteration
- Homemade CNC using Arduino and DC motors with close loop control by Homofaciens
- DC motor control using Arduino and H-Bridge

Technical Specifications :

The Node MCU is based on the ESP8266 microcontroller, which provides the following technical specifications:

- Microcontroller: ESP8266EX
- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins: 11
- Analog Input Pins: 1 (3.2V max)
- Clock Speed: 80MHz (can be overclocked to 160MHz)
- Flash Memory: 4MB
- Wi-Fi: 802.11 b/g/n (2.4 GHz)
- Integrated TCP/IP protocol stack
- On-board USB-to-Serial converter
- Dimensions: 48mm x 26mm
- Weight: 7g
- Programming Language: C, C++, Lua, Arduino.

CHAPTER-5

SOFTWARE

5.1 Software Introduction:

Arduino IDE Software. You can get different versions of Arduino IDE from the Download page onthe Arduino Official website. You must select your software, which is compatible with your operating system (Windows, IOS, or Linux). After your file download is complete, unzip the file.

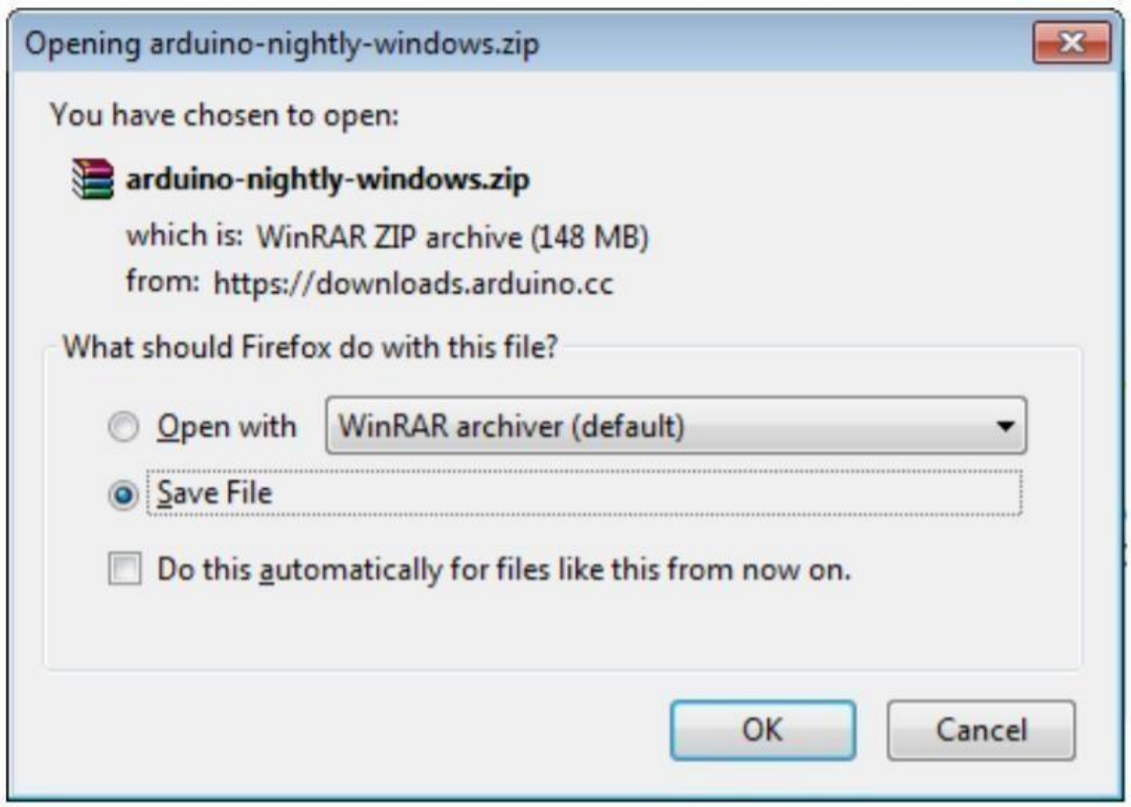

Fig 5.1.1: Opening arduino-nightly-windows.zip

Launch Arduino IDE. After your Arduino IDE software is downloaded, you need to unzip the folder.

Inside the folder, you can find the application icon with an infinity label (application.exe). Doubleclick theiconto start the IDE.

Open your first project. Once the software starts, you have two options:

- Create a new project.
- Open an existing project example.

To create a new project, select File --> New

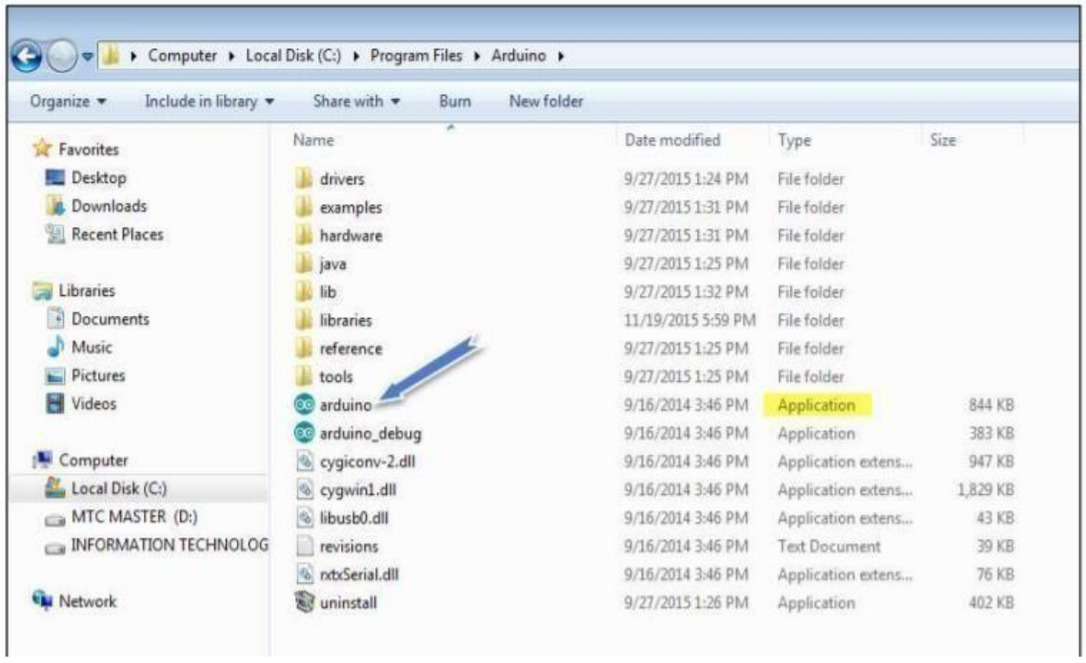

Fig 5.1.2: Launch Arduino IDE

Launch Arduino IDE on your PC and go to File > Preferences.

Add "http://arduino.esp8266.com/stable/package_esp8266com_index.json" to the "Additional Board Manager URLs" field, then navigate to Tools > Board > Boards Manager.Search for "esp8266" and install the package, then select your Node MCU board from Tools > Board.

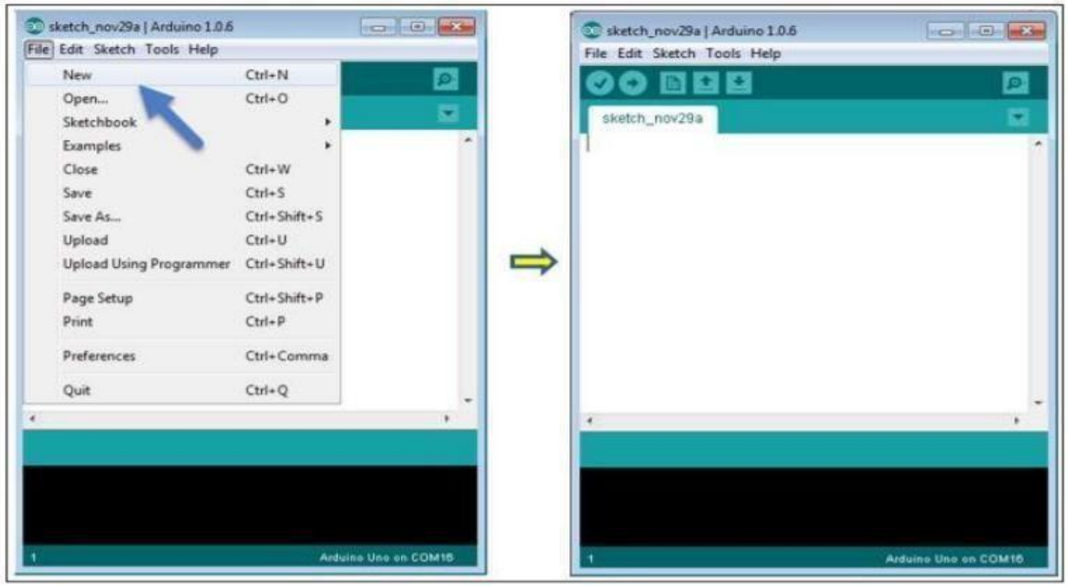

Fig 5.1.3: Create a new project

Choose the correct port from Tools > Port and write your code.

Verify and compile it by clicking the checkmark icon, then upload your code by clicking the right arrow icon.

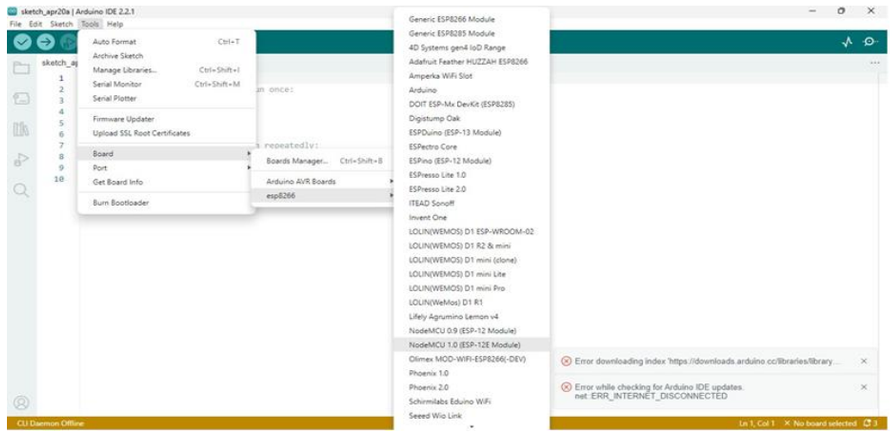

Fig 5.1.4: Selecting Board

Here, we are selecting just one of the examples with the name Blink. It turns the LED on and off with some time delay. Select the serial device of the Select the version of board that you are using. Since I have an Arduino Uno plugged in, I obviously selected"Node MCU 1.0 (ESP-12E Module)" Go to Tools -> Serial Port menu. This is likely to be COM3 or higher (COM1 and COM2 are usually reserved for hardware serial ports). To find out, you can disconnect your Node MCU 1.0 (ESP-12E Module) board and re-open the menu, the entry that disappears should be of the Node MCU 1.0 (ESP-12E Module).

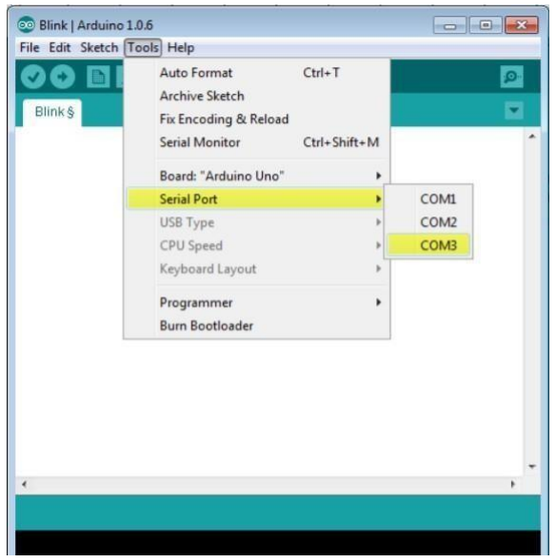

Fig:5.1.5: Select your serial port

Before explaining how we can upload our program to the board, we must demonstrate the function of each symbol appearing in the Arduino IDE toolbar.

A- Used to check if there is any compilation error.

B- Used to upload a program to the esp8266 Node MCU board.

C- Shortcut used to create a new sketch.

D- Used to directly open one of the example sketch.

E- Used to save your sketch.

F- Serial monitor used to receive serial data from the board and send the serial data to the board.Now, simply click the "Upload" button in the environment.

Wait a few seconds; you will see the RX and TX LEDs on the board, flashing. If the upload is successful,the message "Done uploading" will appear in the status bar.

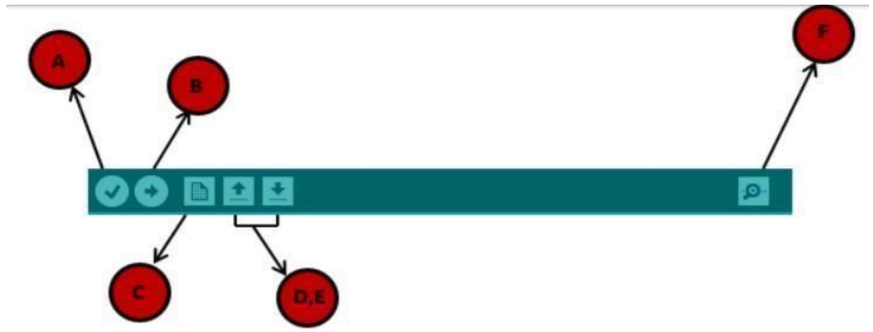

Fig:5.1.6: Function of each symbol appearing in the Arduino IDE toolbar

In this chapter, we will study in depth, the Arduino program structure and we will learn more new terminologies used in the Arduino world. The Arduino software is open-source. The source code for the Java environment is released under the GPL and the C/C++ microcontroller libraries are under the LGPL. Sketch: The first new terminology is the Arduino program called “sketch”. Structure Arduino programs can be divided in three main parts: Structure, Values (variables and constants), and Functions. In this tutorial, we will learn about the Arduino software program, step by step, and how we can write the program without any syntax or compilation error. Let us start with the Structure. Software structure consist of two main functions:

Setup( ) function

Loop( ) function

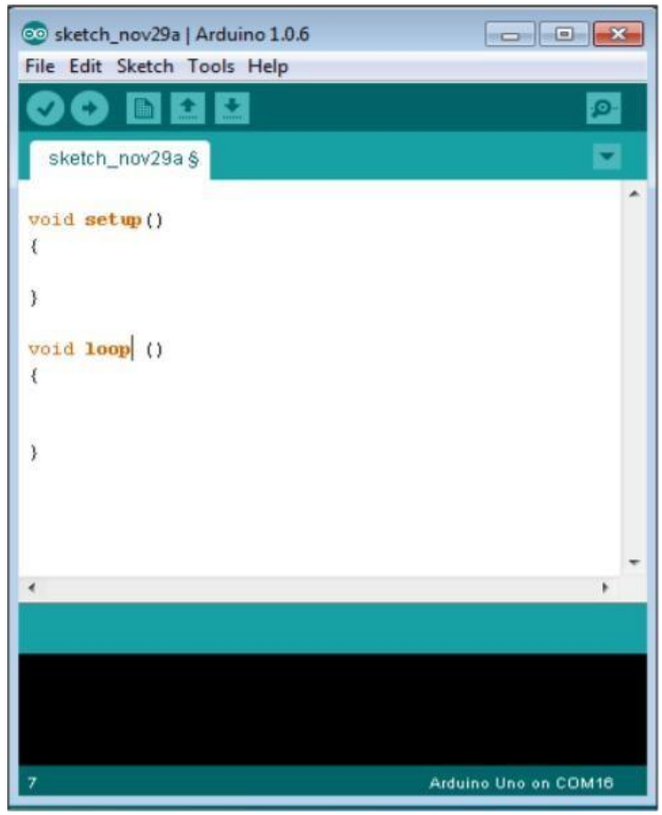

Fig:5.1.7: Bare minimum code

Data types in C refers to an extensive system used for declaring variables or functions of different types.The type of a variable determines how much space it occupies in the storage and how the bit pattern stored is interpreted. The following table provides all the data types that you will use during Arduino programming.

5.2 Code Used For The Prototype :

```
#include <ESP8266WiFi.h>
//#include <BlynkSimpleEsp8266.h>
#include <WiFiClient.h>
#include <ESP8266WebServer.h>
#include <Wire.h>
#include <LiquidCrystal.h>
#include "DHT.h"

LiquidCrystal lcd (16, 5, 4, 0, 2, 14);

#define DHTPIN 15     // Digital pin connected to the DHT sensor
#define DHTTYPE DHT11   // DHT 22  (AM2302), AM2321

int fire = 12;
int buzzer = 13;

const char* ssid = "projectshub";
const char* password = "projectshub";
const char *host = "maker.ifttt.com";
const char *privateKey = "bcIobygfgfKB8xo1-ilmim0pbtRa2Rm9AJToohYUpOp";
ESP8266WebServer server(80); //Server on port 80
void send_event(const char *event);
DHT dht(DHTPIN, DHTTYPE);
const int sensor=A0; // Assigning analog pin A5 to variable 'sensor'
float tempc; //variable to store temperature in degree Celsius
float tempf; //variable to store temperature in Fahreinheit
float vout; //temporary variable to hold sensor reading
```

```
String Message;
const char MAIN_page[] PROGMEM = R"=====(
<!doctype html>
<html>
<head>
 <title>Data Logger</title>
 <h2 style="text-align:center;">FIRE DEPARTMENT ALERTING SYSTEM</h2>
 <style>
 canvas{
  -moz-user-select: none;
  -webkit-user-select: none;
  -ms-user-select: none;
 }
 /* Data Table Styling*/
 #dataTable {
  font-family: "Trebuchet MS", Arial, Helvetica, sans-serif;
  border-collapse: collapse;
  width: 100%;
  text-align: center;
 }
 #dataTable td, #dataTable th {
  border: 1px solid #ddd;
  padding: 8px;
 }
 #dataTable tr:nth-child(even){background-color: #f2f2f2;}
 #dataTable tr:hover {background-color: #ddd;}
 #dataTable th {
  padding-top: 12px;
  padding-bottom: 12px;
  text-align: center;
```

```
    background-color: #050505;
    color: white;
  }
  </style>
</head>
<body>
<div>
  <table id="dataTable">
    <tr><th>Time</th><th>Activity</th></tr>
  </table>
</div>
<br>
<br>
<script>
var Avalues = [];
//var timeStamp = [];
var dateStamp = [];
setInterval(function() {
  // Call a function repetatively with 5 Second interval
  getData();
}, 3000); //5000mSeconds update rate
function getData() {
  var xhttp = new XMLHttpRequest();
  xhttp.onreadystatechange = function() {
    if (this.readyState == 4 && this.status == 200) {
     //Push the data in array
 // var time = new Date().toLocaleTimeString();
  var date = new Date();
  var txt = this.responseText;
  var obj = JSON.parse(txt);
```

```
      Avalues.push(obj.Activity);
     // timeStamp.push(time);
      dateStamp.push(date);
  //Update Data Table
    var table = document.getElementById("dataTable");
    var row = table.insertRow(1); //Add after headings
    var cell1 = row.insertCell(0);
    var cell2 = row.insertCell(1);
    cell1.innerHTML = date;
    //cell2.innerHTML = time;
    cell2.innerHTML = obj.Activity;
    }
  };
  xhttp.open("GET", "readData", true); //Handle readData server on ESP8266
  xhttp.send();
}
</script>
</body>
</html>

)=====";
void handleRoot() {
 String s = MAIN_page; //Read HTML contents
 server.send(200, "text/html", s); //Send web page
}

void readData() {
  int fire_state = digitalRead(fire); //Continuously check the state of PIR sensor

  int t = dht.readTemperature();
```

```
  lcd.setCursor(0, 0);
  lcd.print("T:");
  lcd.setCursor(2, 0);
  lcd.print(t);
  lcd.print("  ");
  delay(100);

    if(fire_state == LOW){
    lcd.setCursor(0, 1);
    lcd.print("fire:D    ");
    digitalWrite (buzzer, HIGH);    //If intrusion detected ring the buzzer
    delay(1000);
    digitalWrite (buzzer, LOW);
    Message = "fire Deteced";
    String data = "{\"Activity\":\""+ String(Message) +"\"}";
    server.send(200, "text/plane", data); //Send ADC value, temperature and humidity JSON to client ajax
request
//    send_event("motion_event");
//    Serial.println("Motion detected!");
    }

    if(fire_state == HIGH){
    lcd.setCursor(0, 1);
    lcd.print("fire:UD   ");
    }
//    Message = temperature;
//    String data = "{\"Activity\":\""+ String(Message) +"\"}";
//    server.send(200, "text/plane", data); //Send ADC value, temperature and humidity JSON to client
ajax request
```

```
  delay(500);                    //Check state of PIR after every half second
}




void setup() {
  Serial.begin(115200);  /* Define baud rate for serial communication */
  pinMode(fire, INPUT);
  pinMode(buzzer, OUTPUT);
  pinMode(sensor,INPUT); // Configuring sensor pin as input

  digitalWrite(fire, 1);

//  lcd.init();                    // initialize the lcd
//  lcd.init();

//  lcd.backlight();

  dht.begin();

  lcd.begin(16, 2);
  lcd.setCursor(0, 0);
  lcd.print(" WELCOME TO THE");
  lcd.setCursor(0, 1);
  lcd.print("   PROJECT   ");
  delay(2000);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print(" FIRE ALERTING ");
```

```
lcd.setCursor(0, 1);
lcd.print("   SYSTEM      ");
delay(2000);
lcd.clear();

lcd.setCursor(0, 0);
lcd.print("SSID:");
lcd.setCursor(0, 1);
lcd.print("projectshub");
delay(2000);
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("PSWD:");
lcd.setCursor(0, 1);
lcd.print("projectshub");
delay(2000);
lcd.clear();
lcd.print("Wifi Connecting");



WiFi.begin(ssid, password);
 int wifi_ctr = 0;
 while (WiFi.status() != WL_CONNECTED) {
   lcd.print(".");
 delay(500);
 }
 lcd.clear();
 lcd.print("Wifi Connected");
 delay(1000);
```

```
 lcd.clear();
 lcd.print(WiFi.localIP()); delay(2000);
 lcd.clear();

 Serial.println("");
 Serial.println("Successfully connected to WiFi.");
 Serial.println("IP address is : ");
 Serial.println(WiFi.localIP());
 server.on("/", handleRoot);      //Which routine to handle at root location. This is display page
 server.on("/readData", readData); //This page is called by java Script AJAX
 server.begin();                  //Start server
 Serial.println("HTTP server started");
}



void loop()
{
  server.handleClient();          //Handle client requests

/*
  float temperature = analogRead(A0);
  temperature = (temperature * resolution);
  temperature = temperature * 100;



  lcd.setCursor(0, 0);
  lcd.print("T:");
  lcd.setCursor(2, 0);
  lcd.print(temperature);
```

```
  delay(100);

  if (digitalRead(fire) == 0)
  {
    lcd.setCursor(9, 1);
    lcd.print("fire:D  ");
  }
  if (digitalRead(fire) == 1)
  {
    lcd.setCursor(9, 1);
    lcd.print("fire:UD");
  }
  delay(200);
*/
}



void send_event(const char *event)
{
  Serial.print("Connecting to ");
  Serial.println(host);
  // Use WiFiClient class to create TCP connections
  WiFiClient client;
  const int httpPort = 80;
  if (!client.connect(host, httpPort)) {
    Serial.println("Connection failed");
    return;
  }
  // We now create a URI for the request
```

```
  String url = "/trigger/";
  url += event;
  url += "/with/key/";
  url += privateKey;
  Serial.print("Requesting URL: ");
  Serial.println(url);
  // This will send the request to the server
  client.print(String("GET ") + url + " HTTP/1.1\r\n" +
               "Host: " + host + "\r\n" +
               "Connection: close\r\n\r\n");
  while(client.connected())
  {
    if(client.available())
    {
      String line = client.readStringUntil('\r');
      Serial.print(line);
    } else {
      // No data yet, wait a bit
      delay(50);
    };
  }
  Serial.println();
  Serial.println("closing connection");
  client.stop();
}
```

CHAPTER 6

RESULT

6.1 WORKING

The proposed system consists of two modules viz. IoT sensor node and application deployed in the central location. The IoT sensor node is designed and integrated with ESP8266 Node MCU. Here all the sensors are integrated with the ESP8266. The proposed architecture of fire detection is shown in the Fig 6.1.1. The various steps of proposed work are explained in this subsection. The first step of forest fire detection is, before the fire starts ignited it monitor the temperature level and the sensors integrated in the ESP8266 Node MCU such as Temperature sensor, Fire sensor. If there is any raise in temperature or it reaches above the threshold value it push the notification to the fire department via Webpage.

Simultaneously it can be detected by using the various sensors such as temperature. If there are any such natural calamities like lightening, burning waste material sensorsintegrated in the ESP8266 Node MCU detects and sends signal to the Wi-Fi. And then send information to the admin if there is a high increase of temperature. With the help of temperature sensor it detects and sends the signal to the admin. According to sensor behavior all the Detected signals are sent to the forest department admin.

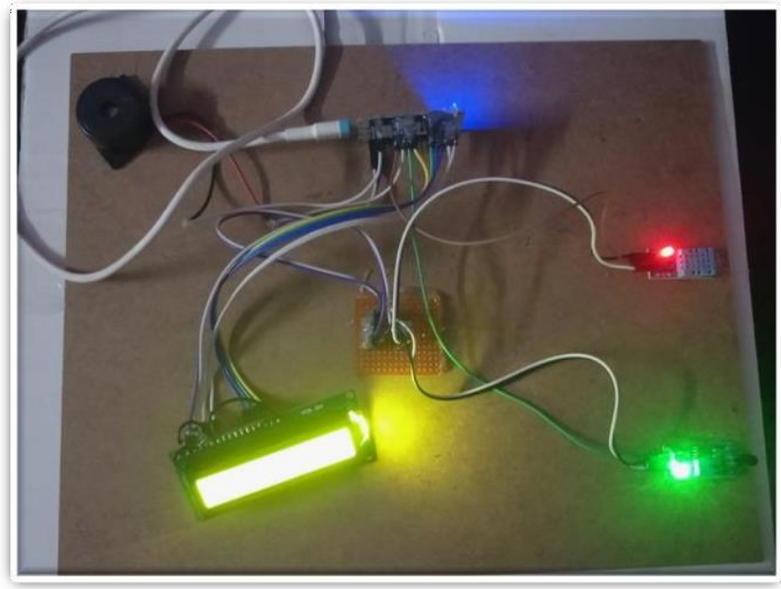

Fig 6.1.1: Prototype of proposed system

- Sensors monitor designated areas for fire incidents.
- Node MCU ESP8266 processes sensor data locally.
- Alerts are displayed on-site via LCD display and buzzer.
- Real-time fire incident information accessible via a website hosted on ESP8266.
- Users connect to ESP8266 Wi-Fi network and access the website using its IP address.
- The system ensures rapid response and proactive fire safety measures with local access.

LIVE WEBPAGE:

- Connect to ESP8266 using Wi-Fi and Note the IP Address.
- Open any Browser in Mobile/PC, just type the IP Address in search bar**.**

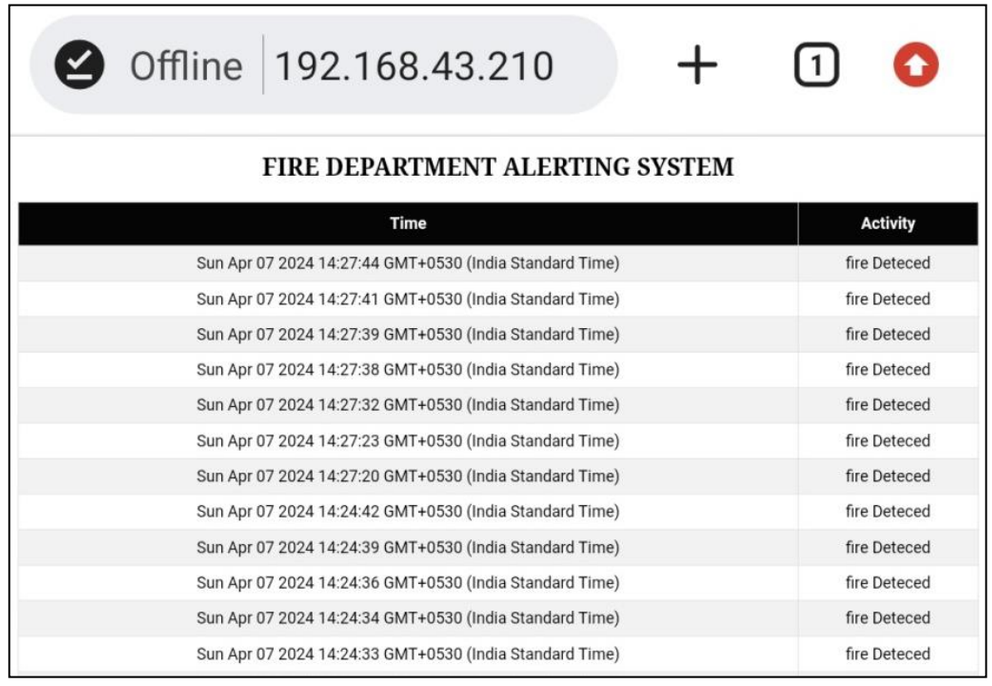

Fig 6.1.2 : Output in a live webpage

6.2 ADVANTAGES:

- Simple operation for users of all levels.
- Low-cost implementation for affordability.
- Real-time monitoring ensures timely response to fire incidents.
- Alerts via LCD display and buzzer for immediate notification.
- Accessible website interface for convenient information retrieval.
- Proactive fire prevention measures reduce potential damage.
- Enhances overall safety and peace of mind for users.

6.3 APPLICATIONS :

- Home fire safety improvement.
- Office building protection.
- Factory fire prevention.
- Public area emergency response.
- Smart city safety enhancement

6.4 RESULT :

The implementation of the IoT-based fire department and alerting system underscores the importance of leveraging technology to enhance emergency preparedness and response. By seamlessly integrating sensor data and communication protocols, the system empowers authorities to proactively address fire incidents, minimizing damage and saving lives.Its scalable architecture and adaptable features position it as a valuable asset in safeguarding the social welfare and regional communities against fire-related hazards

CHAPTER 7

CONCLUSION & FUTURE SCOPE

CONCLUSION :

The integrated IoT system developed for automated detection, monitoring, and resolution of fire incidents in residential and commercial spaces is a significant milestone in fire safety technology. By expanding its solution to cover fire accidents in homes, buildings, and apartments, the project addresses a critical need for comprehensive fire prevention and response measures. Utilizing advanced microcontroller technology, Wi-Fi connectivity, and precision sensors ensures accurate detection of fire hazards, enabling swift and effective intervention. The benefits of this innovative solution are manifold. Not only does it prevent property damage by detecting and controlling fires at their early stages, but it also enhances safety in both residential and commercial spaces. By leveraging IoT technology, authorities and building occupants gain access to real-time data and alerts, empowering them to take proactive measures to mitigate fire risks.

In conclusion, the implementation of this IoT-based fire safety system represents a crucial step forward in safeguarding communities against the devastating impact of fire accidents. Its comprehensive approach, coupled with advanced technology and quick response mechanisms, sets a new standard for fire prevention and emergency management in both residential and commercial settings. As we continue to refine and expand upon this system, we move closer to achieving our goal of creating safer environments for all.

FUTURE SCOPE :

IoT Expansion : The project could evolve to incorporate more IoT devices and sensors, enabling Comprehensive monitoring of additional environmental factors beyond just fire detection.

Smart Integration : Future developments might involve integrating with smart home systems or buildingautomation platforms to create a seamless and interconnected safety ecosystem, enhancing overall efficiency and user experience.

REFERENCS :

[1] Bosch, Ignacio & Gomez, Soledad & Vergara, Luis.(2007). Automatic Forest Surveillance Based on Infrared Sensors.

[2] Y. Deshpande, K. Savla, C. Lobo, S. Bhattacharjee, and J. Patel, "Forest Monitoring System Using Sensors, Wireless Communication, and Image Processing," 2018 Fourth International Conference on Computing Communication Control and Automation (ICCUBEA)

[3] Miriyala, Trinath & Karthik, Ragipati & Mahitha, J & Reddy, V. (2018). IoT based forest fire detection system. International Journal of Engineering & Technology.

[4] Molina-Pico, A., et al., Forest Monitoring and Wild land Early Fire Detection by a Hierarchical Wireless Sensor Network. Journal of Sensors, 2016.

[5] Tsiourlis, G., S. Andreadakis, and P. Konstantinidis, SITHON: a wireless network of in situ optical cameras applied to the early detection-notification-monitoring of forest fires. Sensors,2009.

[6] Lloret, J., et al., A wireless sensor network deployment for rural and forest fire detection and verification. Sensors, 2009.

[7] Sharma, Abhinav Kumar, Md Faiz Raza Ansari, Md Firoz Siddiqui, and Mirza Ataullah Baig. IOT ENABLED FOREST FIRE DETECTION AND ONLINE MONITORING SYSTEM.