

FOREST FIRE DETECTION USING IOT

Submitted in partial fulfillment of the requirements for the award of

**Bachelor of Engineering in
Electronics and Communication Engineering**

By

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(DEEMED TO BE UNIVERSITY)**

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **PRAVEENKUMAR S (37130325)** and **RAM N (37130339)** who carried out the project entitled "**FOREST FIRE DETECTION USING IOT**" under our supervision from October 2020 to March 2021.

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We **PRAVEENKUMAR S (37130325)** and **RAM N (37130339)**, hereby declare that the Project Report entitled **FOREST FIRE DETECTION USING IOT** is done by us under the guidance of **Dr.V.BALAMURUGAN,.M.Tech.,Ph.D** is submitted in partial fulfillment of the requirements for the award of the degree in Electronics and Communication Engineering.

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1.

Place :

2.

Signature of the students

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ABSTRACT

The design of a framework for tracking and preventing forest fires using IOT is presented in this project. An initial investigation into the causes of forest fires, as well as how to prevent them, requires a clear understanding of how to incorporate a valid network architecture capable of detecting potential changes in the ecosystem, so that we can avoid a catastrophe (forest fire) that could result in the loss of a large number of natural resources, wild life and human life.

The main goal of our device is to detect a forest fire and issue an alarm using IoT, a buzzer, and GSM. The design of the system is made up of different types of sensors, these sensors plays a major role in detecting the forest fire and used to alert the people nearby. Also we are able to monitor the observed area in real-time via IOT webpage. We have also implemented a defensive setup using servo motor to sprinkle water in the area around the setup in-case of any minor fire.

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LIST OF ABBREVIATIONS

IOT	- Internet of Things
RTOS	- Real Time Operating System
GPS	- Global Positioning System
UAV	- Unmanned Aerial Vehicle
WSN	- Wireless Sensor Networks
GSM	- Global System for Mobile communication
FTDI	- Future Technology Devices International
EEPROM	- Electronically Erasable Programmable Read-Only Memory
SRAM	- Static Random Access Memory
LEL	- Lower Explosion Limit
UEL	- Upper Explosion Limit
PID	- Photo Ionization Detectors
IR	- Infra Red
OSHA	- Occupational Safety and Health Admin
UV	- Ultra Violet
WAAS	- Wide Area Augmentation System
DGPS	- Differential GPS
ADC	- Analog to Digital Converter
TTF	- Time To First Fix
TDMA	- Time Division Multiple Access
PSDN	- Packet Switched Data Network
ISDN	- Integrated Services Digital Network
IMEI	- International Mobile Equipment Identity
FDN	- Fixed Dialing Number
SoC	- System on a Chip
NodeMCU	- Node MicroController Unit
GPIO	- General Purpose Input Output

CHAPTER 1

1.1 INTRODUCTION

- Forest fires are a common occurrence in almost all parts of the world. It's most common in dry forests during summer. Forest fires of varying severity and magnitude burns a vast area of forest every year.
- Forest fires can be fatal, damaging houses, animal habitat, and trees, also destroying natural resources as well as polluting the environment with toxic pollutants. Carbon dioxide, a primary greenhouse gas, is also released into the troposphere.
- Forest fires contribute to the greenhouse effect and climate change by increasing carbon dioxide levels in the atmosphere. Furthermore, ashes deplete soil nutrients and cause floods and landslides by eroding the soil.
- As a consequence, the development of a reliable forest fire detection method is essential. It detects a fire signal using temperature and smoke detection sensors and sends an alert to the client via an IOT cloud server.

1.2 OBJECTIVES

- The primary objective of this project is to detect the forest fire as soon as possible using emerging the technologies IOT and GSM.
- The aim of this work is to use sensors and a microcontroller to detect a forest fire and alert the client through mobile notification using GSM.
- The setup alerts the local inhabitants and wild life around the particular area via buzzer.
- To locate the actual location of fire inside a dense wild forest using GPS and alert the fire department, so they can respond appropriately before any casualty.

CHAPTER 2

2.1 LITERATURE SURVEY

1. Alexander A. Khamukhin et al : Aerial Forest Fire Surveillance - Evaluation of Forest Fire Detection Model using Aerial Videos

Unmanned aerial vehicles (UAVs), which can offer an aerial view for rapid response in large-scale crisis areas, have increasingly been used to track forest fires. This paper investigates a general model of forest fire detection using aerial videos in order to show its robustness for use in aerial forest fire surveillance. Fire pixels are created using the colour and motion characteristics of fire. Our fire detection model's accuracy is tested using a large database of various scene situations in order to show the reliability as well as the shortcomings of our previous study's fire detection model. There are 49 aerial videos in our collection, with a total of 16898 forest fire frames analysed. Our forest fire detection model is 93.97 percent accurate, with a false alarm rate of 7.08 percent and a miss rate of 6.86 percent, respectively. Thick smoke that covers almost the entire fire is the primary cause of miss detection in our fire detection model. To improve detection accuracy, we propose an additional stage of smoke detection in this study. The colour and motion of the smoke are used to segment the pixels. The results show that in the event of smoke, the smoke detection stage aids in identifying the fire area.[1]

2. Shixiao Wu et al : Speculation of Forest Fire Using Spatial and Video Data

Forest fires are a natural disaster that wreak havoc across the globe. The vegetation bears the brunt of the destruction in high-severity explosions. As a consequence, in order to protect the trees, this fire must be contained within the forest environment. There are currently frameworks of image recognition systems that analyse a static forest fire image to provide information on fire hot spots. With such static images, fire motion/movement analysis with forest zone analysis is challenging. This dilemma can be solved by using real-time video surveillance to track the burn. As a result, the proposed architecture offers a novel method for analysing forest fire flame movement using videos and spatiotemporal data.[2]

3. *Evizal Abdul Kadir et al: Modeling of Wireless Sensor Networks for Detection Land and Forest Fire Hotspot*

Forest fires are a major problem and catastrophe in Indonesia due to the country's tropical location and the prevalence of peat land, which poses a high risk of burning, especially during the dry season. Forest fires are frequent in Riau Province, affecting Indonesia's entire length and width. This study proposes the establishment of Wireless Sensor Networks (WSNs) in Indonesia for the identification of forest fire hotspots, with an emphasis on Riau Province, which is one of the areas with a high risk of forest fire during the dry season. Land sensor systems gather environmental data and report any modifications to a data centre for review using WSN technology. Software processing for fire hotspot identification is done in a data centre in order to determine and conclude whether a fire hotspot has the ability to become a major fire. Sensors will be installed at a variety of locations, including those that have recently seen a fire and those that are expected to do so in the future. Mathematical simulation is used in this case to model the number of sensors that must be installed as well as the forest's size. The design and development of WSNs has a significant effect and feasibility in solving Indonesia's current forest fire and fire hotspot detection problems. WSNs were used in the development of this system, which are ideal for early warning and alarm systems for hotspot detection.[3]

4. Hanh Dang-Ngoc et al : Aerial Forest Fire Surveillance - Evaluation of Forest Fire Detection Model using Aerial Videos

Forest fire control has recently been done using unmanned aerial vehicles (UAVs), which can offer an aerial view for fast response in large-scale disaster areas. One general model of forest fire detection using aerial videos is investigated in this paper in order to demonstrate its robustness for use in aerial forest fire surveillance.

The colour and motion properties of fire are used to remove fire pixels. The fire detection performance is assessed using a large database of various scene conditions to demonstrate the efficacy as well as the shortcomings of our previous fire detection model. In this analysis, we suggest an additional stage of smoke detection to improve detection efficiency. Smoke pixels are segmented using both color and motion characteristics of smoke. The results prove that smoke detection stage give help in detecting the fire area in case of smoke.[4]

5. T.L. Divya et al : Speculation of Forest Fire Using Spatial and Video Data

Forest fires are a natural calamity that devastate the world. In high-severity fires, vegetation takes the brunt of the destruction. As a result, this fire must be detected inside the forest region in order to save trees. Image processing device software are currently available that conduct analysis on a static forest fire image and provide information on fire hot spots. Fire motion/movement mapping with forest region analysis is challenging with such static images. This dilemma can be solved by constantly watching the flames on screen. As a result, the new design provides an innovative approach for analysing forest fire flame movement using images and spatiotemporal functions.[5]

In the upcoming chapter, we are going to discuss the proposed and existing work of the project, which we have implemented using the modern IOT technology.

CHAPTER 3

3.1 AIM AND SCOPE OF THE PRESENT INVESTIGATION

The goal is to find the forest fire as quickly as possible, and pinpointing its exact location and notifying fire units as soon as to take action. The goal is to detect forest fires using various sensors and microcontrollers, and to warn the client through IOT cloud servers and mobile notification, as well as to detect forest fires and alert the fire unit so as they can respond appropriately and avoid any casualties. As a result, the development of an effective forest fire detection technique is required. It uses temperature and smoke detection sensors to detect a fire signal and sends a warning to the client via an IOT cloud server.

Throughout the years, several fire detection solutions have been introduced and used. To begin, video surveillance systems of various types are the commonly used systems for detecting forest fires. While video technology is not the most precise, it is commonly used because of its low cost and reasonable performance.

The design of a framework for tracking and preventing forest fires using IOT is presented in this article. An initial analysis of the causes for forest fires, as well as how to prevent them, is needed to provide a clear understanding of how to incorporate a valid network architecture capable of detecting potential changes in environment, in order to avoid forest fire that can cause loss of natural resource. The primary goal of our device is to detect a fire and issue alarm using a buzzer and GSM.

3.2 EXISTING SYSTEM

- Over the years, many solutions for fire detection have been developed and used
- For example, video surveillance systems of different types are the commonly used systems for forest fire detection.
- While video technology is not the most precise, it is commonly used because to its low cost and reasonable performance.

3.3 PROPOSED SYSTEM

- The design of the proposed fire alarm system is depicted in the block diagram below.
- Temperature, smoke, and fire sensors make up the structure of this fire alarm system.
- During a burn, the sensors can detect the different factors that change.
- These factors' threshold values are fed into the Arduino uno.
- The Arduino Uno's main purpose is to process the analogue inputs from the sensor and send a warning with the sensor's location using GPS.

In chapter 4, we are going to discuss about the circuitry of the proposed work along with the components included in the circuitry.

CHAPTER 4

4.1 BLOCK DIAGRAM

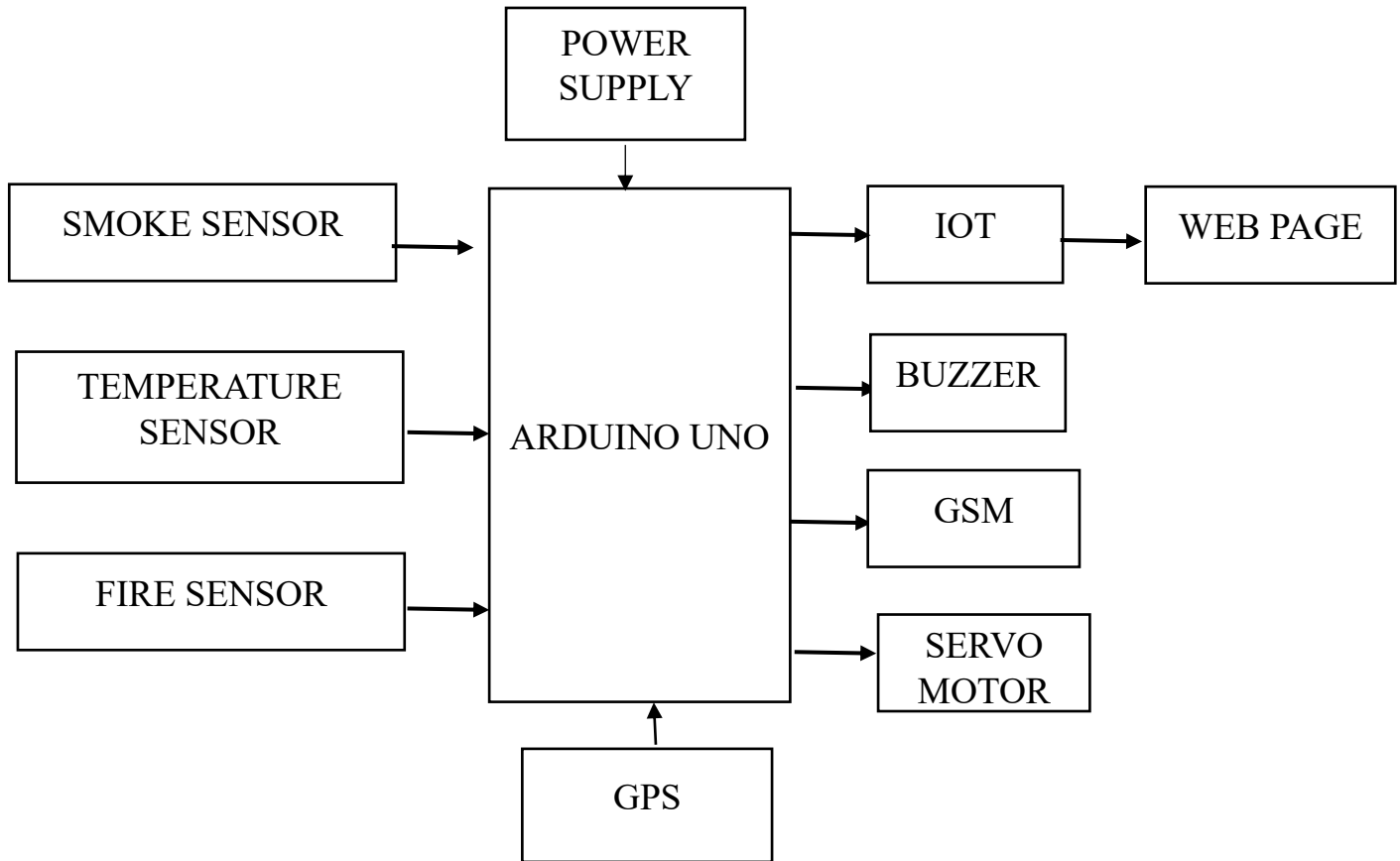


Fig 4.1 : Basic block diagram of forest fire detection system

4.2 HARDWARE REQUIREMENTS

- Arduino uno
- Temperature sensor
- Smoke sensor
- Fire sensor
- ESP8266
- Servo motor
- GPS, GSM
- Buzzer

4.3 EMBEDDED SYSTEM

A period software system (RTOS), that is additionally restricted by period computation, program associated controls an embedded system, that serves a specific purpose among a bigger mechanical/electrical system. It includes each hardware and mechanical elements. the bulk of microprocessors square measure designed to be used in embedded systems, accounting for ninety eight of all microprocessors.

Most embedded computers have low power consumption, small size, changeable operating ranges, and small per-unit cost. This comes at the cost of limited computational resources, making programming and communicating with this much more challenging.

By using existing sensors and connectivity of embedded units, building mechanisms on top of hardware allows us to optimize the resources at system and network levels, and also gives required functions.

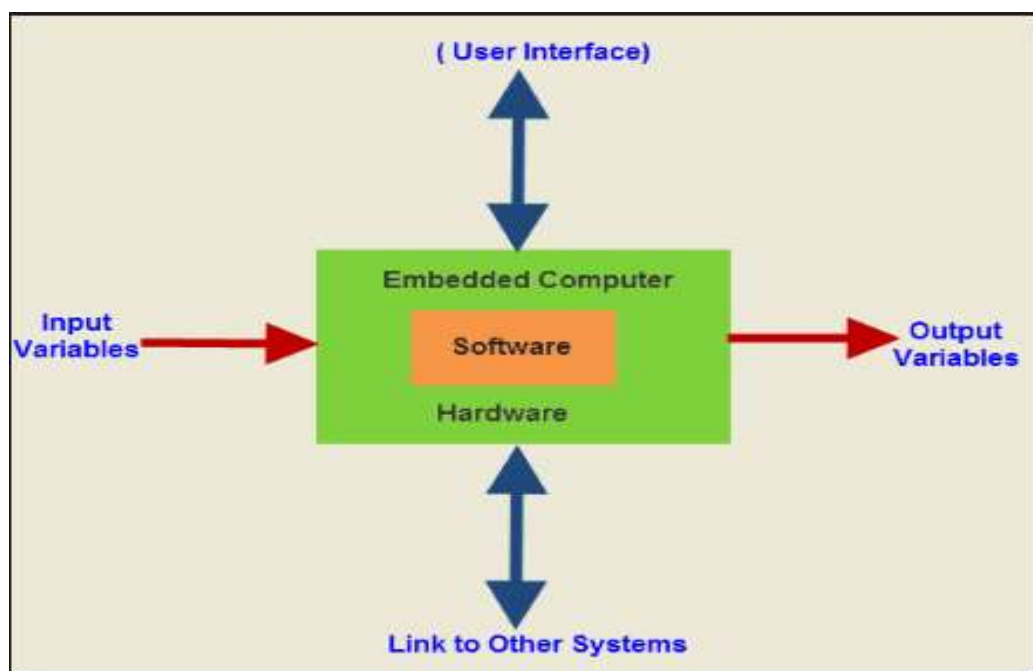


Fig 4.2 : Model flow of an Embedded System

Embedded systems are used in industrial, consumer, medical, automotive, commercial, and military applications. From network telephone switches to end-user mobile phones, telecommunications networks use a range of embedded systems. Data is routed via dedicated routers and network bridges in computer networking.

4.3.1 BLOCK DIAGRAM OF AN EMBEDDED SYSTEM

Embedded processors are used in computers. Many products with a digital interface, such as microwaves, VCRs, and cars, use embedded systems. In some embedded systems, an OS is used. Others are highly specialized in the implementation of entire logic as a single application. They don't have general features, these systems are built into a device for a specific purpose.

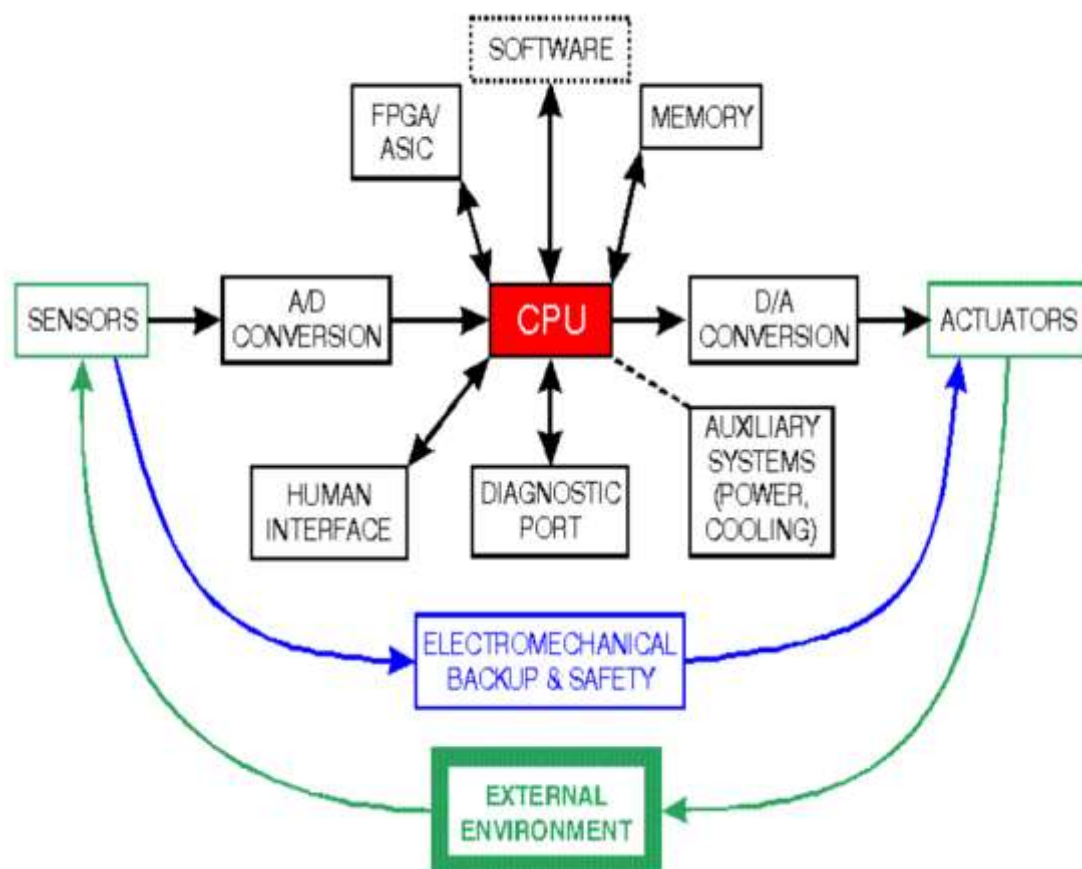


Fig 4.3 : Block diagram of embedded system

4.3.2 EMBEDDED SYSTEMS APPLICATIONS

The applications of embedded systems are: mobile applications, motors, cruise control, engine integrity, assembly line robotics, cars, E-commerce applications, and others.

4.4 HARDWARE COMPONENTS DETAILS

The Hardware Components involved in this setup are Arduino UNO board, Fire sensor, Smoke Sensor, Temperature sensor, Buzzer, Wifi module, GSM module, Step down transformer.

4.4.1 ARDUINO UNO

The term "uno" comes from the Italian word "uno," which means "one(1)." The ATmega328 microcontroller is used in the Arduino Uno microcontroller board. On the frame, there are total 14 digital pins, 6 analog pins, a 16 MegaHertz ceramic resonator, an USB port, a power. It includes everything you'll need to get started with the microcontroller, with a USB to connect it to a device and a AC-to-DC converter or battery for power. The second is an unconnected pin that can be used later. It has been created a more effective RESET circuit. In place of the 8U2, use a super 16U2 It was chosen as the logo for the Arduino 1.0 release. In the future, the Uno and first version of Arduino will be the base model.

In our project we have used Arduino UNO board as our base microcontroller which connects all the sensors, modules and other components. This Arduino UNO board does all the work needed in the project.

4.4.2 POWER

The pin V_{in} is the voltage input to Arduino board. This pin receives a controlled 5V from the board's regulator. The board is powered by the DC power pins (7 - 12Volts), USB. Using 5Volt or 3.3Volt pins for input voltage may cause damage to the board.

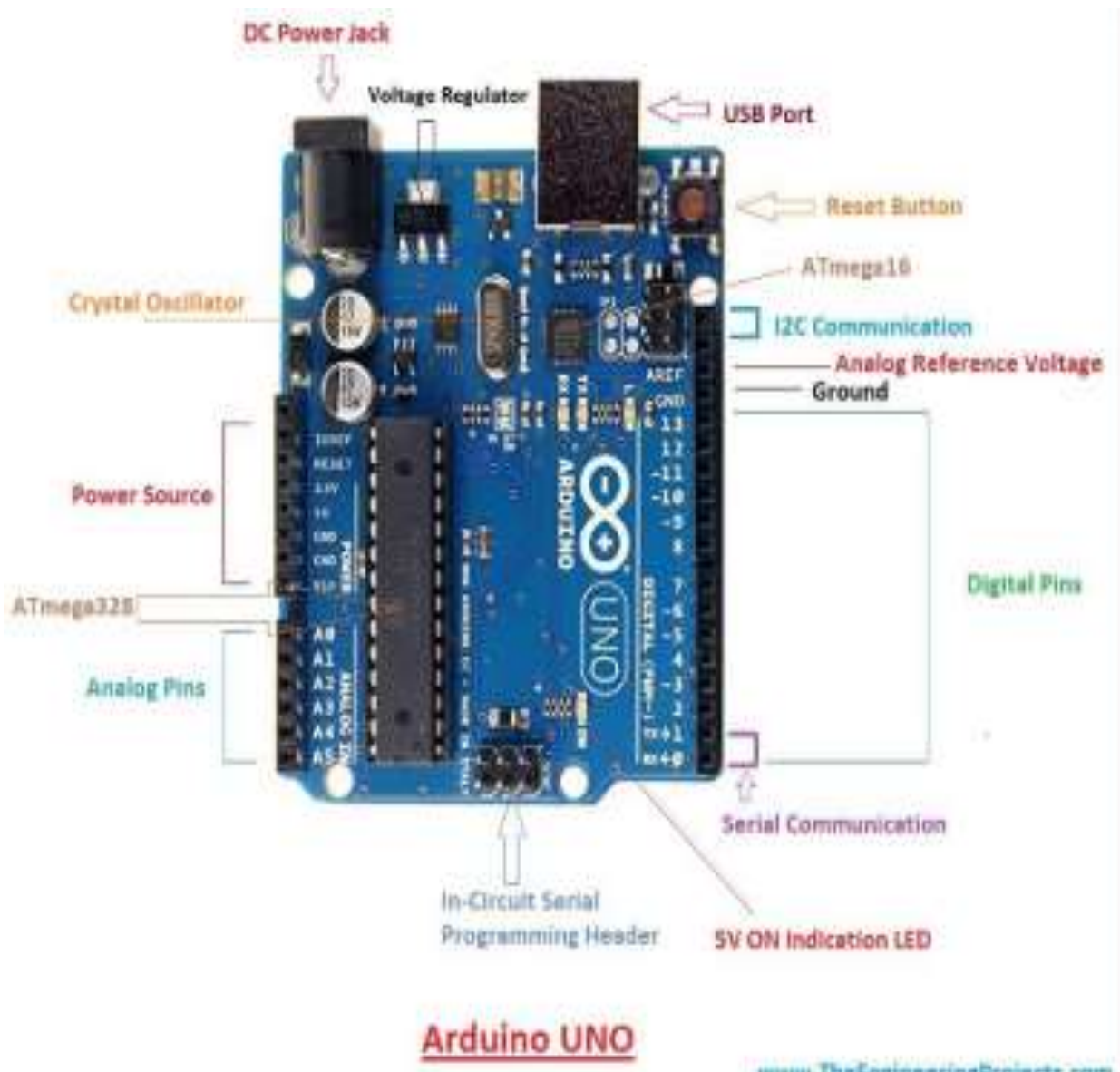


Fig 4.4 : Arduino Uno diagram

4.4.3 PIN CONFIGURATION

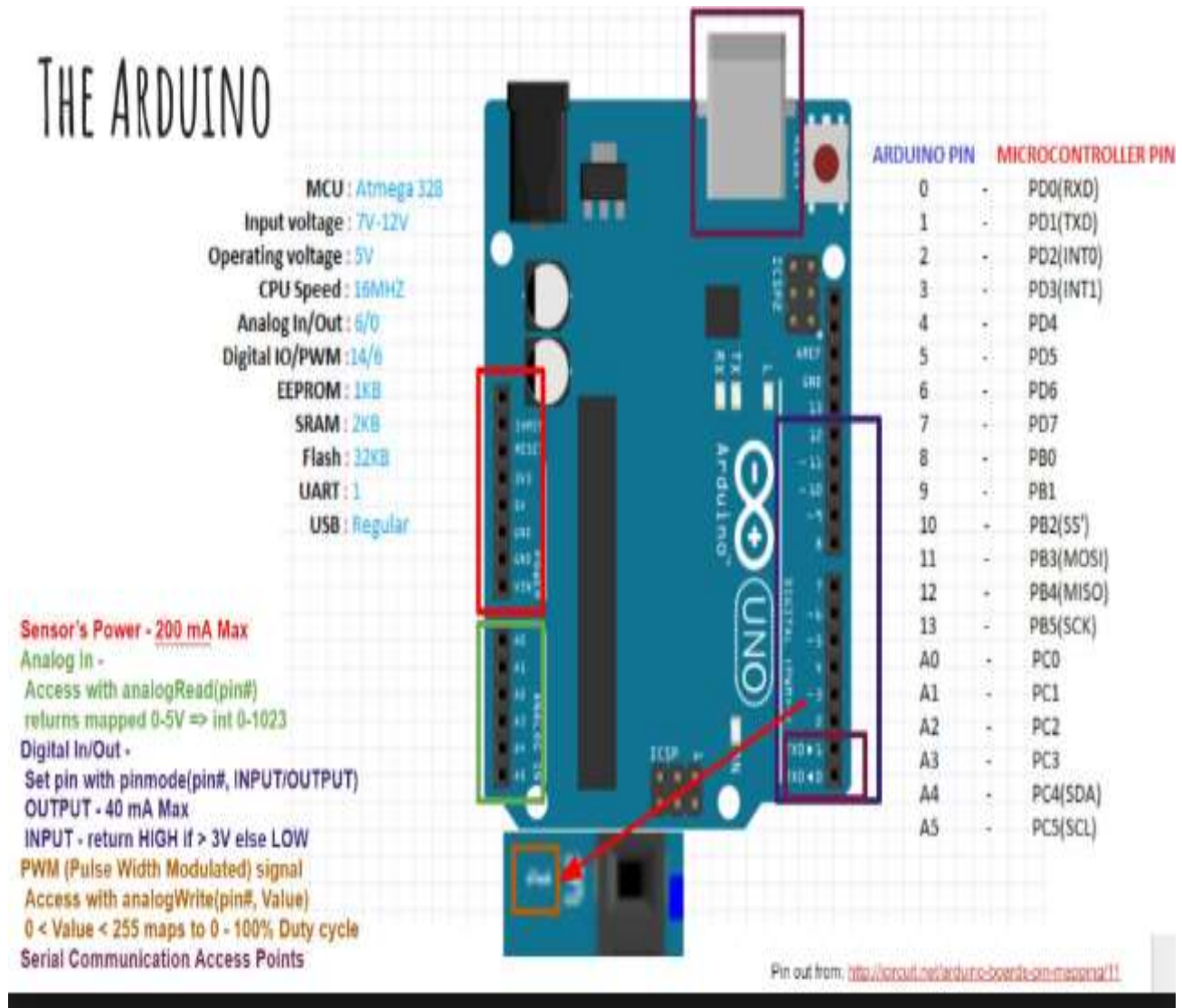


Fig 4.5 : Arduino Uno's pin diagram

4.4.4 USB OVERCURRENT PROTECTION

Computer's USB ports are protected from short circuit by a poly fuse on the Arduino Uno. Although most computers come with built-in security, the fuse provides a protection layer. If above 500 milliampere is applied to the USB pin before the short circuit is removed, the fuse will instantly blow, breaking the connection.

4.4.5 Physical Characteristics

The USB and power port extends beyond the former dimension, making the Uno PCB's full length and width 2.7 and 2.1 inches, respectively. The board is installed with four screw holes for mounting to surface. The distance between digital pins 7 and 8 is 160 milli meter.

4.5 TEMPERATURE SENSOR

We need to calculate the temperature values for deciding whether the fire is caught or not. For that we need to install a sensor that can sense the temperature into the system.

4.5.1 SPECIFICATIONS

Table 4.1 : Specifications

Range	0°...100°C
Accuracy	< 0,1°C + NTC-spread over 0°...70°C
Resolution	2 m°C@30°C and 25 m°C@100°C
Linearity	see table
No. Sensors	1....30
Type	5 kOhm NTC-resistors Max. wireresistance 3,3 Ohm
Conditioner	Wheatstone-bridge with +15 Bits ADC
Calibration	at 0°C and 100°C _ 0,1°C
Drift	1 m°C/°C with periodic calibration and 5 m°C/°C without calibration
Scanfreq.	default max. 10 meas./s
Amb.temp	0°...60°
Control	Micro-Wire™ 5 (Di, Do, Clk en CS)
Levels	0 and 5 Volt
Power	+12 Volt 3,5 mAmp (+5,5 +20 Volt) -5 Volt 1 mAmp (-4,5-8 Volt)
Dimensions	224 x 120 x 60 + 40 mm

4.5.2 TEMPERATURE AND ITS MEASUREMENT

Temperature is a measure of the heat and is defined as the degree of hotness. It wasn't until the invention of the Steam Engine calculating the heat content of the body on a scale arose.

The desire of scientists for understanding the behavior. Years of meticulous scientific research resulted in a plethora of hypotheses, ranging from the basic 'Caloric' definition to the more complex 'Caloric' concept, Carnot's definition of heat as a source of energy differed from that of, which regarded heat as a material substance that is exchanged among materials (which laid the foundation of the first law of thermodynamics).

None of them, however, adequately clarified the principle of temperature. Maxwell's hypothesis provided a solid foundation for it. He specified temperature as a thermal property of a body that provides information about the system's energy content. It is a measure of a substance's average kinetic energy (energy derived from motion) and denotes a heat potential in which heat flows from a higher temperature to a lower temperature.

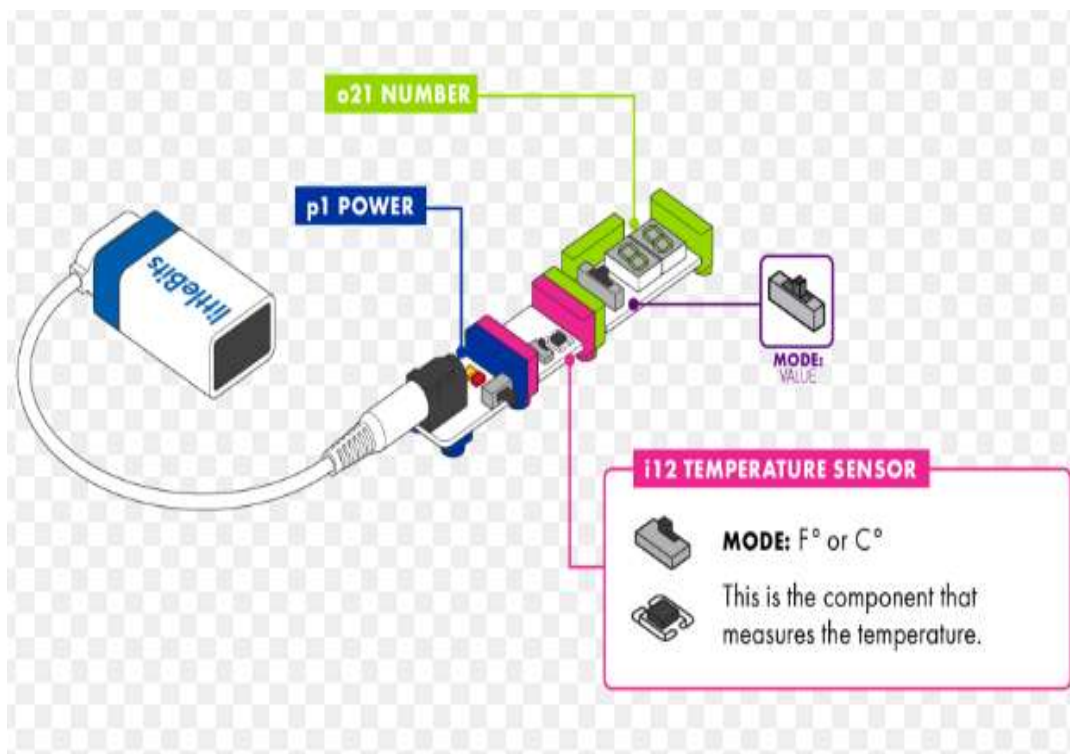


Fig 4.6 : Temperature Sensor

4.5.3 NON-CONTACT TEMPERATURE SENSORS

The convection and radiation are used to detect temperature fluctuations in these temperature sensors. They are used to detect radiant energy emitted by liquids and gases as heat goes up in the convection currents, or to detect radiant energy emitted by an object in the form of IR. The following three types of temperature sensors can be divided into types of touch or even non-contact temperature sensors: electro-mechanical, resistive, and electronic.

4.5.4 THERMOSTAT

Thermostats are electro-mechanical temperature sensors or switches that are made up of two separate metals fused to form a Bi-metallic strip, such as nickel, tungsten, or aluminum. As heat is applied to the strip, linear expansion of dissimilar metals can cause mechanical bending.

Bi-metallic strips are often used to power water heating sources like boiler furnaces, hot water units, and car radiator cooling system.

4.5.5 THE BI-METALLIC THERMOSTAT

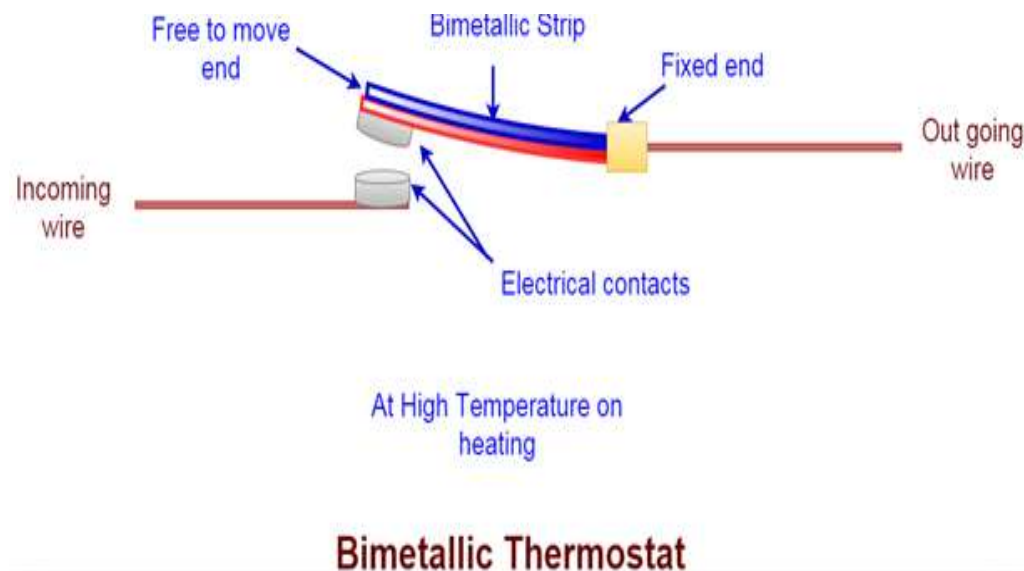


Fig 4.7 : Bimetallic Thermostat

The thermostat is made up of two metals that are thermally distinct and are blend together. When the thermostat is not hot, the vicinity and electrons flows over it. If one metal gets hotter, the metallic strip curves, opening the vicinity and blocking the electrons.

4.5.6 ON/OFF THERMOSTAT

Bi-metallic strips are differentiated into two categories based on how they travel when exposed to temperature variation

The thermostats are used to regulate the temperature of microwaves, iron-box, and hot water unit, as well as to control the house-hold heating systems. Creepers have a bimetallic spiral or coil that unwinds as the temperature rises. Creeper bi-metallic's are more resistant to temperature variances than standard ON or OFF varieties since the strip is larger and narrower.

When used as a temperature sensor, standard snap-action style thermostats have a broad heat range from which the electrical vicinity opens until they close, despite being inexpensive and usable over a wide operating range. Example, it can be set to 21°C but not open until 23°C and holds until 18°C.

4.6 SMOKE SENSOR

It is a detector that sense the presence of various gases in a room and is often used as a part of protection systems. This type of sensors can detect gas leakage and other contaminants, as well as attach to a control system to automatically shut down an operation. A gas detector will sense gas leaks in the area, giving them time to evacuate. Since certain gases can affect organic substances, humans and animals. Combustible, flammable, and poisonous gases, as well as oxygen depletion, can all be detected with gas detectors. This type of system is commonly used in industry, and it can be used in places like oil mines to track manufacturing processes and technologies like photovoltaics.

Gas leakage sensing is the method of using sensors to detect potentially dangerous gas leaks. When a harmful gas is detected, these sensors normally emit an audible warning to alert people. Painting, fuel refilling, building, mining, landfill rescues, and accessing enclosed space may all result in toxic gas exposure.



Fig 4.8 : Smoke Sensor

4.6.1 PHOTOIONIZATION

To ionise chemicals in the sampled gases, PIDs employ a high-photo-energy UV lamps. An electron will be expelled if the ionisation energy of the compound is lower than that of the lamp photons, and the resultant electron flow is directly related to the compound. At concentrations ranges from a few ppb to thousand ppm, a wide variety of compounds can be observed organic esters, Popular air components and mineral acids have no impact.

PIDs have many benefits, including high sensitivity, easy to use. The biggest disadvantage is that measurements is non-compound-specific. PIDs having filter tubes are recently added, which improves the concentration for compounds like benzene.

4.7 INFRARED SENSORS

Infrared sensors uses the radiation that passes through a amount of gas; the energy from the sensor is absorbed. Carbon monoxide absorbs wavelengths between 4.2 and 4.5 micrometers. As the energy is related to that of a wavelength beyond the absorption frequency range, energy difference between the wavelengths are equal to the volume of gas.

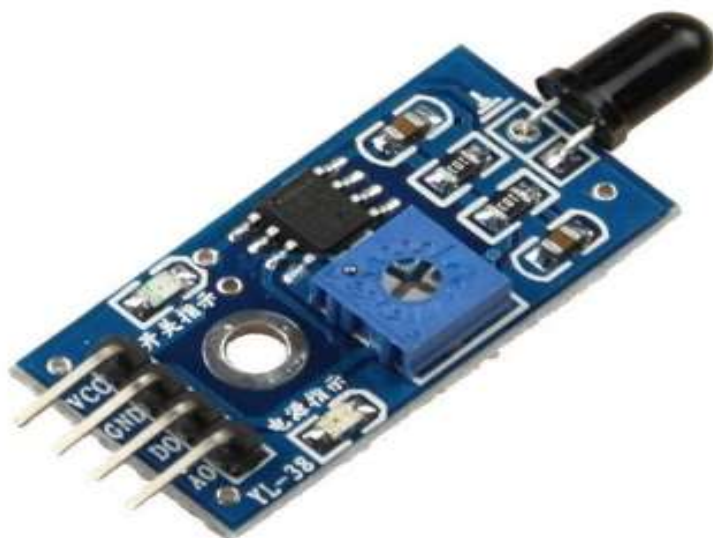
The above said sensors are used in waste-water management plants, chemical factories and other places where explosive gases may be held. Huge areas of space can be tracked using remote sensing technology.

Another field where IR sensors are being studied is engine emissions. They can detect CO and other hazard gases from exhaust of cars and also can be linked to electronic systems for warning.

4.8 OPTICAL FLAME DETECTORS

4.8.1 FIRE SENSOR

The flame detector detects and reacts to the fire. It sounds the alarm devices, cutting the fuel lines and activating the fire distinguishing systems, responding to the fire blaze. When used in industrial furnaces, their aim is to ensure that the furnace is working properly; they do not take any action other than to warn the operator or control system in these circumstances.



4.9 : Fire Sensor

4.8.2 ULTRAVIOLET DETECTOR

UV detectors sense the ultraviolet radiation released in the ignition process. It is capable of sensing fire in 2 to 5 milliseconds, a 3–4 second time delay is often included to reduce fake alarms caused by other reasons.

To reduce the factors of natural-background-radiation, Ultraviolet detectors usually work at wavelengths less than 300 nm. Oily pollutants quickly blind the solar blind UV wavelength band.

4.8.3 UV/IR DETECTOR

These detectors detect fire by comparing the pre-defined values of both UV and IR wavelengths. This reduces the number of false alarms. These sensors are coupled together in a single unit. UV sensor works by sensing the UV rays emitted by the fire. The spectrum of Infrared region range is from 2 to 4 micrometer. This sensor is used in our project to detect the fire in the forest.

4.8.4 IR/IR FLAME DETECTION

The double infrared range flame detectors equal the pre-defined values in 2 infrared values. A single sensor usually tests 4.4 micrometre CO₂ and the other fixed frequency already defined. Detecting CO₂ emissions is suitable for hydrocarbon; the broadband sensor is appropriate for non-carbon based fuel, such as hydrogen.

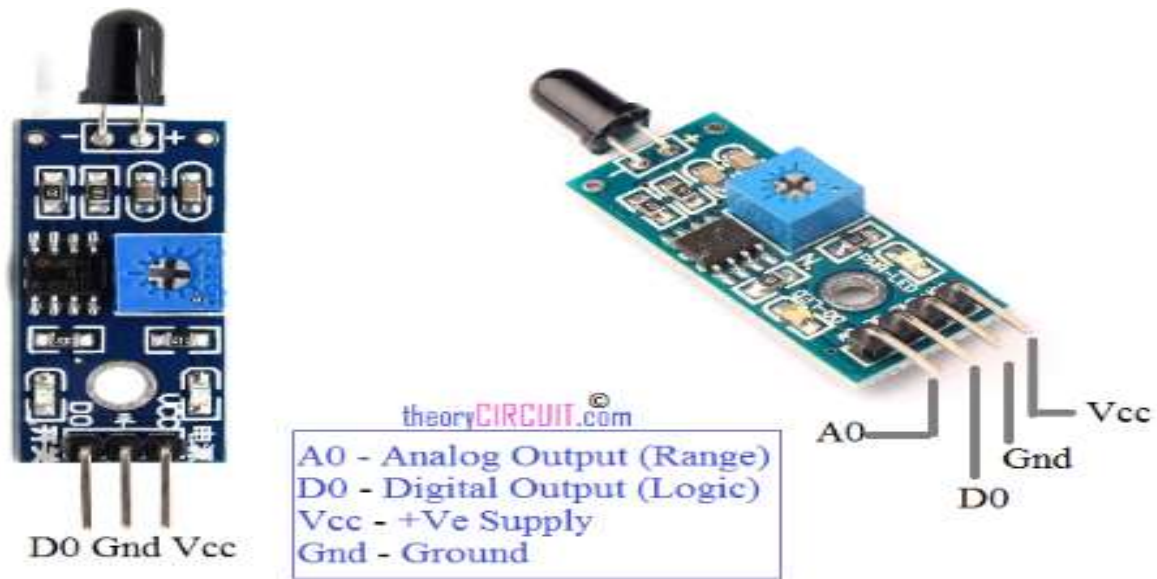


Fig 4.10 : IR flame detector

UV/IR flame detectors has many applications. They are:

- Gas-fueled cookers
- Industrial dry cleaning systems
- Domestic heating systems
- Industrial gas turbines

4.9 GPS

The Global Positioning System is a kind of satellite system that finds and locates an object present in it's navigation area. The GPS was first developed by defence department of United States of America in the year 1973 which was made to accessible for defence as well as common people needs. Recently the GPS technology is been included in smartphones, smartwatches, aircrafts, cars, etc. The GPS system is made up of 24 satellites positioned in the way that it covers all over the globe at a distance each of around 12,000 miles.

They revolve around the earth for every 12 hours, at a tractor speed of about 11,200 kmph. They are placed in such a way that it covers the globe equally in all directions. Each GPS satellite sends out the data of the satellite's current location, orbit, and time of the trajectory. The GPS receivers or base stations uses triangulation principle to determine its exact location. Hence it is a necessary need for the application of GPS in our project work.

4.9.1 GPS WORKING ON MOBILE

A GPS system initially creates an connection link with the satellite and sends an request-response and communicates further. With the energy of the signal the connection is made faster or slower. To speed up GPS detection, most of the GPS protocol follow caching of the data, ie., the previous location is cached up in the GPS server and is used for future references. A GPS system will easily predict which satellites will be available the next time it searches for a GPS signal by remembering its previous position.

4.9.2 OPERATION

In the obtained trajectory the satellite passes twice a day and also each satellite transmits a specific signal parameters to the base station via ciphering mechanism, which GPS devices can decipher and locate the satellite. This data, is used by GPS base-station receiver to determine the geographical coordinates.

The receiver will track the location by finding the distance between it's neighboring satellites, the caughted data,etc. It views it electronically using distance calculate our running path, map a suggested location, find the way around and going on an adventure somewhere.

4.9.3 ACCURACY

Because of their parallel multi-channel configuration the GPS receiver station are preferably accurate when compared to other location tracking mechanisms. When our receivers are first turned on, they quickly lock onto satellites. In thick forest cover or urban areas with tall buildings, they retain a monitoring lock. The accuracy of GPS receivers can be influenced by atmospheric conditions. These factors also affects the sources and may lead to error. The standard Garmin GPS receivers are usually reliable to just 10 metres.

The accuracy in that GPS Receiver is even better in deep oceans. WAAS (Wide Area Augmentation System) improves the accuracy of some GPS receivers, this capability

mechanism will increase accuracy to better than 3 metres in advance.

The use of WAAS satellites would lead to cost effectiveness than traditional GPS transmitter and receiver. Differential GPS (DGPS), which has an average of 1 to 3 metres coverage range, will also improve accuracy. In addition to their GPS, we will need a differential beacon receiver and beacon antenna to transmit the corrected signal with proper encryption and decryption.

4.9.4 NEO-6M GPS CHIPSET

The NEO-6M GPS chipset is at the heart of the system. The chip is in the size of sim card, but has a large functional uses.

4.9.5 NEO-6M GPS CHIPSET FUNCTIONS

The GPS chip leads to detection up to 23 satellites with a 50 channel bandwidth and achieves the maximum degree of sensitivity in the industry, -161 dB monitoring, though drawing just 45 milliamps from the power supply.

This modules can change its location up to 5 times per second, with a horizontal position accuracy of 2.5 metres. The chip's Power Save Mode is one of its best features which is provided to conserve the power. Through selectively swapping portions of the receiver ON and OFF, it allows for a decrease in system power consumption. This power save mode cuts the module's power consumption to just 11mA. The are used eminently in modern smart watches, to increase the battery storage time.

The chip's Power Save Mode is one of its best features which is provided to conserve the power. Through selectively swapping portions of the receiver ON and OFF, it allows for a decrease in system power consumption. It is effectly used in our project to determine the location of forest fire.

4.9.6 SPECIFICATIONS OF NEO-6M GPS CHIPSET

Receiver type: 51 channels, GPS Level1 type of system

Horizontal Accuracy: 2.5m accuracy in horizontal direction

Navigation Rate: 1HZ of frequency rate

Capture time -Cooldown start: 26s - Hot start: 2s

Navigation Sensitivity: -159dBm sensitivity

Protocols: UBX Binary, RTCM communication protocol

Operating Temperature: -40°C to 80°C

Operating Voltage: 2.6V to 3.5V

Operating Current: 40mA

TXD/RXD Impedance: 512Ω

4.9.7 POSITION FIX INDICATOR



Fig 4.11 : NEO-6M GPS Module - Position Fix Indicator

The position fix status is indicated by an Light Emitting Diode on the NEO-6M GPS chipset. Depending on what protocol it's in, it'll blink at different rates:

1. It's not blinking often and it's looking for nearby satellites at a faster rate.
2. Position Fix is sought by blinking every 0.9 second, to indicate the viewer whether it is connected or not.

4.9.8 BATTERY & EEPROM

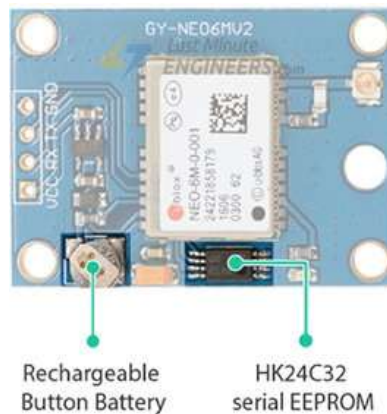


Fig 4.12 : NEO-6M GPS Module - Battery and EEPROM

An two-wire serial EEPROM is included in the module and has 4 kilobytes size. A rechargeable button battery is inbuilt such that it acts as a capacitor for storing the current. The combination of an EEPROM and a battery results in preservation of back-battried RAM.

The clock pulse, most recent location, and module values are all stored in the BBR. Also it is not for long-term data storage, because of the limitation in the storage. The battery has a clock and last spot. Also the time to first patch (TTFF) is reduced to just 0.9 second. Since the GPS has a lag in time connectivity, initial it takes longer to lock the position.

4.9.9 ANTENNA

An antenna is used in our work to make the GPS communicate with the satellite. An small patch antenna is used with a frequency rate of -161 dBm. This antenna can be snapped onto the module's narrow connector.

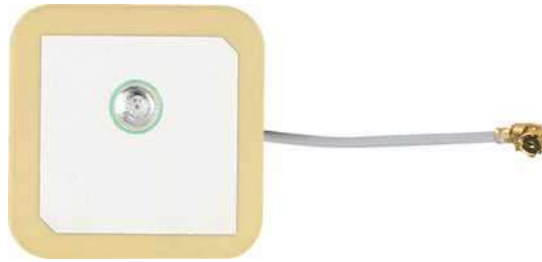


Fig 4.13 : NEO-6M Patch Antenna

4.10 BUZZER

A buzzer is an electronic, electromechanical, or piezoelectric audio signalling system. It is also known as beeper or piezo. The alarm, timers used in daily life validates our feedback by the applications for buzzers and beepers.



Fig 4.14 : Buzzer

4.10.1 ELECTROMECHANICAL

It is a type of buzzer, which is used in an electromechanical system similar to that of an electric bell, but without the metal gong. A relay, for example could be wired to interrupt its own current signal, causing the contacts with the beeper. These units were often hanged to a wall/ceiling as a sounding component. Since it is done mechanically with the help of some electronic instruments, it is termed as electromechanical buzzer.

4.10.2 MECHANICAL

This type of buzzer operates only by a mechanical external force. A joy buzzer is an example of a solely mechanical buzzer which is used by the vehicle drivers in olden days. Doorbells are another example of mechanical driver where an external pressure is applied to operate it.

4.10.3 PIEZOELECTRIC

This type of buzzer is used in our work such that the audio signal source may drive a piezoelectric element, which is then powered by a piezoelectric audio speaker/amplifier to make it work. To make an audible beep, a piezoelectric buzzer/beeper uses acoustic cavity resonance to make it work smarter than other types of buzzers.

4.10.4 APPLICATIONS

The application of buzzers are various, though the technical advances have made buzzers an undesirable component, the buzzers and related circuitry which may still be useful in some situations like:

- Judging panels are examples of current implementations.
- Intended for educational purposes.
- Metronomes in modern musical keyboards.
- Lock-out system for game shows.
- Microwave ovens and other popular household items.
- Electrical security alarms/ anti theft alarm.

4.11 GSM

GSM expands as Global System for Mobile networking and is a mobile communication modem. It is widely used in modern mobile device. GSM is the cellular system that uses 850MHz to 1900MHz frequency ranges to provide mobiles data/voice services to the people. In 1970, Bell Laboratories came up with the concept for this global framework which made an tilt over in the areas of networking.

For coordination purposes, the GSM method was made as an digital system with the TDMA technique. A GSM processes and suppress the data before sending it to a channel of 2 separate streams of data. The infrastructure can handle data speeds ranging from 65 Kbps to 120 Mbps in our project.



Fig 4.15 : GSM Module

4.11.1 GSM ARCHITECTURE

The following components make up a GSM network, which is made up of mobile station, base station and an network subsystem. Their functions are discussed below:

- **Mobile Station:** A mobile phone with a transceiver, a computer, and a processor that is powered by a SIM card. The basic handset is referred to as a mobile station. It operates over a network.
- **Base Station Subsystem:** This device connects the mobile receiver within the network. It was created with transmitter and receiver units, which houses the radio transmitter-receiver (transceiver) and manages the protocols for cell phone network. It acts as a mediator and promotes handoff for basic network communication.
- **The network Subsystems** provides the mobile stations with a direct connection with the link nodes. The Switching Centre offers connectivity to various networks such as ISDN or PSTN, which is the most essential component of the Network Subsystem. It also includes the Register, which are responsible for GSM call routing and roaming, registering the call and data log in its repository. Which keeps track of all mobile devices, each of which is marked by its IMEI unique number. It is abbreviated as "International Mobile Equipment Identity." IMEI is an identity for each and every subscriber who are being involved in the network subsystem.

4.11.2 FEATURES OF GSM MODULE

- It has more efficient and wider range of accessibility
- Encryption and decryption is implemented
- Provides high-quality voice
- Support for emerging services
- International roaming is provided

- ISDN compatibility is obtained
- Provides message service
- Landline management
- Alarm management

4.11.3 GSM GATEWAY/MODEM

A GSM gateway is a system is a network gateway that allows a subscriber to connect over an inter/intra network. It has a SIM card mounted on it and runs on a inter/intra network spectrum that the network provider has subscribed to. It can be used to connect to a device via serial, USB/Bluetooth which we have used in our proposed work.

An GSM modem can be an normal GSM phone that is connected to a serial port / Universal Serial Bus port on the device using the right cable and programmer driver. End to end transaction, supply chain control, surveillance applications, weather forecast, and remote data logging are only a few of the applications for the GSM modem.

4.11.4 WORKING OF GSM MODULE

The GSM gateway is linked to the Microcontroller through the level swapper IC Max232. When a SIM card is injected, the GSM modem receives a pin or password via SMS from any mobile phone, where it communicates the data to the MC via serial communication. This pin is generally used to validate the user.

While using the module there are many sets of instructions used, if the module get's an 'STOP' instruction it results in the MC to generate an output, where the touch points of which are used to disable the power switch. If it gets an "ALERT" instruction it makes an coded warning, which is only transmitted if the input is driven poor. The entire process is projected on a LCD screen for an proper visibility to the user.

4.11.5 GSM MODEM CIRCUIT

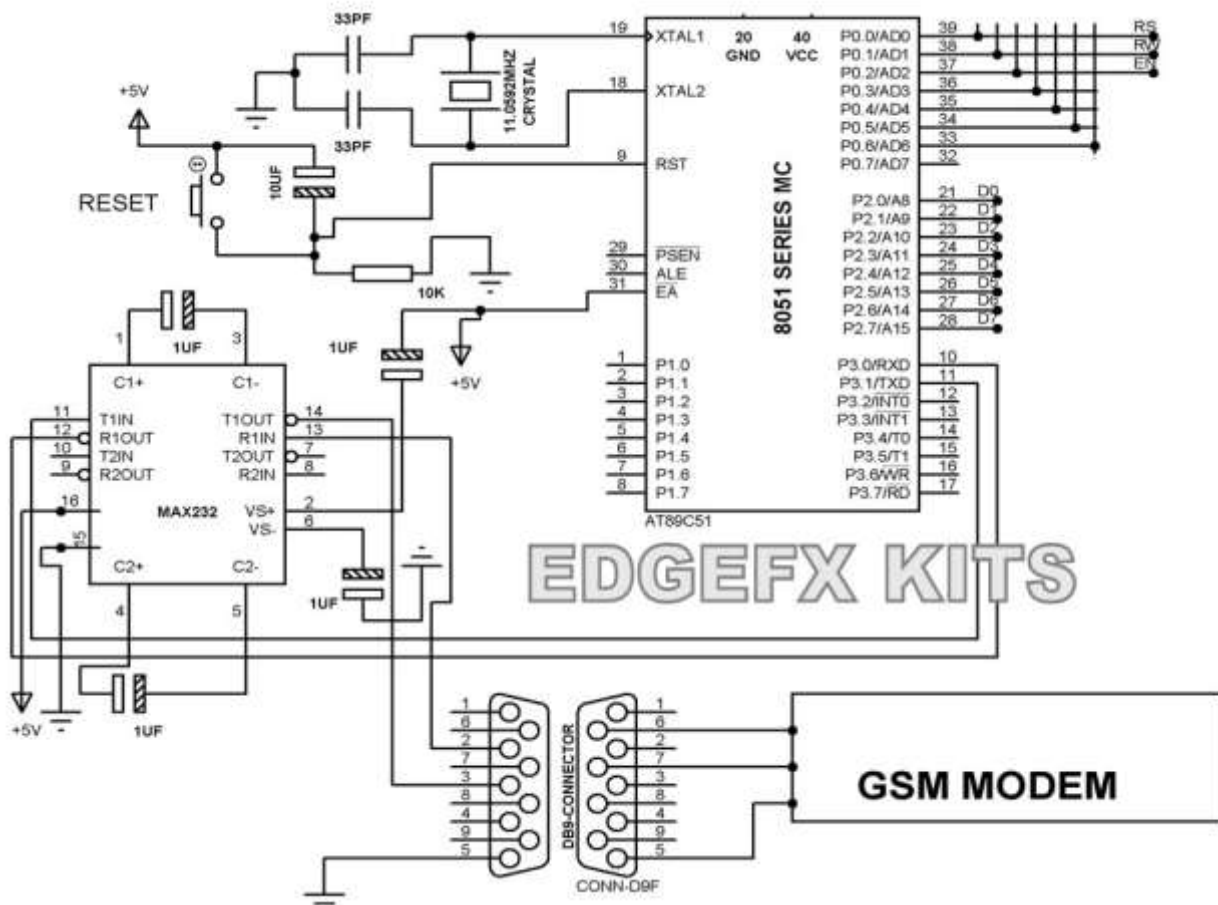


Fig 4.16 : Intelligent GSM Device for Security and Automating

This work is mainly focused on GSM inter connected network technologies for SMS transaction from sender to receiver, as the name implies. SMS inter communication is used for omnipresent appliance accessing and home violation management. Two sub-systems are proposed by the system. The device is capable of instructing a user to adjust the status message manually or automated and specifications via SMS from a particular cell phone number is obtained.

The second feature is security warning, which is done in such a way that when an intruder is detected, the device allows for automated SMS generation, alerting the user to a security danger.

4.12 SERVO MOTOR

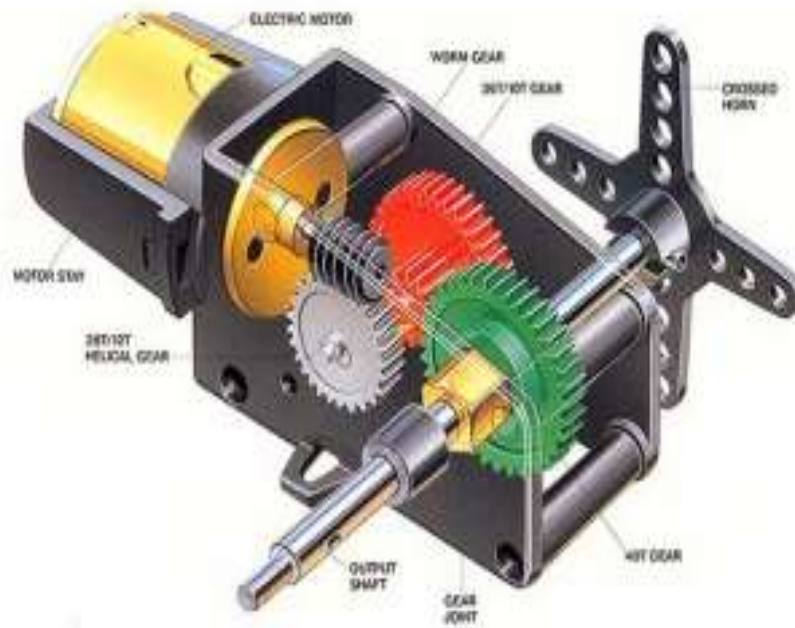
A servomotor is a type of linear/rotary actuator that is used in many areas. It is basically an motor which has an position feedback sensor for the angulation and movement of the knobs. It also necessitates a sophisticated controller, which is designed especially for servomotors. The servomotor that we have used in our project helps us to prevent fire in an positioned area where the forest fire is been detected. The signal is been generated from the arduino uno board via the sensors and thus the servomotor acts according to the signal received to it. It is used in our project to distinguish minor fire by sprinkling water on affected area.

4.12.1 MECHANISM OF SERVOMOTOR

The servomotor is a control system and involves the mechanism that uses location result to regulate its motion along with the last known location. A signal from arduino is fed into the power supply to indicate the path to be traversed for the output shaft.

An encoder is attached to the motor of the servo motor to provide position along with the speed as input. It also necessitates a sophisticated controller, which is designed especially for servomotors. The servomotor that we have used in our project helps us to prevent fire in an positioned area where the forest fire is been detected.

The simplest servomotors uses a potentiometer for position sensing and bang-bang motor control; the motor still rotates at maximum speed. The output shaft velocity is measured by optical rotary encoders, and the motor speed is regulated by a variable-speed drive in more advanced servomotors which is been entered by the manufacturing units. The signal is been generated from the arduino uno board via the sensors and thus the servomotor acts according to the signal received to it. It is used in our project to distinguish minor fire by sprinkling water on affected area.



Servo Motor

Fig 4.17 : Servo Motor

4.12.2 SERVO MOTOR FUNCTIONS

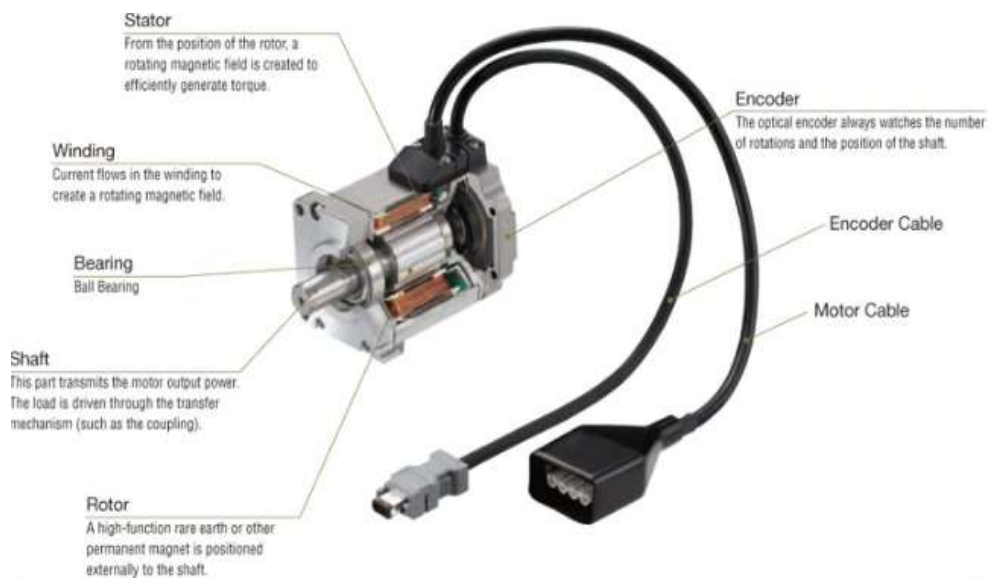


Fig 4.18 : Servo Motor Functions

The role/purpose is to get an input signal corresponding to a servo shaft output shape and move its motor till the shaft switches to that threshold position. It uses the location sensing technology to determine the shaft's rotational orientation, which allows it to figure out which way the motor can turn to move the shaft to the desired position. The shaft cannot quickly rotate around the axis, so it can only turn 200 degrees side ways and work eminently.

4.12.3 ADVANTAGES

- It is used in industries, schools and other area as fire detection devices. When ever they detect fire they sprinkle water around the area to set off the fire.
- In large scale industries it is used in water pumping machines to supply water to the large scale sectors.
- Recently it is used in toys, remote control cars, etc.
- It is used in lathe machines, drillers , mining machines and other types of work.

4.13 ESP8266 Microcontroller

The NodeMCU project is an IoT platform that is free to users to interact and we have implemented in our work model. It includes firmware for a ESP8266 from Systems, as well as components for the ESP-12 frame. The name "NodeMCU" refers to the framework or the firmware. It is simply written in Lua language, an scripting language. It's built with the Espressif Non-Open Source Software Development Kit for ESP8266 and is based on the eLua project. The ESP8266, on the other hand, is difficult to navigate and used as a chip.

We also program it in low-level computer language such as embedded C, micropython, etc., such that the chip hardware can understand. The NodeMCU integrates the arduino UNO and Raspberry pie for an combined application. It is made up of two main components.

1. An ESP8266 firmware designed on top of a proprietary Software Development Kit from the chip manufacturer. The eLUA is an easy script and has a large developer community.

2. A DEVKIT board with an ESP8266 chip mounted on a regular circuit board. It has an USB that is connected to the board, a reset button, an wifi chip, LED lights. The ESP8266 board embedded with devkit is shown in below figure.



Fig 4.19: ESP8266 Chip

The Arduino project that we have included builds a portable IoT controller. This setup has a USB port, LED's, and basic data , similar to NodeMCU. It can interact with sensors and other circuit boards via the inbuilt pins. The Arduino module, unlike the NodeMCU, may have a range of CPU, memory chips for storage, and user interactive environments to interact with it.

In reality, the ESP8266 MCU is similar to an arduino board. Since, the arduino board lags in many features like WIFI connectivity, USB port connectivity, inbuilt camera, etc. We had preferred the use of ESP8266 microcontroller at the client end to communicate with the arduino setup without any delay via WIFI connectivity. They perform well unless and until they are under a common subdomain.

4.14 SOFTWARE COMPONENTS

The software components used in our project are as follows:

- Arduino IDE
- Embedded C
- PHP

4.14.1 EMBEDDED C

Embedded C is programming language, where we used it to program it for the basic components. Each and every processor in a system is linked to embedded software through this embedded C language. It helps us to interact with the hardware kernel through binaries.

For heavy and complex task, embedded C programming is necessary to ease the work. For example, the devices that we use in our daily lives which has an microcontroller and microprocessor in it is been written in this embedded C language and also it is user friendly.

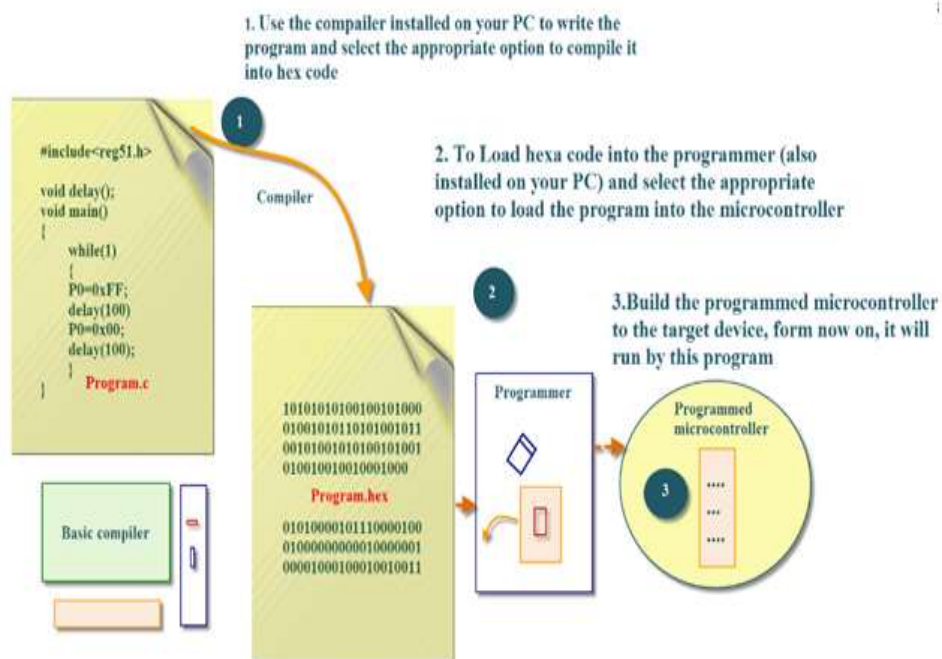


Fig 4.20 : Embedded C

The LED attached to Port of the microcontroller is flickered when the embedded C code is dumped into the hardware. Which helps to indicate the user.

C code is favoured and is considered user friendly when compared over other languages when developing embedded systems. For the reasons mentioned below:

- Easy to follow
- Reliability is a big plus
- Handiness
- Potential to scale

Recently, micropython is coming into picture as a scripting language, for the embedded devices. A programming language has many functions. A code is a set of functions following an algorithm. Embedded softwares have predetermined hardware requirements and functionality, and the addition of third-party hardware or software is strictly controlled. At the time of manufacturing, embedded applications must have the requisite device drivers, and drivers are written explicitly for the hardware. Also each and every program can be written in two ways either in an IDE or in a command line interface.

The output may be forwarded to an embedded device like an LED screen for display. A cross compiler, runs on a computer but produces executable code for the another platform and is needed for software development. A simulator, such as JTAG or SWD, is needed for debugging the piece of code which is being built in an IDE.

The memory and RAM sizes of the embedded devices will differ greatly, hence dumping the code is one of a challenging task. Some systems have 16 Kilobytes of Flash and 4 Kilobytes of RAM and an 8 MHz CPU, while others will compete with modern computers. Communication between processors, as well as between one processor and other components, is important

A keyword used in our work makes a drastic change in the output for example:

- bit
- sbit
- sfr
- small
- large

4.14.2 ARDUINO IDE

Arduino IDE is an user interactive environment. Arduino is made up of a physical programmable microcontroller's that runs on the laptop/PC and is used to edit and upload programming code anywhere and anytime.

The Arduino IDE needs corresponding components to run specific program via an USB cable. They follow standard protocols that divides the roles of the microcontroller into a more compact package. The scripting languages like embedded C, micropython, etc are implemented on the IDE.



Fig No 4.21 : Arduino IDE

This software is used by the IDE to convert the programmable code to a text file in hexadecimal format, which is then loaded into the Arduino board's firmware through a loader application. The source code that we type gets dumped after the compilation process. Sketches are the executable programme's that we created with the help of Arduino Software. The message region shows errors, input when saving and exporting the source code.

The regular options are “File” , “Edit”, “Sketch”, “Tools” , “Help”. In the plain text editor where you can type in your program file. There are set of libraries as like in other IDE’s which are programming a machine. The arduino code that user enters is referred to as arduino scripts. The is written in any language based on the users intention of code. It simply makes use of device-specific libraries.

4.15 INTERNET OF THINGS

Internet of Things is one of the upcoming field where the human work is been reduced with the help of single click of an button. We have included Internet of Things to optimize the human work with the help of sensors, modules, etc. All the components are connected to each other globally via the internet.

Processors, sensors and networks are all examples of enabling technologies that have been used to monitor and control devices for decades. They result on high speed connectivity, widespread use of technology in rural areas, miniaturization, networking and data security, etc. Device to device, device to cloud, Backend data sharing/transferring and device to gateway are the different connectivity methods defined by the Internet Architecture Board, which is been currently under use. These models show how IoT devices can interact and give utility to users in multiple kind of ways.

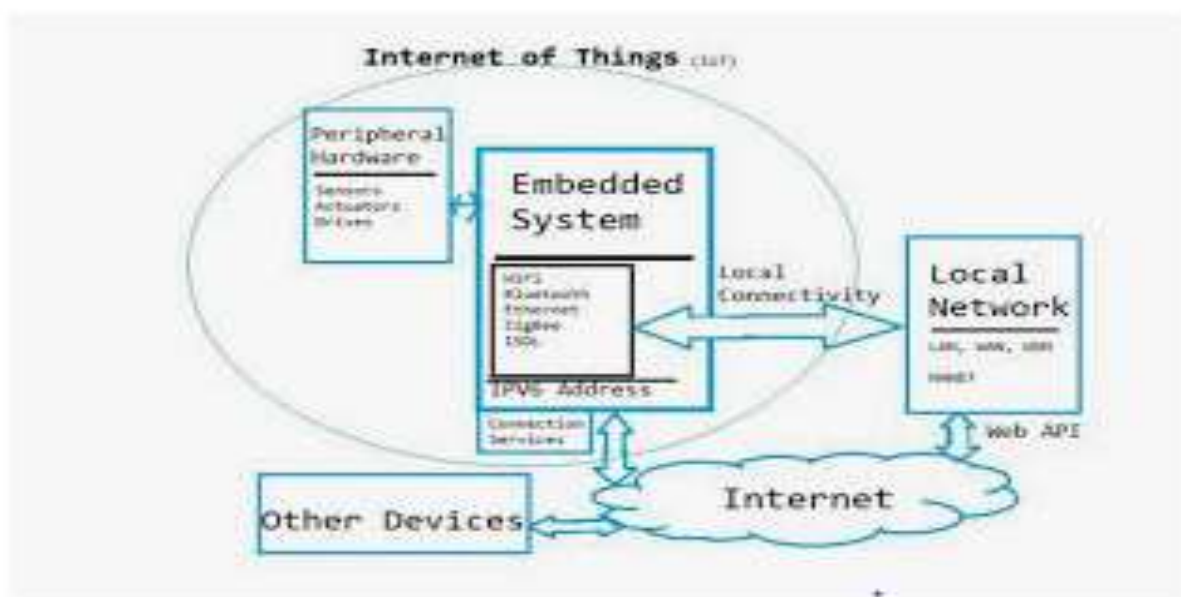


Fig 4.22 : IOT block diagram

Both hardware and software modules are used to construct IoT products. To interact with the real universe and to perform more computationally intensive math problems dedicated hardware modules are used. The functions of popular hardware components are defined, with the hardware to software interface provided by the MCU. IoT based transition was the major thought process for our project.

4.15.1 BENEFITS OF IOT

The Internet of Things provides a variety of advantages to businesses and industrial sector people. The furthermore benefits are as follows:

- Track overall company operations virtually over internet.
- Improve customer service.
- You can save time and resources.
- Boost workforce efficiency.
- Adapt and integrate business models.
- Make more informed management choices.
- Increase your sales.

4.15.2 IOT APPLICATIONS

- Consumer and corporate IoT ,manufacturing and automobile IoT has a large variety of real-world applications .
- Automobiles, telecommunications, power, and other sectors will all benefit from IoT implementations.
- Smart houses projects.
- Wearable devices with sensors and apps.

- Monitoring construction workers or firefighters vital signs at potentially life-threatening locations.
- Server client communication.
- It is used in health care domain
- Used in transportation for tracking the vehicles.
- Used in traffic regulating systems
- Agriculture based developments
- Also used in smart grid development and energy savings.

In the upcoming chapter we are going to discuss about the outputs and results for the proposed work.

CHAPTER 5

5.1 RESULT AND DISCUSSION

The main power of 220 volts will fry out the circuitry so we apply the power to an step-down transformer where the current is been step-downed from 220V to 12V. The current from the transformer is an alternating current, the components majorly used are digital components. Hence, an Analog to Digital Converter is used to transform the alternating current into direct current. This, Direct Current is fed to all the components like wifi module, ESP8266 microcontroller, servo motor, etc.

In forest the input power can be obtained from an solar panel setup, where the current is been carried out to all the devices. An arduino UNO serves as an embedded device that binds the major input sources like temperature sensor, fire sensor and smoke sensor. The fire sensor detects the infra red radiation emitted from the dense fire, while the temperature sensor detects the raise in temperature over the surrounding by continuous monitoring and the smoke sensor detects the unusual smoke caused by the fire. These are the basic three checksums that are obtained to detect the precise forest fire condition.

Once the three threshold conditions are satisfied the outputs are done via three ways, they are.,

1. Display of real-time data in IOT Web Page.
2. Mobile Notification to the authority in-charge.
3. Nearby buzzer-alarm to the local fire station.

5.2 MECHANISM

The fire detection is done by 3 sensors - fire sensor, temperature and smoke detection sensor. If the fire is detected, sensor senses the changes in the surroundings and sends the information/data to the arduino UNO board. Once the arduino conforms the rise in temperature, smoke and fire, it starts the work. The components connected for output were IOT module ESP8266 and GSM module and a buzzer.

A servo motor is also included in the circuitry to extinguish any minor fire. The IOT module ESP8266 is the primary alert system. Through this the client can receive the real-time data all around the globe irrespective of the distance. We can watch and observe the fire anywhere around the globe. It needs to be connected to internet via the wifi. The ESP8266 will be able to communicate with an IOT webpage developed using PHP. Once the arduino board confirms that the temperature values from the temperature sensor is over the threshold value, it will send the real-time temperature values and smoke values along with geometric coordinates with the help of GPS module connect with the circuit. The GPS module sends the exact geometric co-ordinates(latitude and longitude) to ESP8266 which will be uploaded to the webpage in real-time. But internet is mandatory for this method to work or-else the real-time values will not be uploaded in the webpage. Also the receiver should also need internet facility in-order to observe the real-time data from the ESP8266. The secondary alert is the mobile phone notification to the person in-charge.

A GSM module is mounted over the circuit in-order to pass mobile notification to a person in-charge. As same as for IOT module, once the temperature rises above threshold temperature and if smoke is detected, through GSM module the arduino send a mobile notification to the mobile number that is provided.

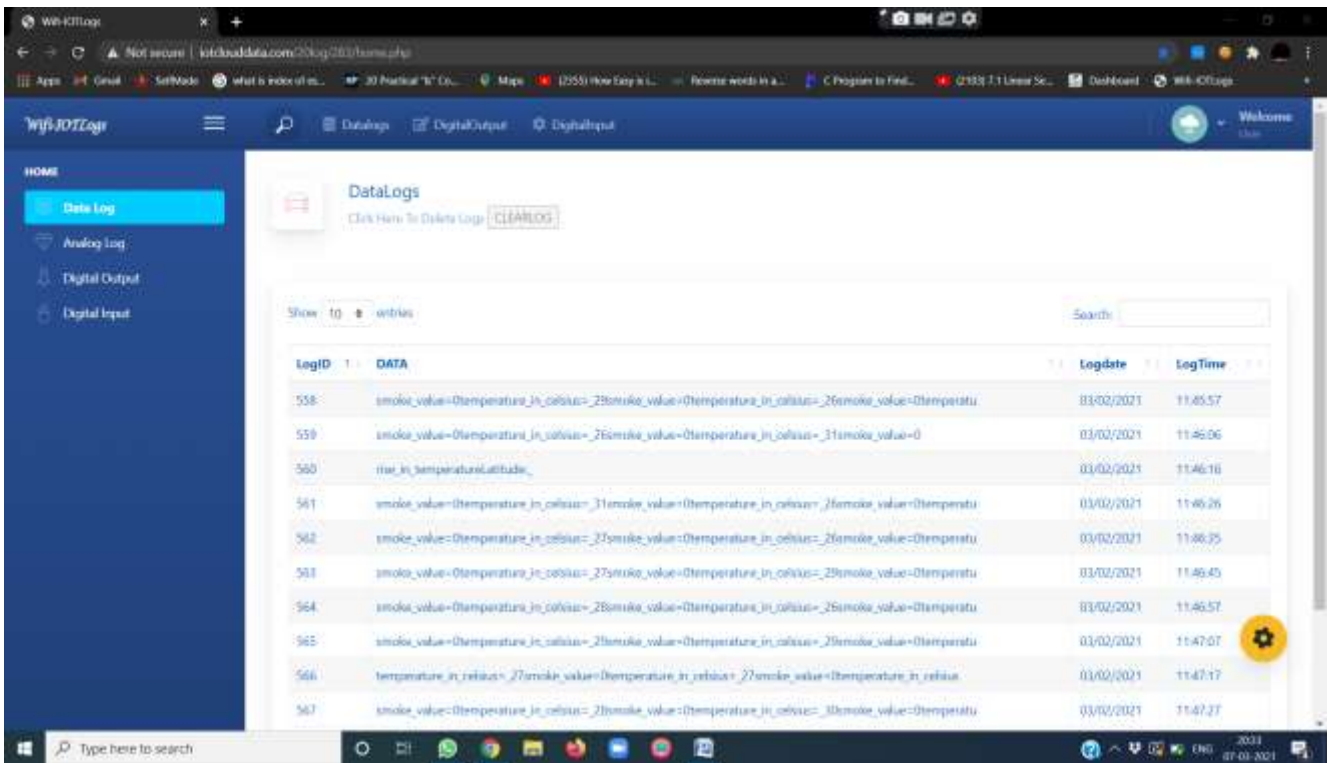
The message will be denoting the alert and also the exact geometric co-ordinates latitude and longitude will be send to the person's mobile number. The exact geometric co-ordinates latitude and longitude will be provided by the GPS module connected to the circuit. This will be even more helpful to know the forest fire as soon as possible. As this part uses GSM module, even without internet we can get the alert. Connecting to internet is not mandatory for GSM module and mobile alert. Once the person in-charge gets the alert he/she can take necessary actions accordingly.

Eventhough we have high level alert systems connected to the module, we need to have a traditional method to alert people in the local who don't have access to above methods. We need a method to alert local fire station or people.

This method should we able to work even without internet and mobile signal in-case if they are not available. For the last 3rd type to alert system we have connected a buzzer along with the circuitry. As the sensor senses the rise in temperature and smoke and fire, the sensors sends the information/data to the arduino Uno which in turn on the buzzer. The buzzer starts alarming so that the local people gets alerted.

5.3 OUTPUT

The IOT webpage output is shown below



The screenshot displays a web browser window with the URL `localhostdata.com/DataLog/263/home.php`. The page title is "Wifi-IOTLog". On the left, a sidebar menu includes "HOME", "Data Log", "Analog Log", "Digital Output", and "Digital Input". The main content area is titled "DataLogs" and features a "CLEAR LOG" button. Below this, a table displays the following data:

LogID	DATA	Logdate	LogTime
558	smoke_value=0temperature_in_celsius=28smoke_value=0temperature_in_celsius=26smoke_value=0temperatu	03/02/2021	11:45:57
559	smoke_value=0temperature_in_celsius=26smoke_value=0temperature_in_celsius=31smoke_value=0	03/02/2021	11:46:06
560	latitude_in_latitude_longitude_	03/02/2021	11:46:16
561	smoke_value=0temperature_in_celsius=31smoke_value=0temperature_in_celsius=26smoke_value=0temperatu	03/02/2021	11:46:26
562	smoke_value=0temperature_in_celsius=27smoke_value=0temperature_in_celsius=26smoke_value=0temperatu	03/02/2021	11:46:35
563	smoke_value=0temperature_in_celsius=27smoke_value=0temperature_in_celsius=28smoke_value=0temperatu	03/02/2021	11:46:45
564	smoke_value=0temperature_in_celsius=28smoke_value=0temperature_in_celsius=26smoke_value=0temperatu	03/02/2021	11:46:57
565	smoke_value=0temperature_in_celsius=28smoke_value=0temperature_in_celsius=26smoke_value=0temperatu	03/02/2021	11:47:07
566	temperature_in_celsius=27smoke_value=0temperature_in_celsius=27smoke_value=0temperature_in_celsius	03/02/2021	11:47:17
567	smoke_value=0temperature_in_celsius=28smoke_value=0temperature_in_celsius=30smoke_value=0temperatu	03/02/2021	11:47:27

Fig 5.1: IOT Webpage

This is the image of IOT webpage developed with PHP. This webpage is connected with IOT module ESP8266 in the circuit. The webpage store the data logs that contains the data from the ESP8266.

The smoke value, temperature value from the sensors and geometric co-ordinates (latitude and longitude) from the GPS module connected with the module will be uploaded in real-time. Also we can see the date and time of upload. This can be viewed and monitored in real-time anywhere around the globe.

The mobile notification alert output is shown

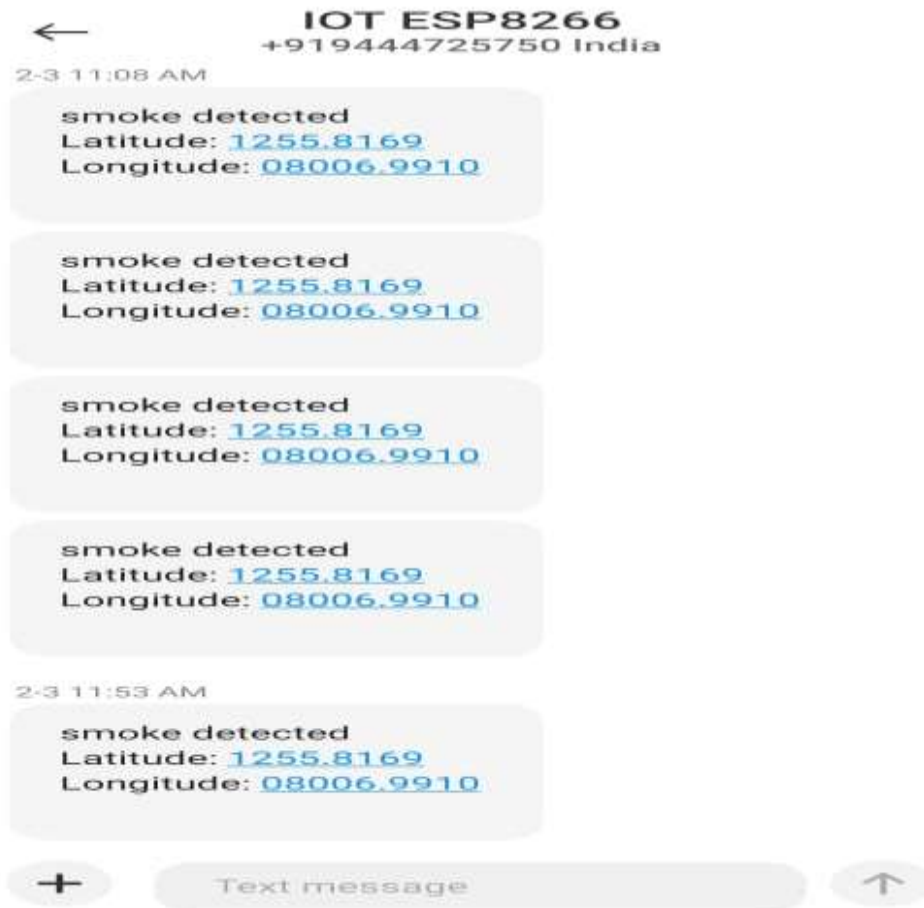


Fig 5.2 : Alert Notification

This is the image of mobile message notification the person in-charge will receive in his/her mobile. The arduino will send signal to GSM module, which in turn alerts by messaging to the pre-given mobile number. It has a alert message along with the exact geometric co-ordinates (latitude and longitude).

The overall setup of Forest Fire Detection System

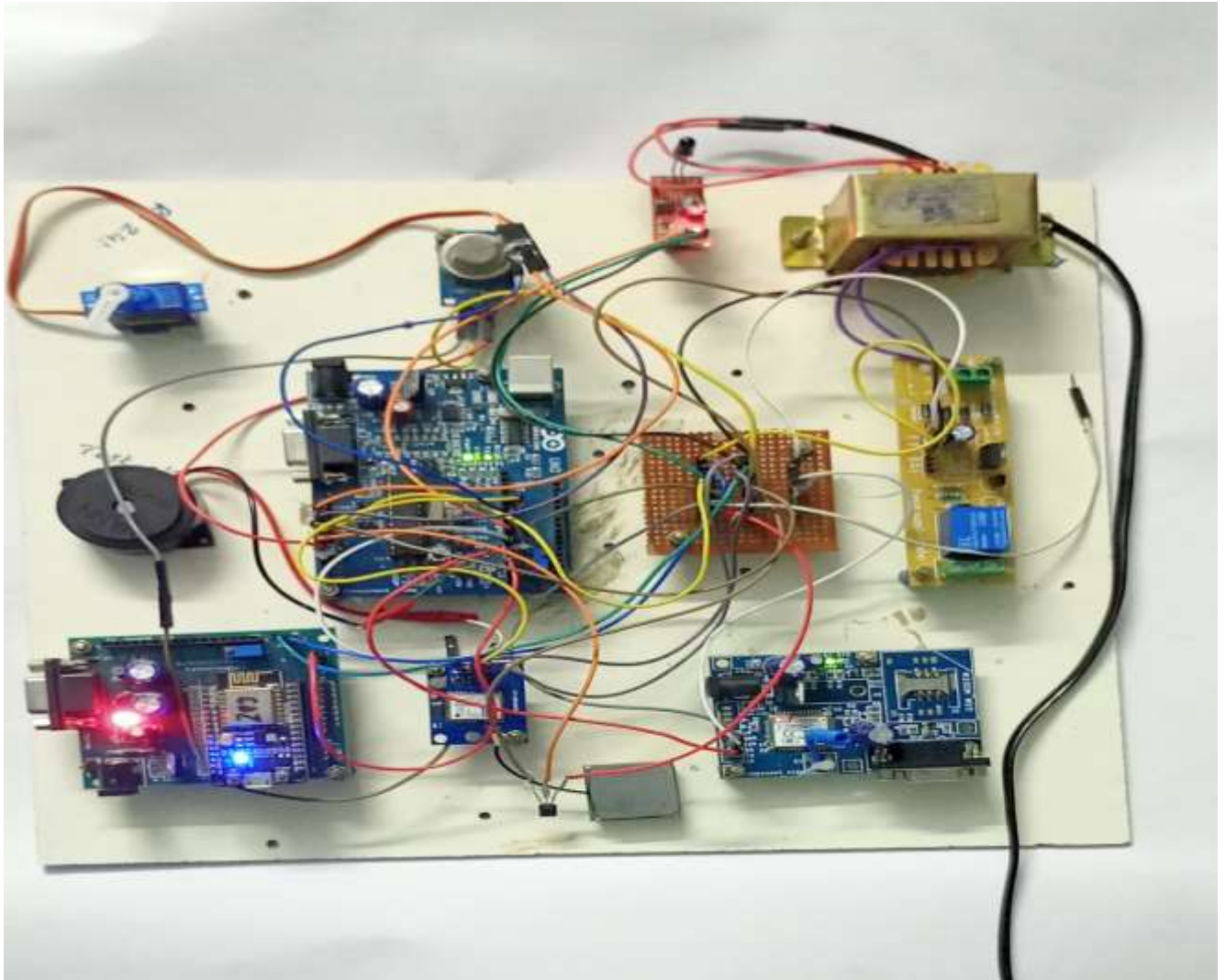


Fig 5.3: The full setup of Forest Fire Detection System

CHAPTER 6

SUMMARY AND CONCLUSION

All of our rising challenges can be solved with the emerging science and technology. Predicting natural calamities is a difficult task, and our method must be validated in real-world conditions. Nearly 40% of Amazon forest in Brazil has suffered forest fire this year, more than 4.6 million acres of forest have been destroyed. Our scheme, on the other hand, would be critical in preventing forest fires, which would save a lot of money and time. The wild life in that area has been affected because of this disaster. The main cause for this much destruction is because of the fact that we didn't detect the fire soon. Also we don't possess high tech-equipment for detecting the forest fire very soon.

Despite the fact that our machine is self-contained and independent, other variables that might influence the hardware were checked over time. It would be introduced in limited woodland regions where forest fires are a frequent phenomenon. To survive all of the temperature variations that can impact its operation, the device must be resilient.

The equipment we used is one of the most effective and well-known for detecting forest fires in a short period of time. We experimented in forest-like environments, but the true challenge will come when we implement in a wide area in real time. At extreme weather conditions, the signal to the GSM module might be unreliable and also in deep forests area's the signal may be unreachable. In future we can overcome this drawback using eminent technology.

With the use of this circuitry, the forest fire can be detected and prevented(in case of minor fires)using servo motor. The locals can be alerted with the help of buzzer, the fire department head will be notified via phone message. Also we can monitor all the sensor values in real-time through webpage, all around the globe. As a conclusion, our work setup can be implemented in real-time environment.

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Forest Fire Detection

by Ram N

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ABSTRACT

The design of a framework for tracking and preventing forest fires using IOT is presented in this project. An initial investigation into the causes of forest fires, as well as how to prevent them, requires a clear understanding of how to incorporate a valid network architecture capable of detecting potential changes in the ecosystem, so that we can avoid a catastrophe (forest fire) that could result in the loss of a large number of natural resources, wild life and human life.

The main goal of our device is to detect a forest fire and issue an alarm using IoT, a buzzer, and GSM. The design of the system is made up of different types of sensors, these sensors plays a major role in detecting the forest fire and used to alert the people nearby. Also we are able to monitor the observed area in real-time via IOT webpage. We have also implemented a defensive setup using servo motor to sprinkle water in the area around the setup in-case of any minor fire.

CHAPTER 1

1.1 INTRODUCTION

- Forest fires are a common occurrence in almost all parts of the world. It's most common in dry forests during summer. Forest fires of varying severity and magnitude burns a vast area of forest every year.
- Forest fires can be fatal, damaging houses, animal habitat, and trees, also destroying natural resources as well as polluting the environment with toxic pollutants. Carbon dioxide, a primary greenhouse gas, is also released into the troposphere.
- Forest fires contribute to the greenhouse effect and climate change by increasing carbon dioxide levels in the atmosphere. Furthermore, ashes deplete soil nutrients and cause floods and landslides by eroding the soil.
- As a consequence, the development of a reliable forest fire detection method is essential. It detects a fire signal using temperature and smoke detection sensors and sends an alert to the client via an IOT cloud server.

1.2 OBJECTIVES

- The primary objective of this project is to detect the forest fire as soon as possible using emerging the technologies IOT and GSM.
- The aim of this work is to use sensors and a microcontroller to detect a forest fire and alert the client through mobile notification using GSM.
- The setup alerts the local inhabitants and wild life around the particular area via buzzer.
- To locate the actual location of fire inside a dense wild forest using GPS and alert the fire department, so they can respond appropriately before any casualty.

CHAPTER 2

2.1 LITERATURE SURVEY

1. Alexander A. Khamukhin et al : *Aerial Forest Fire Surveillance - Evaluation of Forest Fire Detection Model using Aerial Videos*

Unmanned aerial vehicles (UAVs), which can offer an aerial view for rapid response in large-scale crisis areas, have increasingly been used to track forest fires. This paper investigates a general model of forest fire detection using aerial videos in order to show its robustness for use in aerial forest fire surveillance. Fire pixels are created using the colour and motion characteristics of fire. Our fire detection model's accuracy is tested using a large database of various scene situations in order to show the reliability as well as the shortcomings of our previous study's fire detection model. There are 49 aerial videos in our collection, with a total of 16898 forest fire frames analysed. Our forest fire detection model is 93.97 percent accurate, with a false alarm rate of 7.08 percent and a miss rate of 6.86 percent, respectively. Thick smoke that covers almost the entire fire is the primary cause of miss detection in our fire detection model. To improve detection accuracy, we propose an additional stage of smoke detection in this study. The colour and motion of the smoke are used to segment the pixels. The results show that in the event of smoke, the smoke detection stage aids in identifying the fire area.[1]

2. Shixiao Wu et al : *Speculation of Forest Fire Using Spatial and Video Data*

Forest fires are a natural disaster that wreak havoc across the globe. The vegetation bears the brunt of the destruction in high-severity explosions. As a consequence, in order to protect the trees, this fire must be contained within the forest environment. There are currently frameworks of image recognition systems that analyse a static forest fire image to provide information on fire hot spots. With such static images,

² fire motion/movement analysis with forest zone analysis is challenging. This dilemma can be solved by using real-time video surveillance to track the burn. As a result, the proposed architecture offers a novel method for analysing forest fire flame movement using videos and spatiotemporal data.[2]

⁴ 3. **Evizal Abdul Kadir et al: Modeling of Wireless Sensor Networks for Detection Land and Forest Fire Hotspot**

Forest fires are a major problem and catastrophe in Indonesia due to the country's tropical location and the prevalence of peat land, which poses a high risk of burning, especially during the dry season. Forest fires are frequent in Riau Province, affecting Indonesia's entire length and width. This study proposes the establishment of Wireless Sensor Networks (WSNs) in Indonesia for the identification of forest fire hotspots, with an emphasis on Riau Province, which is one of the areas with a high risk of forest fire during the dry season. Land sensor systems gather environmental data and report any modifications to a data centre for review using WSN technology. Software processing for fire hotspot identification is done in a data centre in order to determine and conclude whether a fire hotspot has the ability to become a major fire. Sensors will be installed at a variety of locations, including those that have recently seen a fire and those that are expected to do so in the future. Mathematical simulation is used in this case to model the number of sensors that must be installed as well as the forest's size. The design and development of WSNs has a significant effect and feasibility in solving Indonesia's current forest fire and fire hotspot detection problems. WSNs were used in the development of this system, which are ideal for early warning and alarm systems for hotspot detection.[3]

⁸ 4. **Hanh Dang-Ngoc et al : Aerial Forest Fire Surveillance - Evaluation of Forest**

Fire Detection Model using Aerial Videos

Forest fire control has recently been done using unmanned aerial vehicles (UAVs), which can offer an aerial view for fast response in large-scale disaster areas. One general model of forest fire detection using aerial videos is investigated in this paper in order to demonstrate its robustness for use in aerial forest fire surveillance.

The colour and motion properties of fire are used to remove fire pixels. The fire detection performance is assessed using a large database of various scene conditions to demonstrate the efficacy as well as the shortcomings of our previous fire detection model. In this analysis, we suggest an additional stage of smoke detection to improve detection efficiency. Smoke pixels are segmented using both color and motion characteristics of smoke. The results prove that smoke detection stage give help in detecting the fire area in case of smoke.[4]

5. T.L. Divya et al : Speculation of Forest Fire Using Spatial and Video Data

Forest fires are a natural calamity that devastate the world. In high-severity fires, vegetation takes the brunt of the destruction. As a result, this fire must be detected inside the forest region in order to save trees. Image processing device software are currently available that conduct analysis on a static forest fire image and provide information on fire hot spots. Fire motion/movement mapping with forest region analysis is challenging with such static images. This dilemma can be solved by constantly watching the flames on screen. As a result, the new design provides an innovative approach for analysing forest fire flame movement using images and spatiotemporal functions.[5]

In the upcoming chapter, we are going to discuss the proposed and existing work of the project, which we have implemented using the modern IOT technology.

CHAPTER 3

3.1 AIM AND SCOPE OF THE PRESENT INVESTIGATION

The goal is to find the forest fire as quickly as possible, and pinpointing its exact location and notifying fire units as soon as to take action. The goal is to detect forest fires using various sensors and microcontrollers, and to warn the client through IOT cloud servers and mobile notification, as well as to detect forest fires and alert the fire unit so as they can respond appropriately and avoid any casualties. As a result, the development of an effective forest fire detection technique is required. It uses temperature and smoke detection sensors to detect a fire signal and sends a warning to the client via an IOT cloud server.

Throughout the years, several fire detection solutions have been introduced and used. To begin, video surveillance systems of various types are the commonly used systems for detecting forest fires. While video technology is not the most precise, it is commonly used because of its low cost and reasonable performance.

The design of a framework for tracking and preventing forest fires using IOT is presented in this article. An initial analysis of the causes for forest fires, as well as how to prevent them, is needed to provide a clear understanding of how to incorporate a valid network architecture capable of detecting potential changes in environment, in order to avoid forest fire that can cause loss of natural resource. The primary goal of our device is to detect a fire and issue alarm using a buzzer and GSM.

3.2 EXISTING SYSTEM

- Over the years, many solutions for fire detection have been developed and used
- For example, video surveillance systems of different types are the commonly used systems for forest fire detection.
- While video technology is not the most precise, it is commonly used because to its low cost and reasonable performance.

3.3 PROPOSED SYSTEM

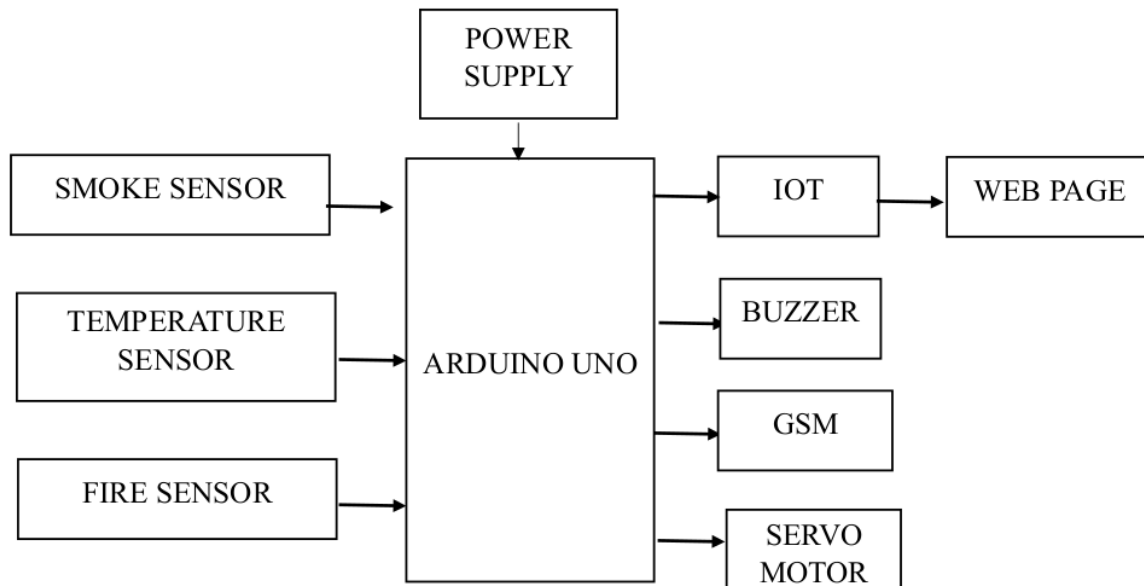
- The design of the proposed fire alarm system is depicted in the block diagram below.
- Temperature, smoke, and fire sensors make up the structure of this fire alarm system.
- During a burn, the sensors can detect the different factors that change.

- These factors' threshold values are fed into the Arduino uno.
- The Arduino Uno's main purpose is to process the analogue inputs from the sensor and send a warning with the sensor's location using GPS.

In chapter 4, we are going to discuss about the circuitry of the proposed work along with the components included in the circuitry.

CHAPTER 4

4.1 BLOCK DIAGRAM



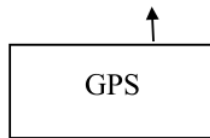


Fig 4.1 : Basic block diagram of forest fire detection system

4.2 HARDWARE REQUIREMENTS

- Arduino uno
- Temperature sensor
- Smoke sensor
- Fire sensor
- ESP8266
- Servo motor
- GPS, GSM
- Buzzer

4.3 EMBEDDED SYSTEM

A period software system (RTOS), that is additionally restricted by period computation, program associated controls an embedded system, that serves a specific purpose among a bigger mechanical/electrical system. It includes each hardware and mechanical elements. the bulk of microprocessors square measure designed to be used in embedded systems, accounting for ninety eight of all microprocessors.

Most embedded computers have low power consumption, small size, changeable operating ranges, and small per-unit cost. This comes at the cost of limited computational resources, making programming and communicating with this much more challenging.

By using existing sensors and connectivity of embedded units, building mechanisms on top of hardware allows us to optimize the resources at system and network levels, and also gives required functions.

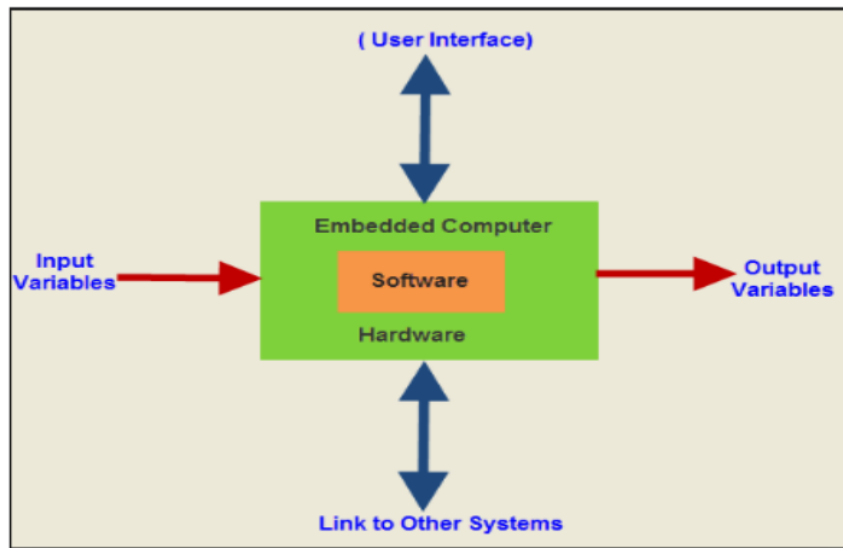


Fig 4.2 : Model flow of an Embedded System

Embedded systems are used in industrial, consumer, medical, automotive, commercial, and military applications. From network telephone switches to end-user mobile phones, telecommunications networks use a range of embedded systems. Data is routed via dedicated routers and network bridges in computer networking.

4.3.1 BLOCK DIAGRAM OF AN EMBEDDED SYSTEM

Embedded processors are used in computers. Many products with a digital interface, such as microwaves, VCRs, and cars, use embedded systems. In some embedded systems, an OS is used. Others are highly specialized in the implementation of entire logic as a single application. They don't have general features, these systems are built into a device for a specific purpose.

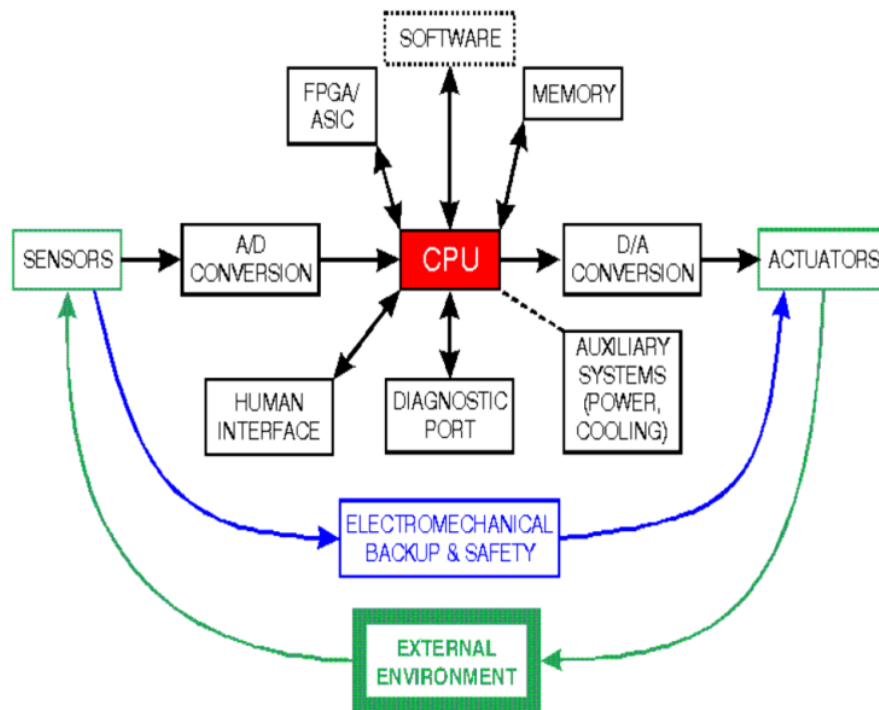


Fig 4.3 : Block diagram of embedded system

4.3.2 EMBEDDED SYSTEMS APPLICATIONS

The applications of embedded systems are: mobile applications, motors, cruise control, engine integrity, assembly line robotics, cars, E-commerce applications, and others.

4.4 HARDWARE COMPONENTS DETAILS

The Hardware Components involved in this setup are Arduino UNO board, Fire sensor, Smoke Sensor, Temperature sensor, Buzzer, Wifi module, GSM module, Step down transformer.

4.4.1 ARDUINO UNO

The term "uno" comes from the Italian word "uno," which means "one(1)." The ATmega328 microcontroller is used in the Arduino Uno microcontroller board. On the frame, there are total 14 digital pins, 6 analog pins, a 16 MegaHertz ceramic resonator, an USB port, a power. It includes everything you'll need to get started with the microcontroller, with a USB to connect it to a device and a AC-to-DC converter or

battery for power. The second is an unconnected pin that can be used later. It has been created a more effective RESET circuit. In place of the 8U2, use a super 16U2. It was chosen as the logo for the Arduino 1.0 release. In the future, the Uno and first version of Arduino will be the base model.

In our project we have used Arduino UNO board as our base microcontroller which connects all the sensors, modules and other components. This Arduino UNO board does all the work needed in the project.

4.4.2 POWER

The pin V_{in} is the voltage input to Arduino board. This pin receives a controlled 5V from the board's regulator. The board is powered by the DC power pins (7 - 12Volts), USB. Using 5Volt or 3.3Volt pins for input voltage may cause damage to the board.

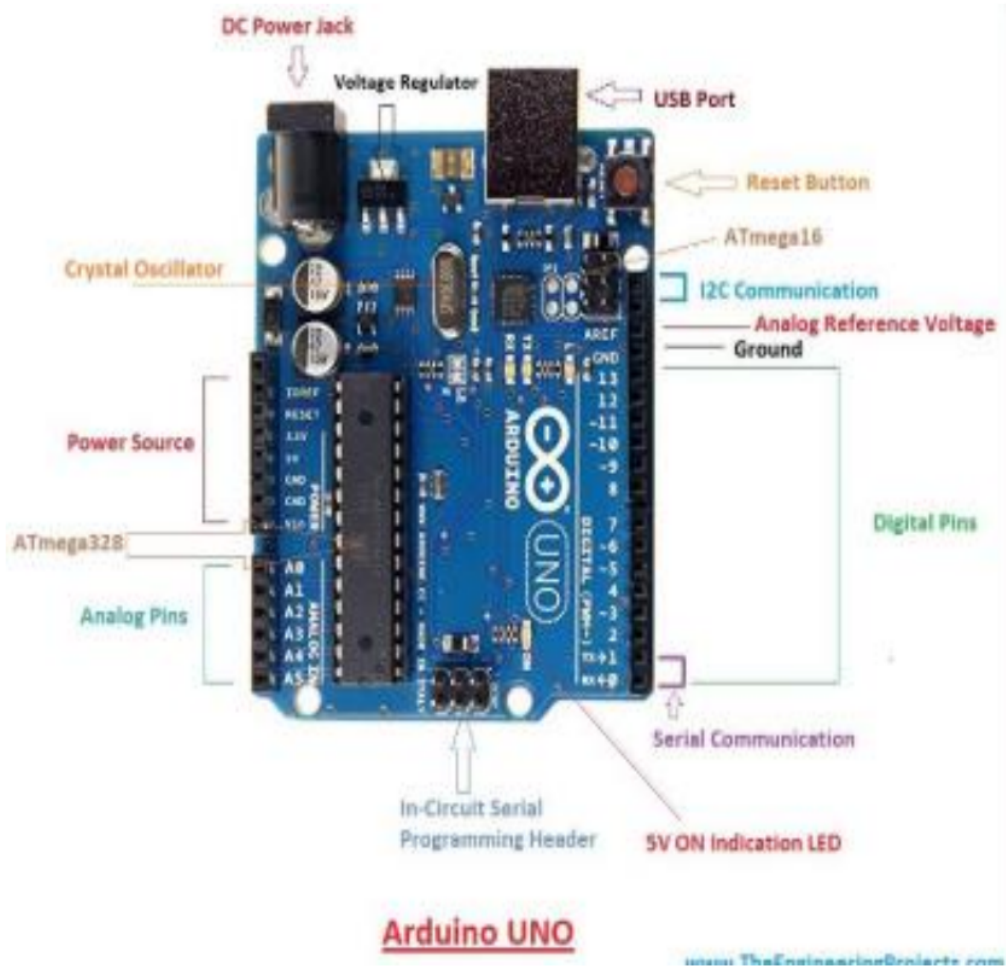


Fig 4.4 : Arduino Uno diagram

4.4.3 PIN CONFIGURATION

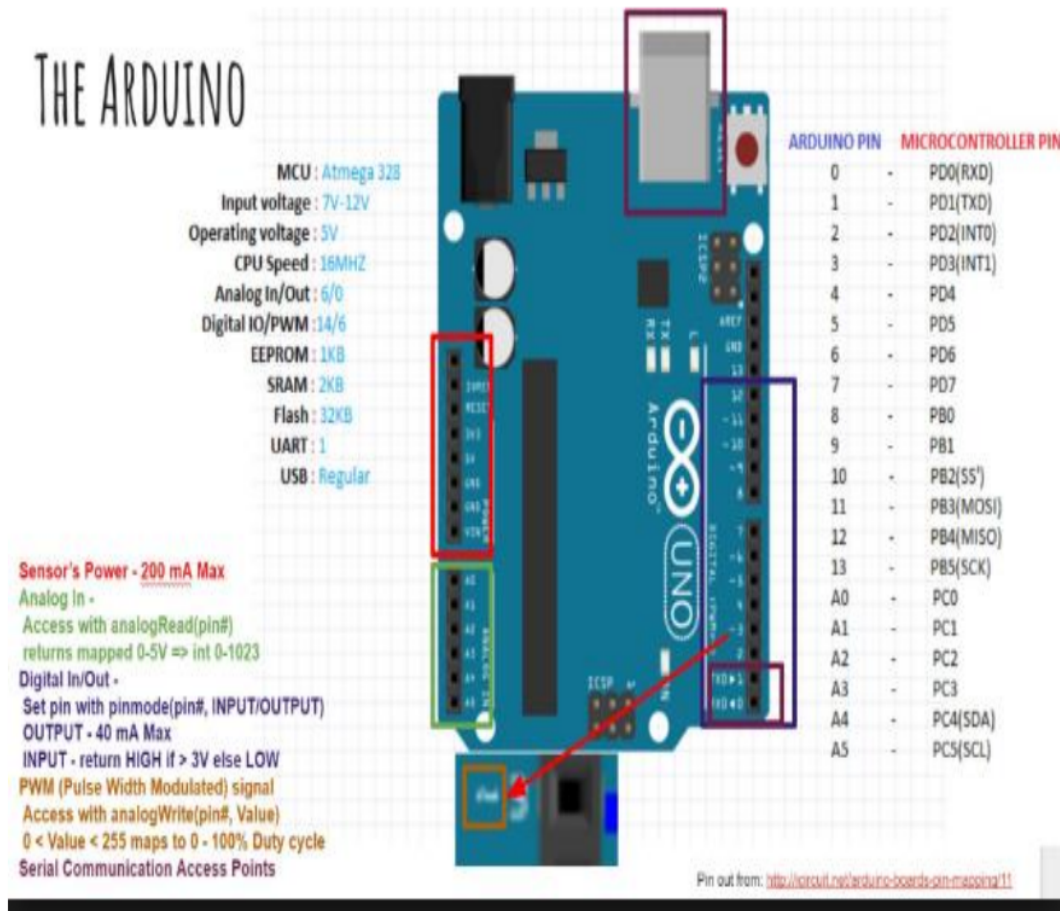


Fig 4.5 : Arduino Uno's pin diagram

4.4.4 USB OVERCURRENT PROTECTION

Computer's USB ports are protected from short circuit by a poly fuse on the Arduino Uno. Although most computers come with built-in security, the fuse provides a protection layer. If above 500 milliampere is applied to the USB pin before the short circuit is removed, the fuse will instantly blow, breaking the connection.

4.4.5 Physical Characteristics

The USB and power port extends beyond the former dimension, making the Uno PCB's full length and width 2.7 and 2.1 inches, respectively. The board is installed with four screw holes for mounting to surface. The distance between digital pins 7 and 8 is 160 milli meter.

4.5 TEMPERATURE SENSOR

We need to calculate the temperature values for deciding whether the fire is caught or not. For that we need to install a sensor that can sense the temperature into the system.

4.5.1 SPECIFICATIONS

Table 4.1 : Specifications

Range	0°...100°C
Accuracy	< 0,1°C + NTC-spread over 0°...70°C
Resolution	2 m°C@30°C and 25 m°C@100°C
Linearity	see table
No. Sensors	1....30
Type	5 kOhm NTC-resistors Max. wireresistance 3,3 Ohm
Conditioner	Wheatstone-bridge with +15 Bits ADC
Calibration	at 0°C and 100°C _ 0,1°C
Drift	1 m°C/°C with periodic calibration and 5 m°C/°C without calibration
Scanfreq.	default max. 10 meas./s
Amb.temp	0°...60°
Control	Micro-Wire™ 5 (Di, Do, Clk en CS)
Levels	0 and 5 Volt
Power	+12 Volt 3,5 mAmp (+5,5 +20 Volt) -5 Volt 1 mAmp (-4,5-8 Volt)
Dimensions	224 x 120 x 60 + 40 mm

4.5.2 TEMPERATURE AND ITS MEASUREMENT

Temperature is a measure of the heat and is defined as the degree of hotness. It wasn't until the invention of the Steam Engine calculating the heat content of the body on a scale arose.

The desire of scientists for understanding the behavior. Years of meticulous scientific research resulted in a plethora of hypotheses, ranging from the basic 'Caloric' definition to the more complex 'Caloric' concept, Carnot's definition of heat as a source of energy differed from that of, which regarded heat as a material substance that is exchanged among materials (which laid the foundation of the first law of thermodynamics).

None of them, however, adequately clarified the principle of temperature. Maxwell's hypothesis provided a solid foundation for it. He specified temperature as a thermal property of a body that provides information about the system's energy content. It is a measure of a substance's average kinetic energy (energy derived from motion) and denotes a heat potential in which heat flows from a higher temperature to a lower temperature.

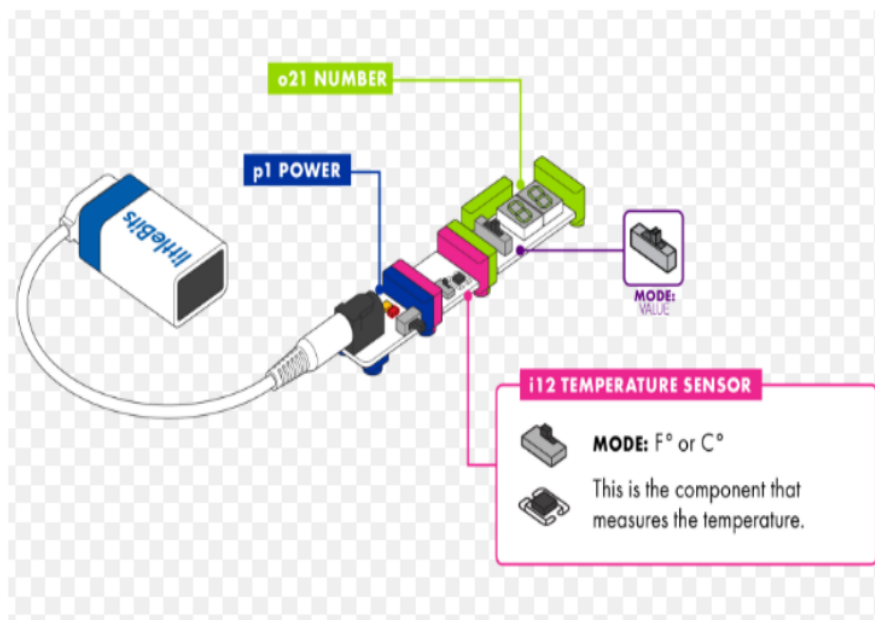


Fig 4.6 : Temperature Sensor

4.5.3 NON-CONTACT TEMPERATURE SENSORS

The convection and radiation are used to detect temperature fluctuations in

these temperature sensors. They are used to detect radiant energy emitted by liquids and gases as heat goes up in the convection currents, or to detect radiant energy emitted by an object in the form of IR. The following three types of temperature sensors can be divided into types of touch or even non-contact temperature sensors: electro-mechanical, resistive, and electronic.

4.5.4 THERMOSTAT

Thermostats are electro-mechanical temperature sensors or switches that are made up of two separate metals fused to form a Bi-metallic strip, such as nickel, tungsten, or aluminum. As heat is applied to the strip, linear expansion of dissimilar metals can cause mechanical bending.

Bi-metallic strips are often used to power water heating sources like boiler furnaces, hot water units, and car radiator cooling system.

4.5.5 THE BI-METALLIC THERMOSTAT

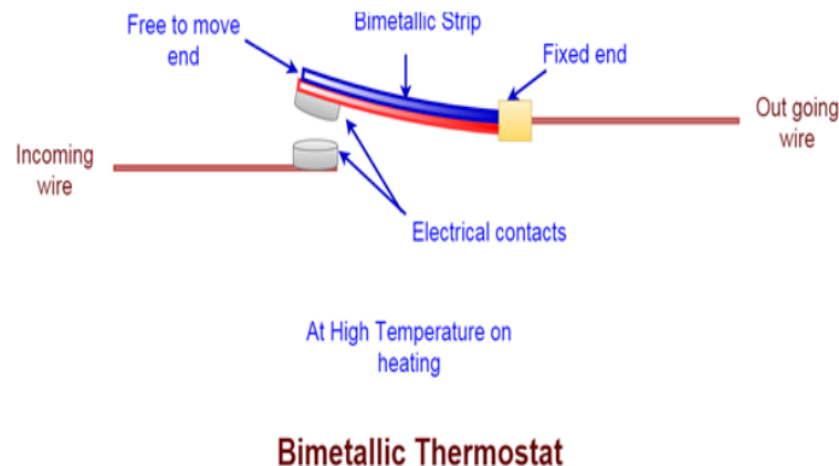


Fig 4.7 : Bimetallic Thermostat

The thermostat is made up of two metals that are thermally distinct and are blend together. When the thermostat is not hot, the vicinity and electrons flows over it.

If one metal gets hotter, the metallic strip curves, opening the vicinity and blocking the electrons.

4.5.6 ON/OFF THERMOSTAT

Bi-metallic strips are differentiated into two categories based on how they travel when exposed to temperature variation

The thermostats are used to regulate the temperature of microwaves, iron-box, and hot water unit, as well as to control the house-hold heating systems. Creepers have a bimetallic spiral or coil that unwinds as the temperature rises. Creeper bi-metallic's are more resistant to temperature variances than standard ON or OFF varieties since the strip is larger and narrower.

When used as a temperature sensor, standard snap-action style thermostats have a broad heat range from which the electrical vicinity opens until they close, despite being inexpensive and usable over a wide operating range. Example, it can be set to 21°C but not open until 23°C and holds until 18°C.

4.6 SMOKE SENSOR

It is a detector that sense the presence of various gases in a room and is often used as a part of protection systems. This type of sensors can detect gas leakage and other contaminants, as well as attach to a control system to automatically shut down an operation. A gas detector will sense gas leaks in the area, giving them time to evacuate. Since certain gases can affect organic substances, humans and animals. Combustible, flammable, and poisonous gases, as well as oxygen depletion, can all be detected with gas detectors. This type of system is commonly used in industry, and it can be used in places like oil mines to track manufacturing processes and technologies like photovoltaics.

Gas leakage sensing is the method of using sensors to detect potentially dangerous gas leaks. When a harmful gas is detected, these sensors normally emit an audible warning to alert people. Painting, fuel refilling, building, mining, landfill rescues, and accessing enclosed space may all result in toxic gas exposure.



Fig 4.8 : Smoke Sensor

4.6.1 PHOTOIONIZATION

To ionise chemicals in the sampled gases, PIDs employ a high-photo-energy UV lamps. An electron will be expelled if the ionisation energy of the compound is lower than that of the lamp photons, and the resultant electron flow is directly related to the compound. At concentrations ranges from a few ppb to thousand ppm, a wide variety of compounds can be observed organic esters, Popular air components and mineral acids have no impact.

PIDs have many benefits, including high sensitivity, easy to use. The biggest disadvantage is that measurements is non-compound-specific. PIDs having filter tubes are recently added, which improves the concentration for compounds like benzene.

4.7 INFRARED SENSORS

Infrared sensors uses the radiation that passes through a amount of gas; the energy from the sensor is absorbed. Carbon monoxide absorbs wavelengths between 4.2 and 4.5 micrometers. As the energy is related to that of a wavelength beyond the absorption frequency range, energy difference between the wavelengths are equal to the volume of gas.

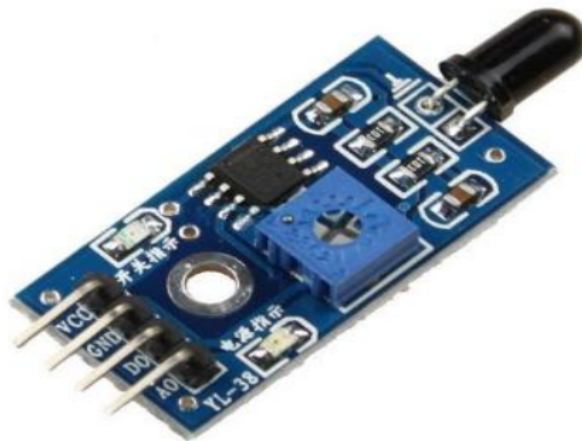
The above said sensors are used in waste-water management plants, chemical factories and other places where explosive gases may be held. Huge areas of space can be tracked using remote sensing technology.

Another field where IR sensors are being studied is engine emissions. They can detect CO and other hazard gases from exhaust of cars and also can be linked to electronic systems for warning.

4.8 OPTICAL FLAME DETECTORS

4.8.1 FIRE SENSOR

The flame detector detects and reacts to the fire. It sounds the alarm devices, cutting the fuel lines and activating the fire distinguishing systems, responding to the fire blaze. When used in industrial furnaces, their aim is to ensure that the furnace is working properly; they do not take any action other than to warn the operator or control system in these circumstances.



4.9 : Fire Sensor

4.8.2 ULTRAVIOLET DETECTOR

UV detectors sense the ultraviolet radiation released in the ignition process. It is capable of sensing fire in 2 to 5 milliseconds, a 3–4 second time delay is often included to reduce false alarms caused by other reasons.

To reduce the factors of natural-background-radiation, Ultraviolet detectors usually work at wavelengths less than 300 nm. Oily pollutants quickly blind the solar blind UV wavelength band.

4.8.3 UV/IR DETECTOR

These detectors detect fire by comparing the pre-defined values of both UV and IR wavelengths. This reduces the number of false alarms. These sensors are coupled together in a single unit. UV sensor works by sensing the UV rays emitted by the fire. The spectrum of Infrared region range is from 2 to 4 micrometer. This sensor is used in our project to detect the fire in the forest.

4.8.4 IR/IR FLAME DETECTION

The double infrared range flame detectors equal the pre-defined values in 2 infrared values. A single sensor usually tests 4.4 micrometre CO₂ and the other fixed frequency already defined. Detecting CO₂ emissions is suitable for hydrocarbon; the broadband sensor is appropriate for non-carbon based fuel, such as hydrogen.



Fig 4.10 : IR flame detector

UV/IR flame detectors has many applications. They are:

- Gas-fueled cookers

- Industrial dry cleaning systems
- Domestic heating systems
- Industrial gas turbines

4.9 GPS

The Global Positioning System is a kind of satellite system that finds and locates an object present in its navigation area. The GPS was first developed by defence department of United States of America in the year 1973 which was made to accessible for defence as well as common people needs. Recently the GPS technology is been included in smartphones, smartwatches, aircrafts, cars, etc. The GPS system is made up of 24 satellites positioned in the way that it covers all over the globe at a distance each of around 12,000 miles.

They revolve around the earth for every 12 hours, at a tractor speed of about 11,200 kmph. They are placed in such a way that it covers the globe equally in all directions. Each GPS satellite sends out the data of the satellite's current location, orbit, and time of the trajectory. The GPS receivers or base stations uses triangulation principle to determine its exact location. Hence it is a necessary need for the application of GPS in our project work.

4.9.1 GPS WORKING ON MOBILE

A GPS system initially creates an connection link with the satellite and sends an request-response and communicates further. With the energy of the signal the connection is made faster or slower. To speed up GPS detection, most of the GPS protocol follow caching of the data, ie., the previous location is cached up in the GPS server and is used for future references. A GPS system will easily predict which satellites will be available the next time it searches for a GPS signal by remembering its previous position.

4.9.2 OPERATION

In the obtained trajectory the satellite passes twice a day and also each satellite transmits a specific signal parameters to the base station via ciphering mechanism, which GPS devices can decipher and locate the satellite. This data, is used by GPS base-station receiver to determine the geographical coordinates.

The receiver will track the location by finding the distance between it's neighboring satellites, the caught data,etc. It views it electronically using distance calculate our running path, map a suggested location, find the way around and going on an adventure somewhere.

4.9.3 ACCURACY

Because of their parallel multi-channel configuration the GPS receiver station are preferably accurate when compared to other location tracking mechanisms. When our receivers are first turned on, they quickly lock onto satellites. In thick forest cover or urban areas with tall buildings, they retain a monitoring lock. The accuracy of GPS receivers can be influenced by atmospheric conditions. These factors also affects the sources and may lead to error. The standard Garmin GPS receivers are usually reliable to just 10 metres.

The accuracy in that GPS Receiver is even better in deep oceans. WAAS (Wide Area Augmentation System) improves the accuracy of some GPS receivers, this capability mechanism will increase accuracy to better than 3 metres in advance.

The use of WAAS satellites would lead to cost effectiveness than traditional GPS transmitter and receiver. Differential GPS (DGPS), which has an average of 1 to 3 metres coverage range, will also improve accuracy. In addition to their GPS, we will need a differential beacon receiver and beacon antenna to transmit the corrected signal with proper encryption and decryption.

4.9.4 NEO-6M GPS CHIPSET

The NEO-6M GPS chipset is at the heart of the system. The chip is in the size of sim card, but has a large functional uses.

4.9.5 NEO-6M GPS CHIPSET FUNCTIONS

The GPS chip leads to detection up to 23 satellites with a 50 channel bandwidth and achieves the maximum degree of sensitivity in the industry, -161 dB monitoring, though drawing just 45 milliamps from the power supply.

This modules can change its location up to 5 times per second, with a horizontal position accuracy of 2.5 metres. The chip's Power Save Mode is one of its best features which is provided to conserve the power. Through selectively swapping portions of the receiver ON and OFF, it allows for a decrease in system power consumption. This power save mode cuts the module's power consumption to just 11mA. The are used eminently in modern smart watches, to increase the battery storage time.

The chip's Power Save Mode is one of its best features which is provided to conserve the power. Through selectively swapping portions of the receiver ON and OFF, it allows for a decrease in system power consumption. It is effectly used in our project to determine the location of forest fire.

4.9.6 SPECIFICATIONS OF NEO-6M GPS CHIPSET

Receiver type: 51 channels, GPS Level1 type of system

Horizontal Accuracy: 2.5m accuracy in horizontal direction

Navigation Rate: 1HZ of frequency rate

Capture time -Cooldown start: 26s - Hot start: 2s

Navigation Sensitivity: -159dBm sensitivity

Protocols: UBX Binary, RTCM communication protocol

15
Operating Temperature: -40°C to 80°C

Operating Voltage: 2.6V to 3.5V

Operating Current: 40mA

TXD/RXD Impedance: 512Ω

4.9.7 POSITION FIX INDICATOR

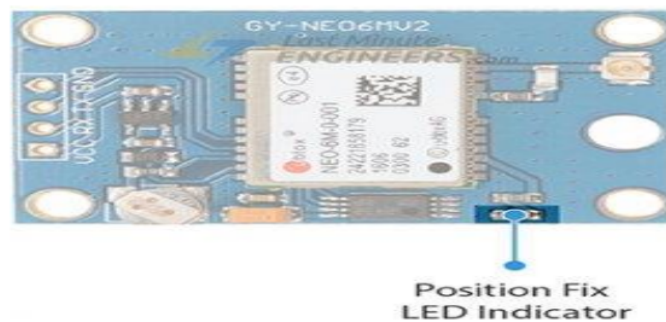


Fig 4.11 : NEO-6M GPS Module - Position Fix Indicator

The position fix status is indicated by an Light Emitting Diode on the NEO-6M GPS chipset. Depending on what protocol it's in, it'll blink at different rates:

1. It's not blinking often and it's looking for nearby satellites at a faster rate.
2. Position Fix is sought by blinking every 0.9 second, to indicate the viewer whether it is connected or not.

4.9.8 BATTERY & EEPROM

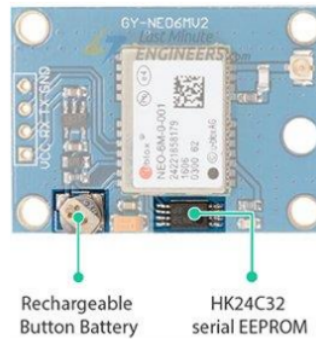


Fig 4.12 : NEO-6M GPS Module - Battery and EEPROM

An two-wire serial EEPROM is included in the module and has 4 kilobytes size. A rechargeable button battery is inbuilt such that it acts as a capacitor for storing the current. The combination of an EEPROM and a battery results in preservation of back-battried RAM.

The clock pulse, most recent location, and module values are all stored in the BBR. Also it is not for long-term data storage, because of the limitation in the storage. The battery has a clock and last spot. Also the time to first patch (TTFF) is reduced to just 0.9 second. Since the GPS has a lag in time connectivity, initial it takes longer to lock the position.

4.9.9 ANTENNA

An antenna is used in our work to make the GPS communicate with the satellite. An small patch antenna is used with a frequency rate of -161 dBm. This antenna can be snapped onto the module's narrow connector.



Fig 4.13 : NEO-6M Patch Antenna

4.10 BUZZER

A buzzer is an electronic, electromechanical, or piezoelectric audio signalling system. It is also known as beeper or piezo. The alarm, timers used in daily life validates our feedback by the applications for buzzers and beepers.



Fig 4.14 : Buzzer

4.10.1 ELECTROMECHANICAL

It is a type of buzzer, which is used in an electromechanical system similar to that of an electric bell, but without the metal gong. A relay, for example could be wired to interrupt its own current signal, causing the contacts with the beeper. These units were often hanged to a wall/ceiling as a sounding component. Since it is done mechanically with the help of some electronic instruments, it is termed as electromechanical buzzer.

4.10.2 MECHANICAL

This type of buzzer operates only by a mechanical external force. A joy buzzer is an example of a solely mechanical buzzer which is used by the vehicle drivers in olden days. Doorbells are another example of mechanical driver where an external pressure is applied to operate it.

4.10.3 PIEZOELECTRIC

This type of buzzer is used in our work such that the audio signal source may drive a piezoelectric element, which is then powered by a piezoelectric audio speaker/amplifier to make it work. To make an audible beep, a piezoelectric buzzer/beeper uses acoustic cavity resonance to make it work smarter than other types of buzzers.

4.10.4 APPLICATIONS

The application of buzzers are various, though the technical advances have made buzzers an undesirable component, the buzzers and related circuitry which may still be useful in some situations like:

- Judging panels are examples of current implementations.
- Intended for educational purposes.
- Metronomes in modern musical keyboards.
- Lock-out system for game shows.
- Microwave ovens and other popular household items.
- Electrical security alarms/ anti theft alarm.

4.11 GSM

GSM expands as Global System for Mobile networking and is a mobile communication modem. It is widely used in modern mobile device. GSM is the cellular system that uses 850MHz to 1900MHz frequency ranges to provide mobiles data/voice services to the people. In 1970, Bell Laboratories came up with the concept for this global framework which made an tilt over in the areas of networking.

For coordination purposes, the GSM method was made as an digital system with the TDMA technique. A GSM processes and suppress the data before sending it to a channel of 2 separate streams of data. The infrastructure can handle data speeds ranging from 65 Kbps to 120 Mbps in our project.



Fig 4.15 : GSM Module

4.11.1 GSM ARCHITECTURE

The following components make up a GSM network, which is made up of mobile station, base station and an network subsystem. Their functions are discussed below:

- **Mobile Station:** A mobile phone with a transceiver, a computer, and a processor that is powered by a SIM card. The basic handset is referred to as a mobile station. It operates over a network.
- **Base Station Subsystem:** This device connects the mobile receiver within the network. It was created with transmitter and receiver units, which houses the radio transmitter-receiver (transceiver) and manages the protocols for cell phone network. It acts as a mediator and promotes handoff for basic network communication.
- **The network Subsystems** provides the mobile stations with a direct connection with the link nodes. The Switching Centre offers connectivity to various networks such as ISDN or PSTN, which is the most essential component of the Network Subsystem. It also includes the Register, which are responsible for GSM call routing and roaming, registering the call and data log in its repository. Which keeps track of all mobile devices, each of which is marked by its IMEI unique number. It is abbreviated as "International Mobile Equipment Identity." IMEI is an identity for each and every subscriber who are being involved in the network subsystem.

4.11.2 FEATURES OF GSM MODULE

- It has more efficient and wider range of accessibility
- Encryption and decryption is being implemented
- Provides high-quality voice

- Support for emerging services
- International roaming is provided
- ISDN compatibility is obtained
- Provides message service
- Landline management
- Alarm management

4.11.3 GSM GATEWAY/MODEM

A GSM gateway is a system is a network gateway that allows a subscriber to connect over an inter/intra network. It has a SIM card mounted on it and runs on a inter/intra network spectrum that the network provider has subscribed to. It can be used to connect to a device via serial, USB/Bluetooth which we have used in our proposed work.

An GSM modem can be an normal GSM phone that is connected to a serial port / Universal Serial Bus port on the device using the right cable and programmer driver. End to end transaction, supply chain control, surveillance applications, weather forecast, and remote data logging are only a few of the applications for the GSM modem.

4.11.4 WORKING OF GSM MODULE

The GSM gateway is linked to the Microcontroller through the level swapper IC Max232. When a SIM card is injected, the GSM modem receives a pin or password via SMS from any mobile phone, where it communicates the data to the MC via serial communication. This pin is generally used to validate the user.

While using the module there are many sets of instructions used, if the module get's an 'STOP' instruction it results in the MC to generate an output, where the touch points of which are used to disable the power switch. If it gets an "ALERT" instruction it makes an coded warning, which is only transmitted if the input is driven poor. The entire process is projected on a LCD screen for an proper visibility to the user.

4.11.5 GSM MODEM CIRCUIT

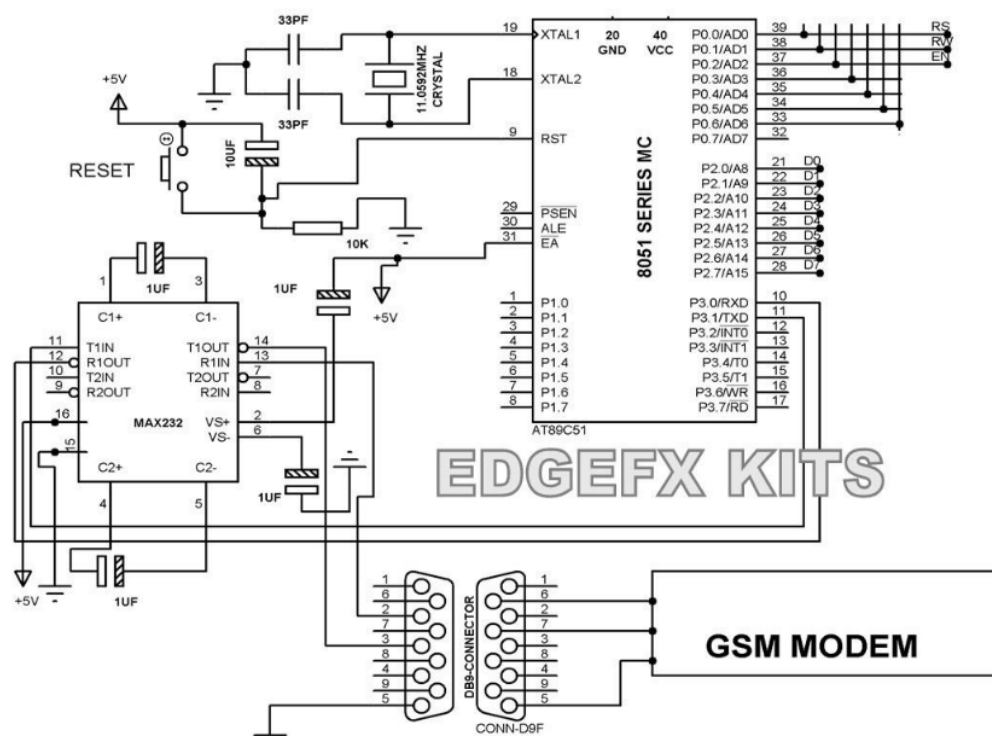


Fig 4.16 : Intelligent GSM Device for Security and Automating

This work is mainly focused on GSM inter connected network technologies for SMS transaction from sender to receiver, as the name implies. SMS inter communication is used for omnipresent appliance accessing and home violation management. Two sub-systems are proposed by the system. The device is capable

of instructing a user to adjust the status message manually or automated and specifications via SMS from a particular cell phone number is obtained.

The second feature is security warning, which is done in such a way that when an intruder is detected, the device allows for automated SMS generation, alerting the user to a security danger.

4.12 SERVO MOTOR

A servomotor is a type of linear/rotary actuator that is used in many areas. It is basically an motor which has an position feedback sensor for the angulation and movement of the knobs. It also necessitates a sophisticated controller, which is designed especially for servomotors. The servomotor that we have used in our project helps us to prevent fire in an positioned area where the forest fire is been detected. The signal is been generated from the arduino uno board via the sensors and thus the servomotor acts according to the signal received to it. It is used in our project to distinguish minor fire by sprinkling water on affected area.

4.12.1 MECHANISM OF SERVOMOTOR

The servomotor is a control system and involves the mechanism that uses location result to regulate its motion along with the last known location. A signal from arduino is fed into the power supply to indicate the path to be traversed for the output shaft.

An encoder is attached to the motor of the servo motor to provide position along with the speed as input. It also necessitates a sophisticated controller, which is designed especially for servomotors. The servomotor that we have used in our project helps us to prevent fire in an positioned area where the forest fire is been detected.

The simplest servomotors uses a potentiometer for position sensing and bang-bang motor control; the motor still rotates at maximum speed. The output shaft velocity is measured by optical rotary encoders, and the motor speed is regulated by a variable-speed drive in more advanced servomotors which is been entered by the manufacturing units. The signal is been generated from the arduino uno board via the sensors and thus the servomotor acts according to the signal received to it. It is used in our project to distinguish minor fire by sprinkling water on affected area.

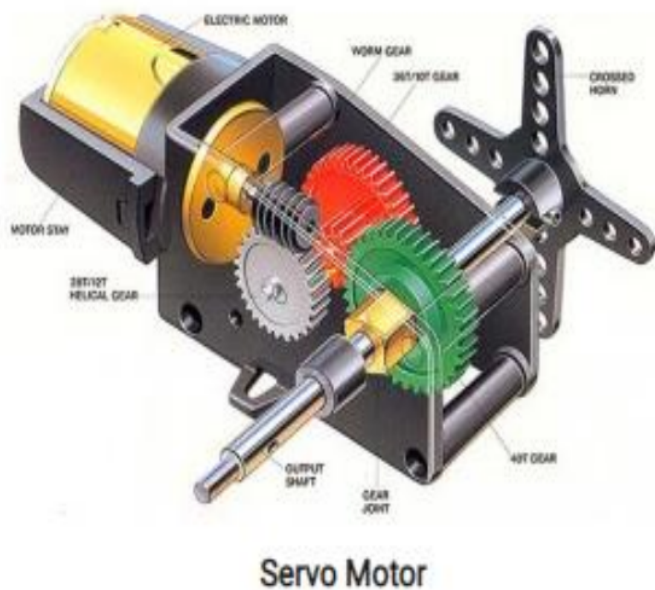


Fig 4.17 : Servo Motor

4.12.2 SERVO MOTOR FUNCTIONS

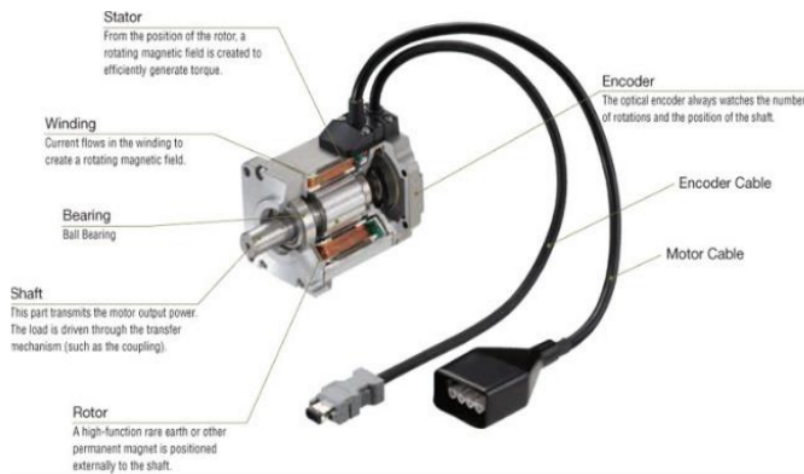


Fig 4.18 : Servo Motor Functions

The role/purpose is to get an input signal corresponding to a servo shaft output shape and move its motor till the shaft switches to that threshold position. It uses the location sensing technology to determine the shaft's rotational orientation, which allows it to figure out which way the motor can turn to move the shaft to the desired position. The shaft cannot quickly rotate around the axis, so it can only turn 200 degrees side ways and work eminently.

4.12.3 ADVANTAGES

- It is used in industries, schools and other area as fire detection devices. When ever they detect fire they sprinkle water around the area to set off the fire.
- In large scale industries it is used in water pumping machines to supply water to the large scale sectors.
- Recently it is used in toys, remote control cars, etc.
- It is used in lathe machines, drillers , mining machines and other types of work.

4.13 ESP8266 Microcontroller

The NodeMCU project is an IoT platform that is free to users to interact and we have implemented in our work model. It includes firmware for a ESP8266 from Systems, as well as components for the ESP-12 frame. The name "NodeMCU" refers to the framework or the firmware. It is simply written in Lua language, an scripting language. It's built with the Espressif Non-Open Source Software Development Kit for ESP8266 and is based on the eLua project. The ESP8266, on the other hand, is difficult to navigate and used as a chip.

We also program it in low-level computer language such as embedded C, micropython, etc., such that the chip hardware can understand. The NodeMCU integrates the arduino UNO and Raspberry pie for an combined application. It is made up of two main components.

1. An ESP8266 firmware designed on top of a proprietary Software Development Kit from the chip manufacturer. The eLua is an easy script and has a large developer community.
2. A DEVKIT board with an ESP8266 chip mounted on a regular circuit board. It has an USB that is connected to the board, a reset button, an wifi chip, LED lights. The ESP8266 board embedded with devkit is shown in below figure.

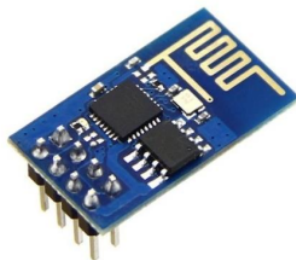


Fig 4.19: ESP8266 Chip

The Arduino project that we have included builds a portable IoT controller. This setup has a USB port, LED's, and basic data , similar to NodeMCU. It can interact with sensors and other circuit boards via the inbuilt pins. The Arduino module, unlike the NodeMCU, may have a range of CPU, memory chips for storage, and user interactive environments to interact with it.

In reality, the ESP8266 MCU is similar to an arduino board. Since, the arduino board lags in many features like WIFI connectivity, USB port connectivity, inbuilt camera, etc. We had preferred the use of ESP8266 microcontroller at the client end to communicate with the arduino setup without any delay via WIFI connectivity. They perform well unless and until they are under a common subdomain.

4.14 SOFTWARE COMPONENTS

The software components used in our project are as follows:

- Arduino IDE
- Embedded C
- PHP

4.14.1 EMBEDDED C

Embedded C is programming language, where we used it to program it for the basic components. Each and every processor in a system is linked to embedded software through this embedded C lanuage. It helps us to interact with the hardware

kernel through binaries.

For heavy and complex task, embedded C programming is necessary to ease the work. For example, the devices that we use in our daily lives which has an microcontroller and microprocessor in it is been written in this embedded C language and also it is user friendly.

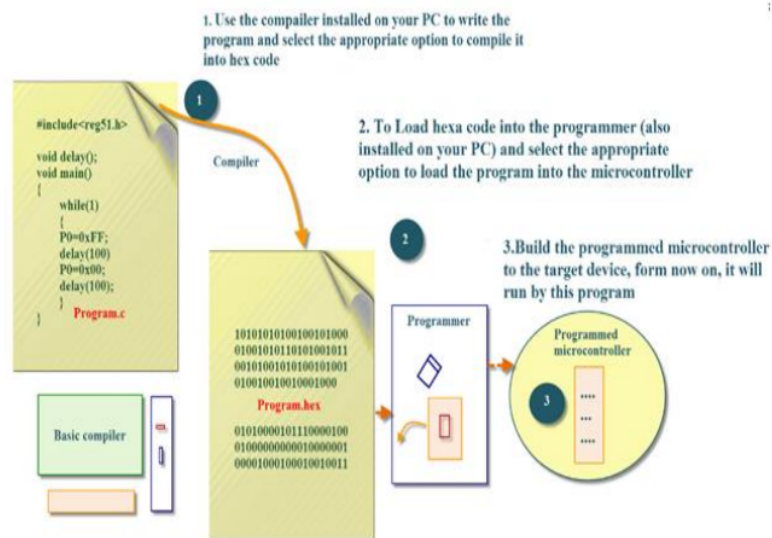


Fig 4.20 : Embedded C

The LED attached to Port of the microcontroller is flickered when the embedded C code is dumped into the hardware. Which helps to indicate the user.

C code is favoured and is considered user friendly when compared over other languages when developing embedded systems. For the reasons mentioned below:

- Easy to follow
- Reliability is a big plus
- Handiness
- Potential to scale

Recently, micropython is coming into picture as an scripting language, for the embedded devices. A programming language has many functions. A code is a set of functions following an algorithm. Embedded softwares have predetermined hardware requirements and functionality, and the addition of third-party hardware or software is strictly controlled. At the time of manufacturing, embedded applications must have the requisite device drivers, and drivers are written explicitly for the hardware. Also each an every program can be written in two ways either in an IDE or in an command line interface.

The output may be forwarded to a embedded devicelike an LED screen for display. A cross compiler, runs on a computer but produces executable code for the another platform and is needed for software development. An simulator, such as JTAG or SWD, is needed for debugging the piece of code which is being inbuilt in an IDE.

The memory and RAM sizes of the embedded devices will differ greatly, hence dumping the code is one of a challenging task. Some systems have 16 Kilobytes of Flash and 4 Kilobytes of RAM and an 8 MHz CPU, while others will compete with modern computers. Communication between processors, as well as between one processor and other components, is important

A keyword used in our work makes an drastic change in the output for example:

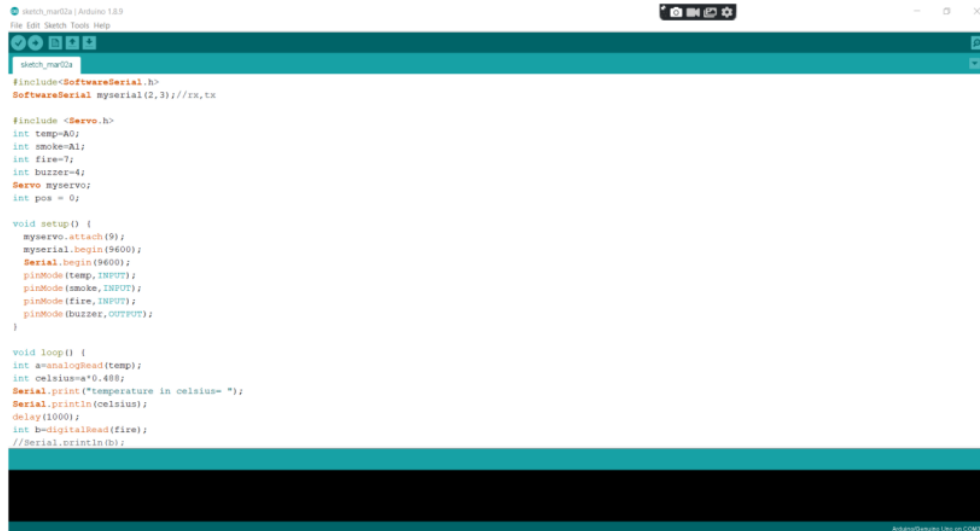
- bit
- sbit
- sfr
- small
- large

4.14.2 ARDUINO IDE

Arduino IDE is an user interactive environment. Arduino is made up of a physical programmable microcontroller's that runs on the laptop/PC and is used to edit and upload programming code anywhere and anytime.

The Arduino IDE needs corresponding components to run specific program via an USB cable. They follow standard protocols that divides the roles of the

microcontroller into a more compact package. The scripting languages like embedded C, micropython, etc are implemented on the IDE.



```
sketch_mar22a (Arduino 1.8.9)
File Edit Sketch Tools Help

sketch_mar22a

#include<SoftwareSerial.h>
SoftwareSerial myserial(2,3);//rx,tx

#include <Servo.h>
int temp=A0;
int smoke=A1;
int fire=7;
int buzzer=4;
Servo myservo;
int pos = 0;

void setup() {
  myservo.attach(9);
  myserial.begin(9600);
  Serial.begin(9600);
  pinMode(temp, INPUT);
  pinMode(smoke, INPUT);
  pinMode(fire, INPUT);
  pinMode(buzzer, OUTPUT);
}

void loop() {
  int a=analogRead(temp);
  int celsius=a*0.488;
  Serial.print("temperature in celsius= ");
  Serial.println(celsius);
  delay(1000);
  int b=digitalRead(fire);
  //Serial.println(b);
}
```

Fig No 4.21 : Arduino IDE

This software is used by the IDE to convert the programmable code to a text file in hexadecimal format, which is then loaded into the Arduino board's firmware through a loader application. The source code that we type gets dumped after the

compilation process. Sketches are the executable programme's that we created with the help of Arduino Software. The message region shows errors, input when saving and exporting the source code.

The regular options are "File", "Edit", "Sketch", "Tools", "Help". In the plain text editor where you can type in your program file. There are set of libraries as like in other IDE's which are programming a machine. The arduino code that user enters is referred to as arduino scripts. The is written in any language based on the users intention of code. It simply makes use of device-specific libraries.

4.15 INTERNET OF THINGS

Internet of Things is one of the upcoming field where the human work is been reduced with the help of single click of an button. We have included Internet of Things to optimize the human work with the help of sensors, modules, etc. All the components are connected to each other globally via the internet.

Processors, sensors and networks are all examples of enabling technologies that have been used to monitor and control devices for decades. They result on high speed connectivity, widespread use of technology in rural areas, miniaturization, networking and data security, etc. Device to device, device to cloud, Backend data sharing/transferring and device to gateway are the different connectivity methods defined by the Internet Architecture Board, which is been currently under use. These models show how IoT devices can interact and give utility to users in multiple kind of ways.

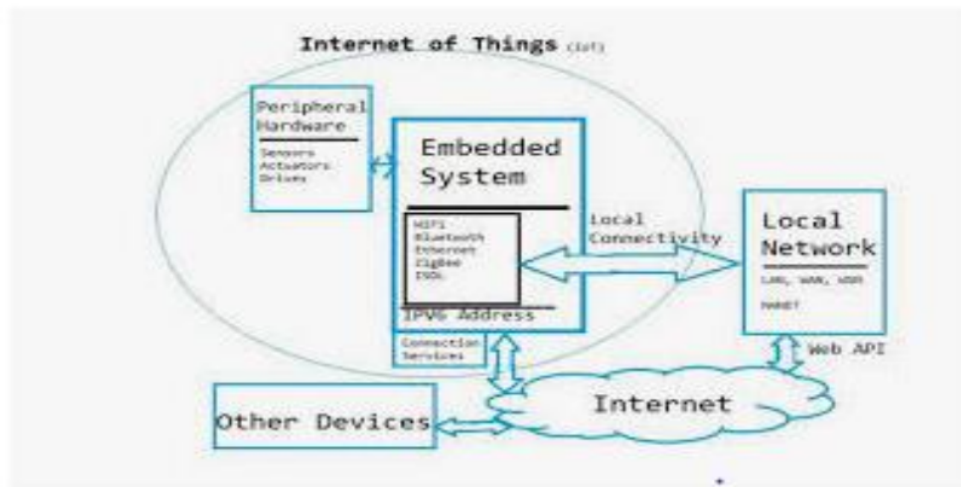


Fig 4.22 : IOT block diagram

Both hardware and software modules are used to construct IoT products. To interact with the real universe and to perform more computationally intensive problems dedicated hardware modules are used. The functions of popular hardware components are defined, with the hardware to software interface provided by the MCU. IoT based transition was the major thought process for our project.

4.15.1 BENEFITS OF IOT

The Internet of Things provides a variety of advantages to businesses and industrial sector people. The furthermore benefits are as follows:

- Track overall company operations virtually over internet.
- Improve customer service.
- You can save time and resources.
- Boost workforce efficiency.
- Adapt and integrate business models.

- Make more informed management choices.
- Increase your sales.

4.15.2 IOT APPLICATIONS

- Consumer and corporate IoT ,manufacturing and automobile IoT has a large variety of real-world applications .
 - Automobiles, telecommunications, power, and other sectors will all benefit from IoT implementations.
 - Smart houses projects.
 - Wearable devices with sensors and apps.
-
- Monitoring construction workers or firefighters vital signs at potentially life-threatening locations.
 - Server client communication.
 - It is used in health care domain
 - Used in transportation for tracking the vehicles.
 - Used in traffic regulating systems
 - Agriculture based developments
 - Also used in smart grid development and energy savings.

In the upcoming chapter we are going to discuss about the outputs and results for the proposed work.

CHAPTER 5

5.1 RESULT AND DISCUSSION

The main power of 220 volts will fry out the circuitry so we apply the power to an step-down transformer where the current is been step-downed from 220V to 12V. The current from the transformer is an alternating current, the components majorly used are digital components. Hence, an Analog to Digital Converter is used to transform the alternating current into direct current. This, Direct Current is fed to all the components like wifi module, ESP8266 microcontroller, servo motor, etc.

In forest the input power can be obtained from an solar panel setup, where the current is been carried out to all the devices. An arduino UNO serves as an embedded device that binds the major input sources like temperature sensor, fire sensor and smoke sensor. The fire sensor detects the infra red radiation emitted from the dense fire, while the temperature sensor detects the raise in temperature over the surrounding by continuous monitoring and the smoke sensor detects the unusual smoke caused by the fire. These are the basic three checksums that are obtained to detect the precise forest fire condition.

Once the three threshold conditions are satisfied the outputs are done via three ways, they are.,

1. Display of real-time data in IOT Web Page.
2. Mobile Notification to the authority in-charge.
3. Nearby buzzer-alarm to the local fire station.

5.2 MECHANISM

The fire detection is done by 3 sensors - fire sensor, temperature and smoke detection sensor. If the fire is detected, sensor senses the changes in the surroundings and sends the information/data to the arduino UNO board. Once the arduino confirms the rise in temperature, smoke and fire, it starts the work. The components connected for output were IOT module ESP8266 and GSM module and a buzzer.

A servo motor is also included in the circuitry to extinguish any minor fire. The IOT module ESP8266 is the primary alert system. Through this the client can receive the real-time data all around the globe irrespective of the distance. We can watch and observe the fire anywhere around the globe. It needs to be connected to internet via the wifi. The ESP8266 will be able to communicate with an IOT webpage developed using PHP. Once the arduino board confirms that the temperature values from the temperature sensor is over the threshold value, it will send the real-time temperature values and smoke values along with geometric coordinates with the help of GPS module connect with the circuit. The GPS module sends the exact geometric coordinates(latitude and longitude) to ESP8266 which will be uploaded to the webpage in real-time. But internet is mandatory for this method to work or-else the real-time values will not be uploaded in the webpage. Also the receiver should also need internet facility in-order to observe the real-time data from the ESP8266. The secondary alert is the mobile phone notification to the person in-charge.

A GSM module is mounted over the circuit in-order to pass mobile notification to a person in-charge. As same as for IOT module, once the temperature rises above threshold temperature and if smoke is detected, through GSM module the arduino send a mobile notification to the mobile number that is provided.

The message will be denoting the alert and also the exact geometric co-ordinates latitude and longitude will be send to the person's mobile number. The exact geometric co-ordinates latitude and longitude will be provided by the GPS module connected to the circuit. This will be even more helpful to know the forest fire as soon as possible. As this part uses GSM module, even without internet we can get the alert. Connecting to internet is not mandatory for GSM module and mobile alert. Once the person in-charge gets the alert he/she can take necessary actions accordingly.

Eventhough we have high level alert systems connected to the module, we need to have a traditional method to alert people in the local who don't have access to above methods. We need a method to alert local fire station or people.

This method should we able to work even without internet and mobile signal in-case if they are not available. For the last 3rd type to alert system we have connected a buzzer along with the circuitry. As the sensor senses the rise in temperature and smoke and fire, the sensors sends the information/data to the arduino Uno which in turn on the buzzer. The buzzer starts alarming so that the local people gets alerted.

5.3 OUTPUT

The IOT webpage output is shown below

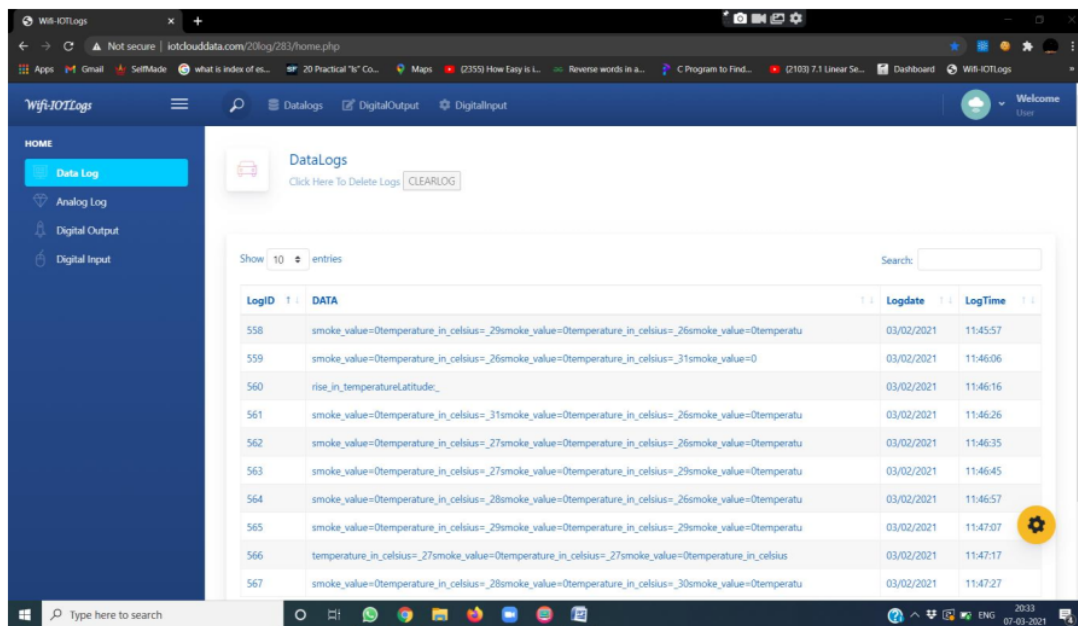


Fig 5.1: IOT Webpage

This is the image of IOT webpage developed with PHP. This webpage is connected with IOT module ESP8266 in the circuit. The webpage store the data logs that contains the data from the ESP8266.

The smoke value, temperature value from the sensors and geometric co-ordinates (latitude and longitude) from the GPS module connected with the module will be uploaded in real-time. Also we can see the date and time of upload. This can be viewed and monitored in real-time anywhere around the globe.

The mobile notification alert output is shown

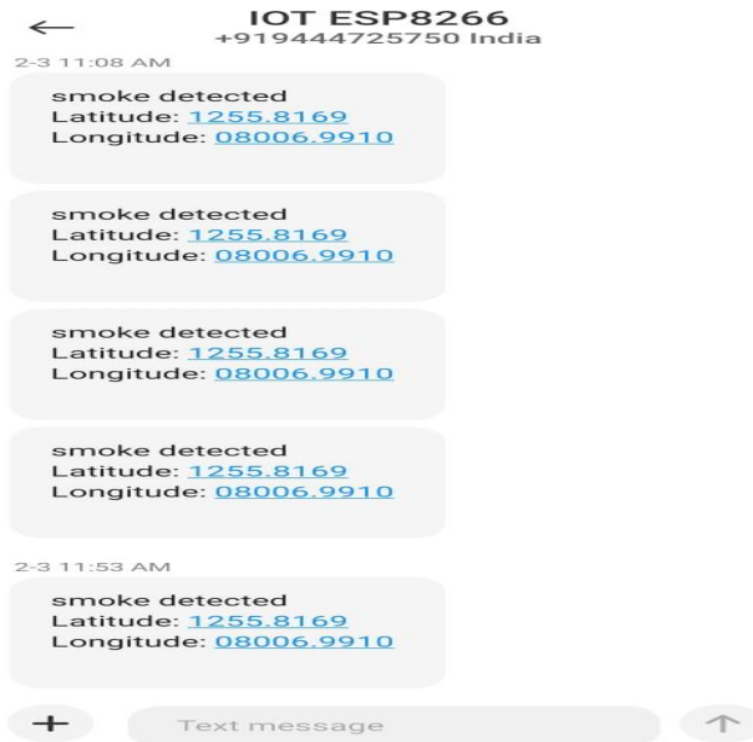


Fig 5.2 : Alert Notification

This is the image of mobile message notification the person in-charge will receive in his/her mobile. The arduino will send signal to GSM module, which in turn alerts by messaging to the pre-given mobile number. It has a alert message along with the exact geometric co-ordinates (latitude and longitude).

The overall setup of Forest Fire Detection System

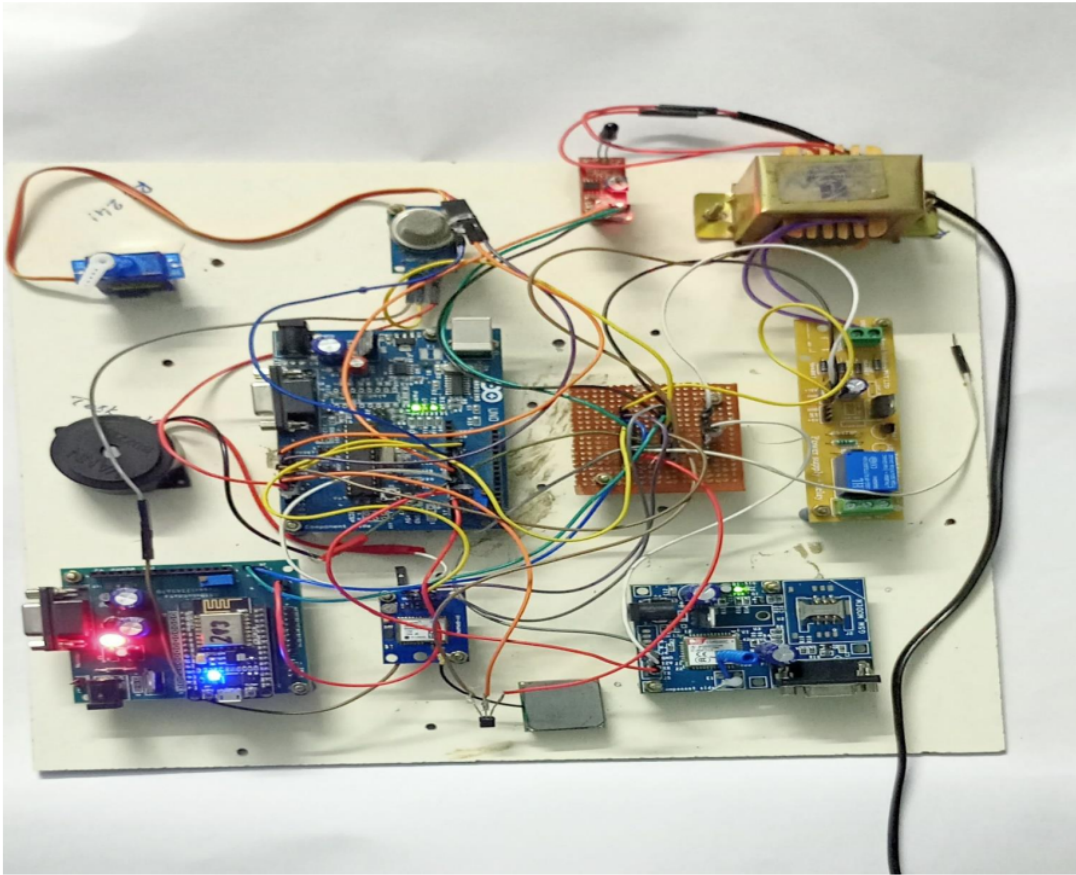


Fig 5.3: The full setup of Forest Fire Detection System

CHAPTER 6

SUMMARY AND CONCLUSION

All of our rising challenges can be solved with the emerging science and technology. Predicting natural calamities is a difficult task, and our method must be validated in real-world conditions. Nearly 40% of Amazon forest in Brazil has suffered forest fire this year, more than 4.6 million acres of forest have been destroyed. Our scheme, on the other hand, would be critical in preventing forest fires, which would save a lot of money and time. The wild life in that area has been affected because of this disaster. The main cause for this much destruction is because of the fact that we didn't detect the fire soon. Also we don't possess high tech-equipment for detecting the forest fire very soon.

Despite the fact that our machine is self-contained and independent, other variables that might influence the hardware were checked over time. It would be introduced in limited woodland regions where forest fires are a frequent phenomenon. To survive all of the temperature variations that can impact its operation, the device must be resilient.

The equipment we used is one of the most effective and well-known for detecting forest fires in a short period of time. We experimented in forest-like environments, but the true challenge will come when we implement in a wide area in real time. At extreme weather conditions, the signal to the GSM module might be unreliable and also in deep forests area's the signal may be unreachable. In future we can overcome this drawback using eminent technology.

With the use of this circuitry, the forest fire can be detected and prevented(in case of minor fires)using servo motor. The locals can be alerted with the help of buzzer, the fire department head will be notified via phone message. Also we can monitor all the sensor values in real-time through webpage, all around the globe. As a conclusion, our work setup can be implemented in real-time environment.

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