

FARM MONITORING SYSTEM

*A Project report submitted in partial fulfilment of the requirements for
the award of the degree of*

BACHELOR OF TECHNOLOGY

IN

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Submitted by

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY AND SCIENCES

(UGC AUTONOMOUS)

(Permanently Affiliated to AU, Approved by AICTE and Accredited by NBA & NAAC)

Sangivalasa, Bheemili Mandal, Visakhapatnam dist. (A.P)

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
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CERTIFICATE

This is to certify that the project report entitled “FARM MONITORING SYSTEM” submitted by L. Sai Teja (319126512030), B. V. Sai Yaswanth (319126512005), B. Jagadeesh (319126512008), T. Samyuktha (319126512059) for the award of the Degree of Bachelor of Technology in Electronics & Communication Engineering of Andhra University, Visakhapatnam is a record of bonafide work carried out under my guidance and supervision.


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ABSTRACT

These days agriculture sector is declining due to less yield from the farm even after severe efforts made by the farmers. There are many factors affecting for this situation, one among them is the absence of farmer, when there needs to be one. Thus, we intend to develop a semi-virtual farmer which can check and manage the farm in the absence of the farmer. The idea is to design a device which can detect the moisture levels of the soil and atmospheric conditions across the farm. It checks the crop condition and pH level of the water; it also checks if any animal entered inside the field. The crop condition and soil nutrients of the farm are checked daily. The pH sensor measures the pH level of the water entering the farm. The rain sensor module is used for rain detection; DHT-11 sensor used to detect the temperature across the farm. Soil moisture sensor measures the water content in the soil. PIR sensor is used for animal detection. Drone is used for checking the farm condition weekly. Hence, we designed a device that can look after the farm and manage it according to the surrounding conditions. The farmer will get updates for every change done in the farm i.e., change in atmosphere and moisture levels, voice note will be sent when there is rainfall, motion detection and 24/7 live streaming as well as checking the crop condition through Drone.

Keywords: Rain sensor, pH sensor, DHT11 sensor, Drone, Moisture Sensor, NPK sensor, PIR sensor.

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CHAPTER 1

INTRODUCTION

1.1 Crop Production

Since farming of domesticated species provided food surpluses that allowed people to live, agriculture is largely responsible for the beginning of human civilization. In addition to acquiring food and raw materials, a large section of the population can labor in agriculture. The history of agriculture dates back thousands of years. Wild grains were collected and domesticated before 105,000 years ago, rice had been domesticated in China between thirteen thousand and 8,200 years before that, and pig were domesticated in Mesopotamian 15,000 years ago.

Our country is facing problems growing crops. Our farming system faces a variety of problems because our country is comprised of numerous regions. Because they are so expensive, most farmers, especially marginal and small-scale farmers, cannot afford high-quality seeds. On Indian soils, crops have been generated for tens of thousands of years without any thought to replenishment. Their yield decreased because of the soil becoming exhausted and depleted. The average yields of all crops are among the lowest on the planet. This big issue can be addressed by adding more manure and fertilizers.

Only a third of the nation's cropland is irrigated, despite the nation's being the second-largest irrigated country in the world after China. Water is the most important agricultural input in India since rainfall there is unforeseeable, unreliable, and changeable. India will not be able to make major agricultural breakthroughs until reliable irrigation systems cover over fifty percent of the planted area.

Agriculture marketing continues to be in disrepair in rural India. Because there are no dependable marketing facilities, farmers are forced to rely on neighboring traders and intermediaries to dispose of their crops, who are sold at a loss.

1.2. Smart Agriculture

Giving the agricultural industry the infrastructure that it needs to leverage modern technologies like big data, cloud computing, and the web of things (also known as the to gauge, track, automate, and analyze processes is the notion behind smart farming. Precision agriculture, another name for smart farming, is technology-managed and sensor-monitored. Intelligent farming is becoming increasingly important due to the growing demand for climate-smart agriculture, rising crop yield demands, the need to use natural resources more effectively, rising use and elegance of technology for communication and information, and the increasing number of people worldwide.

1.2.1. Possibility of autonomous farming

It is commonly acknowledged that integrating information and communications technology (ICT) into agriculture may boost output while reducing costs and environmental impacts.

1.2.2. The Potential of Sustainable Farming

Seventy-five million Internet of Things (IoT) gadgets would be deployed in the agriculture industry by the year 2020, with a twenty percent annual expansion rate, based to a BI Research survey. The worldwide intelligent farming market is expected to grow from a little more than \$5 billion as of 2016 to \$15.3 billion by 2025, quadrupling in size. But, even at the current population level, agriculture is already faced with a variety of difficulties, such as declining soil quality, climatic changes, increased use of natural resources, and carbon footprint. diminution of biotic variety Precision agriculture. intelligent, exact watering, etc.

1.2.3. Technologies for smart farming

An intelligent farm uses technology like sensors for soil moisture, temperature, rainfall, water PH, fertilizers, etc. GPS and other telecommunications technology like sophisticated networking. Software and hardware for specialized applications, as well as for enabling automation and IoT-based solutions.

The "Smart Agricultural Revolution" (IoT) is being advanced by several technologies, including the Internet of Things. edge computing, 5G, blockchain, AI, robotics, and drone technology.

Data analytics tools for forecasting and making decisions. Data collection is an essential part of smart farming because yields of crops, mapping of soil, climate change, fertilizer programmer, weather information, machines, and animal health all produce increasing amounts of data. Continuous data collection across a broad field is done via satellites and drones.

Literature Survey

To build a proper device which can take care of the farm, we had consulted some agriculture scientists to take input regarding healthy crop growth.

Here are the suggestions given by them.

Mr. Prasad, Agriculture Scientist (Agronomy), BCT KVK

- Drip Irrigation is the best way to avoid herbicides and saves more water since excess water may also damage the crop.
- An effective drip irrigation system must be devised that can automatically regulate water flow to plants based on soil moisture levels.

Mr. Srikanth, Agriculture Scientist (Agriculture Engineer), BCT KVK

- Development of an effective IoT-based smart irrigation system is a crucial demand for farmers in the field of agriculture.
- Type of the soil and its nutrients plays a vital role in crop growth.

- Fertilizers used in different stages of plant growth for various crops is also necessary.

Survey Pictures



Project Overview

Crop yield depends on many factors like soil moisture, soil pH, soil nutrients, atmospheric conditions, animal intrusion, pests, weeds, and crop health. This device includes two modules such that all the required parameters are checked thoroughly. The main module measures most of the parameters and contains sensors and micro-controller boards like pH sensor, moisture sensor, DS18B20, rain sensor, PIR sensor, voltage sensor, ESP 32 camera, ESP8266, MEGA2560 (hybrid module of Arduino MEGA and ESP8266). The other module is a drone used for checking the crop health using Image Processing by taking a picture from the farm.

The main module collects the information through various sensors and sends the information to the user through ThingSpeak application and sends notifications via IFTTT by triggering events based on the results. The farm is also managed at the same time by taking measures based on the needs.

The drone checks the condition of the farm and the crop health through image processing using an ESP 32 camera attached to the drone, the plant health is informed to the user by generating a detailed report on what kind of disease is caused and suggests the required remedies needed to safeguard the crop.

This device is an embedded system configured through Internet of Things (IoT) for controlling it from remote areas like home and other areas far from the field. The use of IoT in these applications enhances the ability of the system for better communication with the user. The development of an efficient IoT-based intelligent irrigation system is a key requirement for producers in the land of agriculture, according to many agricultural scientists and agronomists. IoT applications like Blynk, ThingSpeak and IFTTT enhance the user to know about the farm condition and can also manage it by controlling the device through Blynk application from the user's mobile phone. This enhances user interaction with the machine, providing them with more information about how things are going on-site while also allowing remote management of devices.

This device is more beneficial for farmers living far from their fields. Though they may stay close to the farm after planting the crop, sometimes circumstances might prevent them from being available in the field. This device works as a semi-virtual farmer, it protects the crop from getting damaged due to minor atmospheric conditions like low soil moisture and high temperature. For major issues like storms and animal intrusion, voice alerts are sent directly to the farmer's mobile, the farmer can then take necessary action by coming to the field (for example, if there is an animal intrusion). Additionally, they can know about important soil pH levels and required nutrients needed for healthy growth of crops. A pH range of 5 to 6 is typically ideal for most plants. Acid soils have a significant impact on plant growth, requiring different nutrients depending on the crop and its stage of development. The type of fertilizer used as well as manure produced based on the soil condition will vary accordingly.

CHAPTER 2

CROP HEALTH

2.1. Plant Diseases

Fungus or other organisms that mimic fungus are responsible for over 85% of plant illnesses. However, some serious diseases that impact agricultural and food products are caused by bacterial and viral species. Some worms can also cause plant disease. Some plant diseases fall under the category of "abiotic," or non-infectious diseases. These conditions include air pollution, nutrient deficiency, or toxicities, and they thrive in adverse conditions. We shall concentrate on illnesses caused by the three main pathogenic microbes for the time being: fungus, bacteria, and viruses. If a disease of plants is being considered, paying particular attention to how the plant appears can be a great way to determine what kind of pathogen is present.

Physical evidence of the pathogen is a sign of plant disease. For instance, a diseased fungus generates fruiting structures. When you see powdery mould on a violet leaf, *Microsphaera alni*, a parasitic fungus, is what you are seeing. A bacterial canker of fruit stones causes gummosis, a bacterial fluid that appears from the cankers. The thick, liquid exudate, which is primarily formed of bacteria and is a marker of the disease even if the canker itself is composed of tissue from plants and is a symptom.

An illness's visible expression in a plant is referred to as a symptom of a plant disease. One of the signs of the infection is an obvious change in the colour, shape, or functionality of the plant. Leaf withering is one of the typical signs of verticillium wilt, which is caused by the fungus *Verticillium albo-atrum* and *V. dahliae*. Bean plant bacterial blight is typically identified by brown, necrotic spots with a beautiful yellow ring at the leaf edge or inside the leaf. Instead of the sickness itself, what you are witnessing is a symptomatic carried on by the illness's pathogen.

2.2. Disease Classification

In the past, crop diseases have been categorised as either abiotic factors (also known as technology-infectious) or biotic (infectious). Environmentally adverse factors are the root cause of non-communicable diseases. Examples include extremes in temperature, moisture levels that are too high or too low, etc. In addition, disease is frequently caused by dangerous airborne pollutants.

2.2.1. Bacterial Crop Diseases

Crop diseases brought on by bacteria are among the most prevalent infections in the agricultural sector. This makes it difficult to avoid and control this disease. To infect the culture, the causative material must get inside the tissue. It typically shows up as areas that have been harmed by agricultural equipment, insects (such as fleas), or merely adverse weather (such as dust, wind, or heavy rain). However, germs can also enter plants through bodily pores or glands (like those that release honey). Another trait that distinguishes bacterial diseases of crops is that, before favourable conditions allow them to reawaken, their causal agents can remain dormant in crops or soil for an incredibly long time.



Fig 2.2.1.1.- Bacterial disease of plant

Bacterial crop disease symptoms

The main signs of bacterial disease include tumour, soft rot, necrosis, and vascular wilting. Although this type of disease of plants can be identified by its clear symptoms, exact causal agent identification requires laboratory methods.

Common Bacterial Diseases

There are many different diseases because, as was already mentioned, there are a substantial number of germs. Here are some instances of the most prevalent ailments affecting agricultural plants:

- i. Granville's limitations will be seen in the slowing of development, withering of the vigorous culture, and root fatality.
- ii. Necrotic weeping sores, wilting, and leaf rolling are symptoms of fire blight.
- iii. Tobacco is commonly affected by wildfire around the globe, which manifests as yellowish-green spots on the foliage.

Controlling Methods

Several factors make it difficult to manage bacterial diseases in crop plants, including their rapid growth and internal protection from chemicals. A few instances of preventive strategies include the use of free of pathogens seeds produced in areas susceptible to drought, treating seedlings in hot water, ground solarization, and the control of plant diseases using germicidal components of seeds.

2.2.2. Fungus-Induced Crop Diseases

The most frequent issue in agriculture is pathogenic fungus. A third of all food crops are annually destroyed by this type of plant disease, according to study. This issue is serious from both a social and an economic standpoint. These infections primarily impact plants through wounds, stomata, and water pores, like bacterial crop diseases.

Infectious crop diseases symptoms

A fungal infestation typically manifests as either localized or widespread necrosis. Additionally, fungi-caused crop diseases can obstruct normal development or trigger an abnormal burst of it known as hypertrophy. Other signs of agricultural diseases include leaf spots, exfoliation, anthracnose, ulcers, curling of the leaves, and warts.



Fig 2.2.2.1.- Fungal disease of plant

Common Fungal Diseases

The catalogue of crop diseases caused by fungi is extensive, so we will focus on just a few instances of crop plant diseases:

- i. The telltale signs of recent potato blight are deep green, purple in colour, or black ulcers with white rot round the borders.
- ii. A dangerous disease that primarily affects cereals is black stem rust of wheat. Rust-coloured sori that develop on a plant are an expression of it.

Control Techniques

There are many different preventative steps to stop fungal diseases of crop plants. The destruction of plant material harbouring harmful fungi, the use of healthy seeds, regular crop rotation, and the use of chemical and biological fungicides are important management practices.

2.2.3. Nematode-Induced Crop Diseases

Plant roundworms are parasitized by nematodes, which are typically invisible without specialized tools. They primarily impact roots, tubers, and bulbs because they are soil-based organisms. There are more than 4100 types of harmful nematodes.

Nematode Crop Disease Symptoms

Nematodes feed by sucking liquids from plants. Plants with these parasites often have a dried-out, drought-stricken appearance. Additional signs are comparable:

Yellowing, slowed growth, a lack of reaction to water and fertilizer, a plant's gradual general decline, and diminished or even destroyed root systems.



Fig 2.2.3.1.-Nematode disease of plant

Common Nematode Diseases

The type of nematodes directly affects the diseases are:

- i. Stem worms make the stems bulge in a fusiform manner. The disease's signs include distorted leaves, swelling petioles, and the appearance of dark spots on tubers.

- ii. *Aphelenchoides besseyi* causes the rice disease *aphelenchoides*. Disease symptoms include blemishes on the tops of the leaves, a paucity of grains, and a depletion of the culture.
- iii. Serious citrus diseases are caused by the similar nematode *Tylenchulus semipenetrans*. It is distinguished by the slow demise of branches as well as leaves.

Control Techniques

To control parasites, several different things are done. Crop rotation, boosting crop disease opposition, and preparing the soil with the right fumigants and nematicides are all examples of effective management strategies. You can also get rid of nematodes and their eggs by soaking them in boiling water (about 50°C/120°F). However, this strategy for preventing crop disease requires accuracy. You should adjust the frequency of watering based on the temperature to prevent harming the plants themselves. Individual nematode control strategies that encourage plant growth include heavy mulching, fertigation, irrigation during dry spells, and summer and fallow periods.

2.2.4. Virus-related crop diseases

The most significant but most harmful plant foes (subviral contagious agents) include viruses and viroids. Once a plant has become diseased, it cannot be saved. Therefore, it is crucial to comprehend how plant diseases impact crop yield around the world. Most of the time, the virus is transferred by contact among healthy and infected plants. Additionally, viruses can spread vegetatively through insects, pollen, and seeds. However, the most common place for the spread of viruses is in soil.

Viral Crop Disease Symptoms

Malformations, including abnormal growth of shoots, distorted leaves and flowers, necrosis, wilting, and the emergence of annular stripes and spots; dwarfism, which causes both individual plant parts and the entire plant to grow more slowly; and discoloration, including vein clearing and yellowing.



Fig 2.2.4.1.- Viral disease of plant

Common Viral Diseases

Examples of prevalent viral infections in crop plants include:

- i. Dwarfism and leaf patterns resembling mosaics are two indications of tobacco mosaic. The illness is widespread around the world and could have negative economic effects.
- ii. The development of necrotic yellow rings that eventually turn reddish-brown is a symptom of tomato spotted wilt.
- iii. Potato spindle tubers shrink and becoming fusiform, which slows plant growth.

Control Techniques

Most viral illnesses that damage vegetable crops are extremely difficult, if not impossible, to treat, in contrast with earlier diseases. Therefore, control in this circumstance should be as effective as is practical. Some of the most common countermeasures include the raising of tolerant crops, indexing, and checking for viruses that are not spread mechanically. The plant being studied is grafted onto a marker plant, which exhibits similar symptoms when infected. Unfortunately, there are times when it becomes necessary to eliminate infected culture and, in the event of seriously affected large agricultural regions, even to enforce quarantine to protect the remainder crop output.

CHAPTER 3

INTERNET OF THINGS (IoT)

3.1. Idea and explanation

The term "Internet of Things" or IoT for short, refers to a network. The phrase "The internet combining Things" (also known as the is made comprised of the phrases internet and things. The IoT's things are various IoT items with distinct identities that are capable of tracking, actuation, and real-time data monitoring. Additionally, Internet of appliances can collect data from other gadgets as well as either directly or indirectly communicate information with other linked devices and apps in real time. transmitting it to multiple servers after processing it. An international communication network that connects trillions of computers to enable information sharing is known as the internet. IOT can therefore be defined as "a flexible worldwide Connect The infrastructure with technology configuring abilities built around standard and compatible protocols for communication, where both real and virtual items had identities and physical attributes, and online personalities, use clever interfaces, seamlessly integrate into the information the system, and constantly communicate data related to users and their surroundings".

Whenever anything has access to the the web, it can both send and receive information. Due to their capacity for information transmission and/or reception, objects can become "smart". Let's utilise a cell phone example once more. Almost every tune in the world is currently available for listening, but that doesn't mean that your phone truly has every song ever recorded on it. Because your phone can transmit and receive data, even though every song in the world is stored somewhere else.

A thing simply needs access to information to be intelligent; it is not necessary for it to contain super storage or a supercomputer. Connecting to super storage or a supercomputer is all that is required of a thing. All devices linked to the internet can be included into the Internet of Things and Items that send and collect data. objects that

act after learning something both of those things. Furthermore, all three of those provide enormous benefits that span three different categories:

These three have a tonne of advantages that complement one another. devices that collect information and then emit an alarm. something that takes shape before acting. Items that perform both and each of these three has enormous advantages that build upon one another.

1. Information gathering and transmission

Sensors come in a wide variety of different varieties, including temperature, motion, moisture, quality, and light sensors. These sensors work in conjunction with a link to automatically collect information about the environment, which in turn helps us make informed judgements.

2. Getting Information and Using It

We are all very familiar with robots that collect data and act. Your printer receives a document and prints it. Your car keys signal causes at your car's doors to unlock. Numerous examples abound.

3. Using both:

IoT system's architect Let's briefly go back to the farming example. Even though the farmer's input is not actually required, the devices with sensors can gather information on the moisture in the soil to advise him or her on how frequently to water the crops. Instead, the watering system can begin operating as necessary based on the amount of wetness is in the soil.

For connecting to additional wired or wireless devices, the ideal the web of Things device provides a variety of interfaces.

Each IoT-based gadget contains the following parts:

- i. Interface I/O for sensors
- ii. A link to the Internet interface
- iii. Interface for Memory and Storage
- iv. Video and audio interface

3.2. Technology that Supports IoT

A variety of enabling technologies provide the Internet of Things sturdy backbone. Networks of Wireless Sensors Using the cloud. Embedded Systems, Big Data, Security Architectures and Protocols. The protocols for web services, the Internet and search engines WSN (Wireless Sensor Network) (Wireless Sensor Network). It consists of several sensors and nodes connected to monitor diverse kinds of data.

Example-

- i. Air quality monitoring equipment for the home.
- ii. Monitoring system for soil moisture.
- iii. Surveillance apparatus.
- iv. System for monitoring health.
- v. Mechanism for tracking the weather.

On-demand computing, also referred to as cloud computing is a type of Internet-based technology that enables computers and other devices to instantly access pooled processing resources and data. It can come in a variety of formats, including IaaS, PaaS, SaaS, DaaS, and others.

Characteristics

- i. Extensive network access.
- ii. Self-services driven by demand, item.
- iii. Rapid scaling.
- iv. Assessment of service.
- v. Pay-per-use.

Infrastructures as a Service (IaaS) A service that provides infrastructure as a Service (IaaS) offers online services such actual technology, virtual computers, servers, storage,

networking, and data centre space. Azure from Microsoft, AWS, and Google's Compute Engine are the three leading cloud computing services. For instance, web hosting. Electronic devices, etc.

Without the cost and hassle of buying and managing core hardware, software and hosting, PaaS (Platform as a Service) provides a platform based on the cloud with everything needed to support the whole life cycle of producing and disseminating Western web-based (cloud) applications. Examples include computing platforms, hardware, operating systems, and libraries. It essentially provides a platform for app development.

"SaaS" stands for "software as a service." It is a technique for providing applications as a service online. By just using online software access instead of installing and maintaining it, you can avoid difficult software and hardware maintenance. Other names for SaaS apps include hosted software and software that can be downloaded on demand. SaaS apps are programmes that control performance, security, and availability. Examples include Gmail, Office, Google Documents, and more.

Big data analytics is used to search hidden patterns and unknown relationships in large data sets containing various forms of data. Consumer preferences, market trends, and other important business information.

Big data analysis involves several steps, including:

- i. Cleansing of data.
- ii. Munging.
- iii. Processing.
- iv. Visualization.

Examples:

Bank operations:

- i. Data produced by IoT systems for vehicle location and tracking.

- ii. Online shopping and Big-Basket.
- iii. IoT devices such fitness trackers produce health and fitness data.

Protocols for communication. They serve as the foundation of IoT systems, allowing for connective coupling to applications and facilitating data interchange over the internet in terms of formats, encoding, and addressing.

A type of system for computers known as an embedded system combines software with hardware to perform tasks. There are 10 units, a CPU, microcontroller, ROM, RAM, networking parts, and storage components.

Water Management for Crops

To carry out agricultural operations ineffectively, enough water is needed. Agriculture is linked with Web Map Services (WMS) and Sensors Observation Service (SOS) to provide adequate drainage for irrigation, thereby reduces water waste.

Integrated Pest Management and Control

Agriculture IoT solutions give farmers trustworthy environmental data assurance through accurate live data monitoring of humidity, temperature, plant development, and bug levels so that proper care may be done during production.

Food safety and production

Agricultural IoT system precisely measures several variables, including warehouse temperature. Integrated cloud-based recording systems and a shipping transportation management system.

3.3. Use of IoT in Agricultural

A significant opportunity to make things intelligent and smart is seen with the introduction of IoT in a variety of settings, including industry, homes, and even cities.

These days, even the agricultural industry is embracing technology, which has sparked the growth of the "Agricultural Internet of Things".

3.4. IoT Benefits in Agricultural

The advantages of IoT in agriculture include the following:

1. The Internet of Things (IoT) merges cloud computing features such maps of farms and storage in the cloud, among others, thereby rendering it simple to acquire and handle the large volumes of data these sensors generate. Data is available in instantaneous form from everywhere, enabling end-to-end contact and in-the-moment observation of all parties.
2. The Internet of Things (IoT) is regarded as a crucial element for smart agriculture since in the opinion of experts, farmers will be able to increase food output by 70% by the year 2050 with the aid of precision sensors and smart machinery.
3. Costs for IoT productions can be dramatically decreased and increasing profitability and sustainability.
4. The Web and the Internet of Information will increase efficiency in the use of fertilisers, water, and soil.
5. The IoT would also help to protect the environment in a number of ways.
6. All data can be collected using the installed sensors' data gathering capabilities. details on the climate, the wellbeing of the creatures, the condition of the agricultural produce, etc. Data is stored in a specified place. and farmers may analyse information fast and do analysis to make the best decision.
7. Reduction of risks When farmers are given access to current information, they can anticipate prospective problems and comprehend the situation as it stands. Using data, farmers can modify business practises and boost sales.
8. Increased standard using smart agriculture, problems that could develop during farming operations can be avoided and eliminated. Hence, buyers are getting a decent product of high quality as product quality improves.

3.5. IOT-Based Smart Farming System

The IoT-based SMART FARMING SYSTEM is an IoT device that focuses on real-time temperature monitoring of the environment. Depending on the sensors it has built in, it can detect moisture and other sorts. By installing the software in the landscape and getting Raw Data Feeds on different devices such Smart Phones, Tablets, etc., the system's "Plug & Sense" concept enables farmers to apply smart farming right away. A large audience can readily examine and share the data produced by sensors.

With cloud computing technology integration, agriculture experts can work remotely from anywhere. The system occasionally enables the use of big data analytics for the analysis of different types of data.

CHAPTER 4

MAIN UNIT HARDWARE

4.1. SENSORS

4.1.1. DS18B20 Temperature Sensor

A computerized temperature sensor with one wire and a 12-bit ADC is called DS18B20. The sensors' quoted accuracy in the ambient temperature range of -10 deg C through +85 deg C is +/-0.5 deg C.

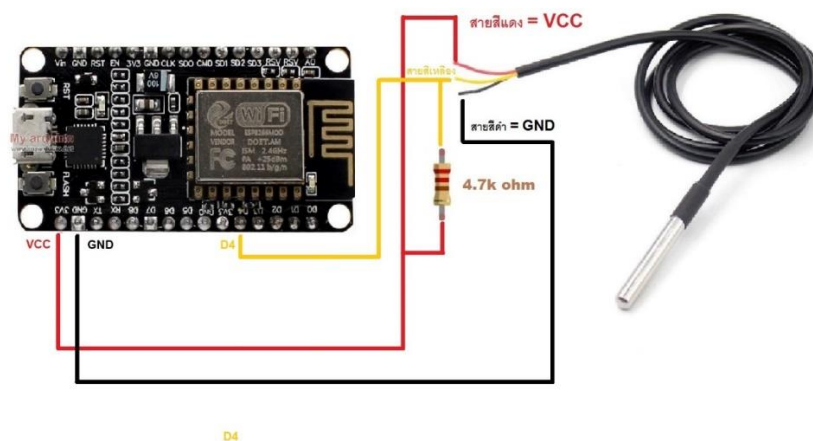


Fig 4.1.1.1.- DS18B20 Temperature Sensor

The DS18B20 sensor is interfaced to the ESP8266 board by The ESP8266's pins D2 and 5V are where the sensor's VCC and GND connect, together with the sensor's DATA pin. For an accurate data connection, a 4.7k Ohm pull-up resistor is attached to the data pin of the 5V supply.

This sensor is used to monitor the temperature across the farm and send information to the Thing Speak through an ESP8266 board. Whenever high temperatures are

detected, it checks the moisture level of soil using a moisture sensor to determine if there's been too much reduction in water availability. If this condition persists, then automatically the system turns on irrigation systems to ensure crops are safe.

Technical specifications:

- i. The range of usable temperatures is -67 to +257 °F, and -55 to 125 °C.
- ii. Selectable resolution from 9 to 12 bits
- iii. A chip with a customized 64-bit ID.
- iv. Employs the technology Wire interface, which enables communication with just one digital pin.
- v. A pin can be shared by several sensors.
- vi. ± 0.5 °C Accuracy between -10 and +85 °C
- vii. Temperature-limit alarm system, item.
- viii. Query execution took less than 750 milliseconds.
- ix. Utilizable with power/data ranges of 3.0 to 5.5 V.

4.1.2. Moisture Sensor

A sensor that detects soil moisture measures the quantity of water in the earth's soil and calculates how much water is stored there by routinely evaluating the soil's moisture level.

The analogue data pin is linked to A0 of the ESP8266, and the voltage-controlled capacitor (VCC) from the amplifier is coupled to the 5 volts port and Ground to GND within the ESP8266 board to connect the moisture sensor to the the ESP8266 board via an amplifier.

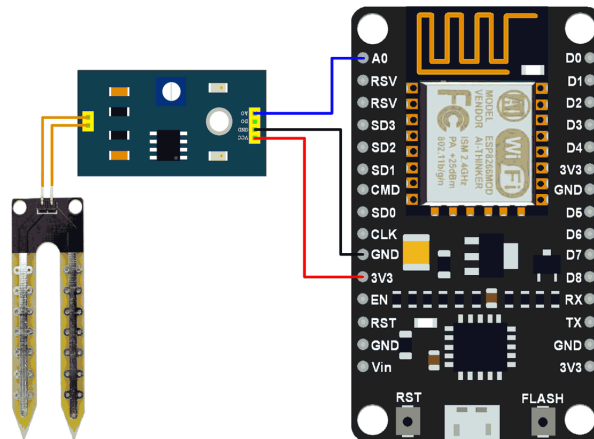


Fig 4.1.2.1.- Moisture Sensor

This sensor measures the soil moisture and takes necessary actions like automatically watering the crop and simultaneously informing the farmer about it. The notifications are passed through ThingSpeak via IFTTT in the form of text messages.

Technical specifications:

- i. 3.3 to 5 volts DC is the operating voltage.
- ii. 15mA is the operating current.
- iii. Adjustable trigger level from preset, digital output range of 0 to 5 volts.
- iv. Analog output ranges from 0 to 5 volts depending on the amount of infrared radiation from a burning flame that hits the sensor.
- v. LEDs that display output and power.
- vi. PCB Dimensions: 3.2 cm x 1.4 cm
- vii. LM393-based design, item.
- viii. Easy to utilise with Microcontrollers or even with regular Digital/Analog ICs
- ix. Small, affordable, and widely accessible

4.1.3. pH Sensor

The pH sensor is a probe or an electrode that determines the alkalinity of a solution. By monitoring the fluctuation of hydrogen ions, it determines how acidic a solution is. The activity's acidity or alkalinity is assessed using the pH range of 0 to 14 in

comparison to pure water, a solution that is neutral. Many crops grow under soil with an average pH of 5.5 to 6.1 which is ideal for plant growth.

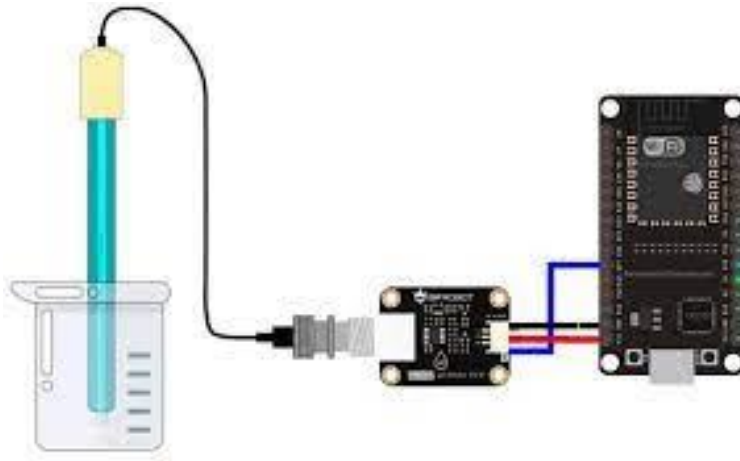


Fig 4.1.3.1.- pH Sensor

The pH interface is attached to the ESP8266 board's analogue input port, and the pH sensors are connected to it through a BNC connector. The ESP8266 board's 5V pin and GND are linked to the VCC as well as GND pins, respectively. The pH sensor's analogue pin A connects to the ESP8266 board's analogue pin.

This sensor is used for knowing the acidity of the farmland by testing the colloidal solution of soil and the water coming to the field. This helps the farmer grow crops that are suitable for the soil and water type. The user can also take required remedies by feeding the farm with necessary salts to increase the acidity of the soil.

Technical specifications:

- i. Power of Module: 5.00V
- ii. Module Dimensions: 43 x 32 mm
- iii. 0 to 14 mph Measuring Range
- iv. Temperature range: 0–60 °C
- v. Precision: 0.1pH (25 °C)
- vi. Response Time: 1 minute

- vii. With BNC Connector pH Sensor
- viii. Interface for PH 2.0 (3-foot patch)
- ix. Adjustment Potentiometer for Gain
- x. LED Power Indicator
- xi. Sensor to BNC connection cable length: 660mm

4.1.4. Rain Sensor

The Rain Sensor consists of a rain board with nickel coated lines, which work on the principle of resistance and a control module which converts analogue input into digital output after evaluating it. It can be powered with +5V and measures moisture through an analog output pin and provides a digital output when the threshold limit is exceeded.

The VCC and GND pins of the rain sensor are linked to the 5V port or GND of the ESP8266 chip board, respectively, via the control module to connect the rain sensor to the ESP8266 board. The ESP8266 board's digital pin is linked to the controller's digital D0 pin. Depending on the situation, the analogue pin A0 is connected.

This sensor is used for the detection of storms near the field. When the rain starts falling near the field, the user receives information through voice notes when the moisture level on the rain board exceeds the threshold limit.

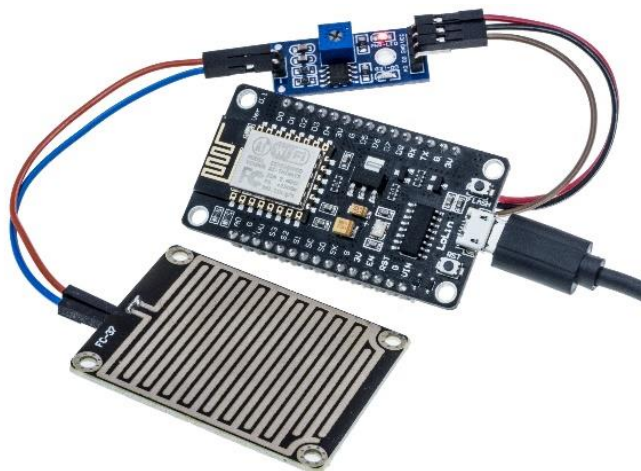


Fig 4.1.4.1.-Rain Sensor

Technical specifications:

- i. Operating voltage ranges from 3.3 to 5V.
- ii. 15 mA is the operational current.
- iii. The sensing pad measures 5 cm by 4 cm and contains a nickel surface on one face.
- iv. the LM393 comparator chip.
- v. AO (Analog o/p voltage) and DO (Digital switching voltage) are the output types.
- vi. PCB module dimensions are 3.2 cm by 1.4 cm.
- vii. Trimpot allows for the modification of sensitivity.
- viii. Power and output indications are Red/Green LEDs.

4.1.5. PIR Sensor

The PIR sensor stands for “Passive Infra-Red” sensor it is used for motion detection for security alarms and thermal sensing applications. These sensors detect motion by taking infra-red rays through a filter window and detect motion when the input IR rays are obstructed by any object or a living thing. A band pass filter is used in this sensor to detect any kind of motion (small or large) effectively.

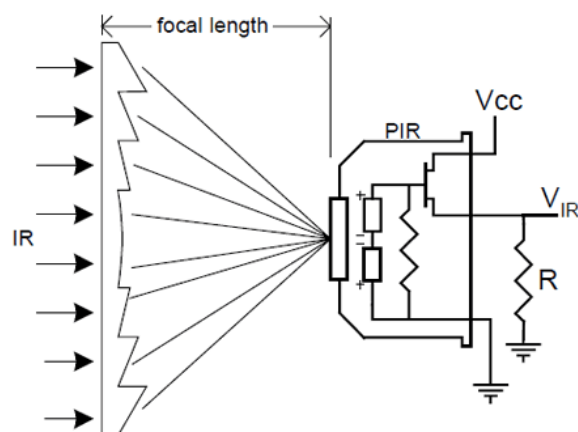


Fig 4.1.5.1.-PIR Sensor

By linking the PIR sensor's VCC pin and the ESP8266 board's VIN pin, the passive infrared sensor is linked to the latter. Connect the ESP8266 board's GND pin to the Ground port of the PIR sensor. Connect the PIR sensor's output pin to the board's digital pin.

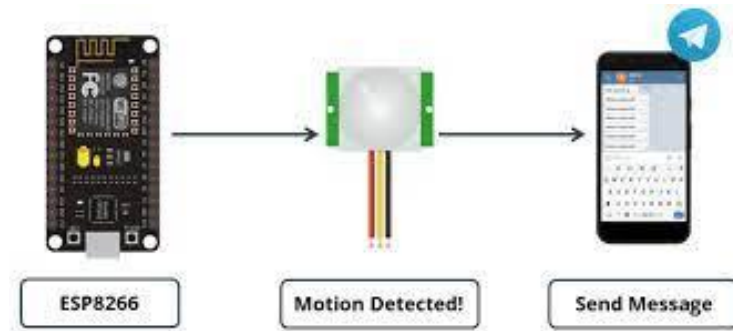


Fig 4.1.5.2.-PIR Sensor linked to Telegram.

This sensor detects any unauthorized intrusion of wild animals or farmers from the neighboring fields. The sensor is placed on two sides of the farm. The sensor detects any intrusion from the direction it is placed. The detected information is captured through ESP32 camera, and the data is sent to the farmer's mobile via photographs through Telegram. The application used here is "Bot Father".

Technical Specifications

- i. Product Type: Body Sensor Module, HC-SR501
- ii. DC 4.5–20V input voltage; 50uA of static current
- iii. Output level: High 3.3 V/Low 0 V
- iv. L cannot be repeated; however, H can be repeated.
- v. Time of delay: 5-200s
- vi. 2.5 seconds each block.
- vii. Board size: 32 mm by 24 mm
- viii. Sensor for angle: 100 cone angles
- ix. -15 to +70 degrees during operation
- x. Sensor for lenses: Dimensions: 23 mm

4.2. BOARDS

4.2.1. ESP32-CAM

A compact low-power camera module built on the ESP32 platform is called the ESP32-CAM. The ESP32-CAM is frequently employed in intelligent Internet of Things (IoT) applications including video surveillance, live streaming, photo-taking, etc.

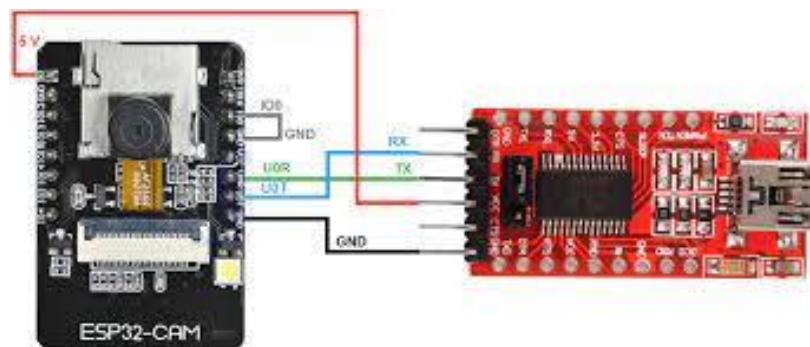


Fig 4.2.1.1.- ESP32-CAM

This board is used by connecting the FTDI module and ESP32-CAM. The 5V & Ground Pin of the ESP32 micro is connected to the FTDI Module's 5V & GND connect the Rx to U0T and Tx to U0R Pin. respectively. Now, short the IO0 and GND Pin together.

This device clicks pictures when the PIR sensor detects motion in the field. The camera is attached to a servo motor which stops at either 0° or 180° based on the direction of intrusion. The clicked photographs are sent to the users mobile. The camera and the servo attached to it only get activated when the PIR sensor detects some motion in the field.

A 32-bit CPU running at an authorised frequency of 240MHz powers the controller. It contains an external 4M PSRAM in addition to its internal 520 KB SRAM. It has a SoC module It incorporates Bluetooth/BLE and 802.11b/g/n Wi-Fi. It supports Wi-Fi image upload, embedded Lwip and FreeRTOS. There is a PSRAM Chip with an onboard voltage regulator IC.

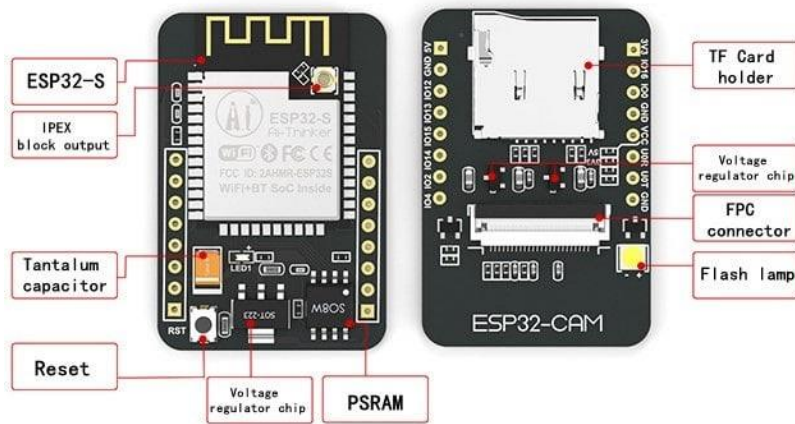


Fig 4.2.1.2.- ESP32-CAM board specifications

This module already includes an antenna. If you'd like to use a third-party antenna with greater strength and range, you can however connect an antenna via the IPEX connector. To use the antenna, you must install a jumper or a zero-ohm resistance on the PCB adjacent to it.

Camera OV2460

The ESP32 CAM's Camera Module is their essential component. The camera module, OV2460 which includes a 24 Pin Camera Holder, is the Camera Module that you can utilise. It features a camera resolution that is the highest, at 1600 1200.

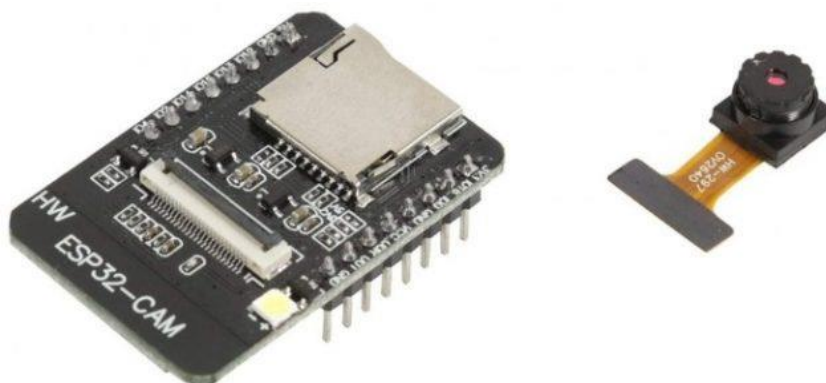


Fig 4.2.1.3.- ESP32-CAM with camera strip

There is a connecting strip with gold plating. You may attach this camera to the ESP32 using this connector. Push this slide in the opposite way to connect it. The pins for connecting the camera are then visible. Simply slide this slide and then insert the camera indicated with a gold plate on the bottom side. The Camera is currently attached to this module. Now that you're prepared, use this module.

SD Card Assistance

An SD Card Holder that can accommodate cards up to 4GB is located on the back. However, even a 16GB SD Card seemed to operate quite fine with this module.

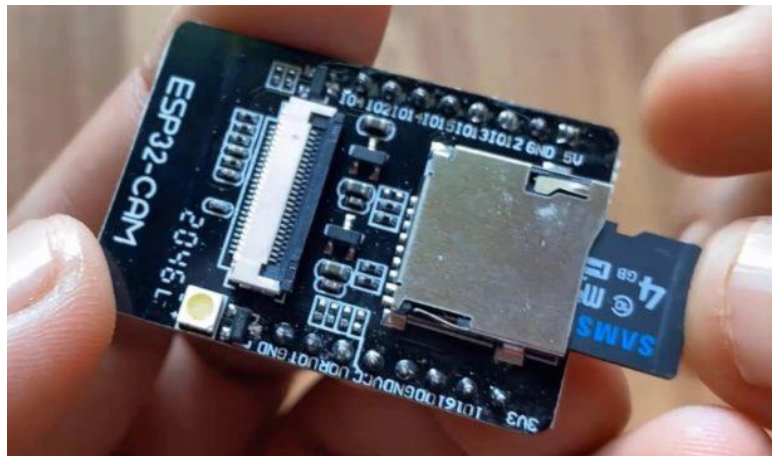


Fig 4.2.1.4.- ESP32 CAM SD Card

When creating projects that rely on photographs, the SD card is utilised to store the images. You can use a 4GB SD Card for studying. The SD Card can be easily put into the SD Card Adapter and inserted.

Numerous GPIO pins, including UART, SPI, I2C, PWM, ADC, and DAC, are supported. This module provides both a 5V pin and a 3.3V VCC pin. Additionally, there are several GND Pins.

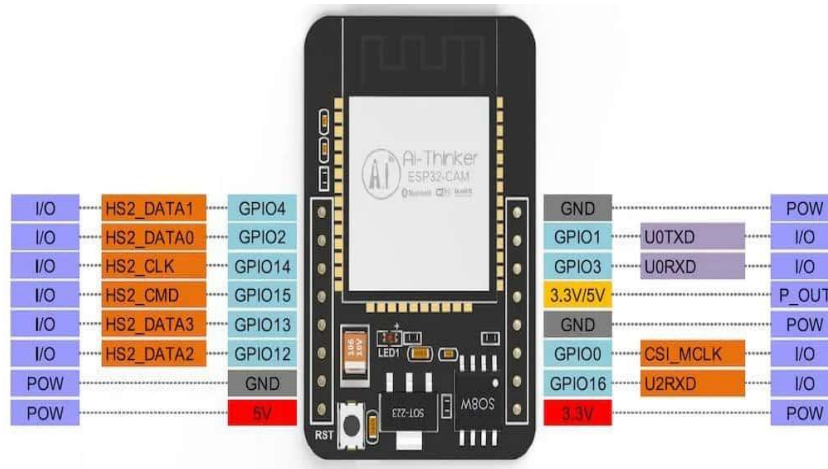


Fig 4.2.1.5.- ESP32 CAM pin specifications

The micro-SD card reader is internally wired to these pins:

14 GPIO: CLK

Input 15: CMD

GPIO 4: Data 1, which connects to the on-board LED, and GPIO 2: Data 0.

Data 2 for GPIO 12 and Data 3 for GPIO 13

FTDI Connection for the ESP32-CAM

To programme the board, you need both an FTDI Unit and any technology-to-TTL Converter Module. It is easy to find FTDI Modules built upon the CP2102 or technology chipset or any other chip.

To use the module, connect the technology modules and the ESP32, which is a CAM module as indicated in the illustration below.

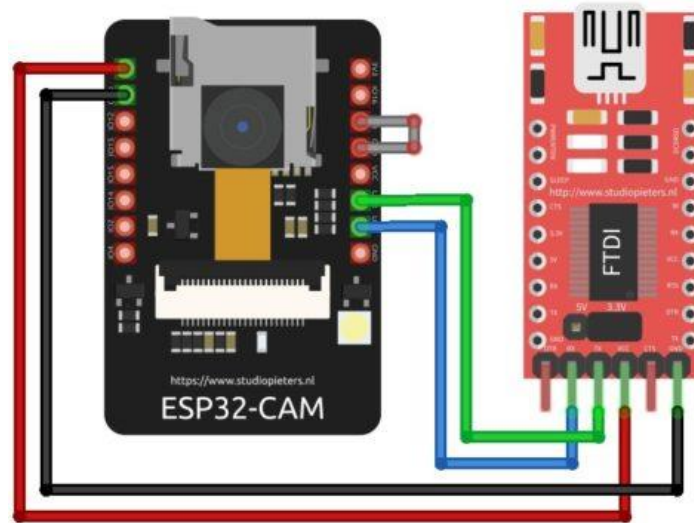


Fig 4.2.1.6.- ESP32 CAM FTDI Module Connection

ESP32 CAM FTDI Module Connection

ESP32-CAM FTDI PROGRAMMER

GND	GND
5V	VCC (5V)
U0R	TX
U0T	RX
GPIO 0	GND

Connect the 5V & GND pins of the ESP32 to the appropriate pins on the FTDI module. Similar connections should be made between Rx and Tx and UOT or UOR Pin. The most important step is to create a short circuit between the technology and GND pins. Doing this will programme the device. Once the programming is finished, you can rid of it.

Setting Up ESP32 CAM Board on Arduino IDE

The ESP32 CAM coding step can now start. To do that, launch the Arduino IDE. choose tools. Next, an ESP32 Board is decided upon. select AI-Thinker the ESP32 Camera from the list after that.

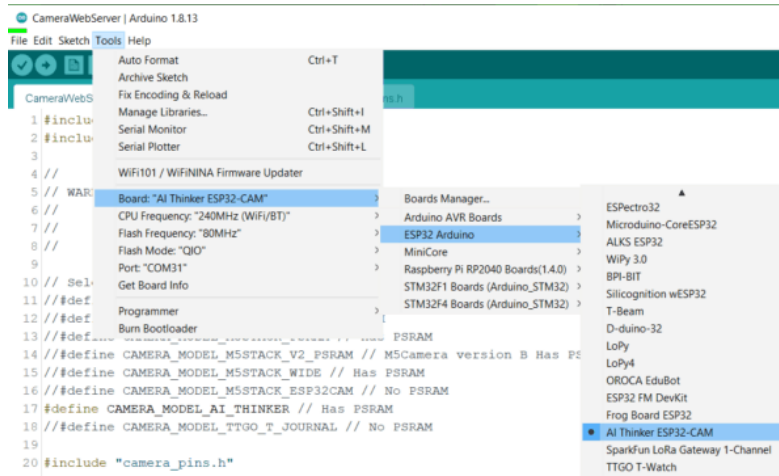


Fig 4.2.1.7.- Arduino IDE tools

Connect the FTDI Module to your computer after which you must choose the COM Port.

4.2.2. ESP8266 Board

A 32-bit CPU and memory that are both integrated within the ESP8266 low-power Wi-Fi module, along with an on-board ROM and RAM, are included. For further development, this device can be connected to an MCU or utilised independently. Moreover, the ESP8266 includes its own AT Command firmware that can be connected to any microcontroller through USB.

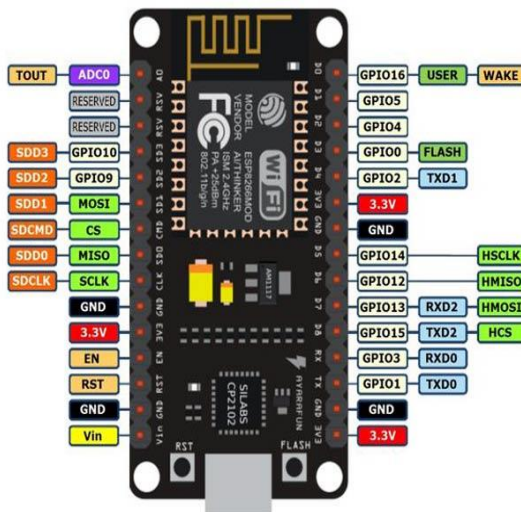


Fig 4.2.2.1.- ESP8266 Board

The ESP8266 can operate in three different ways: as a Wi-Fi client exclusively in "Station" mode; as a router and a Wi-Fi client concurrently in "Access Point" mode; and as both an entry point & a Wi-Fi consumer simultaneously in "AP + Station" mode.

The software required to run the system is present on this device. It oversees gathering data from sensors, relaying it to ThingSpeak through the internet, and launching the necessary operations in response to that data. The sensor connections are powered by the device's 5V1A power source.

The ESP8266 Node MCU is connected to the outside world by a total of 30 pins.

Following are the connections:

Power Pins

1. There are 4 power pins available. three, VIN pin, and 3.3V pins.
2. Using VIN, the technology/ESP8266 and its accessories may be powered directly.
3. The voltage delivered on VIN is regulated internally by the Node MCU module; a 5V regulated source can also be applied to the VIN pin.
4. The 3.3V pin output of the internal voltage regulator can be utilized to power additional parts.
5. The Node MCU/ESP8266's ground pins have the label GND.
6. I2C pins are used to connect I2C sensors and accessories. There is support for both the I2C master's and Slave protocols. The I2C interface can be implemented programmatically, and its maximum clock rate is 100 kHz. The I2C clock rate should, generally, be higher than the slave technology's slowest clock frequency.

GPIO Pins

The Node MCU/ESP8266's 17 GPIO pins can be dynamically assigned to perform I2C, I2S, UART, which is PWM, IR control of the light from a LED, and button operations. A digital GPIO's high resistance, external pull-up, or external pull-down tuning can be

selected for each one. When configured as an input, it may additionally be set to technology-trigger or level-trigger to create CPU interrupts.

ADC Channel

The Node MCU comes with a 10-bit precision SAR ADC. Both tasks can be carried out using ADC. examining the TOUT pin's input voltage and the VDD3P3 pin's power supply voltage. However, they cannot be applied simultaneously.

UART Pins

Two asynchronous technology (RS232 and RS485) UART ports on the Node MCU/ESP8266, UART0 and UART1, allow for data transfers of up to 4.5 Mbps. The technology RXD0, RST0, and CTS0 pins of UART0 can be used for transmission. Because UART1 technology (TXD1 pin) only contains a data transmit message it is frequently used to print logs.

SPI Pins

The Node MCU/ESP8266 supports two SPIs technology (SPI and HSPI) in technology and expert modes. These SPIs additionally provide the following universal SPI capabilities:

The four transfer timing modes for the SPI format 80 MHz and divided 80 MHz clocks are possible. FIFO of up to sixty-four bytes

SDIO Pins

The Node MCU/ESP8266's Secure Digital Input/Output connect (SDIO) functionality is utilized to directly connect SD cards. It supports both the 4-bit 50 MHz & 4-bit 25 MHz technology variants.

PWM Pins

The board has four PWM channels for pulse width modulation. Electronic motors and lights can be powered by PWM outputs that have been programmed. One can alter the PWM frequency band between 1000 and 10000 s (one hundred Hz and 1 kHz).

Follow these instructions to add the ESP8266 board to your Arduino IDE:

1. In your Arduino IDE, go to **File > Preferences**.

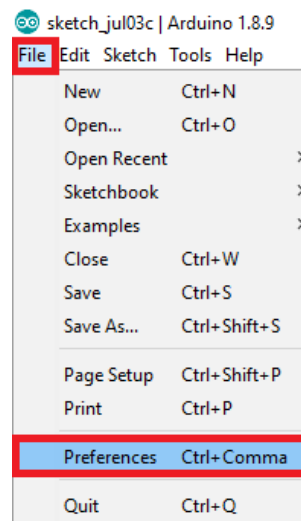


Fig 4.2.2.2.- Arduino IDE

2. Type [http://arduino.esp8266.com/stable/package technology index](http://arduino.esp8266.com/stable/package_technology_index) into the "Other Boards Manager Websites" box., as shown in the image below. After that, click "OK":

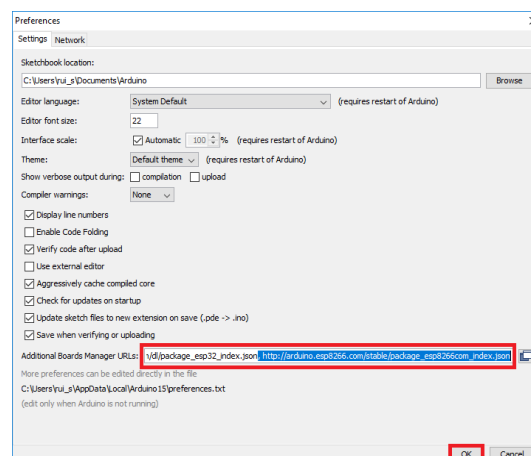


Fig 4.2.2.3.- Arduino IDE preferences

3. Open the Boards Manager. Go to **Tools > Board > Boards Manager...**

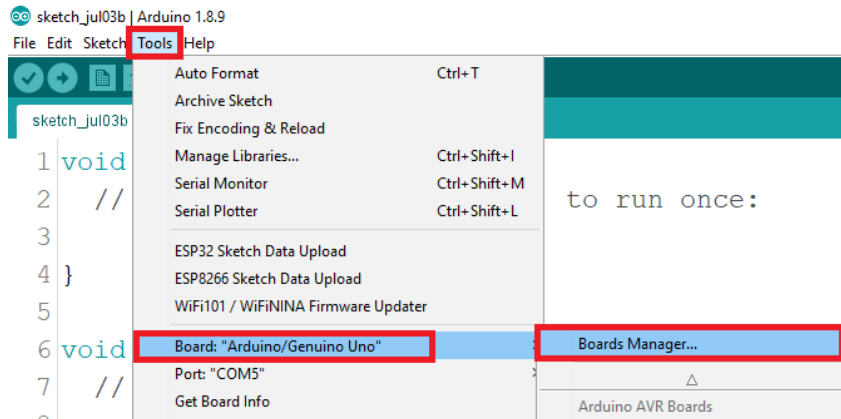


Fig 4.2.2.4.- Arduino IDE tools

4. Choose the "ESP8266 by ESP8266 Community" and press the install button.

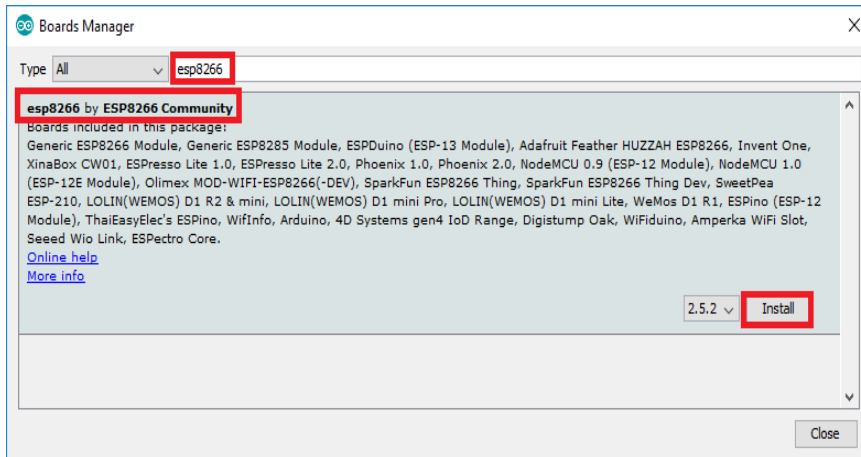


Fig 4.2.2.5.- Arduino IDE libraries

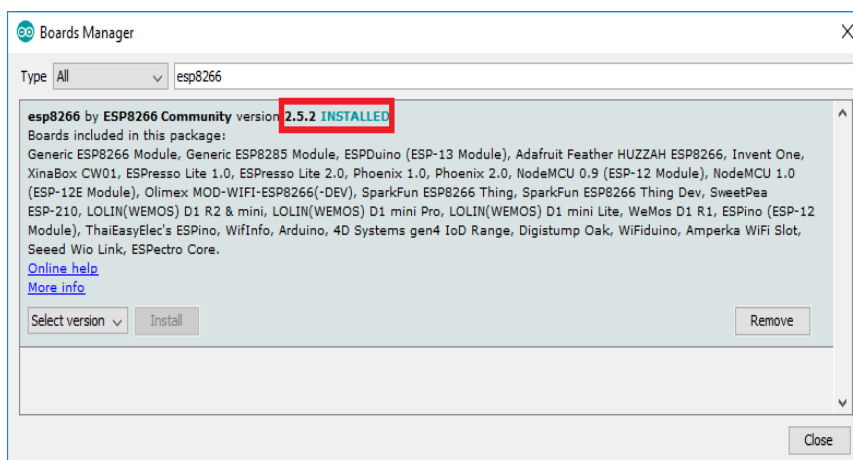


Fig 4.2.2.6.- Arduino IDE libraries installation

4.2.3. MEGA2560 R3

The MEGA2560 is a modified version of the standard ARDUINO MEGA R3 board (hybrid module of Arduino MEGA and ESP8266). With 32 MB of flash memory, it has full integration of the ESP8266 Wi-Fi IC and Atmel ATmega2560 microcontroller.

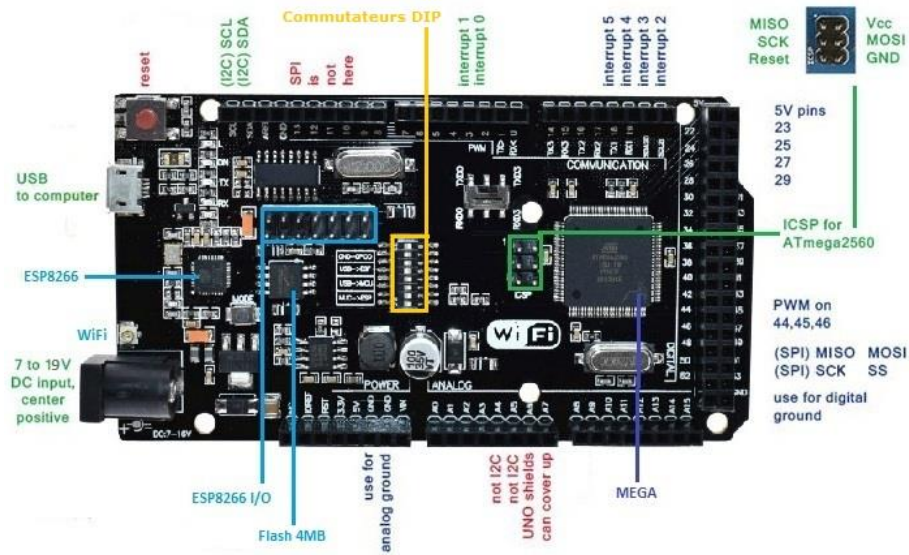


Fig 4.2.3.1.- MEGA2560 (hybrid module of Arduino MEGA and ESP8266)

All parts can be configured to operate jointly or separately. We can update sketches and firmware for our ATmega328 controller as well as for the ESP8266 Wi-Fi chip using USB connectivity, which is useful when creating new projects that call for Uno and Wi-Fi. In addition, a CH340G USB-TTL converter onboard enables us to directly attach modules to the board using a USB cable. This combines them into one simple solution, making it simple to design projects that need several boards.

Because of its many pins for connecting sensors, this board is used to reduce the number of ESP8266 boards in a circuit. This lowers the amount of space and money needed to design the device. This board oversees keeping track of the sensor data and taking the appropriate steps to safeguard the crop.

The MEGA R3 WIFI card is a customised version of the standard ARDUINO MEGA R3 card that combines a USB-TTL CH340G converter, an ESP8266 Wi-Fi module with

a 4 MB flash memory, and the Atmel ATmega2560 microprocessor on a single MEGA size card.

Each component can be set up to function either jointly or separately. A cutting regulator, which permits its external supply with a voltage between 7V and 16V, or even 19V, supplies these components.

Here is a view of ESP8266, Flash memory and map power.

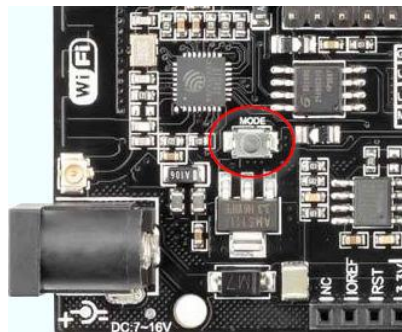


Fig 4.2.3.2.- MEGA2560 flash memory

FYI, the « Mode » button is connected to the GPIO 13 pin from ESP8266 and to a Pullup resistance.

Map configuration

The operating mode is selected using integrated DIP switches:

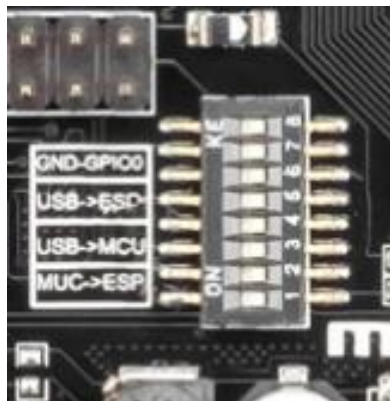


Fig 4.2.3.3.- MEGA2560 dip switches

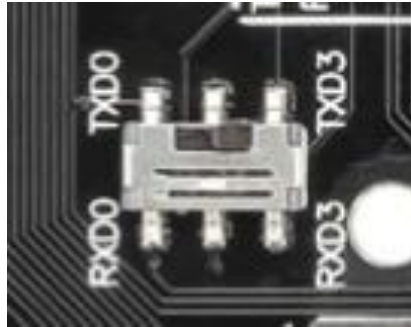


Fig 4.2.3.4.- MEGA2560 Tx&Rx

This switch will be positioned on the left, in the RXD0/TXD0 position.

Connect the card to the PC via a USB connection after setting the card's DIP switches to the "PTS8266 Programming" mode.

Configuration of the Arduino IDE to program the ESP8266.

To start, open the Arduino IDE programming environment and go "in Preferences".

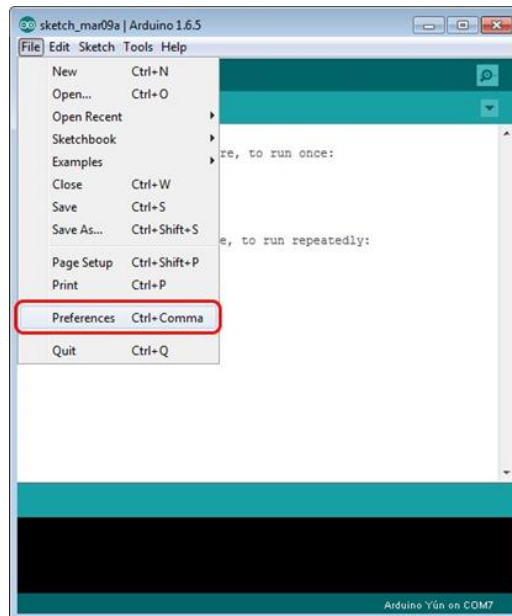


Fig 4.2.3.5.- Arduino IDE

The line "extra card management URL" (highlighted in red) in the window that appears under the tab "Parameters," and then:

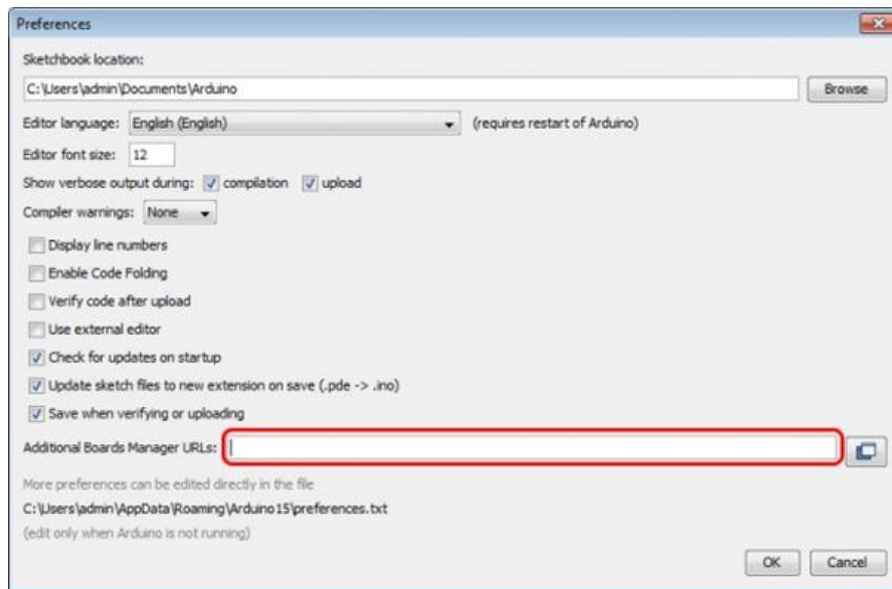


Fig 4.2.3.6.- Arduino IDE sketch box

Next select "Tools" and "Type of card" to bring up the "Card Manager" menu.

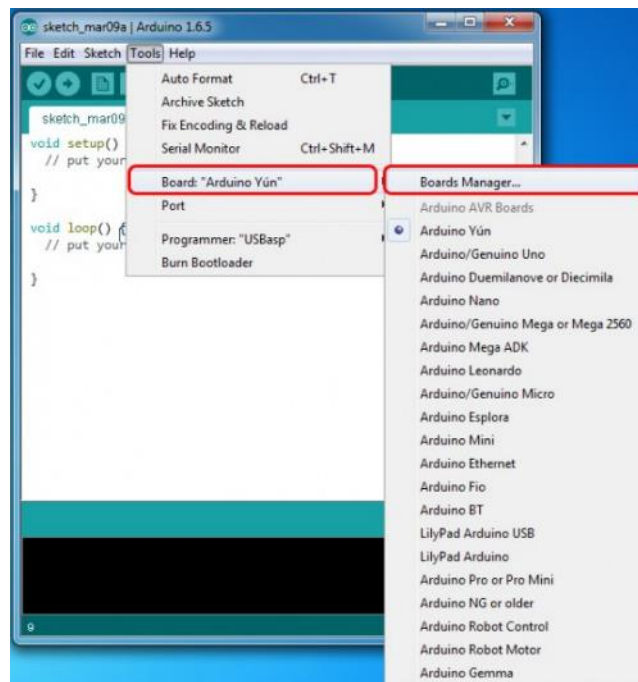


Fig 4.2.3.7.- Arduino IDE setup

In the window that appears, scroll through the list to the script "**esp8266 of ESP8266 Community**" and click on it.

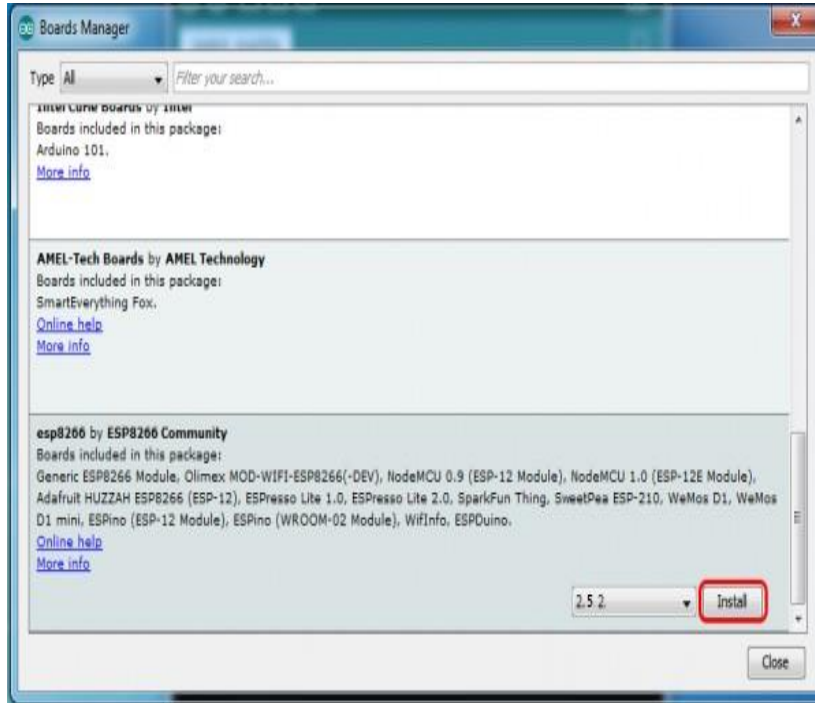


Fig 4.2.3.8.- Arduino IDE setup



Fig 4.2.3.9.- Arduino IDE setup

After installation, close the window.

Go to the tab "Tools" and choose "Library manager". Search "Web sockets" and choose "Web sockets by Markus Sattler Version 2.1.4". Click the button "Install".

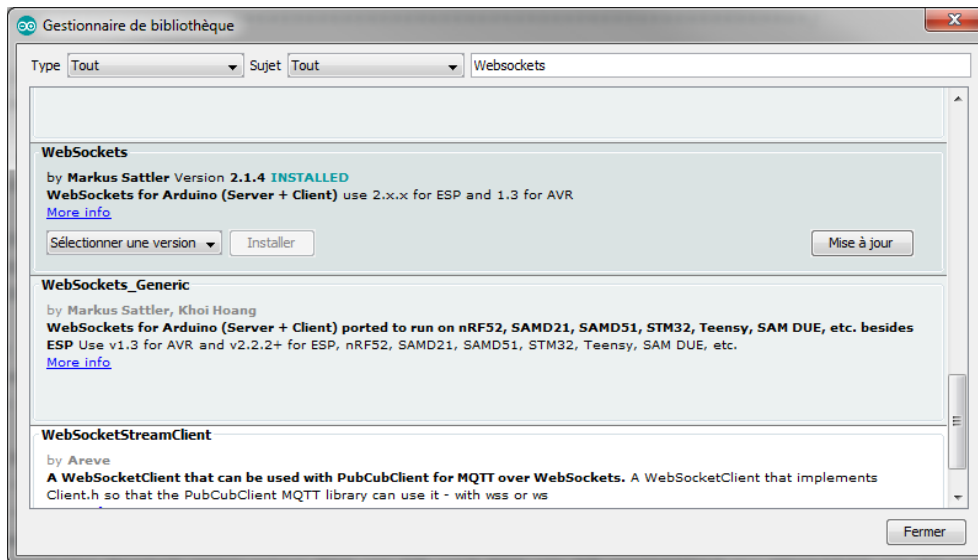


Fig 4.2.3.10.- Arduino IDE setup

After installation, close the window.

Go to the tab "Sketch" and choose "Include a library" then "Add the ZIP library". Add the libraries that are contained in the directory of this project.

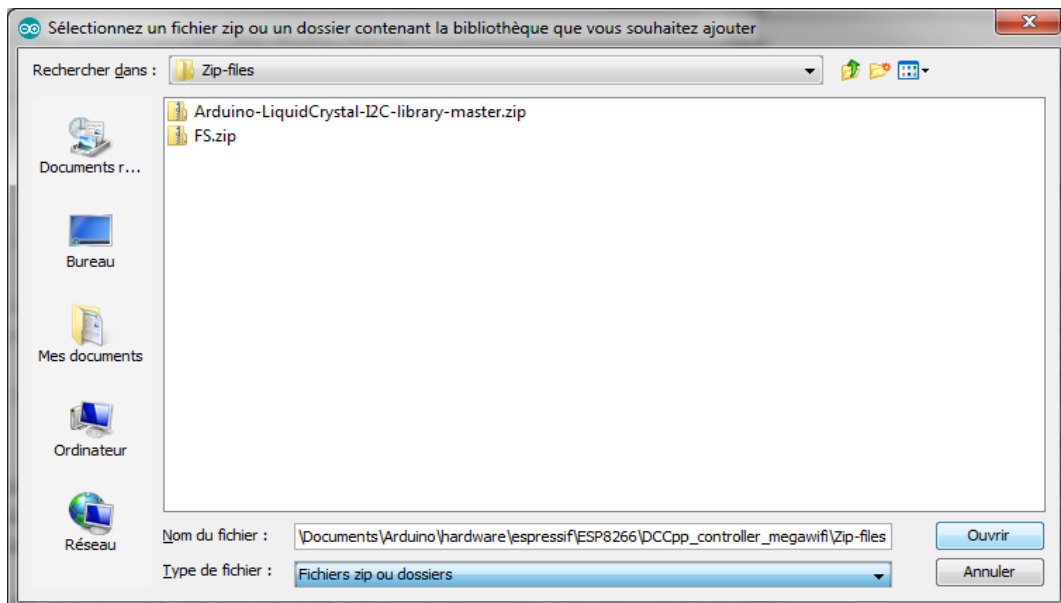


Fig 4.2.3.11.- Arduino IDE setup

After installation, close the window.

Go to the tab **"Tools"** and choose **"Type of card"**. You see the list of peripherals available for programming the ESP8266 chip.

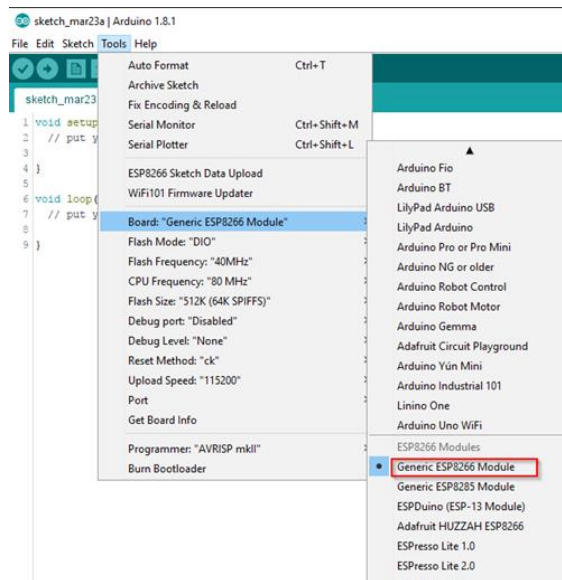


Fig 4.2.3.12.- Arduino IDE setup

Loading data in Flash with Arduino IDE

- i. You must have installed under Windows: to be able to load data into the Flash of the ESP8266 of the D1-Mini or MEGA Wi-Fi R3.
- ii. Python 3.7.2 and Java 8.0 running on Windows 7
- iii. After that, download dezipper and ESP8266FS-0.4.0.zip. As shown below, add the item to the directory.
- iv. "C: Users...Documents Arduino tools ESP8266FS tool esp8266fs.jar," for instance.
- v. Launch the Arduino FDI again.
- vi. Put the files into the Flash, select "ESP8266 Sketch Data Upload" from the "Tools" tab, and then click to load the files. Files will start downloading to the ESP8266 Flash.

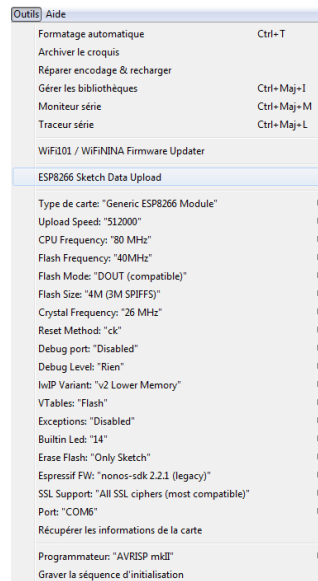


Fig 4.2.3.13.- Arduino IDE setup

Users of MEGA Wi-Fi R3 must set the DIP switches in the location that corresponds to the operation they want to do.

Start by using the IDE Arduino monitor.

- i. Put the DIP switches in the "ESP on USB" position (MEGA Wi-Fi R3).
- ii. Open the monitor, then choose the 115200-communication speed.
- iii. The Boot report should scroll across the screen, indicating that the Wi-Fi connection with the PC has been made.
- iv. The IP address of the Wi-Fi module can now be called from an Internet browser on a PC to launch your application.

4.3. Miscellaneous

4.3.1. PCB Board

An electronic assembly called an electronic circuit board (PCB) uses copper conductors to connect its parts electrically. Printed circuit boards provide mechanical support for electronic components, enabling an enclosure to be used for a device.

When creating a printed circuit board, the manufacturing process, integrated circuit packing, and the framework of the bare board must be taken into mind.

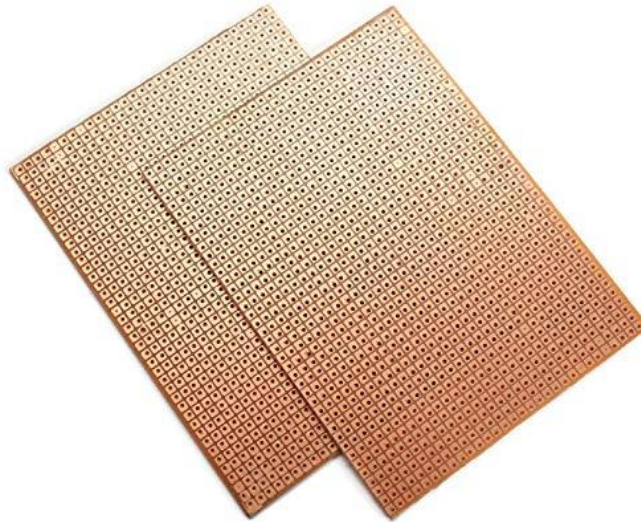


Fig 4.3.1.1.- PCB board

On printed circuit boards, conductive structures include metal traces, cushions, and conducting planes. To create the mechanical structure, layers of conductors are laminated with an insulating substance. The entire construction is plate, coated in a not conductive solder mask, and printed with silk screens material to provide an electronic component legend. Once these fabrication phases are complete, the bare board is moved to the printed circuit board assembly where components are attached to the board and the PCBA is tested.

Throughout the electronics business, printed circuit board design has developed into a distinct vertical. PCBs are crucial because they offer sturdy support to hold components in place, electrical connections between components, and a small packaging that may be integrated into a product. The right software can assist in taking a design from concept all the way to manufacture. Even the simplest circuit board needs to be properly created utilising specialised software tools. In this post, we'll delve deeper into the definition of a PCB, its design, and some crucial ideas to keep in mind when creating circuit boards.

Structure and Applications of PCBs

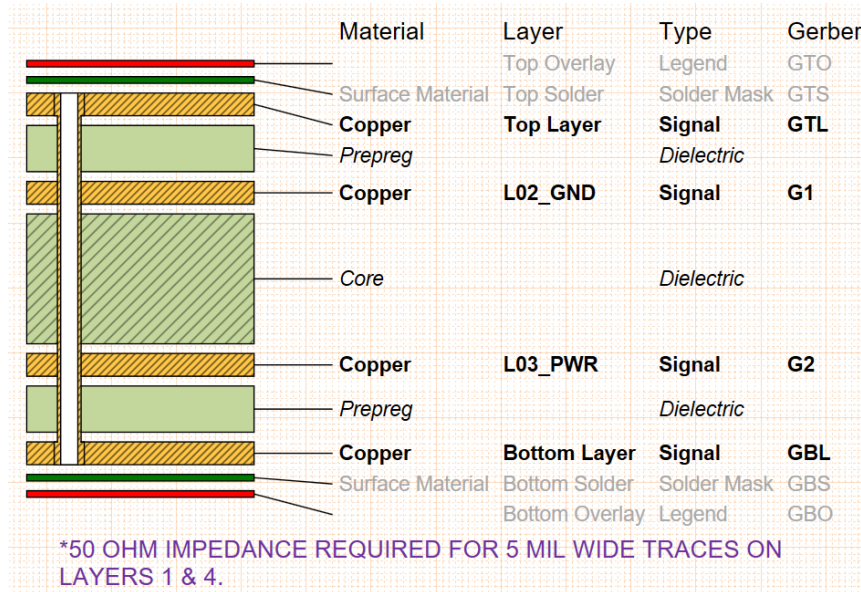


Fig 4.3.1.2.- PCB board structure

The stack-up, or layer layout, of a PCB defines many of its critical performance aspects. The layer stack-up is constructed using alternate layers of prepreg and core material, as well as alternate layers of conductive and insulating material (two types of dielectrics used in the layer stack-up). When designing for high-reliability applications, care should be taken while choosing the dielectric and mechanical properties of the core and prepreg because they will affect reliability and signal/power integrity in the design. For instance, a PCB for a telecom system would need a low-loss PTFE laminate in a tiny package for use in military and medical applications that may be deployed in hostile conditions.

4.3.2. Jumper Wires

Jumpers are tiny metal connections that are used to open and close circuit components. A board of circuits for a power system is controlled by two or more points of connection on them.

They oversee configuring the computer's motherboard and other components of the computer. Think of your motherboard as having an intrusion detection system. A jumper can be activated or deactivated.

Jumper wires are electrical cables with connector pins on both ends. They are used to join two circuit locations together without using solder. Using jumper wires, a circuit can be changed or problems in a circuit can be found. Additionally, they function best when omitting a resistor from a predicted defective region of the circuit.



Fig 4.3.2.1.- Jumper wires

How much voltage (V) and current (I) can jumper cables support? The amount of copper or aluminium in the wire will determine the I and V rating.

An Arduino application shouldn't consume more than 250V and 2A. Additionally, we suggest using solid-core wire, ideally 22 AWG (American Wire Gauge).

There are three types of jumper wires:

- a. a male-to-male jumper.

- b. a male to female jumper.
- c. Jumper between female pins.

Each one can be distinguished from the others by the wire terminal. Male ends feature a protruding pin, whereas female ends don't, but both can plug into items. A male connector, also referred to as a plug, has a sturdy pin enabling centre conduction. A hole is cut out of the centre component of a female connection, also known as a jack, to accommodate the male pin.

Male to male connections is the most common and often used type of jumper wires. For instance, two ports on the breadboard must be connected using a male-to-male connection.

4.3.3. Relay Module

The relay is one type of electromechanical component that functions as a switch. The relay coil is powered by DC to trigger the open or close touch switches. A single channels 5V switch module (NC) is frequently found to have a coil or a pair of contacts, such as normally open (NO) and typically closed (NC). This article gives an overall summary of a 5V relay module's functionality, but before that, it's important to comprehend how a relay is and the way its pins are set up.

In automatic control circuits, a switch known as a 5-volt relay is widely used to control large currents using low current signals. The supplied voltage range for the relay signal is 0 to 5V.

5V Relay Pin Configuration

The pin configuration for the 5V relay is shown below. Each of the five pins on this relay serves one of the purposes stated below.

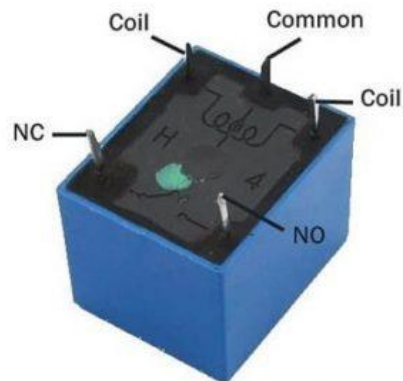


Fig 4.3.3.1.- Relay Pin Diagram

Features

The features of the 5V relay include the following.

- i. The standard voltage is 5V DC.
- ii. The average current is 70 mA.
- iii. The maximum AC load current is 10A at 125V AC or 250VAC.
- iv. DC load current 10A maximum @ 28V DC or 30V DC.
- v. It is made of plastic and comes with 5 pins.
- vi. The operating period is 10 msec.
- vii. 5 msec is the release time.
- viii. A maximum of 300 operations per minute can be switched.

Specifications

- i. Voltage supply runs in the 3.75V to 6V range.
- ii. 2mA is the quiescent current.
- iii. The current is approximately 70mA

CHAPTER 5

SOFTWARE APPLICATIONS

5.1. Blynk framework

Users can remotely control gadgets such the Raspberry Pi, Arduino, and Node MCU via their Android or iOS smartphones using the web-based Internet of Things, also known as IoT, platform Blynk. With the help of this application, you may put together numerous widgets and give them the correct addresses to create a graphical user interface (GUI) or a human-computer interface (HMI). Blynk was developed for use within the Internet of Things. It can do a lot of fun things, including save data, visualise it, show sensor information, remotely control devices, and display data from sensors.

The platform consists of three main parts:

1. You can create gorgeous user experiences for your projects using the Blynk App.
2. Every interaction among the device itself and the smartphone are handled by the Blynk Server.
3. For all popular hardware platforms, Blynk Library enable connectivity to the computer's server and handle all inbound and outgoing commands.

By hitting the Button, users of the Blynk programme can start a process in which information is sent via the Blynk was Cloud and then magically appears on installed hardware. The image demonstrates how it works the opposite way and how everything happens in an instant.

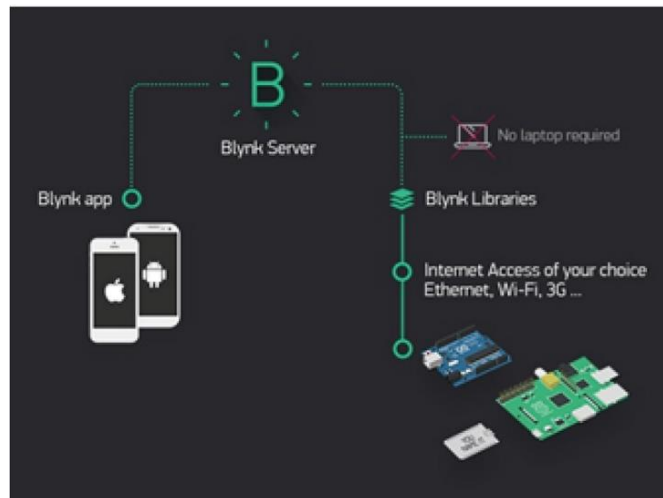


Fig 5.1.1.- Blynk cloud architecture.

Features

1. Similar API & UI for all supported hardware & devices
2. Connection to the cloud using:
3. Wi-Fi
4. BLE and Bluetooth
5. Ethernet
6. USB (Serial)
7. GSM
8. A group of simple-to-use widgets
9. Simple pin manipulation without writing any code.
10. Virtual pins make it simple to introduce new functionality.
11. Using the Super Chart widget to monitor historical data.
12. Bridge Widget-based device-to-device communication, version 12.
13. Sending push alerts, tweets, emails, etc.

Requirements to use Blynk.

Equipment

An Arduino or a Raspberry Pi or other similar development kit. Blynk is an online service. This implies that the equipment you choose needs to be connected to the

internet. Other boards, like the ESP8266 for the the Raspberry Pi with Internet access dongle, Particle technology or Spark Fun the Blynk the Board, are already Internet-capable, while some, like the Arduino Uno, need an Ethernet or Wi-Fi Shield to interact. However, you can still apps-connect it to your desktop or laptop with or without a Then (this is a little trickier for beginners, though we can show you how to do it). It's fantastic that a variety of equipment, which is always growing, supports Blynk.

A Smartphone.

The Blynk App is a nice interface builder. It works with both Android and iOS cell phones. Getting Started with The Blynk App

Create a Blynk Account

After download the Blynk app, you must create a new Blynk account. This account is different to those used for the Blynk Forums if you already have one.

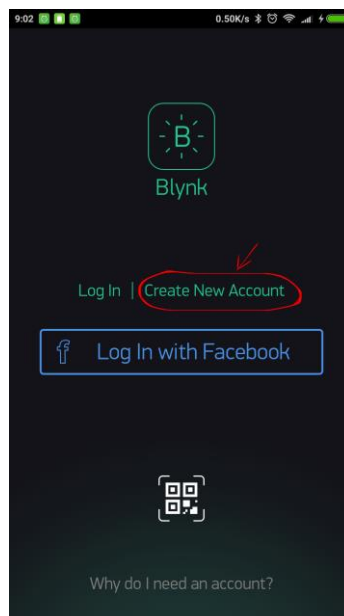


Fig 5.1.2.- Blynk set up.

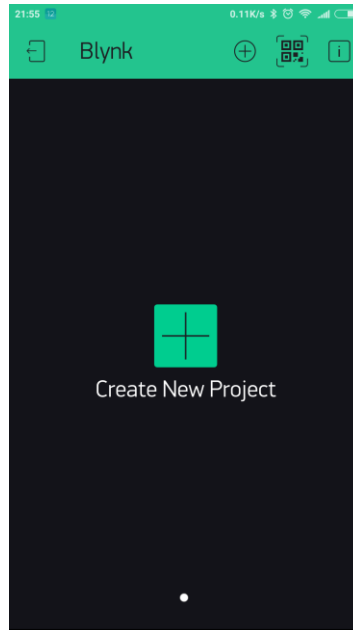


Fig 5.1.3.- Blynk set up.

Choose Your Hardware

Select the hardware model you will use. Check out the list of supported hardware.

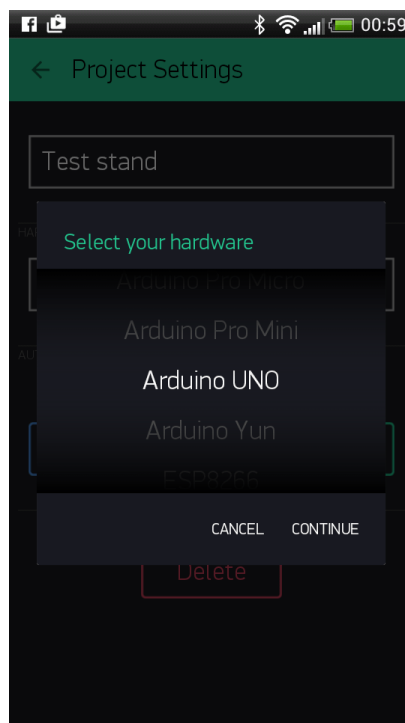


Fig 5.1.4.- Blynk set up.

Auth Token

You need an "Auth Token" to connect your gadget to your smartphone, a unique identification code. Each of your new applications will have a special Auth Token. You will immediately get an Authentication Token through email after the project is created. Additionally, it is copyable by hand. By selecting the devices section, select the required device.

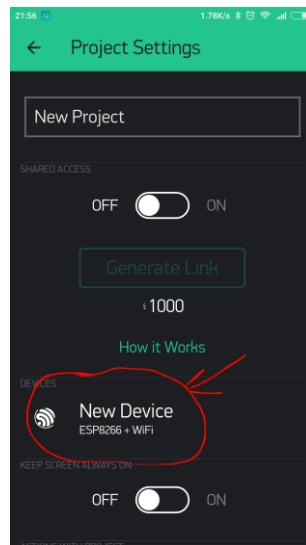


Fig 5.1.5.- Blynk set up.

And you'll see token:

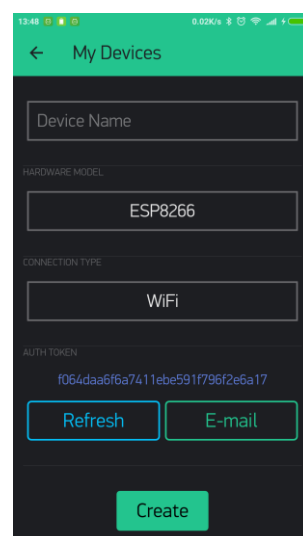


Fig 5.1.6.- Blynk set up.

Now press the “**Create**” button.

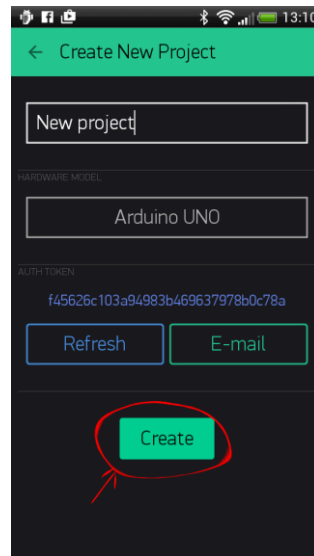


Fig 5.1.7.- Blynk set up.

Add a Widget

Your project's blank canvas is waiting for you; operating system a button to manage our LED.

To access the widget box, click anywhere on the canvas. You can find all the widgets here. Select a button now.

Widget Box

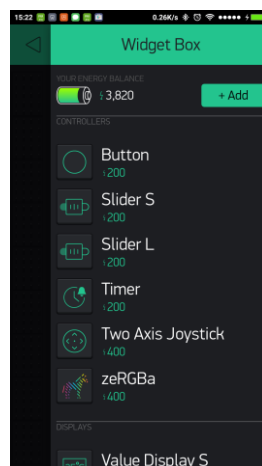


Fig 5.1.8.- Blynk set up.

Tap and grab the widget and operating system it to the desired location using drag-and-drop.

Each widgets have its own settings, or widgets. To get to them, tap the widget.

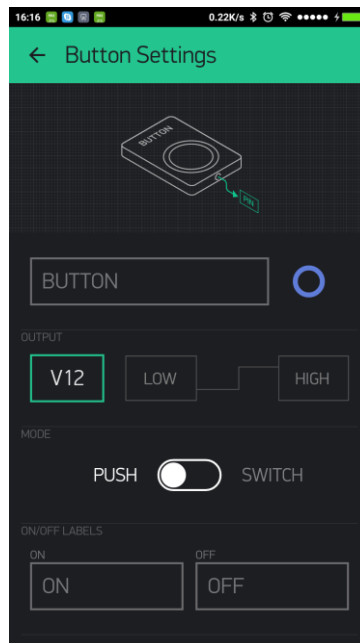


Fig 5.1.9.- Blynk set up.

Run the Project

When you are done setting the parameters, click the PLAY button. After leaving EDIT mode, you may communicate with the equipment in PLAY mode by doing this. While in PLAY mode, new widgets cannot be moved around or arranged. Instead, to switch back to EDIT mode, you must press STOP.

5.2. ThingSpeak

A platform by the name of ThingSpeak provides a huge selection of goods and services that are especially made for creating IoT applications. It allows for the real-time data collection, charting, and development of modules and apps for engaging with web services, social media, and other APIs. We'll then discuss each of these qualities in more detail.

The fundamental building block of ThingSpeak is a "ThingSpeak Channel". The information that we supply to Thing Speak is stored in channels, which are made up of the parts listed below:

- i. 8 areas for storing different kinds of data. Data from sensors or embedded devices can be stored in these fields.
- ii. Three location fields can each hold latitude, longitude, and elevation. They work wonders at keeping up with shifting targets.
- iii. One status field with a brief message describing the information stored in the channel. We must register and set up a channel to use Thing Speak.
- iv. Now that a channel has been built, we may send data for ThingSpeak to process before receiving it. To start learning more about ThingSpeak, register and create a channel.

Use of ThingSpeak in the Project

Data is arranged into channels in ThingSpeak, which describes how the data is retrieved and shown. Depending on whether a device or process is the source of the data, this may be the case. Additionally, notifications are automatically delivered via IFTTT whenever pertinent information is discovered because of numerous sensors operating within the system.

5.3. IFTTT

The cost-free web site and mobile application IFTTT allows users to streamline online-based operations and boost productivity by integrating well-known apps. IFTTT, which stands for "If That Then That," is a tribute to the programme conditional statement. Users can define task automations using "recipes," formulas that explain how an occurrence in one app should trigger an action in another. When a photo is posted on Facebook, for instance, you may construct an automation to immediately upload the image to Instagram, Instagram, Twitter, Flickr, and other photograph-sharing services.

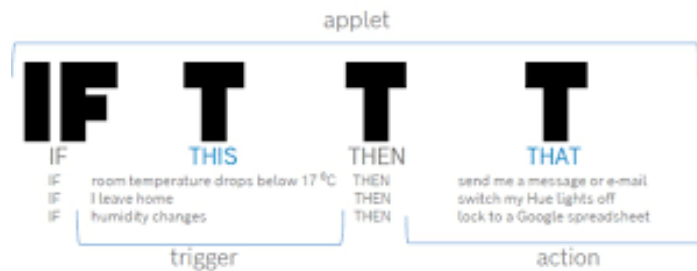


Fig 5.3.1.- IFTTT

How to use IFTTT

IFTTT is simple to use: To begin using automations, create an account and connect IFTTT to your devices. How to begin going is as follows:

Create an IFTTT account.

- i. Make an account on IFTTT first before using it. Visit the IFTTT Get Started page and take the following actions:
- ii. On the page, click Get Started in the top right corner.
- iii. To use an existing login to create your IFTTT account, select Continue with Apple, continue with Google, or Continue with Facebook. Or you can click on Use your email to sign up to create an account with an email address and a password.
- iv. IFTTT will ask you to choose your interest categories. To start, decide on at least one.

Connect IFTTT to your devices.

There are many ways to utilise IFTTT to automate your hardware and software once you've made an account. What's best? The website contains a tonne of guides that can assist you with duties.

For instance, you can instantly link your Spotify account to your SoundCloud likes. Music that is accessible on both platforms will instantly show up in your Spotify library.

Having your Honeywell thermostat turn off the heat when you leave a room is another illustration.

Find the appropriate instruction on the IFTTT website, then click Connect to get going. You will be guided through each stage of the procedure by the guide. To design a unique automation, adhere to following steps:

- i. On the top-right corner, click Create.
- ii. Choose Add in the If This box.
- iii. After selecting a service, pick a trigger.
- iv. To link your account, click Connect.
- v. Click Accept to give IFTTT permission to access your account.
- vi. After filling up the trigger forms, choose Create Trigger.
- vii. To finish the automation, choose Then That and follow the instructions.

Use of IFTTT in the Project

To send messages and voice notes to the user's mobile phone, this app is connected to the Thing Speak application. Through messaging, the user is alerted of minor problems like dry soil. Voice notes are activated to inform the user in the event of animal entry or storms.

5.4. Telegram

You can interact with your acquaintances using the instant messaging service Telegram without giving up your phone number. It accomplishes this using the MTProto communication protocol, which enables you to open many sessions on various devices without being connected at the same time.

The application was developed in 2013 as a substitute for WhatsApp by brothers Pavel and Nicolai Durov. This is how you can use your personal cloud to communicate messages, video files, voice memos, and much more. Additionally, it provides end-to-end encryption so that nobody else can hear what you are saying.

You can use Telegram for many things, some of them are:

1. Sending messages

You can send and receive messages to and from your contacts, as you would expect from an instant messaging network. You can hide your phone number if you prefer to maintain your privacy rather than sharing it. People may be found in a matter of seconds if you know their usernames. You may communicate with numerous people via video calls, audio messages, and text messages. On your PC or mobile device, all of this.

2. Storing files

Unquestionably, this is one of the Telegram's most important advantages. All chat conversations and documents will be stored there unless you choose to remove them because the system has its own cloud.

Use of Telegram in the Project

Moreover, image processing and animal detection are both done using this programme. The user must first download the file before uploading it to our website to execute image processing on an uploaded photo. This can be useful in figuring out whether a plant is healthy.

CHAPTER 6

DRONE FOR IMAGE PROCESSING

6.1. Drone Assembling

A drone is a technologically unmanned aircraft. Using flight schedules that can be technology-controlled in embedded systems, along with onboard sensors and GPS, a drone is a flying machine that may be remotely commanded or flown autonomously.

Drone Components:

6.1.1. Standard Propellers

Propellers from quadcopters or drones are frequently visible up front. There are many different materials used to make propellers, and there are many different sizes available. Although most of them, especially the smaller drones, are constructed of plastic, the more affordable ones are made of carbon fibre. Technological advancement is continually being made to create turbines that are more efficient for both small and large drones. The drone's propellers direct its direction and motion. Therefore, it's essential to ensure that all the propellers are in good condition before launching your drone. The drone's ability to fly is hampered by damaged propellers, which raises the possibility of an accident. In case you discover anything wrong that wasn't there before, you may additionally wish to bring along a spare set of propellers.

6.1.2. Pusher Propellers

The drone is propelled in both directions while in flight by pusher propellers. Pusher propellers, as their name suggests, are used to steer the drone forward or backward. Usually, they live at the technology's back. During static flight, they function by neutralising out the drone's motors torques to move the drone either forwards or backward. Pusher propellers, like ordinary propellers, can be made of polymer or

carbon fibre depending on quality. Most of the pricier ones are made of carbon fibre. Depending on the dimensions of the drone, many sizes are available. In the case of a mishap, pusher prop shields that come with some drones can assist protect your propellers. The pusher propellers may alternatively be made of plastic or carbon fibre, depending on quality. The pricier ones are often made of carbon fibre. Pusher prop guards are a device that certain unmanned aircraft offer to help protect your propellers in the event of an unforeseen catastrophe. Before taking off, always inspect your pusher propellers since this will affect how effectively the aircraft operates.

6.1.3. Brushless Motors

Brushless motors, which outperform those with brushed brushes in terms of both efficiency and operation, are used in all contemporary drone manufacture. The design of the motor is just as important as the drone itself. This is so that you can have an efficient motor and save money on both the purchase and maintenance expenditures. Additionally, you are going to allowed to fly your unmanned aerial vehicle for a longer time if you conserve battery life. The drone motor design market is now fascinating as businesses compete to build the most effective and finest developed motors. The DJI Inspire 1, which was just introduced, is the newest product on the market. This improves performance and cuts down on battery use. It does not make a lot of pointless noises and is also silent.

6.1.4. Landing Gear

To help with landing, some drones have resemblances to helicopter landing gear. Drones that require elevated ground clearances while landing will need sophisticated landing gear to land safely. Additionally, drones used for delivery that transport goods or other stuff may need to be equipped with large landing gear due to the space required to keep the parcels or commodities as it hits the ground. However, not all drones require landing gear. Some tiny drones may operate very well without a set of landing wheels and can securely land on their bellies. Most drones with larger range and longer flying durations have fixed landing gears. In some situations, particularly when using a

camera, a drone landing gear could appear to be an obstruction to getting a full 360-degree picture of the surroundings. The landing gears further boost the drone's safety.

6.1.5. Electronic Speed Controllers

The main function of an electronics speed controller (ESC), an electrical circuit, is to monitor and control the drone's flying speed. The drone's fly route and braking adjustments are also under its control. The ESC converts DC power from the battery to AC power to drive the brushless motors. The ESC controls every aspect of flight and flight efficiency for modern drones. The most recent more effective ESC that increases performance while using less electricity is the DJI Inspiration 1 ESC. The drone's mainframe is where the ESC is primarily housed. Although it is doubtful that you will need to do anything with or modify the ESC, you can find it inside the drone's mainframe in case you do.

6.1.6. Flight Controller

The flight controller is located on the drone's motherboard. It supervises the execution of each command given by the drone's pilot. Data from the GPS Module, receiver, battery monitor, and onboard sensors are all decoded by it. In addition to regulating the drone's direction, the flight controllers are also responsible for managing the motor velocities via the ESC. The commands that operate the camera, control the autopilot's mode, and control any additional autonomous systems are all under the control of the flight controller. Users won't likely need to modify the flight controller because it regularly influences how the drone functions.

6.1.7. The Receiver

Accepting radio signals that the controller sends to the drone is the responsibility of the receiver. The bare minimum number of channels needed to fly a drone is frequently 4. However, it is suggested recommended 5 channels should become accessible. You can use any receiver that is currently on the market to make a drone.

6.1.8. The Transmitter

The transmitter is the part responsible for transmitting radio signals to the drone from the controller to direct it in flight and navigation. Like the receiver, the transmitter must have 4 channels, however 5 is usually recommended. The market offers a wide range of receiver types from which drone manufacturers might choose. Both the receiver and the transmitter need to be using the same wireless signal to connect to the drones while it is in the air. Each transmission has an established code that allows it to be distinguished from all other communications signals in the air.

6.1.9. GPS Module

The GPS module gives the drone its latitude, longitude, and elevation points. It is an important part that makes up the drone. Without the GPS module, drones could not have been as significant today. The modules enable longer-range drone navigation and data collecting at specific on-land locations. The GPS module assists in bringing the drone "home" securely even if no FPV navigation is used. In most modern unmanned aircraft, the GPS module helps in case that it loses connection to the controller to securely return the drone to it. This helps to ensure the safety of the drone.

6.1.10. Battery

The element that makes all movements and replies possible is the drone's battery. Without the battery, the unmanned aircraft would be devoid of any power and couldn't fly. The kind of drone determines the battery requirements. Smaller drones might need fewer batteries because they have lower power needs. On the other hand, larger drones may require a larger battery with more power to run the drone's entire operation. The unmanned aircraft incorporates a battery metre that provides battery information to help the pilot keep track of the battery's performance.

6.1.11. Camera

Some drones feature a detachable camera, while others have one built in. Aerial photography is frequently done using drones, which are rendered possible with the camera. On the market, there are many different types and levels of quality of cameras. Essentially, these make up a drone's major part. All of these are required if you ever need to build a drone for it to function.

6.1.12. Buzzer

This 5V passive buzzer is small enough to mount on a Board. Using Audio Alert in your electronic designs is a terrific idea. It uses a coil element to produce an audible tone and runs on a 5V supply. An electrically powered, mechanically powered, or piezo audio signalling device, sometimes known as a buzzer or beeper. The buzzers and alarms are widely used as timers, alarm clocks, and to confirm human input like mouse clicks.

6.2. Principle Of Drone:

6.2.1. Vertical Motion

Drones employ rotors for control and propulsion. Consider a rotor to be a fan because they both function similarly. Spindly blades drive the air down.

Naturally, since all forces work in pairs, as the rotor pulls the air downward, the air pulls upward against it. Lift's fundamental concept, which boils down to managing the upward and downward forces, is as follows. The lift increases with rotor rotation speed and vice versa.

A drone can now hover, rise, or drop in the vertical plane. The net thrust produced by the drone's four propellers must be bigger than the pull of gravity pulling it downward for it to hover. Simply increase the four rotors' thrust (speed) to generate an upward force greater than the amount of weight needed to climb. After that, you might

possibly somewhat lessen the amount of thrust, but the drone would then be under the influence of three forces: weight, propellers, and air drag. Thus, stronger thrusters than those required for basic hovering are still needed. You must do the exact reverse to descend: Simply slow down the rotation of the rotor until the descending force is the net force.

6.2.2. Turning (Rotating)

Say you wish to turn a hovering drone that is facing north to face east. How can switching the four rotors' power help you do this? I'll sketch a picture of the rotors (viewed from above) labelled 1 through 4 before responding.

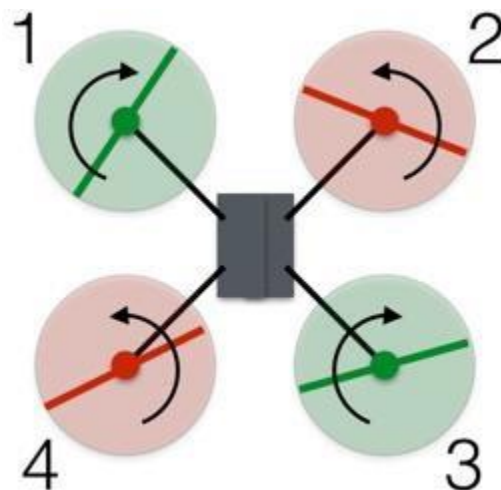


Fig 6.2.2.1.- Drone Principle

The red and green rotors in this configuration alternately spin in a clockwise and an anticlockwise way. In the anticlockwise rotation of the two pairs of rotors, the total angle momentum is equal to 0. By multiplying the angle of motion by the value of the moment of inertia, angular momentum is determined similarly to linear momentum. like bulk, but with a rotational emphasis. The angular momentum is influenced by the rotors' rate of rotation.

When there is no tension occurring on the system in question (in the instance of the drone), then the entire angular momentum must remain constant (in this case, 0). To

make things more obvious, I'll say that the red in the opposite direction rotors have an upward angular momentum while those in green clockwise blades have an adverse angular momentum. I'll assign the following values to each rotor: +2, +2, which means that -2, -2.

Put the drone in the right-handed position. Reduce the angular velocity of rotor 1, causing it to acquire a directional momentum of -1 as opposed to -2. The drone's total angular momentum is now positive, barring any more events. That is obviously not feasible. The drone as a result rotates anticlockwise, giving the structure a negative angular momentum.

The drone did rotate when rotor 1's spin was reduced, but this also reduced rotor 1's thrust. The drone now drops because the gravitational pull is greater than the net upward force. The drone leans downhill in the direction of rotor 1 because of the unbalanced thrust forces.

To rotate the unmanned aircraft without generating any of these other problems, increase the spin of blades 2 and 4 and decrease the speed of blades 1 and 3. Since the rotors' angular momentum is still greater than zero, the drone's body must rotate. However, because the overall force is still equal with the gravitational force, the drone continues to hover. The lower propulsion rotors are diametrically opposed to one another, which allows the drone to maintain balance.

6.2.3. Forwards and Sideways

The same holds true for side-to-side motion. Like an automobile, a quadcopter drone's entire body serves as the front. Therefore, explaining how to go forwards also includes instructions on how to proceed reverse or to either side.

The forward propulsion of the vehicle is provided in part by the rotors. Here is an exterior view of an unmanned aircraft moving (with forces) at a constant speed.

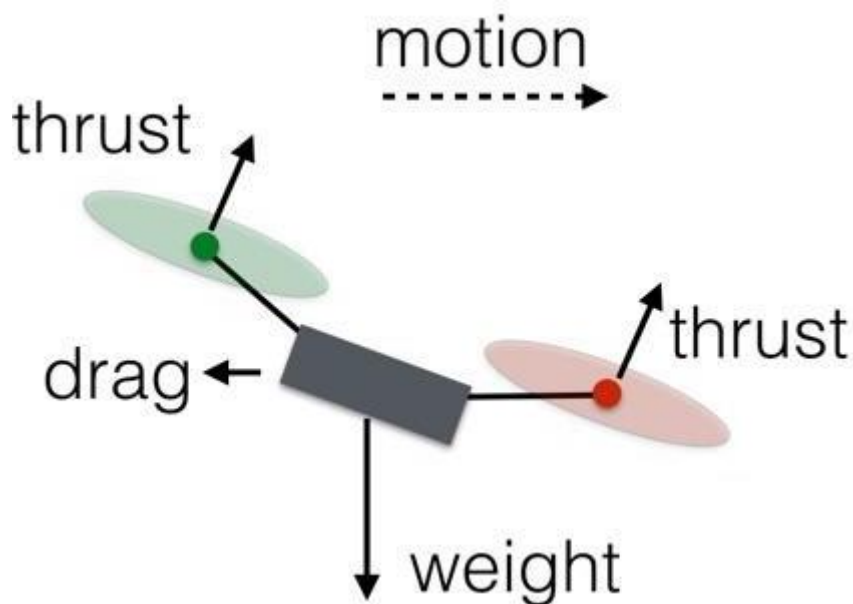


Fig 6.2.2.2.- Forces acting on drone

By accelerating the rotation of blades three and four (the two located at the rear) while decreasing the rotation of blades 1 and 2. Since the total thrust power is always equal to the weight, the drone will stay at the exact same vertical level. The rear rotors' increased rotation will also have no effect on the momentum of the angle since one of them is turning anticlockwise to the other. Since the front rotors also share this characteristic, the drone cannot rotate. Due of the greater force at its back, the unmanned aircraft will tilt forward, though. The net thrust force will now have a component to travel forward and a component to go backward with a slight rise in force for all rotors.

6.3. Applications of Drones

1. Farmers can benefit from drones by using them to measure and record crop height. They make use of a remote sensing technique known as Lidar, which illuminates the crop with a laser and measures the reflected light to determine distance.
2. Drones can fly to hazardous areas to evaluate the condition of the air and check for the presence of bacteria or atmospheric components. These drones are equipped with biological sensors.

3. Drones can scan the size of the impacted areas during wildfires and gauge how quickly the fires are expanding. Photos obtained might show specifics of the damage.
4. To capture footage of sporting events that would be difficult to obtain otherwise, like recording and live operating system footage, television sports networks use drones. Drone usage is subject to regulations set forth through the FAA, sporting tournaments, the venue, or local law enforcement.
5. They can also be utilised in agriculture, healthcare, disaster relief, asset protection, wildlife monitoring, firefighting, search and rescue, and communications relay.
 - i. Indoor Drones
 - ii. Animal Repelling
 - iii. Children's fun Toys

6.4. Drone Controlling

Flight Controllers

Quadcopters' quality and capabilities are just as crucial as the controllers that are used with them in terms of importance. The whole thing is meaningless if a quadcopter does not have a good fly controller. Apps exist for this purpose, but some of them are just inferior to the controllers in terms of quality.

6.4.1.F3 EVO Controller

The F3 Racing EVO flight controller is the ideal board for your upcoming multirotor (drone) racing build thanks to its capabilities. Amazing flight performance has been achieved in a stackable, race-ready compact. It is very reasonably priced and has the most up-to-date sensors, race timing, and logging technologies. It also has good communication choices. The F3 EVO Pro is a race timing transponder system that was created with the serious racer in mind. Use the integrated micro-SD card connector to examine your race and flight telemetry and Blackbox logs. Whether you're an aerial

photographer, an FPV racer, or both, the F3 EVO has all the functionality you could possibly want for the brain of your multirotor.

The open-source clean flight control (FC) software, which has a large and welcoming community of users and developers, is used by the F3 Racing Evo. Being open source means you can add to the system as well. The principal developer of clean flight built the hardware to be more powerful than the previous generation of STM32F1 based boards. For optimal installation compatibility with current products, the F3 EVO board's stack pins, ESC/Servo outputs, and connections are in the same area as those on the F3 Acro and Deluxe boards.

In conclusion, the F3 EVO makes your multirotor (drone) fly like it's on rails by utilising cutting-edge CPU, sensor, and software technology. The Clean flight software makes it possible to fly precisely, which is essential for quick FPV racing. efficiently performs flight computations using the ARM Cortex-M4 72Mhz CPU and Math co-processor (FPU) to complete more tasks in less time. The gyroscope and accelerometer sensors are connected to the rapid SPI bus, allowing the software to get more information even faster to assist in further stabilising your craft.

6.4.2. HOBBY-POWER KK2.15 Controller

Features that set it apart from the competition include the ability for customers to self-update, polarity protection, and customizable signal to motors.

The multi-rotor drone types can be controlled by the Hobby-power KK2.15 next-generation flight controller board. All you must do to get started flying your drone is connect the board into it, determine the type of craft it is, look at how the electric motors and propellers are arranged, and calibrate the ESCs.

With the addition of an additional auto-levelling feature and a more sensitive 6050 MPU system, this board has been improved from the first in its line.

6.4.2. DJI NAZA-M V2 Controller

A device can be distinguished by features like GPS, automated course deviation correction, an altitude stabilisation method, IOC, error identification and warning, improved IMU calibration, and RTL.

For users of hexacopter and octocopter aircraft, The DJI technology M V2 flying the controller, that also has more features, has upgraded the first aircraft its kind. It has assistance that is specifically designed to hexacopters and octocopters to guarantee that a safe landing is feasible in the case of an unanticipated motor failure. The revised model has GPS, RTL, and better position keeping capabilities for improved flight performance. The automatic course deviation compensation also lessens general compass interference and any effects of a magnetic disturbance.

6.4.3 PIXHAWK PX4 2.4.6 Controller

An exterior technology-colored LED, dual technology-angle LED, the NuttX RTOX continuous operation structure, automated and manual settings, and Micro SD are among the extraordinary features.

Uavs for aerial photography work well. The New Pixhawk PX4 2.4.6 flight controller board uses 32-bit microprocessor technology and integrated sensor technology. This makes it possible to do away with the necessity for an 8-bit APM or CPU. It has a main controller efficiency that supports backup control options as well as an external multicoloured LED.

A redundant power supply failover and input are provided in both automatic and manual modes. Images and a storage device in general are possible with the Micro SD.

6.4.4. LHI PRO RACING F3 Flight Controller

1. One Shot ESC, Autotune, In-Fly PID Tuning, Black Box Flight Data Logging, Support for RGB LED Strips, Additional PID Controllers

2. Most suitable for: Racing small FPV quadcopters.
3. Mini quads designed for racing and equipped with FPV work best with the LHI Pro Racing F3 Flight Controller. It offers an RGB LED strip support, black box flight data logging, and support for a variety of different flight controllers, making maintenance and software updates easier.
4. You have the option of using a CC3D, CJMCU, or Sparky. It has more RC channels than 8, which makes it ideal for racing.

6.5. Uses of Flight Controller

The operator's transmitter sends signals to the flight controller, which receives them. This makes it possible for the user's commands and instructions to reach the quadcopter in midair. Furthermore, useful for coordinating with sensors installed on board for a smooth flight is the flight controller. This might include gadgets like gyroscopes, accelerometers, and similar things.

There is still more that the controller can do. A multicopter with four separate motors is called a quadcopter. Every motor runs at a certain speed. The flight controller determines the speeds of all four of the motors before sending an electrical signal to the Electronics Speed Controllers, which are or ESCs. A smoother flying is made possible by this.

6.6. Sensors in a Flight Controller

6.6.1. The Accelerometer

An accelerometer is the primary component of practically all flight controllers. This instrument effectively measures the helicopter's linear acceleration in a three-axis system. This sensor provides an output that enables the user to estimate the drone's position.

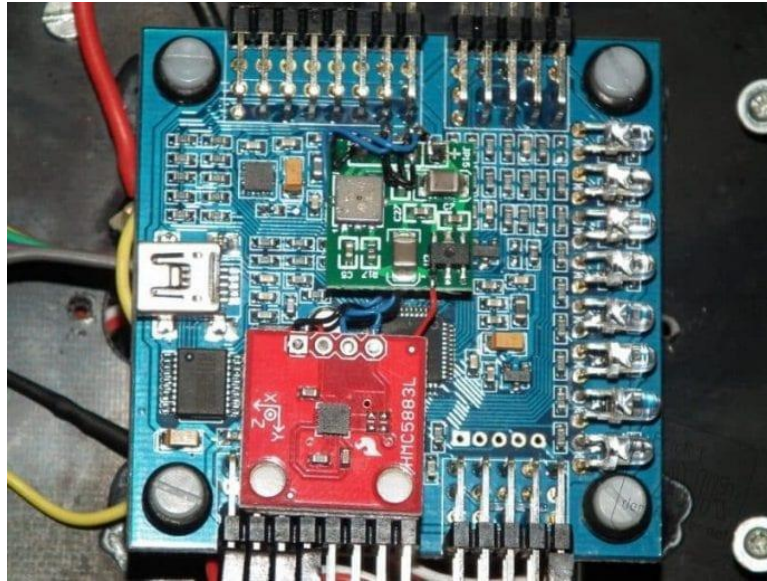


Fig 6.6.1.1.- Accelerometer

An accelerometer's ability to sense and react to gravity alone makes it stable in flight, resulting in a smooth flight. The linear axis of the accelerometer should be in line with the main axis of the UAV when mounting it on a flight controller board.

6.6.2. The Gyroscope

The gyroscope is helpful for determining the rate of angular change, just like the accelerometer. Again, this is measurable on up to three dimensions. To acquire the angle, though, you'll need to make some adjustments. The sensor's rotating axis and the axis of the UAV should line up.

6.6.3. Inertia Measurement Unit (Imu)

The gyroscope and the accelerometer are both a part of this component of the quadcopter flight controller. Several systems integrate the usage of a magnetometer and similar devices.



Fig 6.6.3.1.- Inertia Measurement Unit

6.6.4. The Magnetometer

This sensor, as its name suggests, is an electronic compass mounted on the controller board. This is extremely important to do to align the drone's heading with the earth's magnetic field.

6.6.5. The Barometer

As everyone is aware, a barometer measures pressure. An accurate measurement of the device's height above sea level can be obtained using a pressure sensor on the drone. The pressure sensor and GPS altitude together provide the height information that is the most precise.

6.6.6. Features for good flight control.

- i. **Gyro stabilization** – This enables the pilot to maintain good control and midair stability for the quadcopter.
- ii. **Self-leveling** – By letting go of the pitch, this helpful feature enables the quadcopter to maintain level flight.
- iii. **Orientation mode** – The ability to control the orientation of the drone is provided by a quadcopter's orientation mode.

- iv. **Altitude holds** – Without the need to continuously adjust the throttle, The quadcopter can hover and retain stability at a certain height above the ground thanks to this capability.
- v. **Position hold** – Similar to an altitude hold, this characteristic permits the quadcopter to keep a fixed point or location.
- vi. **Return home** – This unique function, which is featured in many helicopters, enables the craft to return to its takeoff point even if the user loses control.
- vii. **Waypoint navigation** – Another intriguing characteristic of a helicopter is this. Because of this characteristic, the device can adhere to a few spots on a map that are part of the flight plan.
- viii. **GPS** – Recently, this trait has grown significantly in prominence. It not only enables the device to hold its position but also conveniently records the flying data.

CHAPTER 7

IMAGE PROCESSING

7.1. Introduction to Digital Image Processing

With a computer, digital image processing entails editing digital images. It is a division of signals and systems that places a significant emphasis on pictures. The fundamental goal of DIP is to build an apps that is an image-processing computer system. Algorithms are employed in digital image processing to alter the images. The most popular and extensively used software for processing digital photos is Adobe Photoshop.

For instance, MATLAB, Adobe Photoshop, etc.

Additionally, it is employed in the process of turning image sensor signal into digital image. In image processing, a selection of algorithms is employed.

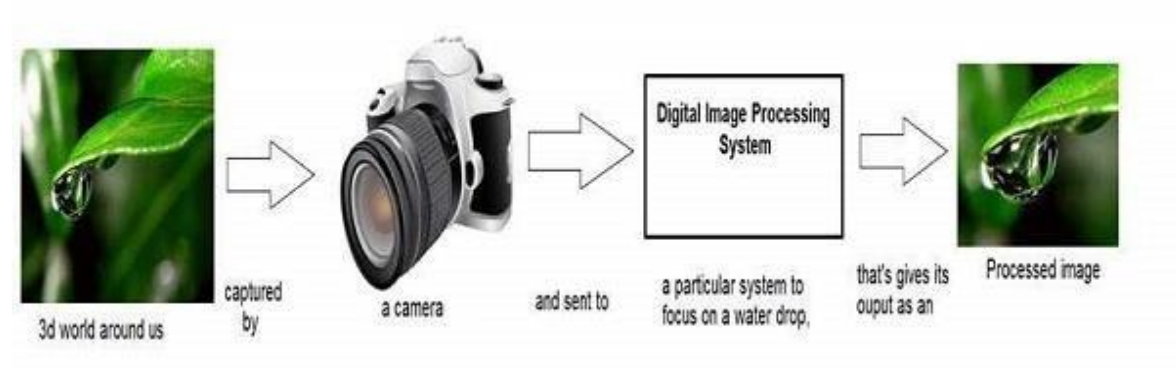


Fig 7.1.1.- Digital Image Processing system

7.2. Purpose of Digital Image Processing

Pictures are improved for interpretation by humans. Data can be taken from images and used for automated interpretation. The pixels in the image can be changed to produce any desired density and contrast. Pictures may be easily retrieved and stored.

A physical image must first be transformed into digital data to be analysed to build simulations or retrieve information from it.

The following are a few typical applications for image processing:

1. Visualizing is the technique of enhancing or manipulating photographs that have been taken with a camera to produce better results. This may involve enlarging, rescaling, sharpening, blurring, turning grayscale photos into colour, locating edges, extracting images, and identifying pictures.
2. Restoration and sharpening of photos: This mainly involve enhancing noisy photographs.
 - i. Image retrieval: This refers to high-resolution image search.
 - ii. Pattern recognition: This involves defining various objects in an image.
 - iii. Image recognition: This involves detecting objects in an image.

7.3. Leaf Disease Detection Using Convolutional Neural Networks

Picture manipulation is a procedure that is used to accomplish a variety of objectives. The image may be improved, important information may be extracted from it, or other operations may be carried out on it. The Pytorch framework and vgg-16 architecture can be used to process images using convolutional neural networks (CNN). This is accomplished by gathering information from the image, correctly labelling it, saving it in a database or file format, and then using that data to train the network. The process's ultimate purpose is to produce precise output using the trained dataset.

7.3.1. Convolutional Neural Networks (CNN)

A particular kind of neural network called a CNN is utilised for deep learning tasks that require the processing of visual input. While there are other types of networks that are beneficial for various tasks, CNNs are frequently the best choice for recognising and identifying things. CNN operates under the straightforward presumption that not all pixels are necessary to recognise some elements in an image.

A CNN can include several layers, and each layer teaches the CNN to detect the various facets of the image being processed. A kind of filter or kernel is applied to each image to produce an output that improves and becomes more accurate with each layer. The filters could start out as fundamental traits in the deeper layers.

The level of detail of the filters rises with each layer, checking and identifying traits that uniquely reflect the input item. As a result, the input for the following layer is the partially recognisable image from the output of each layer, also known as the convolved image. The final layer, an FC layer, has a picture or object that the CNN identifies.

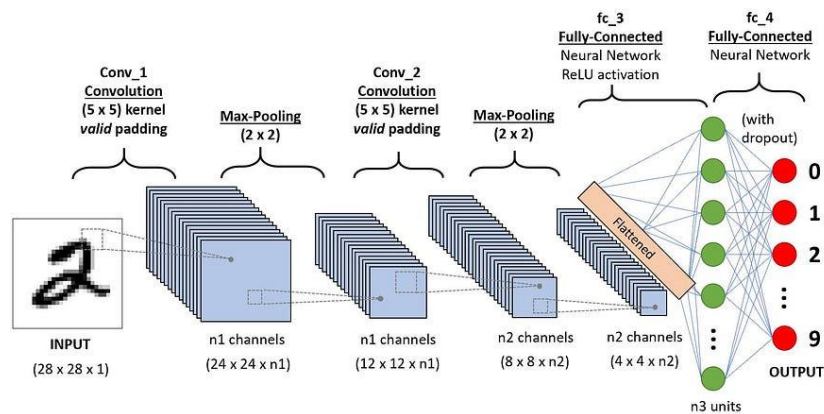


Fig 7.3.1.1.- Convolutional Neural Networks

Convolution involves applying several different filters on the input image. Each filter carries out its task by illuminating portions of the image, following which it passes the result to the filtering in the layer below. As each layer can detect different features, the procedures are repeated for many, many, or even a thousand layers. After analysing all the visual data through its numerous layers, the CNN can finally recognise the entire object.

7.3.2. PyTorch

PyTorch is a fully functional framework for creating deep learning models; it is a popular machine learning application for language processing and image identification. Most machine learning developers find Python to be simple to learn and use.

The following are some of PyTorch's key attributes:

1. PyTorch.org has a sizable and active community with top-notch documentation and tutorials. The forums are supportive and lively.
2. It is developed in Python and incorporates well-known Python libraries like SciPy, NumPy, and Cython for converting Python code to C code for faster performance. PyTorch is very simple for Python developers to understand because of its similar syntax and usage to Python.
3. Major cloud platforms offer strong support for it.
4. TorchScript, the scripting language, is flexible and user-friendly in eager mode. While operations in this quick-start execution mode are carried out as soon as they are called from Python, it is also possible to switch to a graph model for enhanced performance in C++ runtime settings.
5. It supports distributed training, parallel processing, and GPU and CPU computing. This implies that computational tasks can be split between several CPU and GPU cores, and training can be carried out over several GPUs.
6. PyTorch supports dynamic computational graphs, allowing for runtime modification of network behaviour. Compared to many machine learning frameworks, which demand that neural networks be specified as static objects prior to runtime, this offers a significant flexibility benefit.
7. Pre-trained models can be called from the PyTorch Hub with as little as one line of code in some circumstances.
8. It is simple to share parameters with third-party toolkits like TensorBoard and construct new custom components by subclassing a standard Python class. Libraries may be imported and used in line with ease.
9. PyTorch includes a reputable collection of APIs that can be utilised to enhance core features.

10. It provides both "graph mode" for high-performance execution and "eager mode" for experimentation.
11. It contains a sizable array of tools and frameworks covering anything from reinforcement learning to computer vision.
12. It facilitates the development of high-performance C++ programmes using a pure C++ front-end interface that is familiar to Python programmers.

7.3.3. VGG16

VGG16 is an object recognition and classification algorithm that, when used to classify 1000 images into 1000 separate categories, has an accuracy rate of 92.7%. It is a popular method for categorising photos and is easy to use with transfer learning.

Uses of VGG16

The object detection and classification an algorithm VGG16 can classify 1000 images into 1000 distinct categories with a 92.7% accuracy rate. It is a popular picture categorization technique that is easy to utilise with transfer learning.

VGG16 Architecture

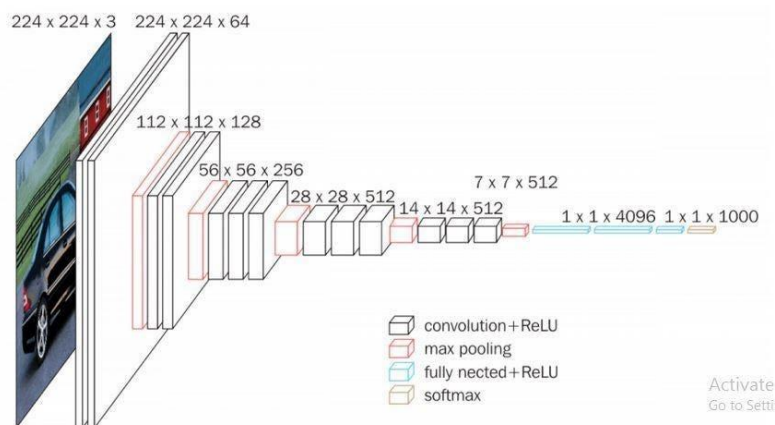


Fig 7.3.3.1.- VGG16 Architecture

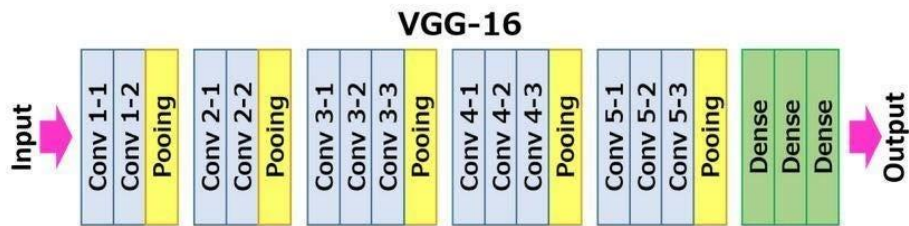


Fig 7.3.3.1.- VGG16 Architecture

1. 16 weighted layers are represented by the number 16 in VGG16. Only 16 of the total 21 layers in the VGG16 are weight layers also known as learnable parameter layers (13 convolutional layers, 5 max pooling layers, and 3 dense layers).
2. The VGG16's input tensor has three RGB channels and a size of 224, 244.
3. The most notable aspect of VGG16 is that it continuously used the identical padding and maxpool layers of a 2x2 filter having stride 2 and favoured convolutional layers that were part of a 3x3 filter having stride 1 across numerous hyper-parameters.
4. The convolution and max pool layers are arranged consistently across the whole architecture.
5. There are 64 filters in Conv-1 Layer, 128 filters in Conv-2 Layer, 256 filters in Conv-3 Layer, 512 filters in Conv-4 Layer, and 512 filters in Conv-5 Layer.
6. Following a set of convolutional layers, 3 Fully connected (FC) layer are added, the third of which performs ILSVRC classification in 1000 ways and has 1000 channels. A total of 4096 channels (one for every single class) are present in each of the first two FC layers. The final layer is the soft-max layer.

7.3.4. Flask

The output models are saved using Flask. It is a Python-based micro web framework that offers an IP address. We can browse using any web browser by using the IP address. A user-drawn image is sent to the model through the predict function. According to the findings, a plant illness is identified, and the user is advised to take supplements in addition to receiving information on the ailment's aetiology.

With Flask, a web application framework built on Werkzeug and Jinja2, Python is implemented to create websites.

There are benefits to adopting the Flask framework:

1. A quick debugger and integrated development server are included.
2. Lightweight.
3. Support for secure cookies.
4. Jinja2 templating.
5. REST-based request dispatching.

CHAPTER 8

METHODOLOGY

8.1. Main Module

The main module gathers data from all the sensors connected to it, communicates the information to the user via the ThingSpeak app, and notifies the user via IFTTT by setting off events based on the data. By taking actions based on requirements, the farm is also maintained concurrently.

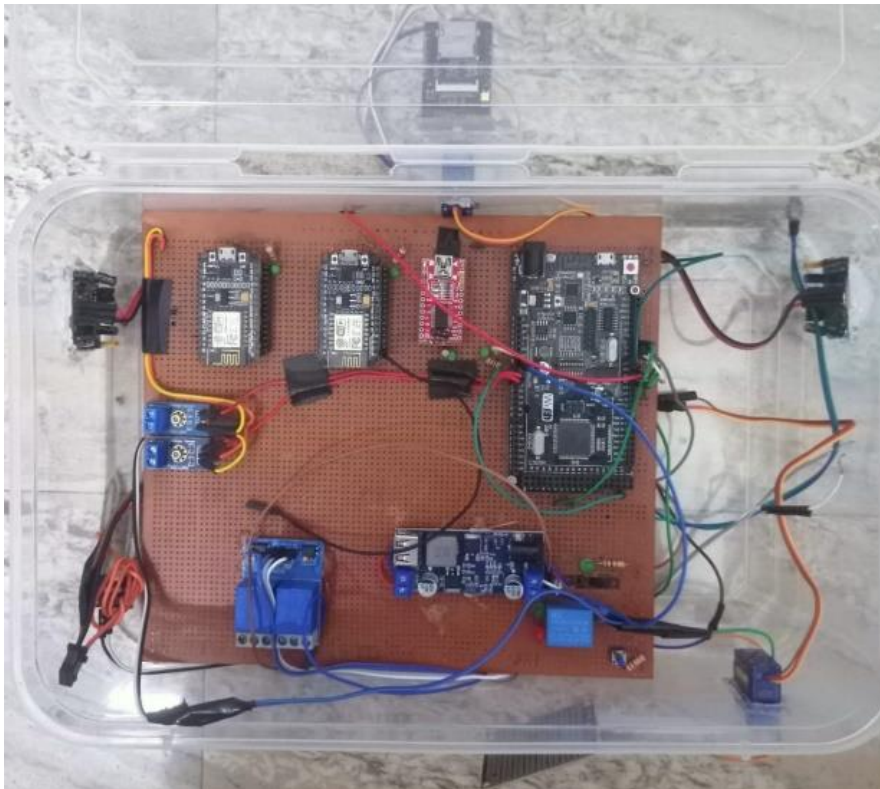


Fig 8.1.1.- Main Module

The complete process's algorithm

- Step 1: Start the experimental setup.
- Step 2: Connect to wi-fi module.
- Step 3: Read all the sensor values.

- Step 4: Get the values from analog pins and digital pins.
- Step 5: Read values in Blynk and Telegram apps.
- Step 6: Delay to 10 seconds between each sensor.
- Step 7: Repeat step 4, 5 & 6 until the process ends.
- Step 8: End

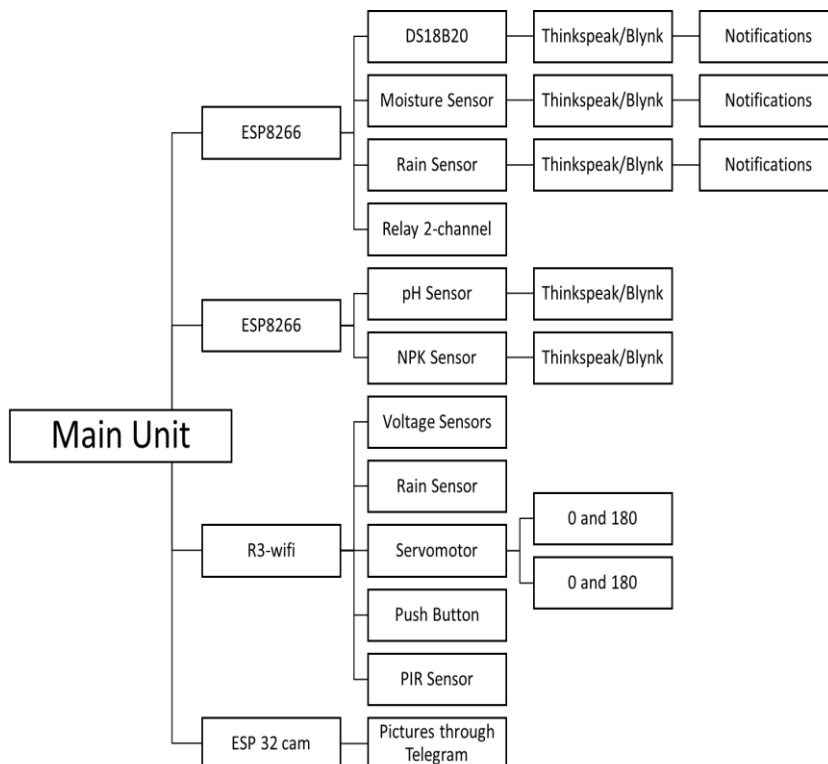


Fig 8.1.2.- Main Module Architecture

The DS18B20 sensor is used to monitor the temperature across the farm and send information to the Blynk app through an ESP8266 board. Whenever high temperatures are detected, it checks the moisture level of soil using a moisture sensor to determine if there's been too much reduction in water availability. If this condition persists, then automatically the system turn on irrigation systems to ensure crops are safe. It also sends notifications to the user's mobile to inform the farm condition through IFTTT. The increase or decrease in temperature can be observed in Blynk app.

The Moisture sensor measures the soil moisture and takes necessary actions like automatically watering the crop and simultaneously informing the farmer about it. The notifications are passed through IFTTT in the form of text messages. The increase or decrease in temperature can be observed in Blynk app.

The pH sensor is used for knowing the acidity of the farmland by testing the colloidal solution of soil and the water coming to the field. This helps the farmer for growing crops that are suitable for the soil and water type. The user can also take required remedies by feeding the farm with necessary salts to increase the acidity of the soil. It also sends notifications to the user's mobile to inform the farm condition through IFTTT. The increase or decrease in temperature can be observed in Blynk app.

The Rain sensor is used for the detection of storms near the field. When the rain starts falling near the field, the user receives information through voice notes when the moisture level on the rain board exceeds the threshold limit.

The PIR sensor detects any unauthorized intrusion of wild animals or farmers from the neighboring fields. The sensor is placed at two sides of the farm. The sensor detects any intrusion from the direction it is placed. The detected information is captured through ESP32 camera, and the data is sent to the farmer's mobile via photographs through Telegram. The application used here is "Bot Father." Unlike other sensors the PIR sensor is connected to MEGA2560 R3 board.

8.1.1. ESP8266

Two ESP8266 boards, an ESP32 CAM, and sensors attached to them make up the main module. A DS18B20 temperature sensor, a moisture sensor, and a rain sensor are all found on one board. When the temperature rises close to the field, the system immediately checks the soil moisture levels because the DS18B20 and moisture sensor are connected in series. The rain sensor provides storm information. To carry out their respective functions, the pH sensor and NPK sensor are both present on the other ESP8266 board.

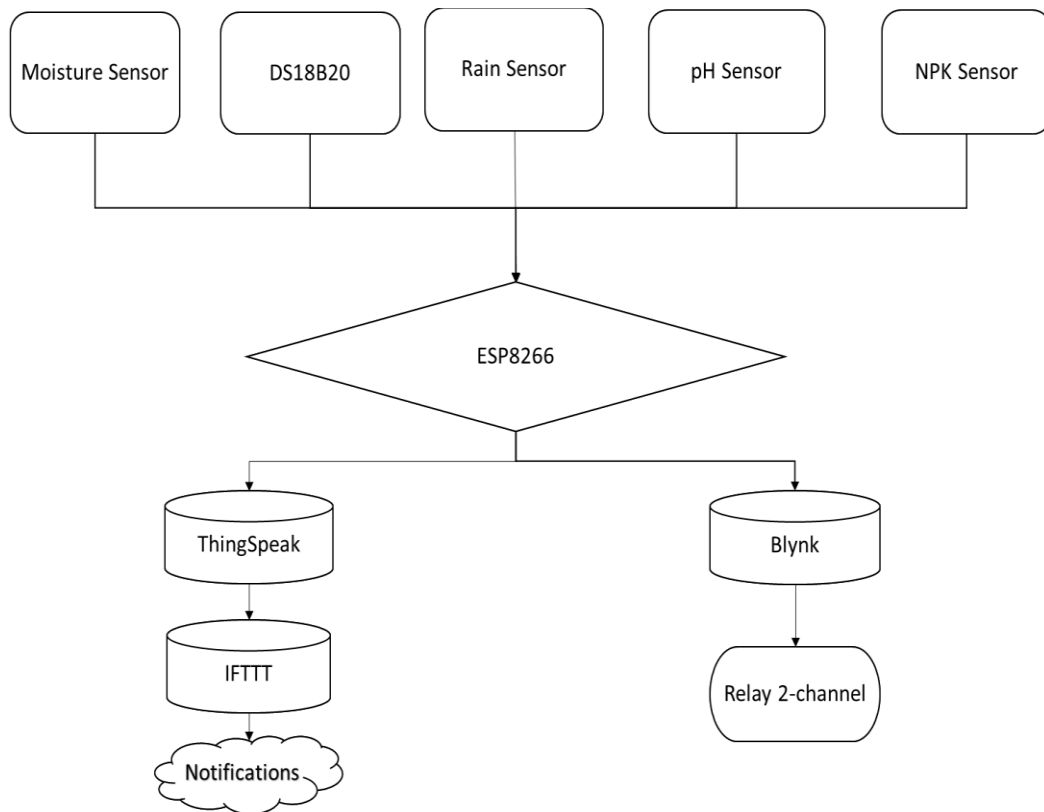


Fig 8.1.1.1- ESP8266

8.1.2. MEGA2560 R3

Like the earlier ESP8266 board, this one has an ESP32 camera and a PIR sensor that together warn the user of animal trespass. To protect the main module from storm water after transmitting the information to the user, a rain sensor is also connected to this board together with the ESP8266. Voltage sensors are also included in this circuit to monitor the system for a consistent minimum voltage.

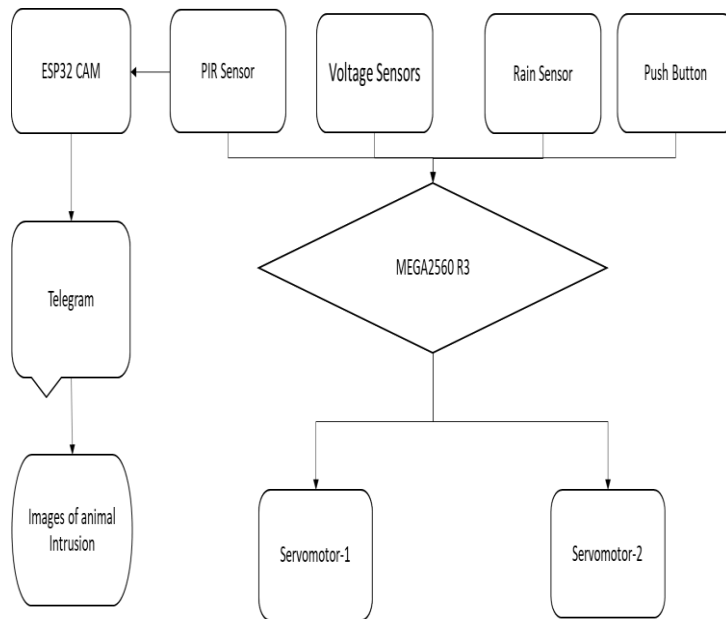


Fig 8.1.2.1.- MEGA2560 R3

8.2. Drone and Image Processing

The drone inspects the state of the farm and the health of the crops using image processing using an ESP 32 camera that is attached to the aircraft. The plant health is reported to the user by producing a detailed report on what kind of disease is responsible and making recommendations for the necessary treatments to protect the crop.



Fig 8.2.1.-Drone Module

Every component of the drone is managed by the flight controller. The GPS, transmitter, and motors, etc. Moreover it is linked to an ESP32 camera, which captures images in the field and delivers them to the user's mobile. When the IR sensor attached to the flight controller transmits a signal, pictures are collected. To learn more about the crop's health and nutrient deficiencies, the user uploads the image to a web page.

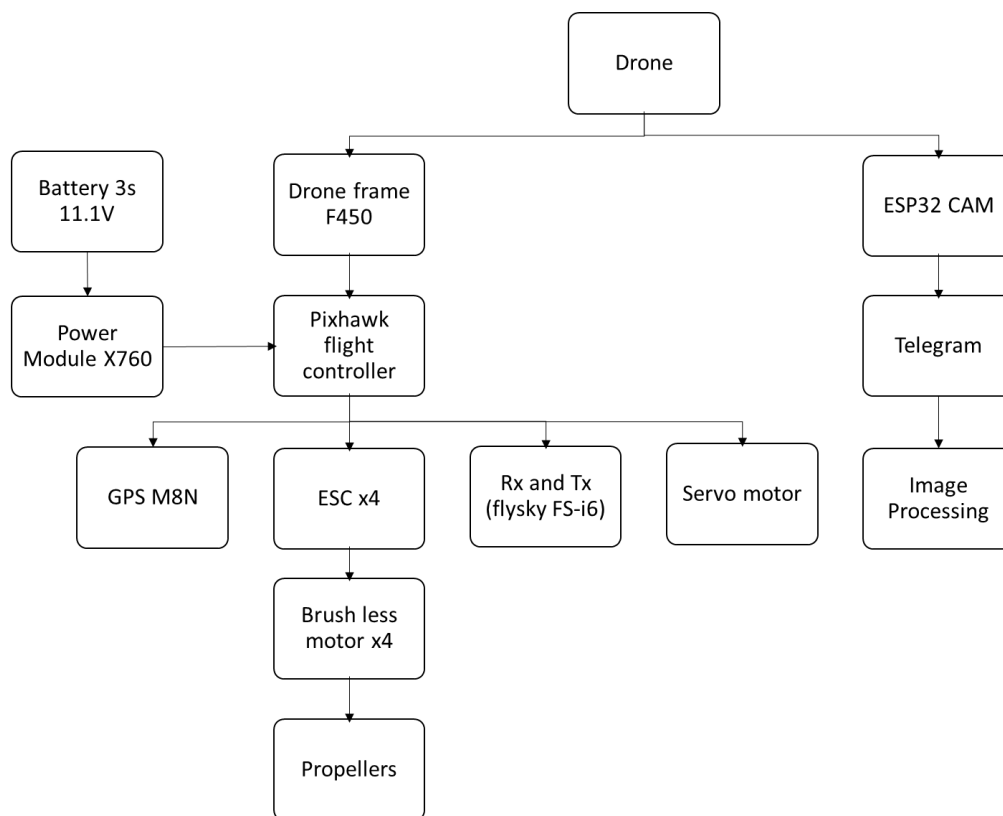


Fig 8.2.2.-Drone Module architecture

8.3. Experimental Setup

All the sensors are interfaced together with their respective boards and can now work automatically without the presence of the user. Using a computer or a mobile phone, the user can remotely control the device they are using. The outputs of the sensors can be seen in Blynk app as well as in ThingSpeak.

The farm condition is updated to the user via IFTTT notifications. The crop health is checked through the drone. The prototype images of the main module and drone are shown in the figures.

The DS18B20 temperature sensor is a digital sensor which can show analog outputs according to the requirement of the user. This sensor can measure the temperature ranging from -55°C to 125°C and the output is displayed in both Celsius as well as Fahrenheit. The output of temperature sensor is shown in Fig.8.3.1.

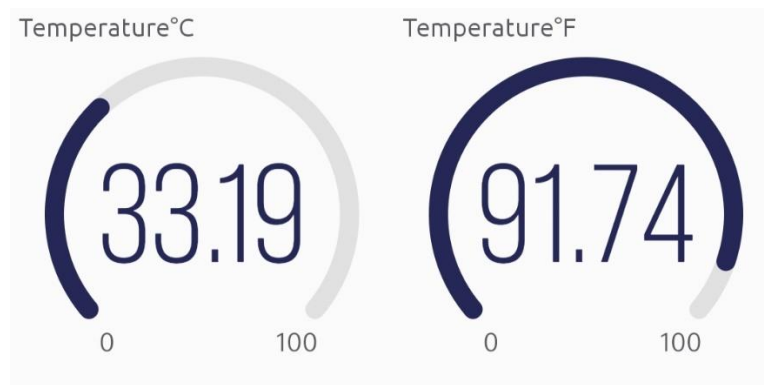


Fig.8.3.1.-DS18B20 temperature sensor output

The Moisture sensor is an analog sensor which measures the moisture value using capacitance to measure dielectric permittivity of the surrounding medium. It ranges from 0 to 100 percentage of the moisture level. The output of moisture sensor is shown in Fig.8.3.2.

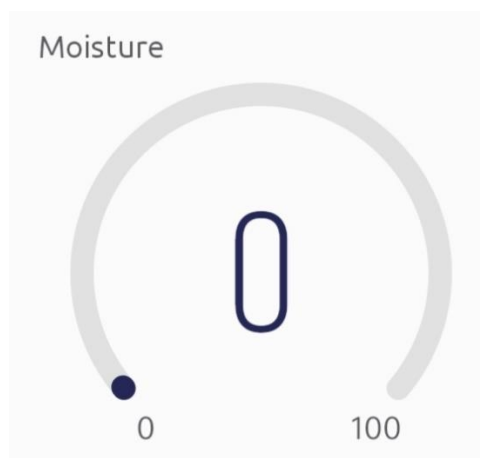


Fig.8.3.2.-Moisture sensor output

The pH sensor is also an analog sensor which ranges from pH values 0 to 14. The output of pH sensor is shown in Fig.8.3.3.

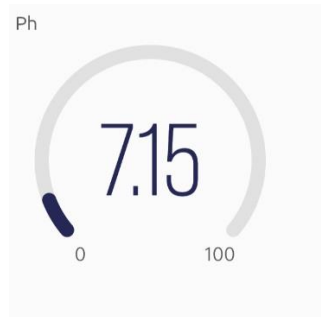


Fig.8.3.3.-pH sensor output

The rain sensor can work as both digital as well as analog sensor. However, in this device we only consider digital values for the detection of storms. Since we consider only digital values from this sensor, it ranges from 0 to 1, where 0 means no rainfall and 1 means heavy storms. The output of the rain sensor is shown in Fig.8.3.4.

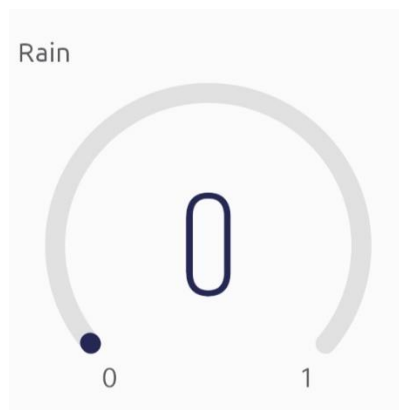


Fig.8.3.4.-Rain sensor output

All digital sensors are initially set to low, or "0," while all analogue sensors are also set to zero. The sensor values are as follows when the system is "ON":

- i. The temperature sensor displays the outside temperature in both degrees Fahrenheit and Celsius.
- ii. Because the earth has no water, the moisture sensor output is "0."
- iii. The rain sensor indicates "0" as there is no rainfall near the farm.
- iv. The PIR sensor indicates "0" since there is no motion in the field.

- v. The pH sensor indicates “0” as there is no solution given to it for checking the pH content.

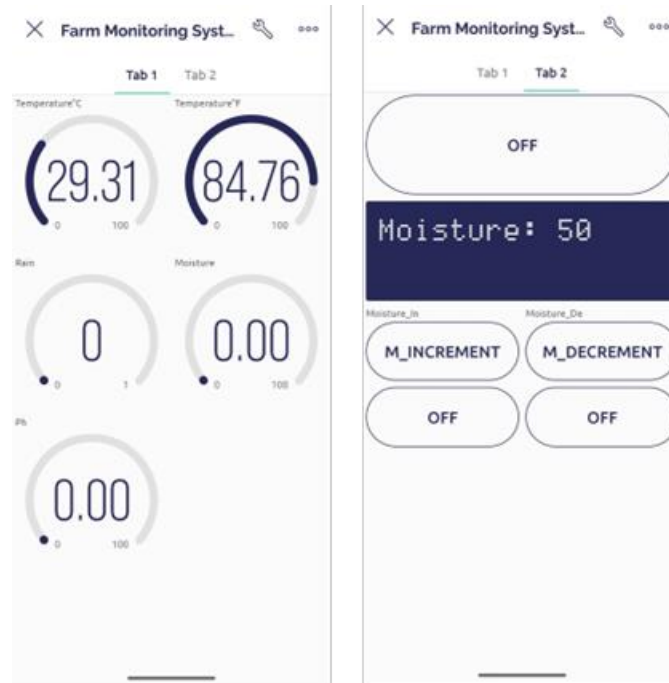


Fig 8.3.5.-Blynk outputs

CHAPTER 9

RESULTS, CONCLUSION & FUTURE SCOPE

RESULTS

Both the Blynk app and Thing Speak can display the outputs from ESP8266 boards.

The following are the sensor outputs in the Blynk app:

- i. The moisture sensor value indicates “66” since there is water in the soil.
- ii. The temperature sensor shows the surrounding temperature in both Celsius as well as Fahrenheit.
- iii. The rain sensor indicates “0” as there is no rainfall near the farm.
- iv. The PIR sensor indicates “0” since there is no motion in the field.
- v. The pH sensor indicates “9.17” as the solution given to it is Basic.

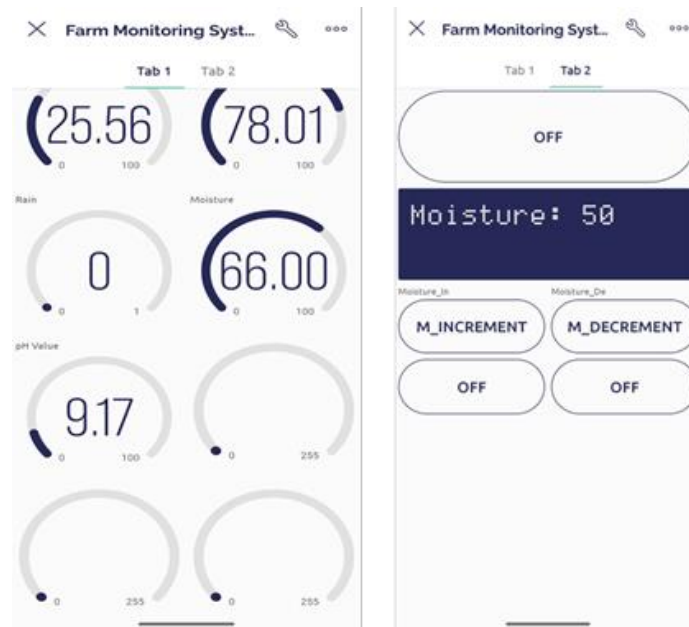


Fig 9.1.1.-Blynk outputs

The IFTTT notifications are sent to the user mobile phone for various sensors as follows:

This app is linked with the Thing Speak application to trigger messages and voice notes to the user's mobile phone. For minor issues like dry soil, the user is informed through messages. In case of animal intrusion or storms, voice notes are triggered to alert the user.

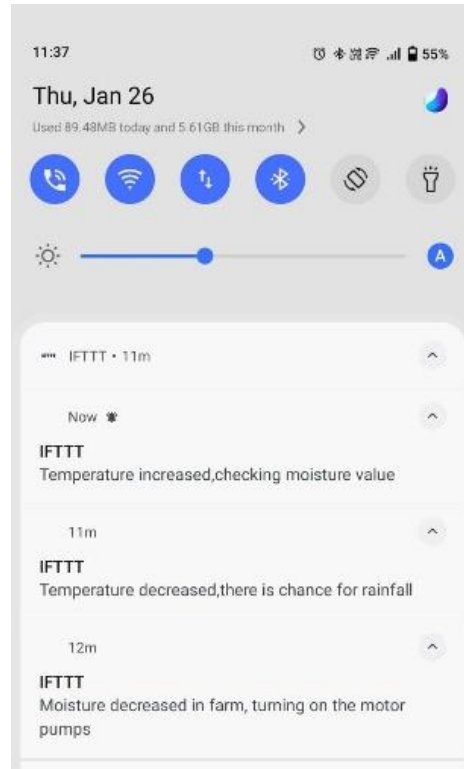


Fig 9.1.2.-IFTTT outputs

The outputs in ThingSpeak are as follows:

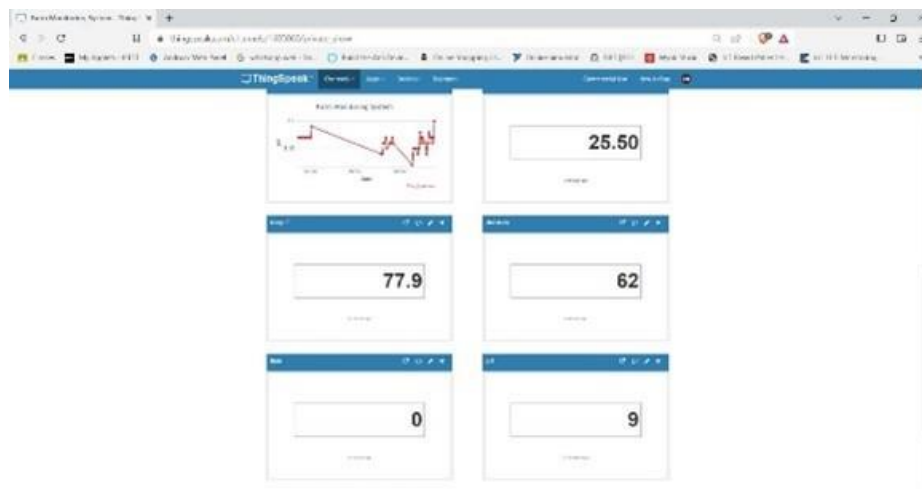


Fig 9.1.3.-ThingSpeak outputs

It displays the data from each sensor and sets off events to deliver notifications to the user whenever the latest information becomes relevant because of numerous sensors working in the system.

For the farm's protection, every sensor provides reliable results. By uploading a leaf image to the website designed for image processing, the crop's health can be evaluated. The image captured through the drone is sent through Telegram and then it is further processed by uploading the image into the website provided to the user.

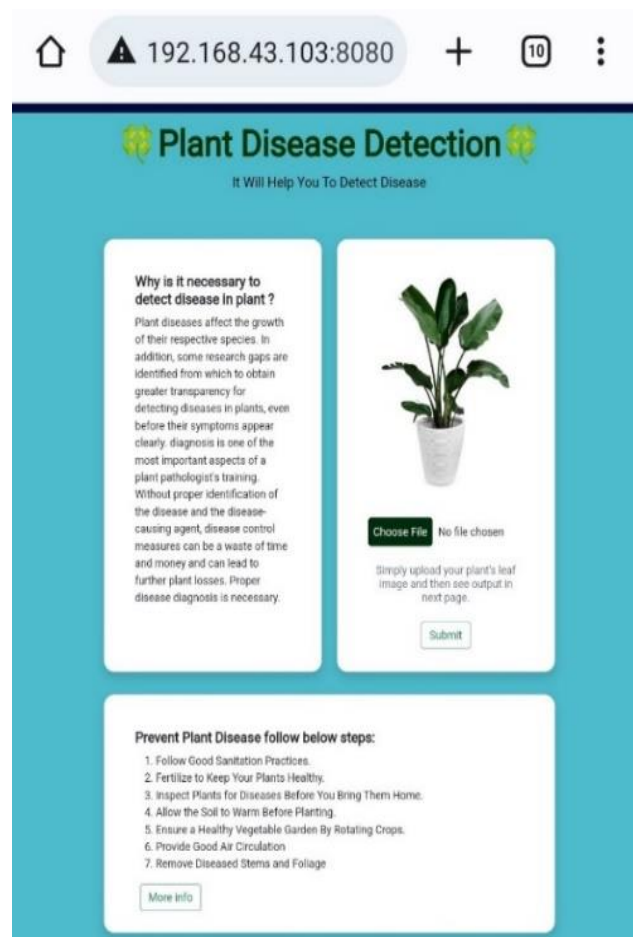


Fig 9.1.4.-Image Processing Homepage

The processed image outputs are as follows:

- i. The output identifies the disease from which the crop is infected.
- ii. The webpage contains a brief overview of the disease.

- iii. Specific recommendations for the treatments to be used are provided.
- iv. Vendor links for the necessary supplements are also provided.



Fig 9.1.5.-Image Processing output

CONCLUSION

Our Farm Monitoring System saves time and resources vs doing it manually. Smart agriculture using IoT will change the way agriculture is done by increasing output, improving quality, and possibly even saving farmer lives. Technology that makes farming more efficient and stress-free is desperately needed.

Since that India's economy is entirely agro-centric, recent technology advancements have made it imperative to raise the yield of our country's annual crop production. By implementing such technologies, the nation's agriculture industry hopes to greatly boost crop production while preserving natural resources.

These tools allow farmers to manage irrigation, temperature, and humidity while monitoring the health of the farm and crop development. Farmers will have less trouble interacting with sensors for agricultural metrics and microcontrollers thanks to the Internet of Things, wireless sensor networks connectivity, and improved communication pathways for the transfer of meaningful data between different nodes.

As a result, farmers may use their cell phones or computers to control various farm equipment and monitor their crop. Users of these devices have access to a wide range of apps that can help them develop their skills and crop output.

The micro-controllers in this project's sensors have been connected successfully, and the drone can now take pictures in the field. This enables task automation from a distance.

The initiative offers a practical response to the challenges of irrigation and field work by remote control drone and smart irrigation system, according to all observational and experimental data. Such a system's application in actual environments may boost crop yields, increase output overall, and cut costs.

FUTURE SCOPE

Popularity is growing for smart farming. In the agricultural industry, the concept of "Smart Agriculture" is swiftly gaining traction. Unquestionably, a networked farm offers a variety of advantages, such as high-precision crop control, useful data collection, and automated farming methods.

IoT technology aid farmers and producers in minimising waste and maximising yield. Prediction analytics for smart farming, smart greenhouses, animals tracking and geofencing, agricultural drones, and smart agriculture sensors are used to collect the data.

According to ABI Intelligence data, the number of IoT devices in use in the farming sector is expected to reach 75 million by 2020 and rise at an average rate of 20% each year.

In addition, it is expected that by 2025, the global market for smart agriculture would have tripled in size, reaching \$15.3 billion. With effective, data-driven, and incredibly precise farming techniques, it is safe to say that this type of farming will be considered smart in the future. We might assume that the Internet of Things will permanently change how we produce food.

FUTURE UPGRADES

1. Instead of using GPS, use GNSS to hold position and travel in an accurate path.
2. Use Pixhawk cube for stability in the drone control.
3. Upgrade the Image processing module from ESP32 CAM to Raspberry Pi4 for system compatibility and single system processing.
4. Develop a Smart Warehouse to store the harvested crop.

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CERTIFICATES RECEIVED

