

# **AN IOT APPROACH FOR CROP HEALTH AND GROWTH MONITORING**

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

**BACHELOR OF TECHNOLOGY  
IN  
ELECTRONICS AND COMMUNICATION ENGINEERING**

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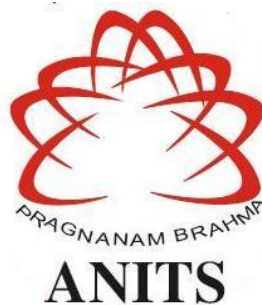
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*(Permanently Affiliated to AU, Approved by AICTE and Accredited by NBA & NAAC with 'A' Grade)*

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

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**CERTIFICATE**

This is to certify that the project report entitled "AN IOT APPROACH FOR CROP HEALTH AND GROWTH MONITORING", submitted by V.Sravani(318126512115), Y.Jaya Charitha (318126512119), S.Sai Rahul (318126512103), M.Narayana Swamy (318126512092), M.P.M Sai Kiran(318126512087) in partial fulfillment of the requirements 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

Mankind is consuming the planet's resources beyond what the Earth is providing, according to the reports, by 2050 the world population would be 9.2 billion and there food consumption yearly would be almost twice of the Earth's resources. As of today, this ultra-modern technology IOT can assist in acquiring timely, accurate crop information and production essential for the success of precision agriculture technology. The better approach is to implement non-invasive technology at a low cost to monitor crop growth and health, helping small to medium farmers to increase their productivity. Hence, in this project we would like to implement IOT techniques with medium cost sensors to deliver real time, affordable and precise data processing for agriculture producing an **Smart and Automated Decision-Making and Alerting Systems (SADMAS)**. A detailed analysis of plant parameters, sensors and their compatibility using SADMAS based on IOT systems will be verified. Therefore, basic IOT system techniques are going to be implemented for growing a crop with good health and at a feasible cost to the farmers

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# CHAPTER 1

## INTRODUCTION

### 1.1 Agriculture

Agriculture is the key of development in the rise of human civilization, whereby farming of domesticated species created food surpluses that enabled people to live . In addition to providing food and raw material, agriculture also provides employment opportunities to a very large percentage of the population. The history of agriculture dates back thousands of years ago. Wild grains were collected and eaten from 105,000 years ago, rice was domesticated in China between 13,500 & 8,200 years ago and pigs were domesticated in Mesopotamia around 15,000 years ago.

Mainly, our country is facing several issues in growing crops. As our country has diverse regions there are several issues in our cropping system. Good quality seeds are out of reach of the majority of farmers, especially small and marginal farmers mainly because of exorbitant prices of better seeds. Indian soils have been used for growing crops over thousands of years without caring much for replenishing. This has led to depletion and exhaustion of soils resulting in their low productivity. The average yields of almost all the crops are among the lowest in the world. This is a serious problem which can be solved by using more manures and fertilizers.

Although India is the second largest irrigated country of the world after China, only one-third of the cropped area is under irrigation. Irrigation is the most important agricultural input in a tropical monsoon country like India where rainfall is uncertain, unreliable and erratic India cannot achieve sustained progress in agriculture unless and until more than half of the cropped area is brought under assured irrigation.

Agricultural marketing still continues to be in a bad shape in rural India. In the absence of sound marketing facilities, the farmers have to depend upon local traders and middlemen for the disposal of their farm produce which is sold at throw-away price.

Agriculture is an important industry and like all other industries it also requires capital. The role of capital input is becoming more and more important with the advancement of farm

technology. Since the agriculturists' capital is locked up in his lands and stocks, he is obliged to borrow money for stimulating the tempo of agricultural production.

Due to these several difficulties in our agricultural system there are several people in our country, dying due to lack of nutritious food.

## **1.2 Food crisis**

Famine is many times discussed in terms of area, duration, number of people affected, the scarcity and cost of food, and death rate. But many times the reality of famines are overlooked, it comes down to that tons of miserable people suffering from starvation are physically and emotionally damaged. The fact is that in a famine people do not just all of a sudden lay down and die, it is a horrible often prolonged death that these people are put through.

The main effect of lack of food is malnutrition, Despite India's 50% increase in GDP since 2013, more than one third of the world's malnourished children live in India. Among these, half of the children under three years old are underweight.

One of the major causes for malnutrition in India is economic inequality. Due to the low economic status of some parts of the population, their diet often lacks in both quality and quantity. Women who suffer from malnutrition are less likely to have unhealthy babies. Nutrition deficiencies inflict long-term damage to both individuals and society. Compared with their better-fed peers, nutrition-deficient individuals are more likely to have infectious diseases such as pneumonia and tuberculosis, which lead to a higher mortality rate. Besides, nutrition-deficient individuals are less productive at work. Low productivity not only gives them low pay that traps them in a vicious circle of under-nutrition, but also brings inefficiency to the society, especially in India where labor is a major input factor for economic production. On the other hand, over-nutrition also has severe consequences. In India national obesity rates in 2010 were 14% for women and 18% for men with some urban areas having rates as high as 40%. Obesity causes several non-communicable diseases such as cardiovascular diseases, diabetes, cancers and chronic respiratory diseases.

One obvious result of starvation is weight loss. The body reacts differently to different levels of weight loss. Humans can relatively safely handle up to a ten percent weight loss, physical energy and fitness are not impaired at this point but a strong sense of hunger is felt. Beyond this point the body weakens and begins to adapt itself in various ways. This stage is usually marked by decrease in activity and the sufferer begins to rest considerably longer. The body will start to get rid of more weight so that less energy is needed to maintain vital processes and to move the lighter body. Once 15 to 20 percent of normal body weight is lost the victim will move into a state of semi-starvation and is no longer capable of much. In this state, besides the physical signs of weight loss and weakness, depression and apathy will also set in.

If a lack of food continues a persons pulse rate will slow, blood pressure will fall, and the heart muscle atrophies. The last organ to loose any weight is the brain. Speech usually remains clear but it may be slowed dramatically. One thing that does not change and has been reported to become more acute is hearing. This increase in acuteness is probably due to an increased sensitivity to noise and general irritability. While the brain continues to function, serious psychological effects take place. The main effect has been called “the persistent clamour for hunger” basically it is the obsession with things to eat. In this late stage of hunger the victim will sleep for long hours and wake up and concentrate only on his growing weakness and ways to get food. Normally honest people are willing to do anything to get food. Along with a willingness to break their normal morals people also become indifferent about the welfare of others, cases have been reported where mothers have snatched food from their starving babies and fathers have fought over scraps of food with their sons.

Famine affects people of all ages but it is the elderly and young whom suffer the most during a famine. Old people tend to be helpless during famine because they cannot look for or fight for food and no one is willing to help them. Their bodies do not allow them to take in unfamiliar foods and they are more inclined then those younger then them to give up on life. Children, especially those under five, have specific needs for protein. Many times children are given food but it is not high enough in protein so they suffer anyways.

## **1.3 Smart Agriculture**

Smart farming is a management concept focused on providing the agricultural industry with the infrastructure to leverage advanced technology – including big data, the cloud and the internet of things (IoT) – for tracking, monitoring, automating and analyzing operations. Also known as precision agriculture, smart farming is software-managed and sensor-monitored. Smart farming is growing in importance due to the combination of the expanding global population, the increasing demand for higher crop yield, the need to use natural resources efficiently, the rising use and sophistication of information and communication technology and the increasing need for climate-smart agriculture.

### **1.3.1 Potential of smart agricultural**

The introduction of information and communications technology (ICT) into agriculture is widely recognized as a means of increasing its productivity, lowering its costs and reducing its environmental impact.

### **1.3.2 Future scope of Smart Agriculture**

BI Intelligence survey expects that the adoption of IoT devices in the agriculture industry will reach 75 million in 2020, growing 20% annually. At the same time, the global smart agriculture market size is expected to triple by 2025, reaching \$15.3 billion (compared to being slightly over \$5 billion back in 2016) But, even at the current population level, the agriculture already faces a number of challenges like

Deteriorated quality of the soil, Climate changes, Increased consumption of natural resources, Carbon footprint, Decrease in biological diversity, Precision farming, Smart, precision irrigation e.t.c.,

## **1.4 Smart farming technologies**

The intelligent farm includes the use of technology such as:

Sensors for soil scanning and water, light, humidity and temperature management.

Telecommunications technologies such as advanced networking and GPS.

Hardware and software for specialized applications and for enabling IoT-based solutions, robotics and automation.

## **Technologies used in smart agriculture**

The technologies driving the 'smart farming revolution' include the Internet of Things (IoT), edge computing, 5G, block chain, AI, machine learning, robotics and drones.

Data analytics tools for decision making and prediction. Data collection is a significant part of smart farming as the quantity of data available from crop yields, soil-mapping, climate change, fertilizer applications, weather data, machinery and animal health continues to escalate.

Satellites and drones for gathering data around the clock for an entire field. This information is forwarded to IT systems for tracking and analysis to give an “eye in the field” or “eye in the barn” that makes remote monitoring possible.

The combination of these technologies facilitates machine-to-machine (M2M) derived data. This data feeds into a decision support system so that farmers can see what is happening at a more granular level than in the past. For example, by precisely measuring variations within a field and adapting the strategy accordingly, farmers can greatly increase the effectiveness of pesticides and fertilizers and use them more judiciously. Similarly, smart farming techniques, help farmers better monitor the needs of individual animals and adjust their nutrition to prevent disease and enhance herd health.

By making farming more connected and intelligent, precision agriculture helps reduce overall costs and improve the quality and quantity of products, the sustainability of agriculture and the experience for the consumer. Increasing control over production leads to better cost management and waste reduction.

The ability to trace anomalies in crop growth or livestock health, for instance, helps eliminate the risk of losing yields. Additionally, automation boosts efficiency. With smart devices, multiple processes can be activated at the same time, and automated services enhance product quality and volume by better controlling production processes.

Smart farming systems also enable careful management of the demand forecast and delivery of goods to market just in time to reduce waste. Precision agriculture is focused on managing the supply of land and, based on its condition, concentrating on the right growing parameters

– for example, moisture, fertilizer or material content – to provide production for the right crop that is in demand. The types of precision farming systems implemented depend on the use of software for the management of the business. Control systems manage sensor input, delivering remote information for supply and decision support, in addition to the automation of machines and equipment for responding to emerging issues and production support.

### **1.4.1 Smart farming the future of agriculture**

Smart farming and IoT-driven agriculture are laying the groundwork for a “third green revolution,” which refers to the combined application of information and communications technologies. This includes devices such as precision equipment, IoT sensors and actuators, geo-positioning systems, unmanned aerial vehicles (UAVs) and robots.

IoT technology helps better control agricultural processes to reduce production risks and enhances the ability to foresee production results, which helps farmers better plan and distribute product. Data about exact batches of crops and the quantity of crops to harvest can help farmers cut down on labor and waste, for example.

Additionally, in a number of sectors, including agriculture, service providers and mobile operators are modernizing their network infrastructure, bringing network resources to the edge and integrating far distances through technologies such as small cells and massive MIMO to get ready for the 5G roll-out.

As of today, this ultra-modern technology IOT can assist in acquiring timely, accurate crop information and production essential for the success of precision agriculture technology. The better approach is to implement non-invasive technology at a low cost to monitor crop growth and health, helping small to medium farmers to increase their productivity. Hence, in this project we would like to implement IOT techniques with medium cost sensors to deliver real time, affordable and precise data processing for agriculture producing an Smart and Automated Decision-Making and Alerting Systems (SADMAS).

In our project we are working on smart agriculture where we are using IOT and sensors like DHT 11 sensor, IR sensor and soil sensor and the parameters that we are using are soil moisture,



soil temperature humidity .A motor which is used to on off the LED lights and pump ,thereby we get the results of the soil temperature, soil moisture and humidity by these parameters we can find the disease that may occur in beforehand and remedies can be also shown in blynk.

# CHAPTER-2

## DISEASES

### 2.1 Diseases in plants:

Most plant diseases – around 85 percent – are caused by fungal or fungal-like organisms. However, other serious diseases of food and feed crops are caused by viral and bacterial organisms. Certain nematodes also cause plant disease. Some plant diseases are classified as “abiotic,” or diseases that are non-infectious and include damage from air pollution, nutritional deficiencies or toxicities, and grow under less than optimal conditions. For now, we’ll look at diseases caused by the three main pathogenic microbes: fungus, bacteria and virus. If plant disease is suspected, careful attention to plant appearance can give a good clue regarding the type of pathogen involved.

A sign of plant disease is physical evidence of the pathogen. For example, fungal fruiting bodies are a sign of disease. When you look at powdery mildew on a lilac leaf, you’re actually looking at the parasitic fungal disease organism itself (*Microsphaera alni*). Bacterial canker of stone fruits causes gummosis, a bacterial exudate emerging from the cankers. The thick, liquid exudate is primarily composed of bacteria and is a sign of the disease, although the canker itself is composed of plant tissue and is a symptom.

A symptom of plant disease is a visible effect of disease on the plant. Symptoms may include a detectable change in color, shape or function of the plant as it responds to the pathogen. Leaf wilting is a typical symptom of verticillium wilt, caused by the fungal plant pathogens *Verticillium albo-atrum* and *V.dahliae*. Common bacterial blight symptoms include brown, necrotic lesions surrounded by a bright yellow halo at the leaf margin or interior of the leaf on bean plants. You are not actually seeing the disease pathogen, but rather a symptom that is being caused by the pathogen.

## 2.2 Types Of Diseases

Traditionally, there are several types of crop disease: abiotic (also known as non-infectious) and biotic (infectious). Unfavourable environmental conditions often generate non-communicable diseases. Examples are low or high temperature, excess, or lack of moisture. Also, diseases are usually caused by harmful impurities in the air.

### 2.2.1 Crop Diseases Caused By Bacteria

Among the most common infections in agriculture are crop diseases caused by bacteria. In this regard, the prevention and control of this kind of disease are pretty tricky. To infect the causal agent needs to get into the culture's tissue. It occurs mainly through damaged areas, such as caused by agricultural tools, insects (fleas), or simply unfavourable weather conditions (dust, wind, heavy rain). But bacteria can also infect plants through natural holes or glands (for example, which secrete nectar).

Another feature of bacterial crop diseases is that causal agents, once in a plant or soil, can remain dormant for a long time until favourable conditions arise for them. First of all, significant temperature fluctuations and high levels of humidity act as catalysts for bacterial activity



**Fig 2.2.1.1 -Bacterial disease for plant**

## **Symptoms Of Bacterial Crop Diseases**

The main bacterial disease indications include vascular wilting, necrosis, soft rot and tumour. Although this type of plant disease can be identified due to its pronounced symptoms, identifying a specific causal agent requires laboratory methods.

## **Common Bacterial Diseases**

As noted earlier, due to a huge number of bacteria, there are many disease types. Here are some examples of the most common diseases of crop plants:

- Granville wilt exposes itself in growth retardation, wilting of the high culture's part, and the death of the roots
- Fire blight symptoms include necrotic weeping ulcers, wilting and rolling of leaves.
- Wildfire of tobacco is widespread in the world and shows itself as yellowish-green spots on leaves.

## **Control Measures**

It is complicated to control bacterial diseases of crop plants for several reasons: high spreading rate and protection from exposure to chemicals due to being inside the plants. Preventive measures may include using pathogen-free seeds produced in drought-prone regions, hot water for seed treatment, soil solarisation, control of plant diseases with germicidal compounds of seeds.

Also, crop diseases can be prevented by spraying. Of course, sanitary measures are imperative, which include weed control, sterilization of tools, proper waste disposal, and avoidance of cultivation under conditions when leaves are wet.

### **2.2.2 Crop Diseases Caused By Fungi**

Pathogenic fungi are the most typical agricultural problem. According to research, this plant disease type destroys about a third of all food crops every year. In this regard, this problem is severe both from a humanitarian and economic point of view. Like bacterial crop diseases,

these infections affect plants mainly through wounds, stomata, and water pores. Also, fungal spores are often carried by gusts of wind.

### **Symptoms Of Fungal Crop Diseases**

Often, a fungal infection is expressed in local or general necrosis. Also, crop diseases caused by fungi can interfere with the average growth or contribute to its abnormal burst, called hypertrophy. Other crop diseases symptoms include:

- spots on leaves;
- exfoliation;
- rot;
- anthracnose;
- ulcers;
- curls of leaves and warts.



**Fig2.2.2.1-Fungal disease for strawberries**

### **Common Fungal Diseases**

The list of crop diseases caused by fungi is pervasive, so that we will limit ourselves to just a list of some of the most common examples of crop plant diseases:

- Late blight of potato is expressed by dark green, purple or black lesions with white mould around the edges. Black stem rust of wheat is a dangerous disease that mainly affects cereals. It is expressed in the appearance of rust-coloured sori on a plant.

- Symptoms of Coffee rust are powdery yellow-orange spots with a brown center on the lower part of leaves.

## **Control Measures**

Preventive measures to check crop plant diseases caused by fungi are pretty varied. Key management actions include destroying plant matter containing dangerous fungi, using healthy seeds, regular crop rotation, chemical, and biological fungicides.

### **2.2.3 Crop Diseases Caused By Nematodes**

Nematodes are parasitizing plants roundworms, which usually cannot be seen without special equipment. They live in the soil, and therefore mainly affect roots, tubers, and bulbs. There are over 4100 dangerous nematode species.

#### **Symptoms Of Nematode Crop Diseases**

Essentially, nematodes feed by sucking juices from plants. Because of this, plants affected by these parasites often appear dried out, as if they are suffering from drought. Other symptoms are also similar:

- yellowing;
- growth retardation;
- lack of response to fertilizers and water;
- the gradual general decline of a plant;
- reduction or even destruction of root systems.



Fig 2.2.3.1-Nematode disease for carrots



Fig 2.2.3.2-Nematode disease for rice

## Common Nematode Diseases

Diseases directly depend on the type of nematodes:

- Fusiform thickening of the stems is provoked by stem worms. The disease is expressed in the deformation of leaves, swelling of petioles, and the appearance of dark spots on tubers.
- Aphelenchoides, a disease of rice, is provoked by *Aphelenchoides besseyi*. Disease marks are blemishes on the tops of leaves, lack of grains, and culture depletion.
- The corresponding nematode *Tylenchulus semipenetrans* cause serious citrus diseases. It is characterized by the gradual death of not only leaves but also branches.

## Control Measures

Parasite control involves a wide range of activities. In particular, crop rotation, improving crop disease resistance, and soil treatment with appropriate fumigants with nematicides are effective measures. You can also destroy nematodes and their eggs with hot water (about 50°C/120°F). However, this method of controlling crop diseases requires accuracy. You should adjust the watering time according to the temperature to not harm the plants themselves. Measures that promote plant growth are practical against individual nematodes: heavy mulch, fertigation, watering in drought, and summer and autumn fallow.

## 2.2.4 Crop Diseases Caused By Virus

The most minor but most critical plant enemies are viruses and viroids (subviral contagious agents). After infection, it is almost impossible to save a plant. Therefore the effect of plant diseases on crop production is of critical importance throughout the world. In most cases, the

infection spreads as a result of healthy plants with sick contact. Viruses can also spread through vegetative reproduction, through seeds, pollen, and insects. But viruses most often spread through the soil.

## Symptoms Of Viral Crop Diseases

The symptoms of crop diseases caused by virus are usually divided into four types:

- malformations, such as abnormal growth of shoots, distortion of leaves and flowers;
- necrosis, wilting and the appearance of annular stripes and spots;
- dwarfism, growth retardation of both individual parts and the whole plant;
- discolouration, e.g. yellowing, and vein clearing.

## Common Viral Diseases

Among the common examples of viral diseases in crop plants:

- Tobacco mosaic manifests in dwarfism and mosaic-like patterns on leaves. The disease is widespread throughout the world and can have significant economic consequences.
- Tomato spotted wilt is accompanied by the appearance and growth of necrotic yellow rings that gradually turn reddish-brown.
- Potato spindle tuber inhibits plant growth, tubers become fusiform and shrink.



Fig 2.2.4.1-Virus for creeper



Fig 2.2.4.2- Virus for bitter guard



## **Control Of Crop Diseases Caused By Viruses**

Unlike previous infections, most vegetable crop disease caused by viruses is extremely difficult to defeat, often impossible. Therefore, control, in this case, should be as effective as possible. Among the most common measures is the cultivation of resistant crops, indexing, determining the absence or virus presence that is not mechanically transmitted. The plant under study is grafted onto an indicator plant, which develops corresponding symptoms in the virus presence. Unfortunately, sometimes it is necessary to destroy infected cultures, and if large agricultural areas are affected, even to introduce quarantine to save the rest of the crop yield.

# CHAPTER 3

## IOT TECHNOLOGY & ARDUINO UNO

### 3.1 IOT

#### 3.1.1 Concept and Definition

The Internet of Things (IoT) is a term used to describe a network. The Internet of Things (IOT) is made up of two words: internet and things. Things in the IoT refer to a variety of IoT devices with distinct identities and the ability to perform remote sensing, actuation, and live monitoring of specific types of data. IoT devices can also share data in real time with other connected devices and applications, either directly or indirectly, or collect data from other devices, process it, and send it to different servers. The alternative word for the internet is a global communication network that connects trillions of computers around the world to enable information sharing. As a result, the IOT can be defined as "A dynamic Global Network Infrastructure with self-configuring capabilities based on standard and interoperable communication protocols, where physical and virtual things have identities, physical attributes, and virtual personalities, use intelligent interfaces, and are seamlessly integrated into the information network, and frequently communicate data associated with users and their environment."

When something is connected to the internet, that means that it can send information or receive information, or both. This ability to send and/or receive information makes things "smart." Let's use smartphones again as an example. Right now you can listen to just about any song in the world, but it's not because your phone actually has every song in the world stored on it. It's because every song in the world is stored somewhere else, but your phone can send information and then receive information.

To be smart, a thing doesn't need to have super storage or a super computer inside of it - it just needs access to it. All a thing has to do is connect to super storage or to a super computer. In the Internet of Things, all the things that are being connected to the internet can be put into three categories:

Things that collect information and then send it. Things that receive information and then act on it. Things that do both. And all three of these have enormous benefits that compound on

each other. Things that collect information and then send it. Things that receive information and then act on it. Things that do both.

And all three of these have enormous benefits that compound on each other.

### 1. Collecting and Sending Information

Sensors could be temperature sensors, motion sensors, moisture sensors, air quality sensors, light sensors, you name it. These sensors, along with a connection, allow us to automatically collect information from the environment which, in turn, allows us to make more intelligent decisions.

### 2. Receiving and Acting on Information

We're all very familiar with machines getting information and then acting. Your printer receives a document and it prints it. Your car receives a signal from your car keys and the doors open. The examples are endless.

### 3. Doing Both:

The Goal of an IoT System Let's quickly go back to the farming example. The sensors can collect information about the soil moisture to tell the farmer how much to water the crops, but you don't actually need the farmer. Instead, the irrigation system can automatically turn on as needed, based on how much moisture is in the soil.

An ideal Internet of Things device has multiple interfaces for connecting to other devices, which might be wired or wireless.

The following components are found in any IoT-based device:

- Sensors' I/O interface
- An Internet connection interface.
- Memory and Storage Interface
- Audio/Video interface.

Wearable sensors, smart watches, IoT smart home monitoring, IoT intelligent transportation systems, and IoT smart health devices are examples of IoT gadgets.

### 3.1.2 IOT Enabling Technologies

Internet of Things has a strong backbone of various enabling technologies Wireless Sensor Networks, Cloud Computing, Big Data, Embedded Systems, Security Protocols and Architectures, Protocols enabling communication, web services, Internet and Search Engines.

WSN (Wireless Sensor Network): It is made up of a number of sensors/nodes that are linked together to monitor various types of data.

Example –

- Indoor air quality monitoring system
- Soil moisture monitoring system
- Surveillance system
- Health monitoring system
- Weather monitoring system

Cloud computing, it is often known as on-demand computing, is a sort of Internet-based computing that allows computers and other devices to access shared processing resources and data on demand. It can take many different forms, such as IaaS, PaaS, SaaS, DaaS, and so on.

Characteristics –

- Broad network access
- On demand self-services
- Rapid scalability
- Measured service
- Pay-per-use

IaaS (Infrastructure as a service) Infrastructure as a service provides online services such as physical machines, virtual machines, servers, networking, storage and data center space on a pay per use basis. Major IaaS providers are Google Compute Engine, Amazon Web Services and Microsoft Azure etc. Ex : Web Hosting, Virtual Machine etc.

PaaS (Platform as a service) Provides a cloud-based environment with a very thing required to support the complete life cycle of building and delivering Web web based (cloud) applications – without the cost and complexity of buying and managing underlying hardware, software provisioning and hosting. Computing platforms such as hardware, operating systems and

libraries etc. Basically, it provides a platform to develop applications. Ex : App Cloud, Google app engine

SaaS (Software as a service) It is a way of delivering applications over the internet as a service. Instead of installing and maintaining software, you simply access it via the internet, freeing yourself from complex software and hardware management. SaaS Applications are sometimes called web-based software on demand software or hosted software. SaaS applications run on a SaaS provider's service and they manage security availability and performance. Ex : Google Docs, Gmail, office etc.

Big Data Analytics: Big data analytics is the process of examining large data sets containing various forms of data types i.e. Big Data – to uncover hidden patterns, unknown correlations, market trends, customer preferences and other useful business information.

Several steps involved in analyzing big data –

- Data cleaning
- Munging
- Processing
- Visualization

Examples –

- Bank transactions
- Data generated by IoT systems for location and tracking of vehicles
- E-commerce and in Big-Basket
- Health and fitness data generated by IoT system such as a fitness bands.

Communication Protocols: They form the backbone of IoT systems to enable connectivity and coupling to applications and these protocols facilitate exchange of data over the network as these protocols enable data exchange formats, data encoding and addressing.

Embedded Systems: It is a sort of computer system which consists of both hardware and software to perform specific tasks. It includes microprocessor/microcontroller, RAM/ROM,

APPLICATION NAME	DESCRIPTION
Crop Water Management	In order to perform agriculture activities in inefficient manner, adequate water is essential. Agriculture IoT is integrated with Web Map Service (WMS) and Sensor Observation Service (SOS) to ensure proper water management for irrigation and in turn reduces water wastage.
Precision Agriculture	High accuracy is required is required in terms of weather information which reduces the chances of crop damage. Agriculture IoT ensures timely delivery of real time data in terms of weather forecasting, quality of soil, cost of labour and much more to farmer.
Integrated Pest Management or Control	Agriculture IoT systems assures farmers with accurate environmental data via proper live data monitoring of temperature , moisture, plant growth and level of pests so that proper care can be taken during production.
Food production & safety	Agriculture IoT system accurately monitors various parameters like warehouse temperature, shipping transportation management system and also integrates cloud based recording systems.

networking components, I/O units and storage devices.

Examples –

- Digital camera
- DVD player, music player
- Industrial robots
- Wireless Routers etc.

### **3.1.3 IOT Application in Agriculture**

With the adoption of IoT in various areas like Industry, Homes and even Cities, huge potential is seen to make everything Intelligent and Smart. Even the Agricultural sector is also adopting IoT technology these days and this in turn has led to the development of “AGRICULTURAL Internet of Things (IoT)”

Table 2.1 Various projects and applications are integrated in Agricultural fields leading to efficient management and controlling of various activities.

### **3.1.4 Benefits of IOT in Agriculture**

The following are the benefits of IoT in Agriculture:

1. IoT enables easy collection and management of tons of data collected from sensors and with integration of cloud computing services like Agriculture fields maps, cloud storage etc., data can be accessed live from anywhere and everywhere enabling live monitoring and end to end connectivity among all the parties concerned.
2. IoT is regarded as key component for Smart Farming as with accurate sensors and smart equipment's, farmers can increase the food production by 70% till year 2050 as depicted by experts.
3. With IoT productions costs can be reduced to a remarkable level which will in turn increase profitability and sustainability.
4. With IoT, efficiency level would be increased in terms of usage of Soil, Water, Fertilizers, Pesticides etc.
5. With IoT, various factors would also lead to the protection of environment.
6. Data collection All data can be collected with the help of installed sensors. Such data like weather condition, health condition of cattle, crops, etc. Data is stored in one place, and farmers can easily check it and analyse to make the right decision.
7. Reduction of risks When farmers up-to-date information collected, they can understand what situation will be in the future, and they can predict some problems that may arise. Moreover, farmers may use data to improve their sales and change business processes.

8. Higher quality Smart agriculture makes it possible to avoid challenges and remove all issues that may arise during farming processes. So the quality of the product is growing and consumers get a good product of high quality.

## **3.2 Definition IOT Based Smart Farming System**

IOT based SMART FARMING SYSTEM is regarded as IoT gadget focusing on Live Monitoring of Environmental data in terms of Temperature, Moisture and other types depending on the sensors integrated with it. The system provides the concept of “Plug & Sense” in which farmers can directly implement smart farming by as such putting the System on the field and getting Live Data feeds on various devices like Smart Phones, Tablets etc. and the data generated via sensors can be easily shared and viewed by a

agriculture consultants anywhere remotely via Cloud Computing technology integration. The system also enables analysis of various sorts of data via Big Data Analytics from time to time.

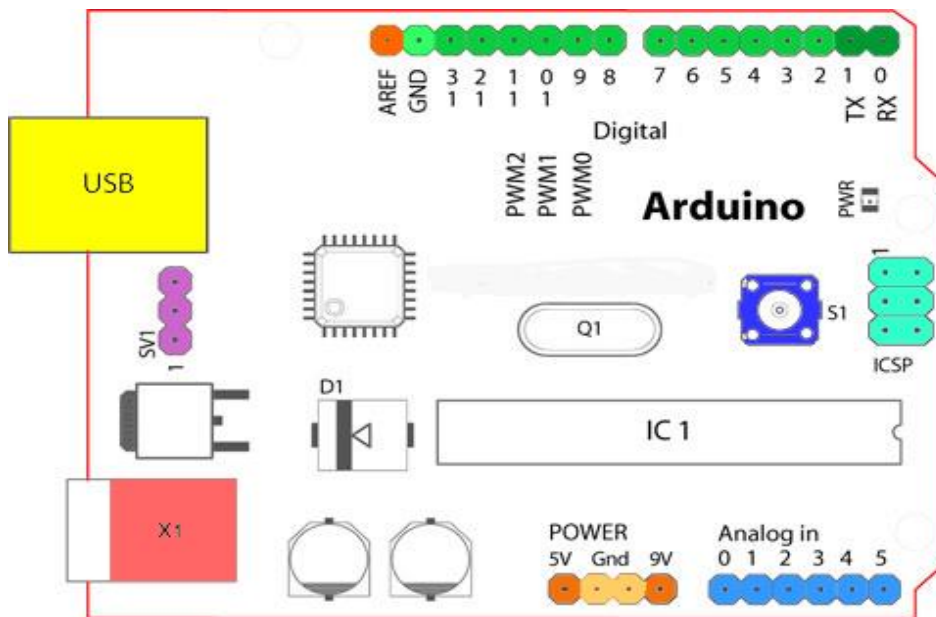
## **3.3 ARDUINO UNO**

Arduino comprises of both a physical programmable circuit board (commonly known as a microcontroller) and a programming software, or IDE (Integrated Development Environment) that can be run on a PC, used to compose and transfer PC code to the circuit board. It can be done by using the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. Unlike other programmable circuit boards, the Arduino does not require a different equipment (called a software engineer) to upload code to the circuit board, one can essentially utilize a USB link. Also, the Arduino IDE utilizes a rearranged rendition of C++, making it simpler to figure out how to program. In a word, Arduino make the functions of the micro-controller into a more accessible package. The Uno is one of the more prevalent boards in the Arduino family and an extraordinary option for the beginners.

### **3.3.1 Common Components of Arduino Boards**

There are different types of Arduino boards for different purposes. But all the boards have the majority of following components in common.





**Fig 3.3.1.1 Common Components of Arduino Boards**

Starting clockwise from the top center :

- Analog Reference pin (orange)
- Digital Ground (light green)
- Digital Pins 2-13 (green)
- Digital Pins 0-1/Serial In/Out - TX/RX (dark green) - These pins cannot be used for digital i/o (digital Read and digital Write) if you are also using serial communication (e.g. Serial begin).
- Reset Button - S1 (dark blue)
- In-circuit Serial Programmer (blue-green)
- Analog In Pins 0-5 (light blue)
- Power and Ground Pins (power: orange, grounds: light orange)
- External Power Supply In (9-12VDC) - X1 (pink)
- Toggles External Power and USB Power (place jumper on two pins closest to desired supply) - SV1 (purple)
- USB (used for uploading sketches to the board and for serial communication between the board and the computer; can be used to power the board) (yellow)

## Digital pins:

In addition to the specific functions listed below, the digital pins on an Arduino board can be used for general purpose input and output via the `pinMode()`, `digitalRead()`, and `digitalWrite()` commands. Each pin has an internal pull-up resistor which can be turned on and off using `digitalWrite()` (w/ a value of `HIGH` or `LOW`, respectively) when the pin is configured as an input. The maximum current per pin is 40 mA.

- **Serial:** 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. On the Arduino Diecimila, these pins are connected to the corresponding pins of the FTDI USB-to-TTL Serial chip. On the Arduino BT, they are connected to the corresponding pins of the WT11 Bluetooth® module. On the Arduino Mini and LilyPad Arduino, they are intended for use with an external TTL serial module (e.g. the Mini-USB Adapter).
- **External Interrupts:** 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the `attachInterrupt()` function for details.
- **PWM:** 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the `analogWrite()` function. On boards with an ATmega8, PWM output is available only on pins 9, 10, and 11.
- **BT Reset:** 7. (Arduino BT-only) Connected to the reset line of the Bluetooth® module.
- **SPI:** 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.
- **LED:** 13. On the Diecimila and LilyPad, there is a built-in LED connected to digital pin 13. When the pin is `HIGH` value, the LED is on, when the pin is `LOW`, it's off.

## Analog pins:

In addition to the specific functions listed below, the analog input pins support 10-bit analog-to-digital conversion (ADC) using the `analogRead()` function. Most of the analog inputs can also be used as digital pins: analog input 0 as digital pin 14 through analog input 5 as digital pin 19. Analog inputs 6 and 7 (present on the Mini and BT) cannot be used as digital pins.

- I2C: 4 (SDA) and 5 (SCL). Support I2C (TWI) communication using the Wire library (documentation on the Wiring website).

### **Power Pins:**

- VIN (sometimes labelled "9V"). The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin. Note that different boards accept different input voltages ranges, please see the documentation for your board. Also note that the Lily Pad has no VIN pin and accepts only a regulated input.
- 5V. The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.
- 3V3. (Diecimila-only) A 3.3 volt supply generated by the on-board FTDI chip.
- GND. Ground pins.

### **Other Pins:**

AREF. Reference voltage for the analog inputs. Used with `analogReference()`.

Reset. (Diecimila-only) Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

### **Arduino UNO:**

The Uno is one of the most popular Arduino boards. It consists of 14-digital I/O pins, where 6-pins can be used as PWM(pulse width modulation outputs), 6-analog inputs, a reset button, a power jack, a USB connection and more. It includes everything required to hold up the microcontroller; simply attach it to a PC with the help of a USB cable and give the supply to get started with a AC-to-DC adapter or battery

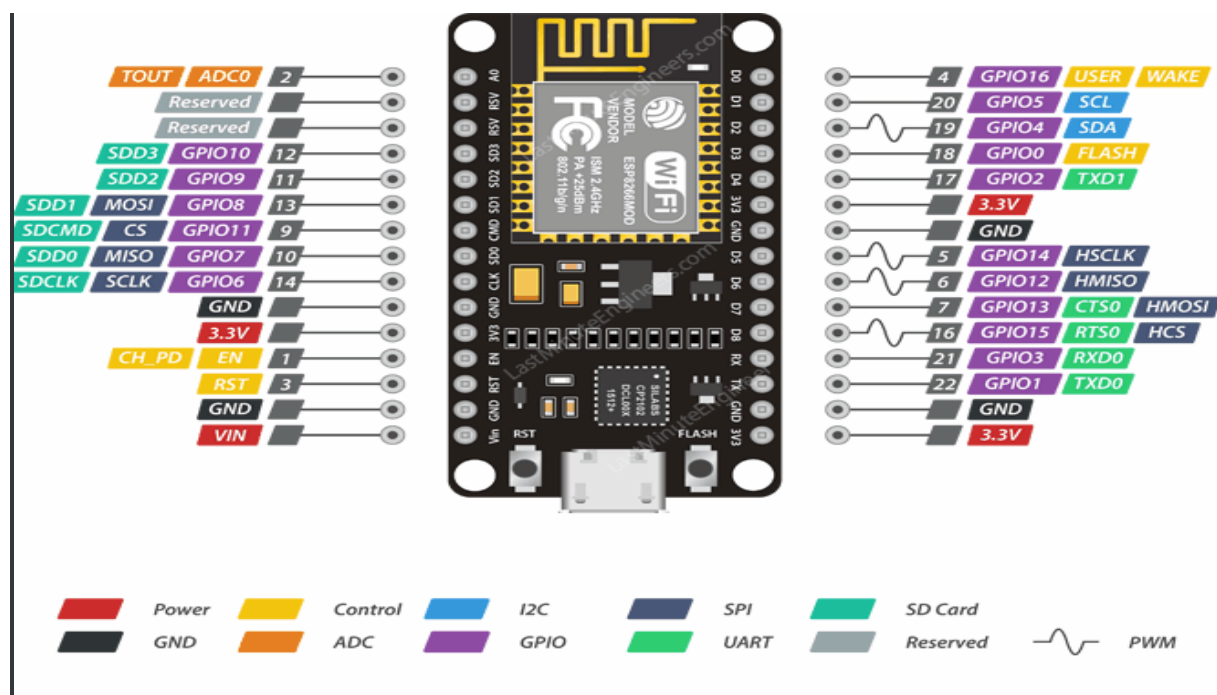
## Arduino Software:

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board.

### 3.3.2 WIFI MODULE-ESP 8266 (NODE- MCU):

The ESP8266 Node MCU has total 30 pins that interface it to the outside world. The connections are as follows:

**Power Pins** : There are four power pins viz. one VIN pin & three 3.3V pins. The VIN pin can be used to directly supply the ESP8266 and its peripherals, if you have a regulated 5V voltage source. The 3.3V pins are the output of an on-board voltage regulator. These pins can be used to supply power to external components.



**GND** is a ground pin of ESP8266 NodeMCU development board.

**I2C Pins** are used to hook up all sorts of I2C sensors and peripherals in your project. Both I2C Master and I2C Slave are supported. I2C interface functionality can be realized programmatically, and the clock frequency is 100 kHz at a maximum. It should be noted that I2C clock frequency should be higher than the slowest clock frequency of the slave device.

**GPIO Pins** ESP8266 Node MCU has 17 GPIO pins which can be assigned to various functions such as I2C, I2S, UART, PWM, IR Remote Control, LED Light and Button programmatically. Each digital enabled GPIO can be configured to internal pull-up or pull-down, or set to high impedance. When configured as an input, it can also be set to edge-trigger or level-trigger to generate CPU interrupts.

**ADC Channel** The Node MCU is embedded with a 10-bit precision SAR ADC. The two functions can be implemented using ADC viz. Testing power supply voltage of VDD3P3 pin and testing input voltage of TOUT pin. However, they cannot be implemented at the same time.

**UART Pins** ESP8266 NodeMCU has 2 UART interfaces, i.e. UART0 and UART1, which provide asynchronous communication (RS232 and RS485), and can communicate at up to 4.5 Mbps. UART0 (TXD0, RXD0, RST0 & CTS0 pins) can be used for communication. It supports flow control. However, UART1 (TXD1 pin) features only data transmit signal so, it is usually used for printing log.

**SPI Pins** ESP8266 features two SPIs (SPI and HSPI) in slave and master modes. These SPIs also support the following general-purpose SPI features:

- 4 timing modes of the SPI format transfer

- Up to 80 MHz and the divided clocks of 80 MHz

- Up to 64-Byte FIFO

**SDIO Pins** ESP8266 features Secure Digital Input/Output Interface (SDIO) which is used to directly interface SD cards. 4-bit 25 MHz SDIO v1.1 and 4-bit 50 MHz SDIO v2.0 are supported.

**PWM Pins** The board has 4 channels of Pulse Width Modulation (PWM). The PWM output can be implemented programmatically and used for driving digital motors and LEDs. PWM frequency range is adjustable from 1000  $\mu$ s to 10000  $\mu$ s, i.e., between 100 Hz and 1 kHz.

**Control Pins** are used to control ESP8266. These pins include Chip Enable pin (EN), Reset pin (RST) and WAKE pin.

- EN pin – The ESP8266 chip is enabled when EN pin is pulled HIGH. When pulled LOW the chip works at minimum power.
- RST pin – RST pin is used to reset the ESP8266 chip.
- WAKE pin – Wake pin is used to wake the chip from deep-sleep.

### **3.4 Applications of ARDUINO AND NODE-MCU**

ARDUINO UNO board is used in the following applications:

- Weighing Machines
- Traffic Light Count Down Timer
- Parking Lot Counter
- Embedded systems
- Home Automation
- Industrial Automation
- Medical Instrument
- Emergency Light for Railways

Following are some major applications used for Node-MCU :

- Internet Smoked Alarm.
- VR Tracker.
- Octopod.
- Serial Port Monitor.
- ESP Lamp.
- Incubator Controller.
- IoT home automation.
- Security Alarms.

# CHAPTER 4

## BLYNK

### 4.1 Introduction to Blynk

Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other various operations. Blynk is a Platform with IOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet. It's a digital dashboard where we can build a graphic interface for any project by simply dragging and dropping widgets. This application is used to create a graphical interface or human machine interface (HMI) by compiling and providing the appropriate address on the available widgets.

There are three major components in the platform:

#### 4.1.1 Blynk App

It allows us to create amazing interfaces for our projects using various widgets we provide. The Blynk innovation is the smartphone app. It allows us to create one or more projects. Each project can contain graphical widgets, like virtual LEDs, buttons, value displays and even a text terminal, and can interact with one or more devices. With the help of the Blynk library, it is possible to control Arduino or ESP32 pins directly from our phone, without any requirement of writing the code. It is also possible to share a project with friends and even customers so that they can access the connected devices but are unable to modify the project. For example, we can imagine a scenario where we build a smartphone application where we can control lights, window blinds and room temperature from our phone.



**Fig 4.1.1.1 Blynk App Logo**

## **4.1.2 Blynk Server**

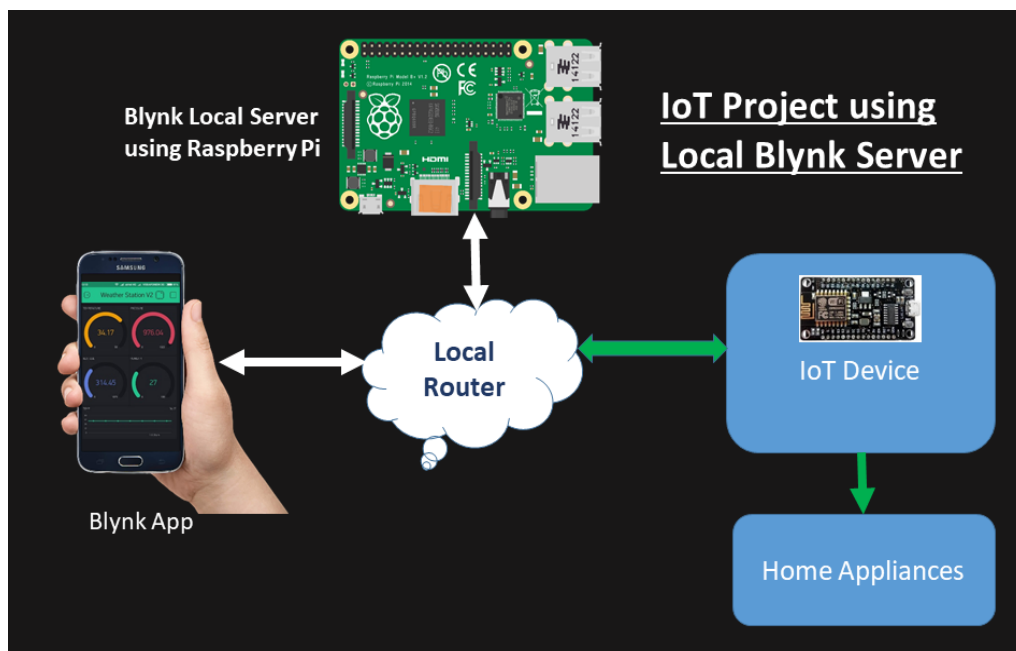
It is responsible for all the communications between the smartphone and hardware. We can use the Blynk Cloud or run our private Blynk server locally. It's open-source which can easily handle thousands of devices and can even be launched not only on NodeMCU but also on a Raspberry Pi. Unlike IoT platform such as IFTTT, Twilio, and even Adafruit IO, we can host a private instance of the full Blynk server and connect our smartphone Blynk app to it. The Blynk Cloud server is an excellent choice for most projects, as it is always there, ready to use. However, the Cloud Blynk server has imposed limitations. Some limitations are due to the topology of the server depending on our geographical location, the server may be in a different continent, which makes communications between the app, the devices and the server slow due to the amount of time it takes packets to travel across the Internet.

Another imposed limitation is that in the Cloud server, we can only use a small number of widgets. Blynk is using the concept of “energy” to implement a pricing system for its widgets. In the Cloud server we may start a new project with 1000 energy units. An LED widget may cost 200 units, leaving 800 units for other widgets. On a private server, we can set our own energy limits. We can configure our server to allocate 100,000 energy units to new users. Of course, we can purchase additional energy units to spend on the Cloud Blynk server, and this is a legitimate consideration especially if the users of our Blynk project are distributed around the world. However, a private Blynk server gives you additional benefits:



- Essentially unlimited energy units, so that you can build any Blynk application you can think of.
- Minimal latency, which is useful when your application is used in a limited geographic area and responsiveness is important.
- Total control of your data. You can keep your own backups of your Private server, migrate your server to a new host, implement whichever security mechanisms you wish, and finely control your users.

We can run an instance of the Blynk server on any host that has a Java runtime environment. We can use any Raspberry Pi with WiFi, it does not need to be a Zero W. In fact, you can use any Linux or Windows host you want, including virtual machines.



**Fig 4.1.2.1 Blynk Server**

### 4.1.3 Blynk Libraries

It is used for all the popular hardware platforms, it enables communication with the server and process all the incoming and outgoing commands. The Blynk platform supports range of devices and connectivity types. The support is implemented by means of a Blynk library that targets a device and connectivity type combination. For example, if we want to use our Arduino Uno with an Ethernet shield, we would use the library “Blynk Simple Ethernet” which contains the Blynk firmware plus the required

connectivity support. Blynk also supports clients that are not a microcontroller, we can write client code in Javascript, Python or Lua. This means that we can have a Blynk project that interacts with an Arduino and with Python code running on a Linux virtual machine somewhere on the Cloud.

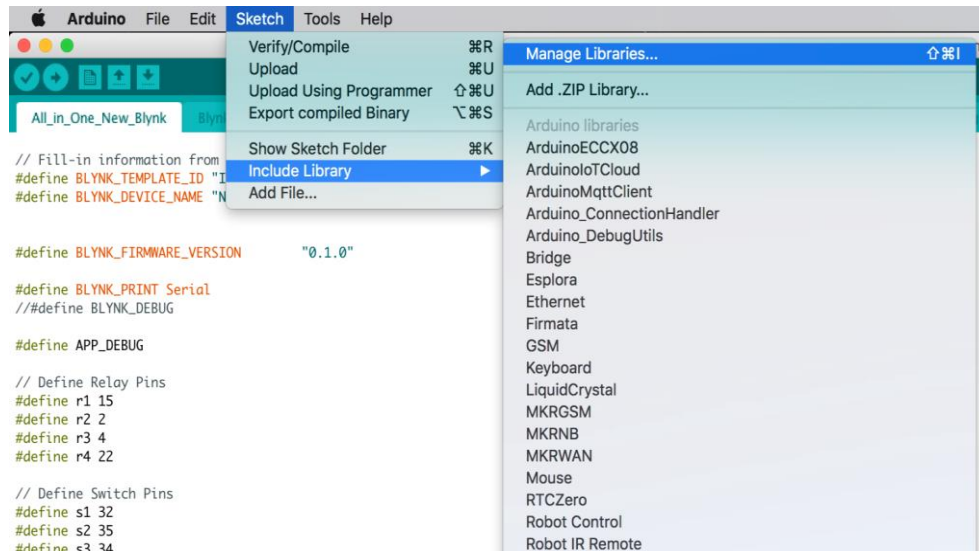
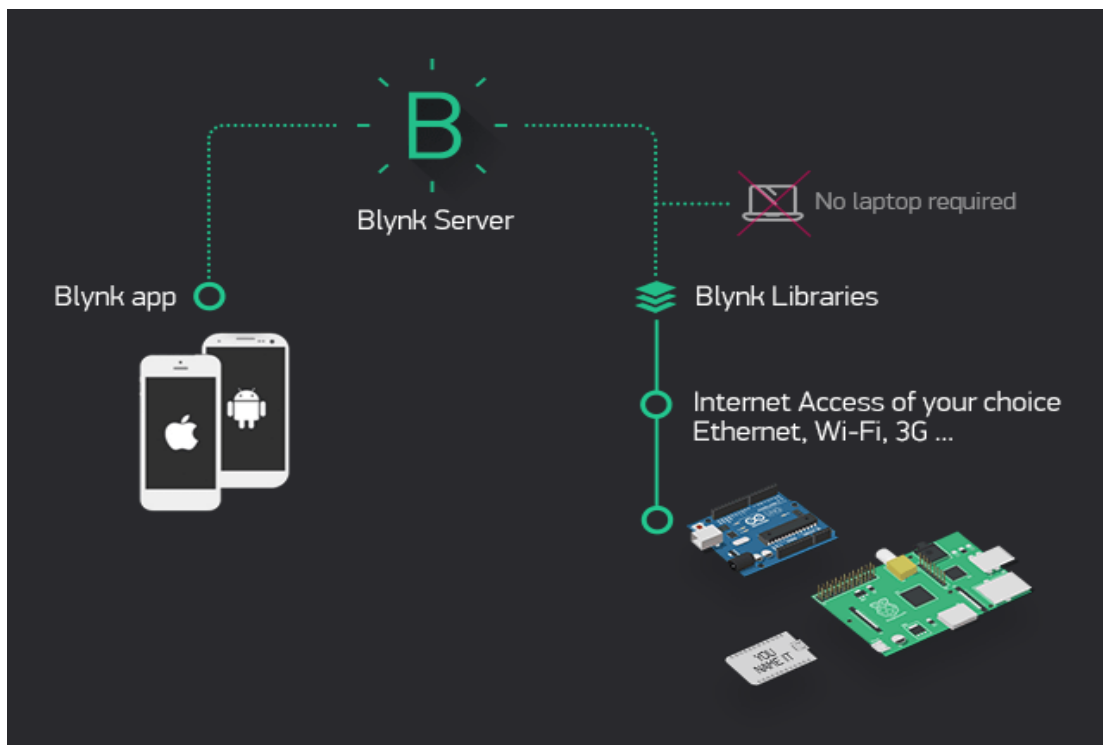


Fig 4.1.3.1 Blynk Libraries

## 4.2 Uses of Blynk

- With Blynk, we can create smartphone applications that allow us to easily interact with microcontrollers or even full computers such as the Raspberry Pi.
- The main focus of the Blynk platform is to make it super-easy to develop the mobile phone application. With Blynk, you can control an LED or a motor from your mobile phone with literally zero programming.
- Blynk is a robust and scalable tool that is used by hobbyists and the industry alike.
- We can use it to monitor the soil humidity of your vegetable garden and turn on the water, or open up our garage door, with our phone.

- We can also use it to control smart furniture that can learn from our routines, or embed IoT and AI to traditional industrial products such as a boiler, or for improving the integrity and safety of oilfields.
- Blynk is free to use for personal use and prototyping. Their business model generates profits by selling subscriptions to businesses that want to publish Blynk-powered apps for their hardware products or services.



**Fig 4.2.1 Blynk Architecture**

### **4.3 Implementation of Blynk App**

In this project Blynk app is proposed for the communication between the hardware components via smartphone using ESP8266 Wi-fi module. Through Arduino the data is transmitted to Node MCU, as ESP8266 is a Wi-Fi module the Blynk app is connected to Node MCU through the internet. The Blynk server receives the information signal from the corresponding pins of the ESP8266 Wi-Fi module and displays the corresponding values.

The temperature and humidity values are sensed by DHT11 sensor along with soil moisture content using soil moisture sensor and the values are represented in gauge meter of the Blynk application. These values are also displayed on super charts. The app can monitor the live values and also store the record of the past values in the terminal window. Furthermore, if there is any shortage of water in the crop field the pump can be ON/OFF using the buttons depending upon the requirement of the user. In addition to this, the farmer can control the LED lights turn ON and turn OFF based on his need.

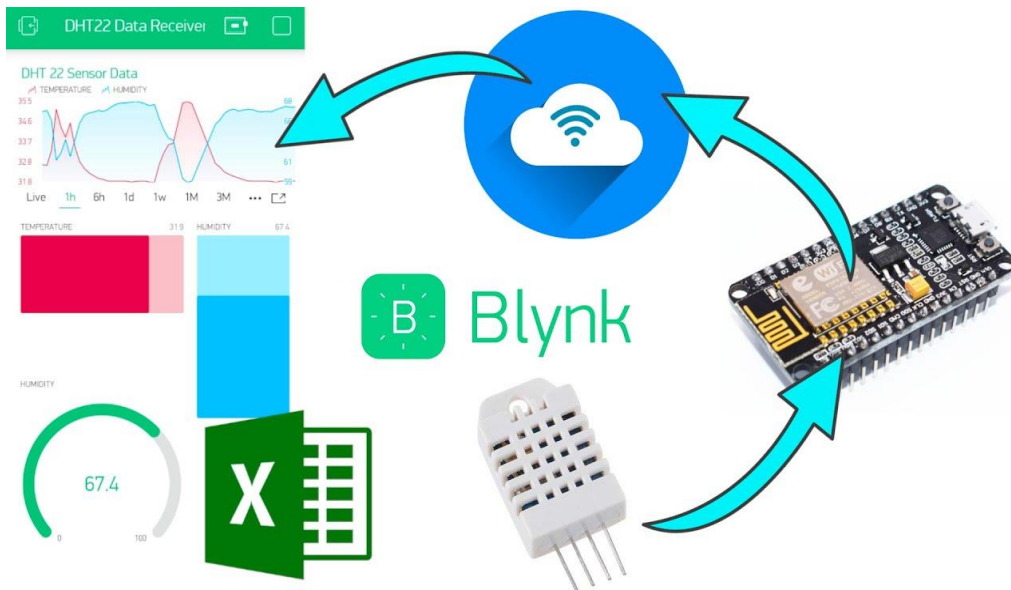
#### **4.4 Blynk with CSV file**

A CSV is a comma-separated values file, which allows data to be saved in a tabular format. CSVs look like a garden-variety spreadsheet but with a .csv extension. CSV files can be used with most any spreadsheet program, such as Microsoft Excel or Google Spreadsheets. They differ from other spreadsheet file types because we can only have a single sheet in a file, they cannot save cell, column, or row. Also, we cannot not save formulas in this format.

These files serve a number of different business purposes. They help companies export a high volume of data to a more concentrated database, for instance. They also serve two other primary business functions:

- CSV files are plain-text files, making them easier for the website developer to create
- Since they're plain text, they're easier to import into a spreadsheet or another storage database, regardless of the specific software you're using
- To better organize large amounts of data

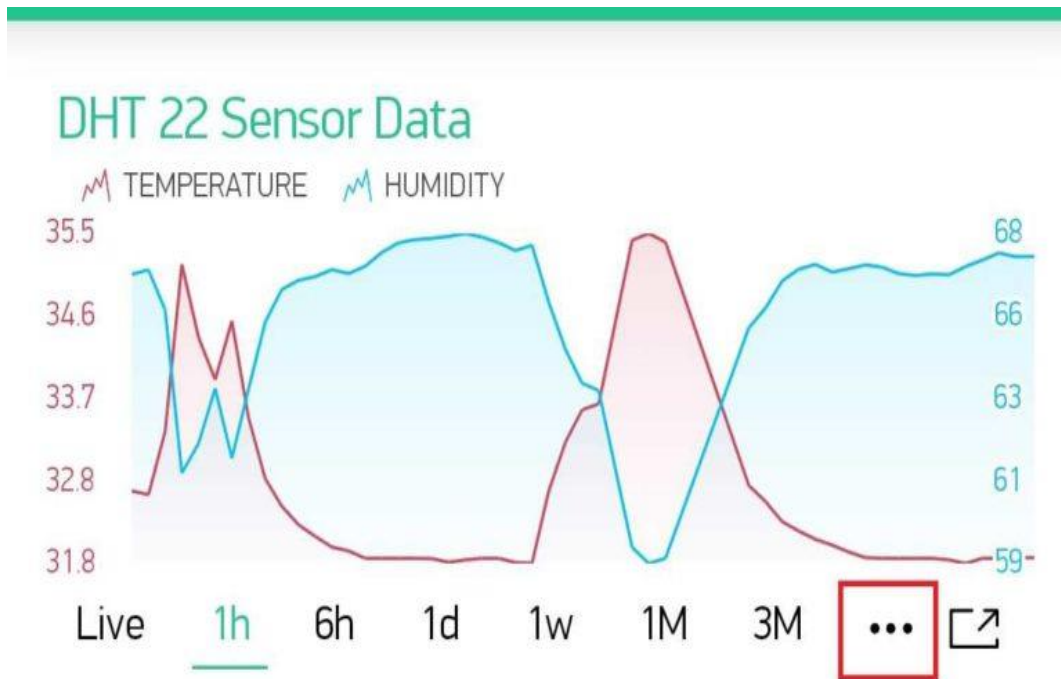
This concept of CSV file is an added advantage in the Blynk app. Not all the farmers are well-educated enough or they may be some illiterates who cannot exactly understand the operation of Blynk. Therefore, during such circumstances the data from the Blynk server can be exported to the Kissan Centres with the help of the CSV file so that the data received by them can be monitored. This study can lead to any precautionary steps if the state of the crop is poor or that any disease may attack upon it. All these kind of issues can be addressed and taken care by the Kissan Centres which help them to suggest preventive measures to the farmer so that an immediate action can be expected leading to healthy farming.



**Fig 4.4.1 Blynk with CSV file**

**Steps to export .CSV File:**

Step 1: Click on three horizontal dot, just below your chart.



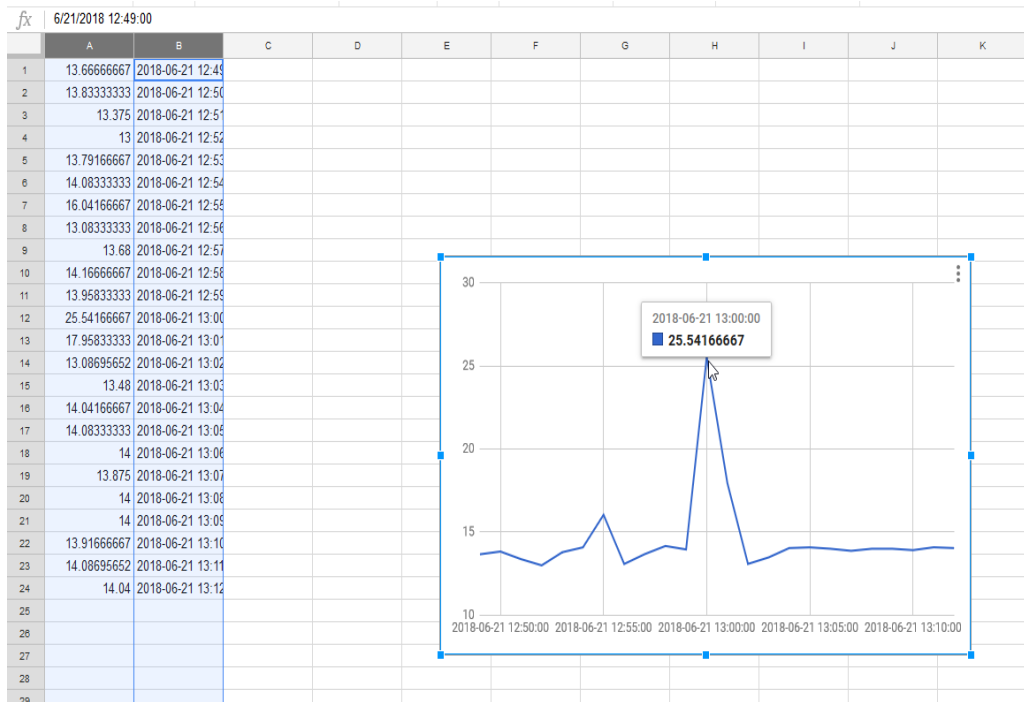
**Fig 4.4.2 Superchart containing CSV File**

Step 2: Now click Export to CSV. It will send this CSV file directly to your email id.



**Fig 4.4.3 Exporting CSV file**

Step 3: Download the CSV file in the mail and open it using excel sheet and then select the list of values displayed and plot the graph using them.



**Fig 4.4.4 CSV file excel sheet**

# CHAPTER 5

## INTERFACE

### Introduction

The transfer of data between micro controllers and peripherals is called interfacing. A hardware interface specifies the plugs, sockets, cables and electrical signals e.t.c., that pass through each line between the CPU and a auxiliary device or communications network. It also stipulates which data to trigger to which functions, and the control software that "drives" the hardware is also part of the hardware interface. Interfacing devices for performing some specific tasks. For example., consider a security system with user changeable password project, in which an interfacing device, keypad is interfaced with micro controller to enter the password .Used to solve many composite problems in circuit designing with appropriate features, reliability, availability , cost e.t.c.,

### 5.1 Interfacing tools

1. Motherboards
2. USB-External Peripherals
3. Network

#### 5.1.1 Motherboards

The CPU socket on the motherboard determines which CPU chip can be used in the computer. Peripheral cards, such as high-end graphics cards, plug into the bus on the motherboard inside the computer case. The most common bus and newest is PCI Express which was introduced in 2004 with transfer rate of 250MByte/s. it is high speed bus.

The interface between computer motherboards and smaller boards (daughter boards) or cards in the expansion slots is called the bus. Industrial motherboards communicate with and control peripheral devices via buses or other communication standards.

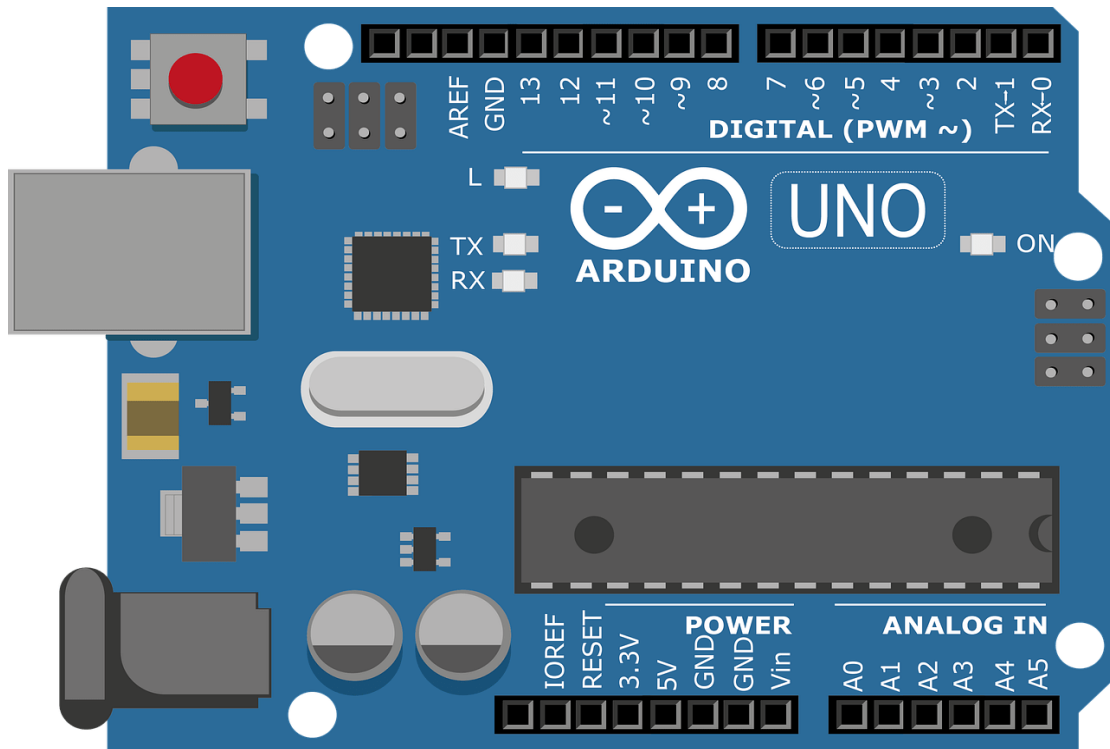


Fig5.1.1.1-mother board of ARDUINO

## 5.1.2 USB-External Peripherals

The most widely used hardware interface for attaching external devices to computer is USB, it connects keyboard, mouse, print and other external devices, in addition, SATA is a common storage drive and optical drive interface and NVMe is an increasingly popular SSD interface. The GPIB iEEE488 standard Is used for process control instruments



Fig 5.1.2.1- Types of external ports

### 5.1.2.1 Mini-USB



These connectors used to be the standard for mobile devices, cameras, and MP3 players. Like their name suggests, they're smaller than a regular USB port. That's why they're often used for smaller devices. They aren't used as often anymore, but you still may find some devices that have this compatibility.

### **5.1.2.2 Macro-USB**

This is currently considered to be the standard connector for mobile devices and other gadgets, except the devices that Apple produces. The micro allows information to be read without help from a computer, meaning you can directly connect one device to a phone with help from one of these bulk USB cables.

### **5.1.2.3 HDMI**

High-Definition Multimedia Interface, a standard for simulation transmitting digital video and audio from a source such as computer or TV cable box to a computer monitor. Originally developed by a electronics manufacturers. It has been widely adapted with almost all televisions and computer monitors. There are three types of HDMI. They are Standard, Mini, Micro HDMI Cables.

### **5.1.2.4 USB-A**

A type-A connector is one you've probably used a fair amount. If you've ever purchased these bulk USB cables, they're what you typically plug into a computer USB port when you transfer data, use an external keyboard for typing, or utilize a mouse for a PC, all external devices are connected using them.

### **5.1.2.5 Ethernet**

Ethernet is a technology that connects devices in a network. It helps devices to communicate via protocol which is a set of rules or common network language. Internet cable is a physical set of wires that allows data to transfer compared to wireless technology Disturbances are less. Internet cable used for fast speeds like

Cat 5e or Cat 6e. Internet cable connects your modem, router and other wireless internet capable device to carry broadband signals. Internet cable offers a strong network security than Wi-Fi since it is connected to a physical cable making it hard outsiders to access the internet network.

### 5.1.2.6 USB-C

One of the newer USB cables on the scene is the type-C. Unlike other connectors, this one is actually reversible, meaning that it can be plugged in upside down if you want. It also offers higher speeds data transfer and is generally thought to be more powerful. It's become the standard for many new laptops, tablets, and phones (and even by Apple).

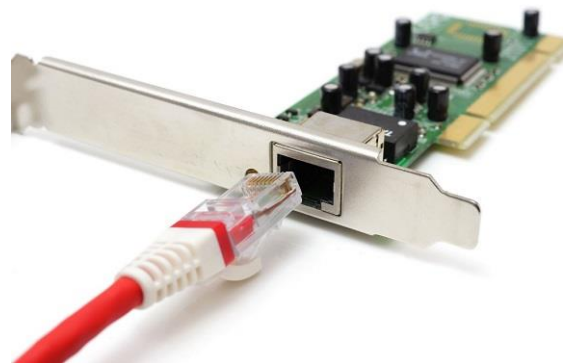
### 5.1.3 Networks

A network interface will usually have some form of network address. This may consist of a node ID and a port number or may be a unique node ID in its own right. Network interfaces provide standardized functions such as passing messages, connecting and disconnecting, etc.

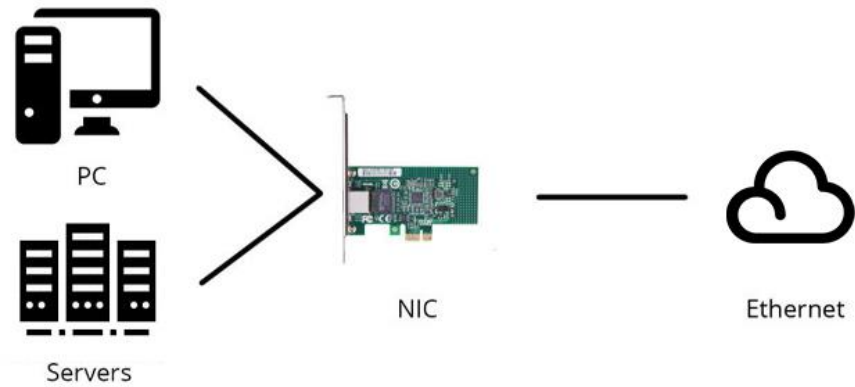
The de facto standard for connecting devices to local networks (LANs)

is Ethernet, which is also used to hook up a cable or DSL modem. The standards for wireless are Wi-Fi and Bluetooth. In networks interface NIC (Network Interface Card) plays important role.

A network interface card (NIC or network adapter) is an important hardware component used to provide network connections for devices like computers, servers, etc. With its wide applications, there are various types of network interface cards emerging in the market like PCIe card and server network card



**Fig5.1.3.1-NIC(Network Interface Card)**



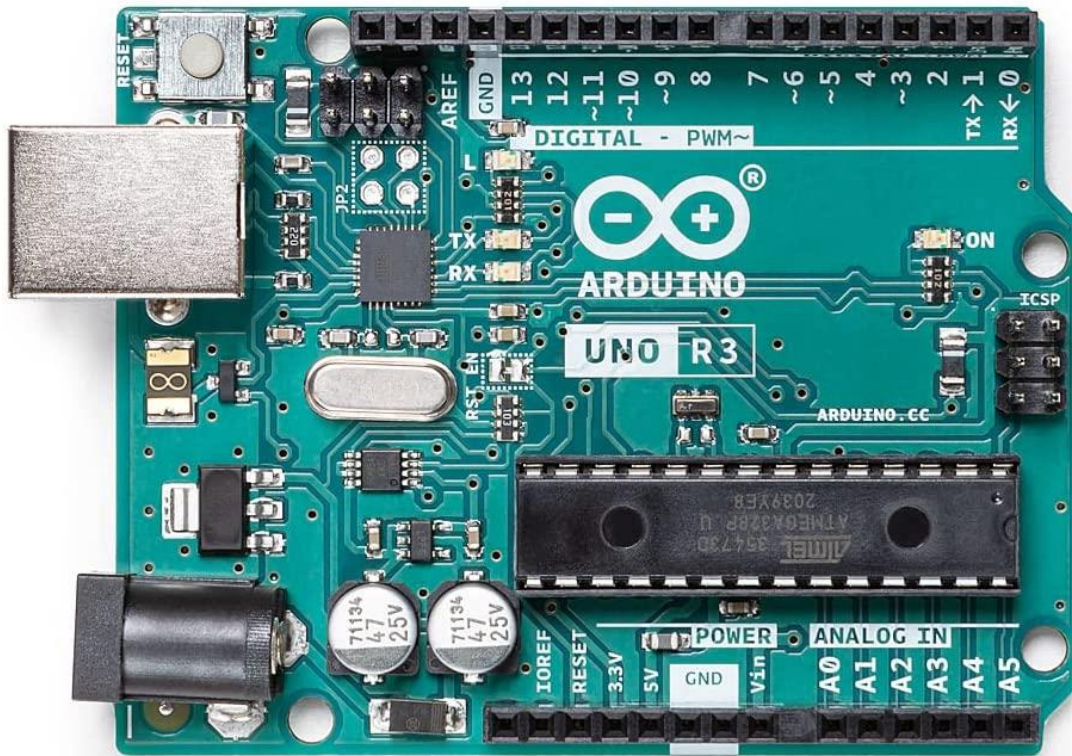
**Fig 5.1.3.2-network interface**

The above image shows network interface through NIC in wireless way

## **5.2 Interface between ARDUINO and NODE MCU**

### **5.2.1 ARDUINO**

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs and use them. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. Thanks to its simple and accessible user experience, Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. It is easy to use and flexibly



**Fig 5.2.1-arduino board**

**Vin:** This is the input voltage pin of the Arduino board used to provide input supply from an external power source.

**5V:** This pin of the Arduino board is used as a regulated power supply voltage and it is used to give supply to the board as well as onboard components.

**3.3V:** This pin of the board is used to provide a supply of 3.3V which is generated from a voltage regulator on the board

**GND:** This pin of the board is used to ground the Arduino board.

**Reset:** This pin of the board is used to reset the microcontroller. It is used to Resets the microcontroller.

**Analog Pins:** The pins A0 to A5 are used as an analog input and it is in the range of 0-5V.

**Digital Pins:** The pins 0 to 13 are used as a digital input or output for the Arduino board.

**Serial Pins:** These pins are also known as a UART pin. It is used for communication between the Arduino board and a computer or other devices. The transmitter pin number 1 and receiver pin number 0 is used to transmit and receive the data resp.

**External Interrupt Pins:** This pin of the Arduino board is used to produce the External interrupt and it is done by pin numbers 2 and 3.

**PWM Pins:** This pins of the board is used to convert the digital signal into an analog by varying the width of the Pulse. The pin numbers 3,5,6,9,10 and 11 are used as a PWM pin.

**SPI Pins:** This is the Serial Peripheral Interface pin, it is used to maintain SPI communication with the help of the SPI library. SPI pins include:

**SS:** Pin number 10 is used as a Slave Select

**MOSI:** Pin number 11 is used as a Master Out Slave In

**MISO:** Pin number 12 is used as a Master In Slave Out

**SCK:** Pin number 13 is used as a Serial Clock

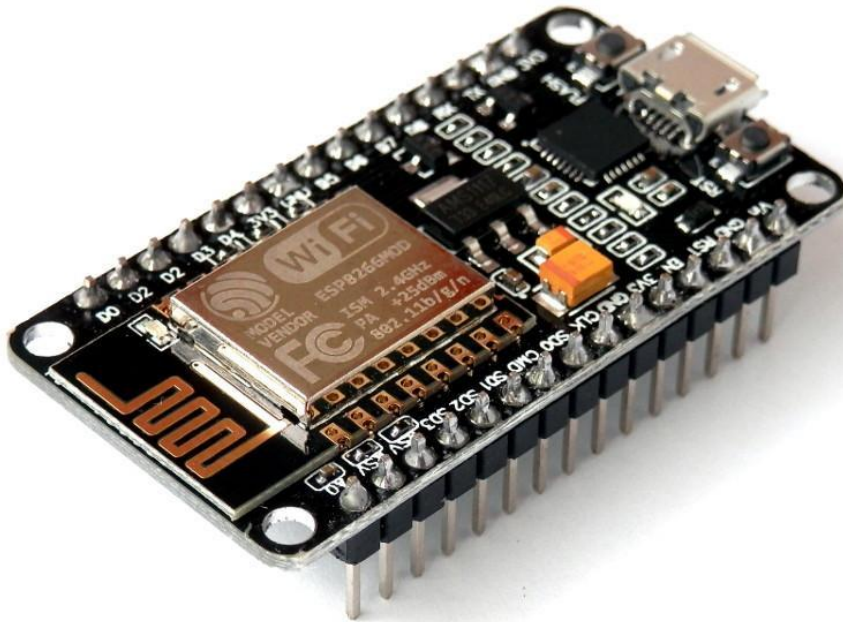
**LED Pin:** The board has an inbuilt LED using digital pin-13. The LED glows only when the digital pin becomes high.

**AREF Pin:** This is an analog reference pin of the Arduino board. It is used to provide a reference voltage from an external power supply.

## 5.2.2 NODE MCU

NodeMCU is an open source platform based on ESP8266 which can connect objects and let data transfer using the Wi-Fi protocol. In addition, by providing some of the most important features of microcontrollers such as GPIO, PWM, ADC, and etc, it can solve many of the project's needs alone.

It is easy to use, Programmability with Arduino IDE or IUA languages It has an internal antenna



**Fig 5.2.2.1-NodeMCU board**

NodeMCU is great for connecting cloud and Arduino is great at talking with different types of sensors.

### **5.2.2.1 ESP8266 NodeMCU Pinout**

#### **Power Pins**

There are four power pins viz. one VIN pin & three 3.3V pins. The VIN pin can be used to directly supply the ESP8266 and its peripherals, if you have a regulated 5V voltage source. The 3.3V pins are the output of an on-board voltage regulator. These pins can be used to supply power to external components.

#### **Ground**

It is a ground pin of ESP8266 NodeMCU development board.

## **I2C pins**

These pins are used to hook up all sorts of I2C sensors and peripherals in your project. Both I2C Master and I2C Slave are supported. I2C interface functionality can be realized programmatically, and the clock frequency is 100 kHz at a maximum. It should be noted that I2C clock frequency should be higher than the slowest clock frequency of the slave device.

## **GPIO Pins**

ESP8266 NodeMCU has 17 GPIO pins which can be assigned to various functions such as I2C, I2S, UART, PWM, IR Remote Control, LED Light and Button programmatically. Each digital enabled GPIO can be configured to internal pull-up or pull-down, or set to high impedance. When configured as an input, it can also be set to edge-trigger or level-trigger to generate CPU interrupts.

## **ADC Channel**

The NodeMCU is embedded with a 10-bit precision SAR ADC. The two functions can be implemented using ADC viz. Testing power supply voltage of VDD3P3 pin and testing input voltage of TOUT pin. However, they cannot be implemented at the same time.

## **UART Pins**

ESP8266 NodeMCU has 2 UART interfaces, i.e. UART0 and UART1, which provide asynchronous communication (RS232 and RS485), and can communicate at up to 4.5 Mbps. UART0 (TXD0, RXD0, RST0 & CTS0 pins) can be used for communication. It supports fluid control. However, UART1 (TXD1 pin) features only data transmit signal so, it is usually used for printing log.

## **SPI Pins**

ESP8266 features two SPIs (SPI and HSPI) in slave and master modes.

These SPIs also support the following general-purpose SPI features:

4 timing modes of the SPI format transfer

Up to 80 MHz and the divided clocks of 80 MHz

Up to 64-Byte FIFO

## **SDIO Pins**

ESP8266 features Secure Digital Input/Output Interface (SDIO) which is used to directly interface SD cards. 4-bit 25 MHz SDIO v1.1 and 4-bit 50 MHz SDIO v2.0 are supported.

## **PWM Pins**

The board has 4 channels of Pulse Width Modulation (PWM). The PWM output can be implemented programmatically and used for driving digital motors and LEDs. PWM frequency range is adjustable from 1000  $\mu$ s to 10000  $\mu$ s, i.e. between 100 Hz and 1 kHz.

## **Control Pins**

These pins are used to control ESP8266. These pins include Chip Enable pin (EN), Reset pin (RST) and WAKE pin.

### **EN pin**

The ESP8266 chip is enabled when EN pin is pulled HIGH. When pulled LOW the chip works at minimum power.

### **RST pin**

RST pin is used to reset the ESP8266 chip.

### **WAKE pin**

Wake pin is used to wake the chip from deep-sleep

## **5.2.3 Interfacing between ARDUINO and NodeMCU**

Arduino will take reading and send the readings to nodemcu over serial connection. Nodemcu will send a mqtt(MQ Telemetry Transpor) message for every reading it receives. If you have just one sensor to monitor you can directly use the analog input available on nodemcu

On Arduino side, we will take sample periodically and send a JSON(JavaScript Object Notation) message over softserial to nodemcu. Please note that Arduino uno works on 5v and nodemcu works 3v3 level. So you should use a level shifter to connect arduino soft serial pins to the nodemcu uart port (It also works without level converter , but it is not recommended).



On nodemcu side we need to receive the messages sent by arduino over serial. Arduino will send the messages in JSON format. We will not be doing any processing on nodemcu

Here we have to write code to both arduino and nodemcu. Without code they don't know what to do. It's like giving instructions to them

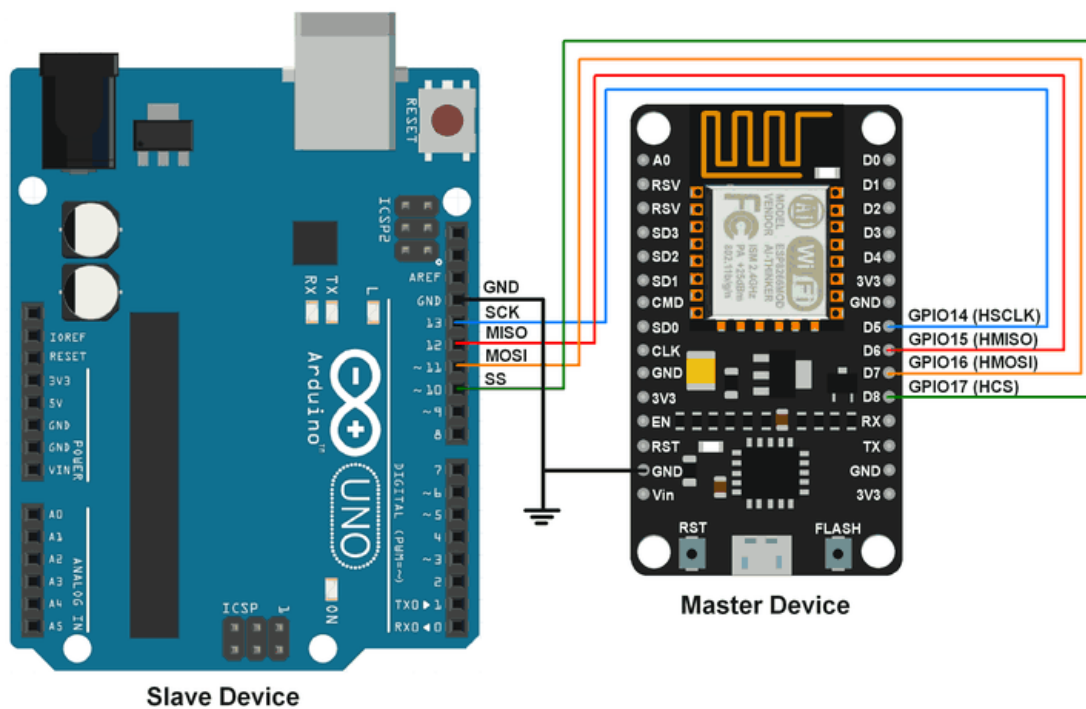
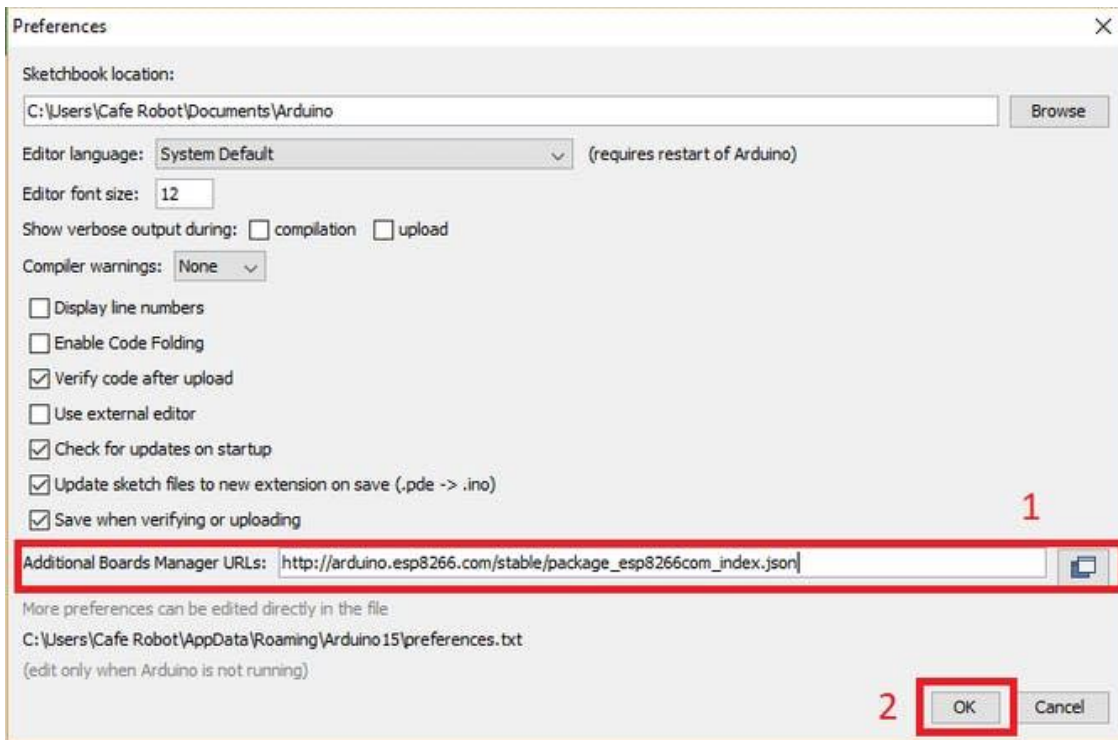


Fig 5.2.3.1-connections to arduino and nodemcu

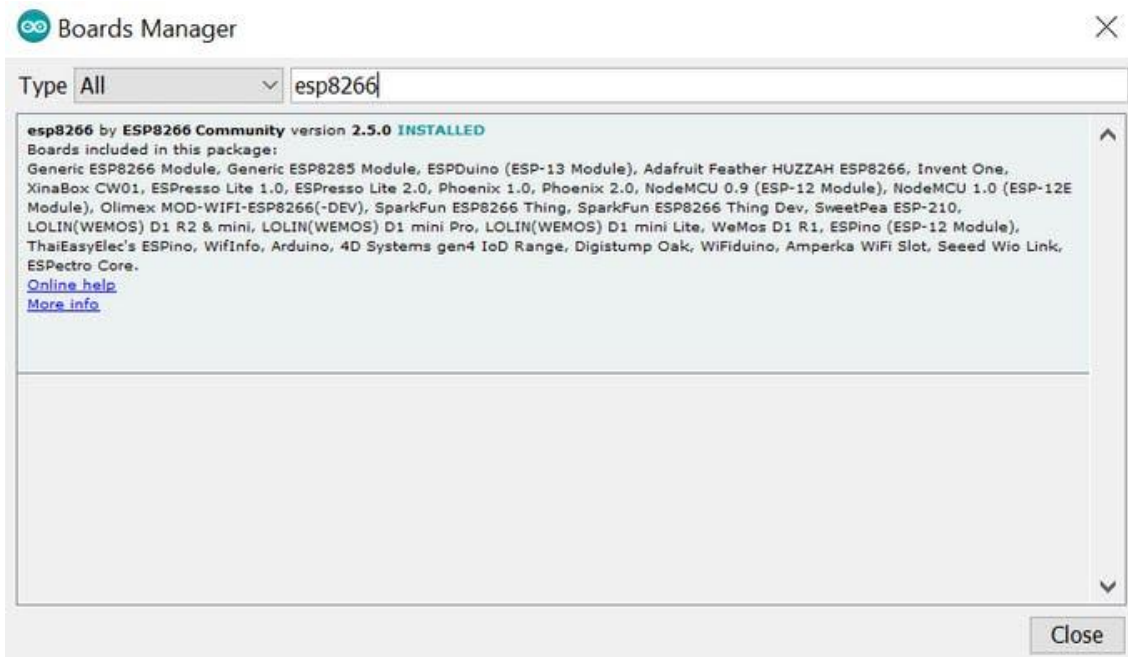
### 5.2.3.1 How to program NodeMCU using Arduino IDE

In order to use Arduino IDE to program the NodeMCU, you have to introduce it to the software at first.

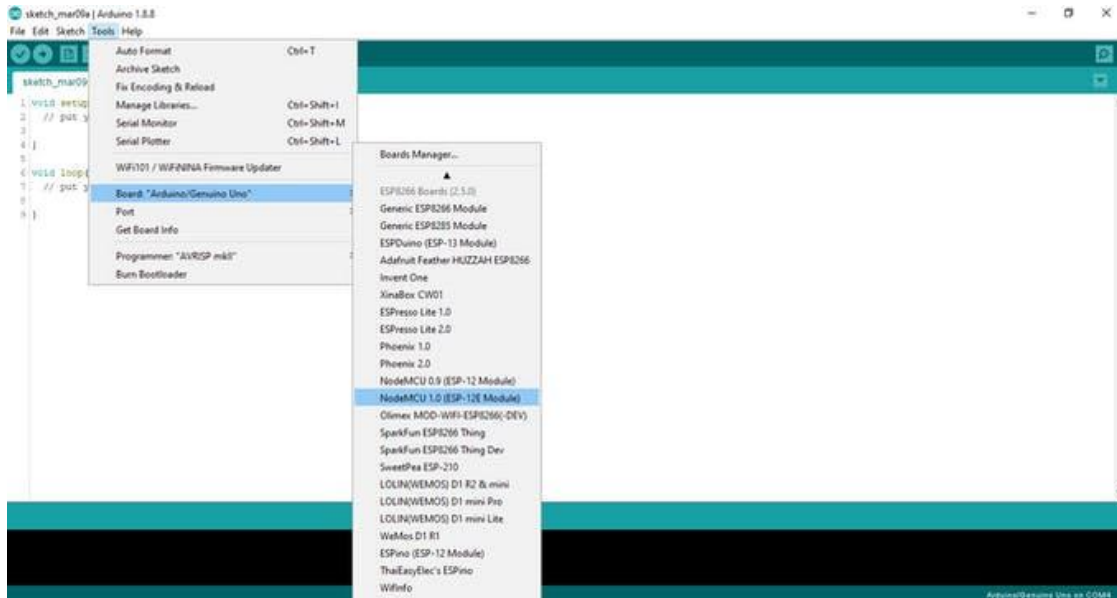
**step1.** Choose Preferences in the File menu and enter the copied code in Additional Board Manager URLs part. Then press ok



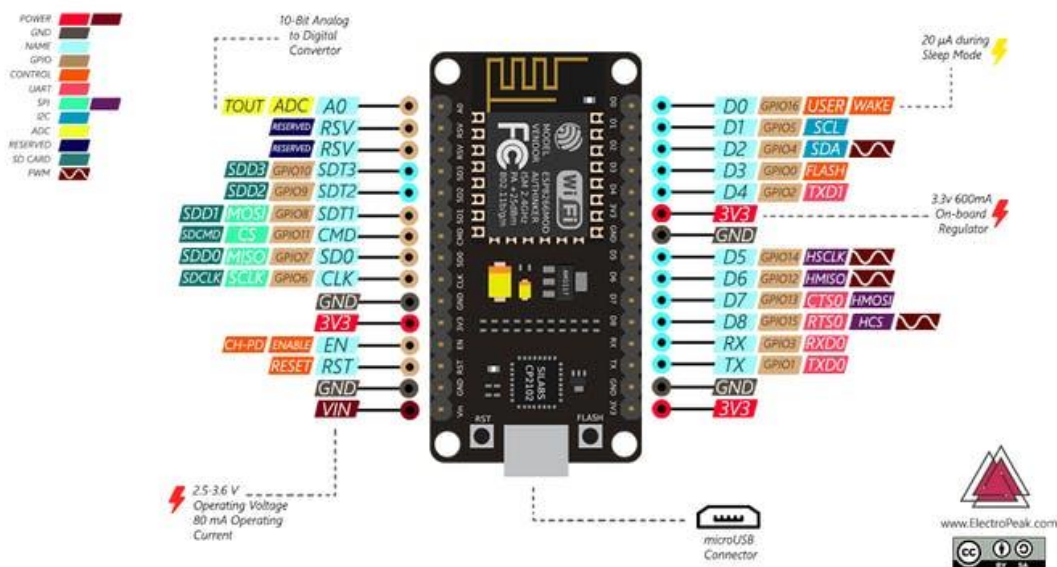
**Step2.** Search the word ESP8266 in Boards>boards manager from Tools menu. Then install ESP8266 boards. After complete installation, you will see the INSTALLED label on ESP8266 boards.



After these two steps, you can see ESP8266 based boards such as NodeMCU in your Arduino IDE boards list, and you can choose your desired board to upload the code.



You can see the NodeMCU pinouts below



In order to use digital pins, you should select GPIO numbers. For example, the D7 pin is defined as GPIO13. So you should set up the pin number 13 whenever you want to use D7 in your program. Also, you can use pin D2(GPIO4) as SDA and pin D1(GPIO5) as SCL

## 5.3 Interfacing between NodeMCU and Blynk App

### Interfacing steps - NodeMCU and Blynk App

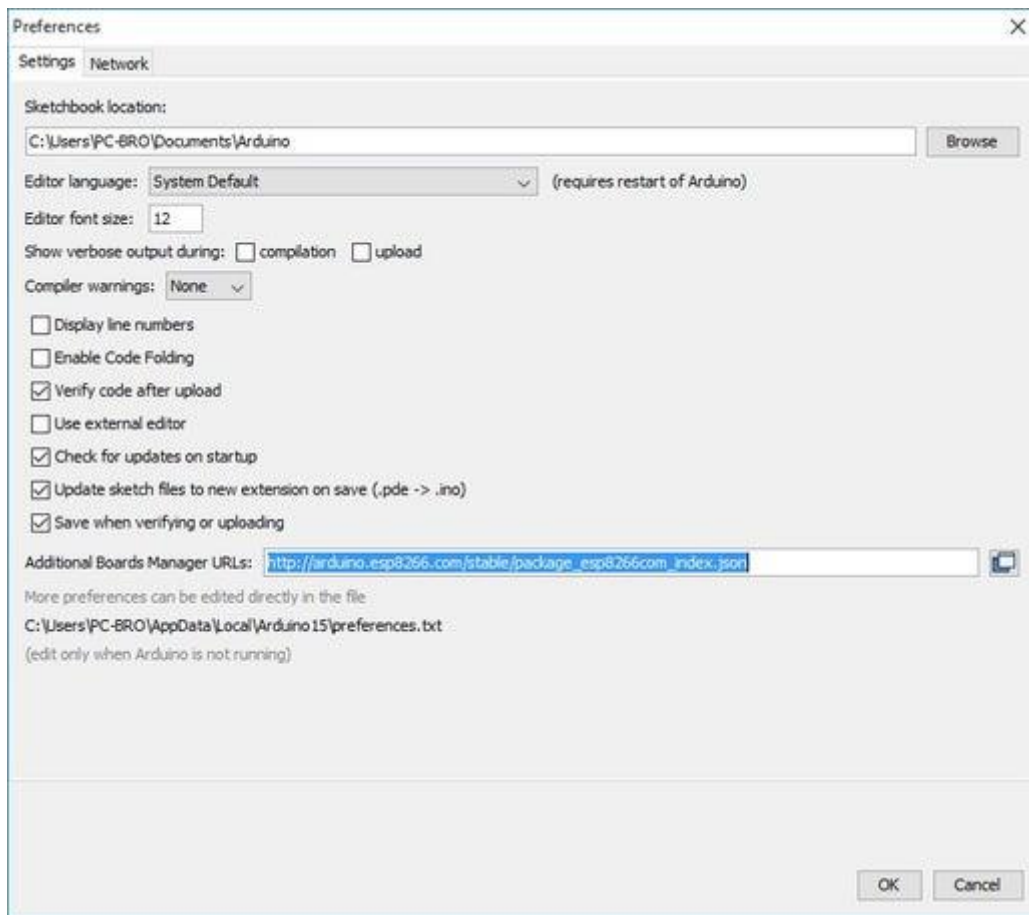
- **Step 1: Getting Hardware**



Fig5.3.1-NodeMCU board

1. Node MCU V1.0 or ESP8166-12E
2. Mobile (Android or ios)
3. USB Data Cable
4. LED - 1
5. Resistor 1K – 1

- **Step 2: Installing Arduino Board Package**



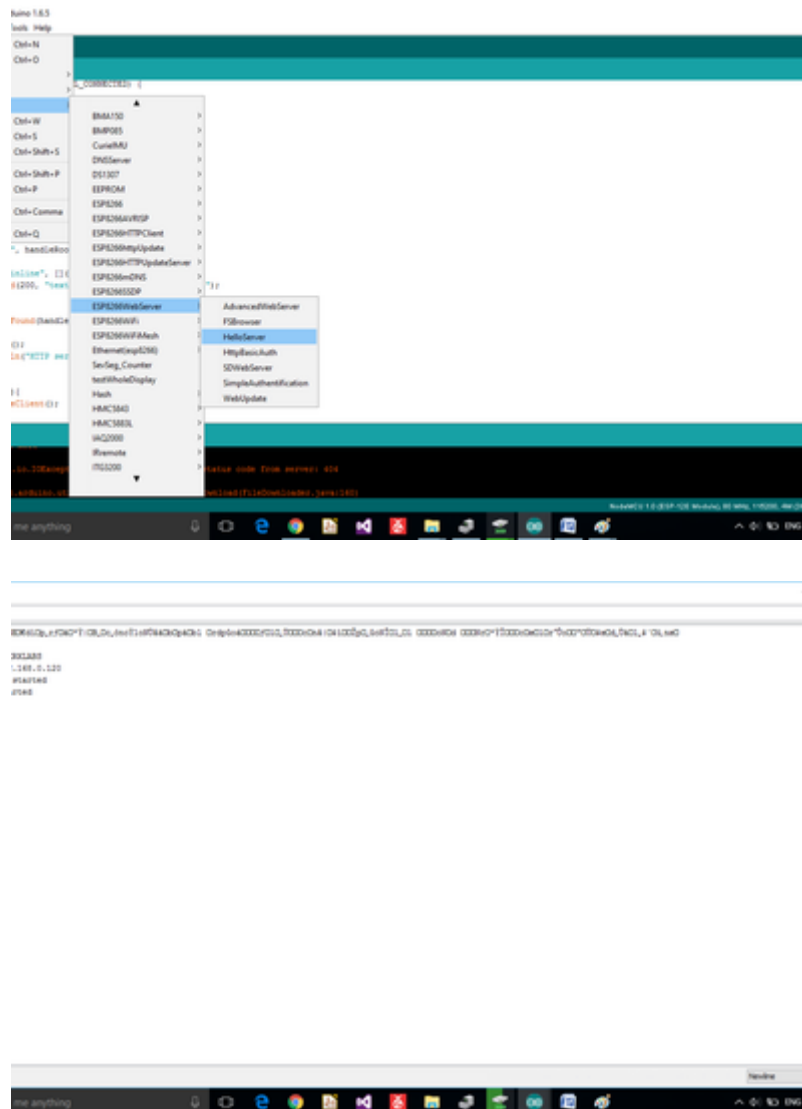
Open Arduino IDE in your laptop or PC

Go to File then preferences. Add [http://arduino.esp8266.com/stable/package\\_esp8266c...](http://arduino.esp8266.com/stable/package_esp8266com_index.json) into Additional Board Manager URLs field.

Go to tools and then boards and then click on board manager and search ESP8266 in search bar and click on install.

Wait for installation to finish

- **Step 3: Testing ESP8266 With Sample Codes**



As next step we can check our board by uploading some sample code.

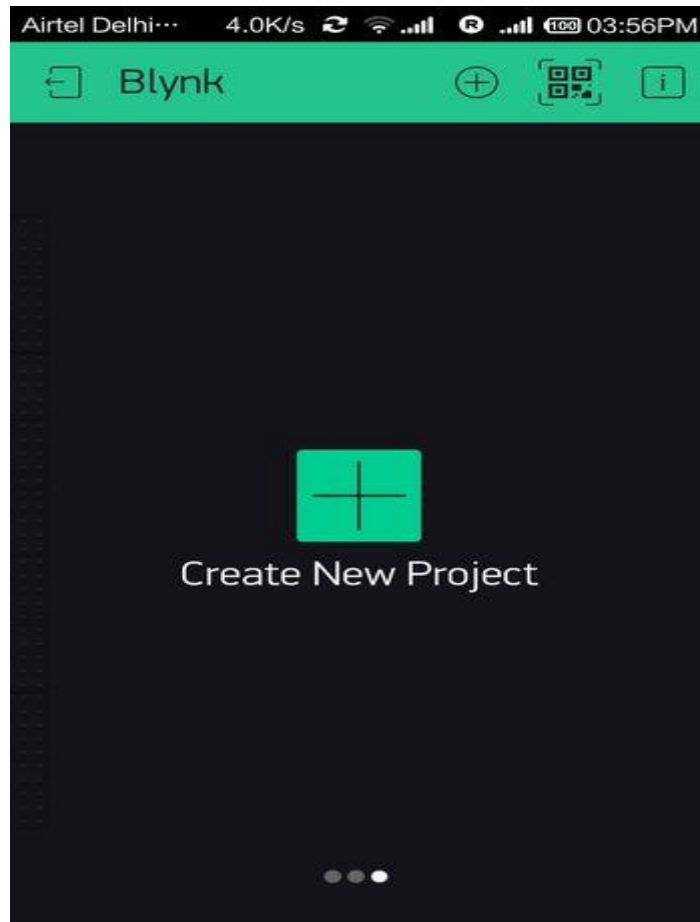
**Blink LED:** Firstly we can upload blink led code from the examples. Go to File then Examples then drop down and click on esp8266 then click on blink. Compile and upload that code. After uploading on Board LED should blink.

**Hello Server:** Now we can try connecting to our WiFi using esp8266. For that go to file examples and then ESP8266 Web server then hello server. Compile and upload that code.

Don't forget to Change SSID with your WiFi name and password with your wifi password.

After uploading also check arduino's serial terminal. On serial terminal it should show connected to WiFi network.

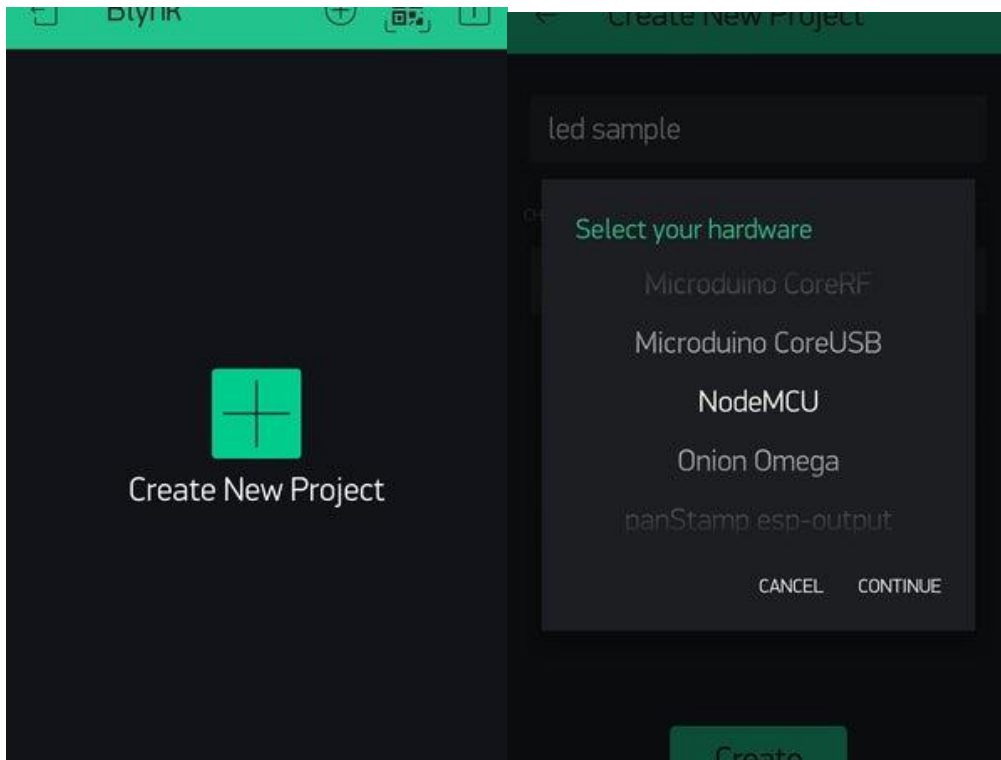
- **Step 4:** Getting Started With Blynk



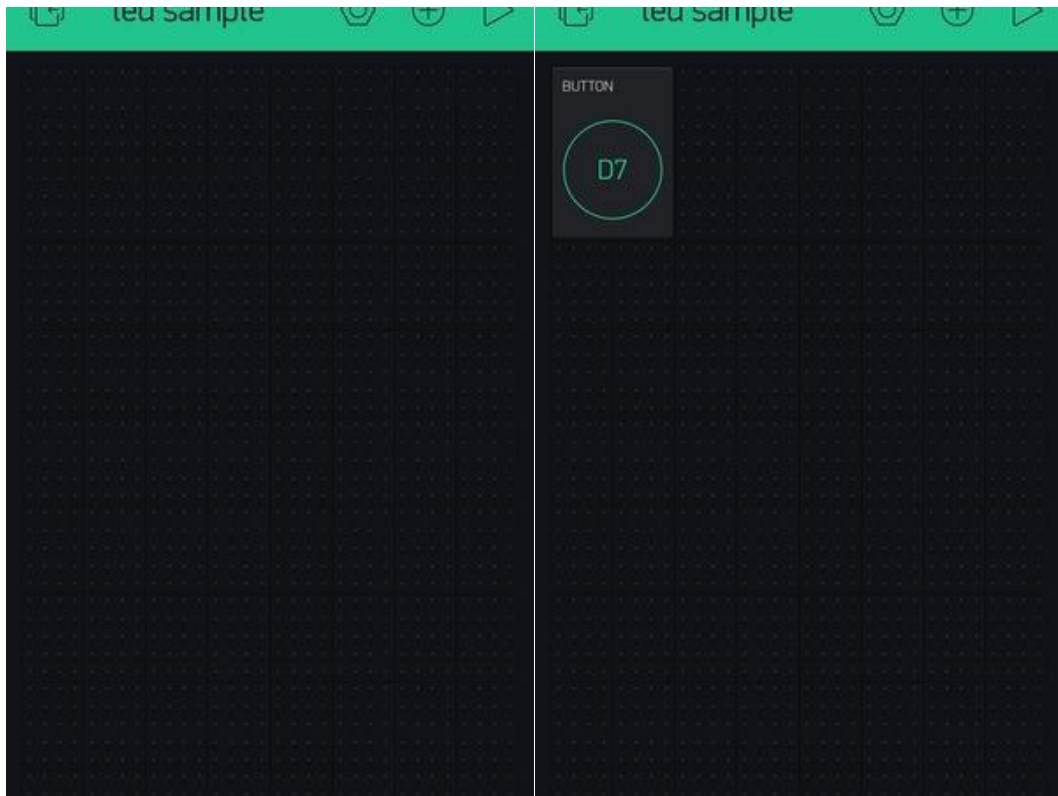
Blynk is a Platform with iOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet.

It's a digital dashboard where you can build a graphic interface for your project by simply dragging and dropping widgets. It's really simple to set everything up and you'll start tinkering in less than 5 mins. Blynk is not tied to some specific board or shield. Instead, it's supporting hardware of your choice. Whether your Arduino or Raspberry Pi is linked to the Internet over Wi-Fi, Ethernet or this new ESP8266 chip, Blynk will get you online and ready for the Internet Of Your Things.

- **Step 5:** Controlling Led Through Blynk App







Download Blynk app from play store or ios

After installation open the app and create new account by providing mail id then click on create new project icon

Name your project and select NodeMcu from hardware and connection type Wi-Fi

Then click on + icon on your upper right side of your main screen to add button to control led

Drag button icon on the main screen and then click on that button icon

Change Pin to whatever pin you want to connect your led in output section. I connected led to D7 so i changed pin to D7. Then change the mode type if you want it as switch. Please refer the image

Then go back to main screen

Check your mail box. Blynk send you Authorization token. Now we need to install Blynk libraries for arduino

Download all three files

Then install libraries. In case you don't know how to install Arduino libraries – check [here](#). Follow "Importing a .zip Library" guide.

Open Blynk ESP8266 standalone example from examples. Add auth token which you get on your mail in that

```
char auth[] = "";
```

Also don't forget to change your wifi ssid and password

Compile and upload the code

### **Connecting Led to NodeMcu:**

Connect led ground to GND pin and positive pin to D7 through resistor

Now come back to your app and click on play icon and then press switch icon

led should Turn on

# CHAPTER 6

## WORKING

### 6.1 Working Principle Of Smart Farming System

Our goal was to build a prototype model that could be quickly installed in the field and used by farmers who may lack technical understanding. The system is automated thanks to the Internet of Things.

We used a wireless and Wi-Fi enabled ESP8266 node MCU. With the help of jumper wires, we connected the ESP8266 and DHT11 temperature and humidity sensors, soil moisture sensor, LEDs, and IR sensor on a breadboard. The data is continuously read and uploaded to the Blynk app cloud using the ESP8266. When a foreign object enters the field, the LEDs and the IR sensor send us a signal. The readings from the DHT11 sensor and the soil moisture sensor are presented on the blynk app, and if the values read exceed the threshold value, the farmer is notified via the blynk app. A mobile application will be used to monitor the entire system. All of the sensors will be linked to a system that will be available 24 hours a day, seven days a week.

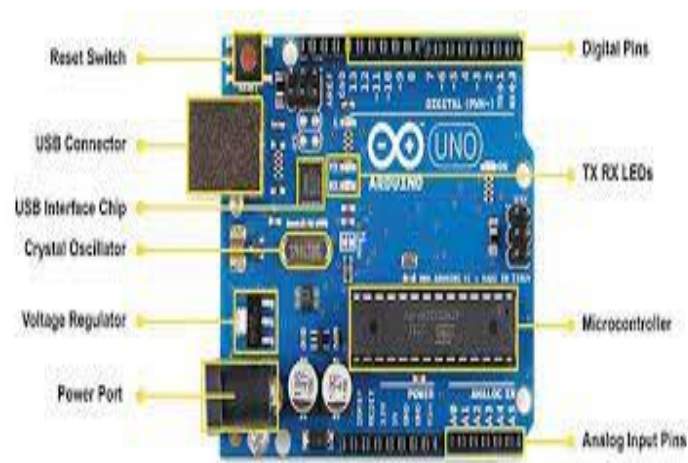
### 6.2 Components And Modules

Various components and modules utilised for IOT-based SMART FARMING SYSTEM development are addressed in this section:

#### 6.2.1 ARDUINO UNO

Arduino is an open-source electronics prototyping platform with flexible and user-friendly hardware and software. Arduino can accept input from a variety of sensors and reproduce the appropriate output for actuators, motors, and other devices. It's designed for people who are familiar with basic electronics and the C programming language. The Arduino platform consists primarily of an Arduino Board and the Arduino IDE, which is used to programme it.

Sensor Modules, Motors, Arduino UNO, and Arduino Software (IDE)-1.0 are examples of external hardware. The ATmega328P is used in the Uno, which is a microcontroller board. There are 14 digital input/output pins (six of which can be used as PWM outputs), six analogue inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button on the board. Compatible with the microcontroller; it's a plug-and-play idea; simply connect it to a computer through USB connection or power it using an AC-to-DC adapter or battery to get started. You can fiddle with your UNO without fear of making a mistake, and in the worst-case situation, it can be readily replaced at a low cost. The Arduino Integrated Development Environment (IDE) is a Java-based cross-platform application that runs on Windows, Mac OS X, and Linux. The Arduino Uno is a microcontroller board that uses the ATmega328 microcontroller (datasheet). It contains 14 digital input/output pins, 6 analogue inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.



**Fig6.2.1.1 ARDUINO UNO**

## **6.2.2 WI-FI Module ESP 8266.**

NodeMCU is an open-source Lua-based firmware and development board designed specifically for Internet of Things (IoT) applications. It comprises firmware that operates on Espressif Systems' ESP8266 Wi-Fi SoC and hardware based on the ESP-12 module. The ESP-12E module on the NodeMCU ESP8266 development board contains an ESP8266 chip with a Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor runs on a configurable clock frequency of 80MHz to 160MHz and supports RTOS. To store data and

programmes, the NodeMCU contains 128 KB of RAM and 4MB of Flash memory. It is perfect for IoT projects due to its high processing power, built-in Wi-Fi / Bluetooth, and Deep Sleep Operating capabilities. The ESP8266 Wi-Fi Module is a SOC with a TCP/IP protocol stack built in, allowing any microcontroller to connect to a Wi-Fi network. The ESP8266 module is a low-cost module that supports APSD for VOIP applications and Bluetooth co-existence. 802.11b/g/n Wi-Fi Direct, 1MB Flash Memory, SDIO 1.1/2.0, SPI, UART, and a Standby Power Consumption of 1.0mW are the technical specifications.

A Micro USB jack and VIN pin can be used to power NodeMCU (External Supply Pin). It is compatible with UART and SPI.

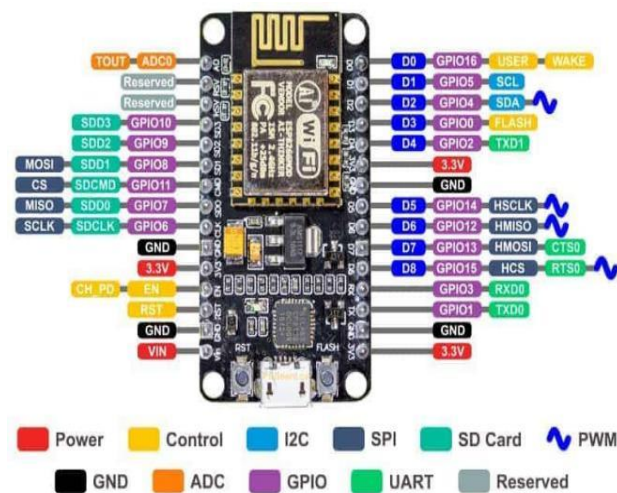


Fig 6.2.2 WIFI MODULE-ESP 8266

## 6.2.3 SENSORS

### 6.2.3.1 Temperature and humidity sensor (DHT11)

The DHT11 is a Humidity and Temperature Sensor that outputs a calibrated digital output. The DHT11 may be connected to any microcontroller, such as an Arduino or a Raspberry Pi, and provide instantaneous results. The DHT11 is a low-cost humidity and temperature sensor with excellent long-term stability and dependability. It is a composite digital temperature and

humidity sensor. A calibrated digital signal output of temperature and humidity is contained in the sensor.



Fig 6.2.3.1.1 Temperature and humidity sensor-DHT 11

### 6.2.3.2 Soil moisture sensor

Sensors that monitor the volumetric water content in soil are known as soil moisture sensors. Because direct gravimetric measurement of free soil moisture necessitates the removal, drying, and weighting of a sample, soil moisture sensors indirectly measure the volumetric water content by using another property of the soil as a proxy for the moisture content, such as electrical resistance, dielectric constant, or neutron interaction.

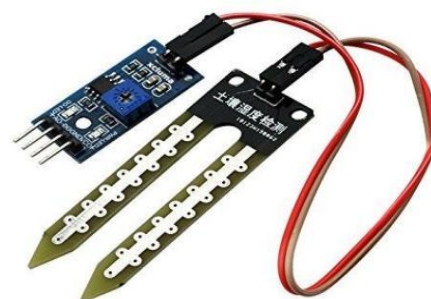


Fig 6.2.3.2.1 Soil Moisture sensor

### 6.2.3.3 IR Sensor

A passive infrared sensor (PIR sensor) is a type of electronic sensor that detects infrared (IR) light emitted by objects in its field of vision. They're most commonly found in motion detectors with a PIR sensor. Radiation is emitted by all objects with a temperature greater than absolute zero. Because it radiates at infrared wavelengths, this radiation is usually invisible to the naked eye, but it can be detected by electrical instruments built for that purpose.

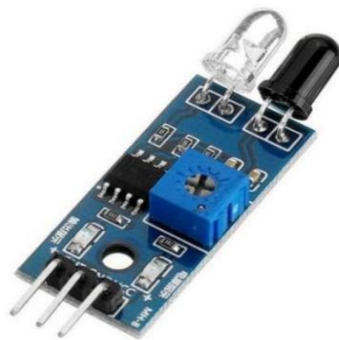


Fig6.2.3.3.1IR Sensor

### 6.2.4 Relay module

A relay is an electromechanical component that serves as a switch. DC energises the relay coil, allowing contact switches to be opened or closed. A coil and two contacts, such as normally open (NO) and normally closed (NC), are usually included in a single channel 5V relay module (NC). A 5v relay is **an** automatic switch that is typically used to regulate a high-current utilising a low-current signal in an automatic control circuit. The relay signal's input voltage varies from 0 to 5V.

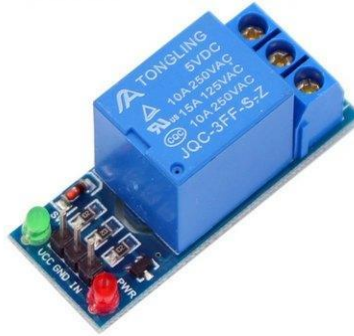


Fig6.2.4 Relay module

## 6.2.5 NODEMCU ESP8266 interface with BLYNK APP

The NodeMCU ESP8266 Wifi Module will accept orders from the smartphone via the internet. Blynk is an IoT platform that includes customised mobile apps, a private cloud, a rules engine, and a device management analytics dashboard. The software side of things becomes easier with Blynk than the hardware side. Blynk is ideal for interacting with small projects such as monitoring your room's temperature or remotely turning lights on and off.

## 6.2.6 Power supply

The 12V, 9Ah rechargeable sealed lead-acid (SLA) battery has a 5-hour (0.2) and 20-hour (0.05C) discharge rating. Because of lower losses, longer discharge times result in higher capacity readings.

The lead-acid performs well on high load currents. This battery act as an internal power supply for the whole circuit.



Fig6.2.6.1 Battery



## 6.3 Circuit Description

A programmed ARDUINO is coupled to sensors (soil moisture and temperature) and a wifi module in this circuit. The model's basic principle is to use an ARDUINO to store data from sensors and then send it to a wifi module. The wifi module uses cloud computing to provide data updates to a device. A rechargeable battery is attached to the power source. For charging the battery, there is also a charging circuit with an AC/DC converter. There is also an adaptor that can expressly provide power to ARDUINO circuits if the battery is not charged.

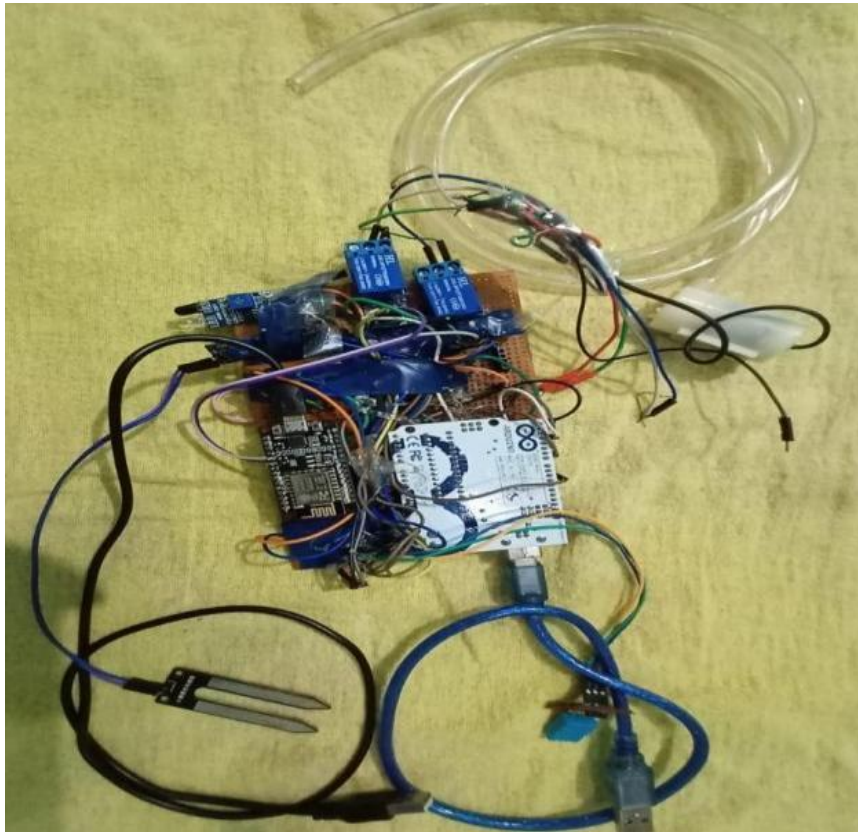


Fig 6.3.1 experimental setup

## 6.4 BLYNK APP

Blynk is a new platform that lets you easily create interfaces to manage and monitor your hardware projects from your iOS or Android mobile. You can create a project dashboard after downloading the Blynk software and arranging buttons, sliders, graphs, and other widgets on

the screen. You may use the widgets to turn pins on and off, as well as display data from sensors.



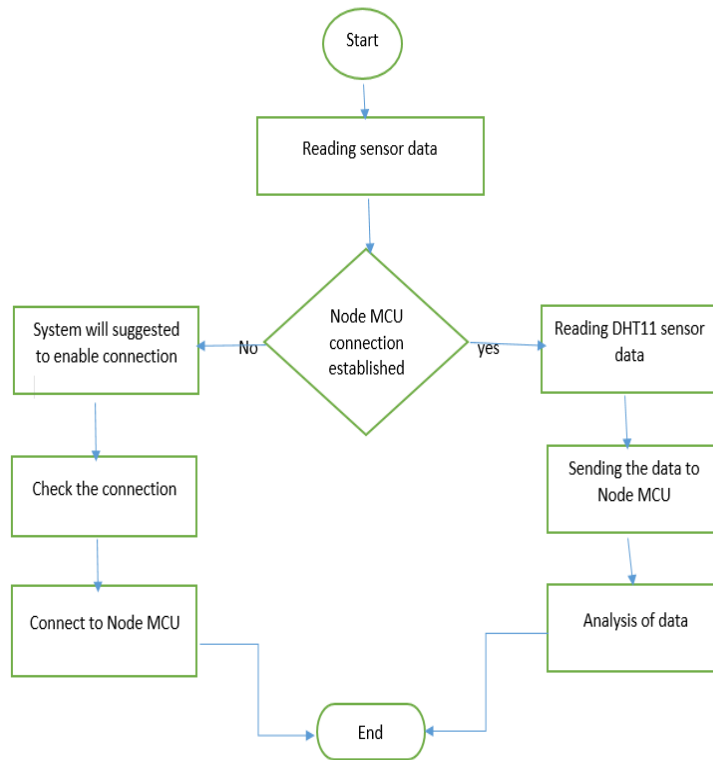
Fig 6.4.1BLYNK APP SETUP

## 6.5 Algorithm of entire process

- Step 1: Start the experimental setup.
- Step 2: Connected to wi-fi module
- Step 3: Read temperature and humidity values.
- Step 4: Get temperature and humidity value s from analog pins .
- Step 5: Read values from soil moisture sensor.
- Step 6: Delay to 10 seconds

- Step 7: Repeat step 4, 5 & 6 until the process end
- Step 8: End

## 6.6 Flowcharts



**Fig 6.6.1 Flow chart for connecting DHT 11 sensor to NODEMCU**

Step 1: Start the experimental setup.

Step 2: Process the data from DHT11 sensor.

Step 3: Check whether connection with nodemcu is established or not.

Step 4: If connection is established then continue the process or else return the control to the beginning and establish the connection.

Step 5: Read temperature and humidity values.

Step 6: Send the data to node mcu.

Step 7: Analyze the data and compare it with the threshold values.

Step 8: Display the output on the blynk app.

Step 9: End.



**6.6.2 flow chart for connecting soil moisture sensor to node mcu**

Step 1: Start the experimental setup.

Step 2: Process the data from soil moisture sensor.

Step 3: Check whether connection with nodemcu is established or not.

Step 4: If connection is established then continue the process or else return the control to the beginning and establish the connection.

Step 5: Read soil moisture values.

Step 6: Send the data to node mcu.

Step 7: Analyze the data and compare it with the threshold values.

Step 8: Display the output on the blynk app.

Step 9: End.



### 6.6.3 Flow chart for Connecting water level sensor to Node MCU

Step 1: Start the experimental setup.

Step 2: Process the data from water level sensor.

Step 3: Check whether connection with nodemcu is established or not.

Step 4: If connection is established then continue the process or else return the control to the beginning and establish the connection.

Step 5: Read water level values.

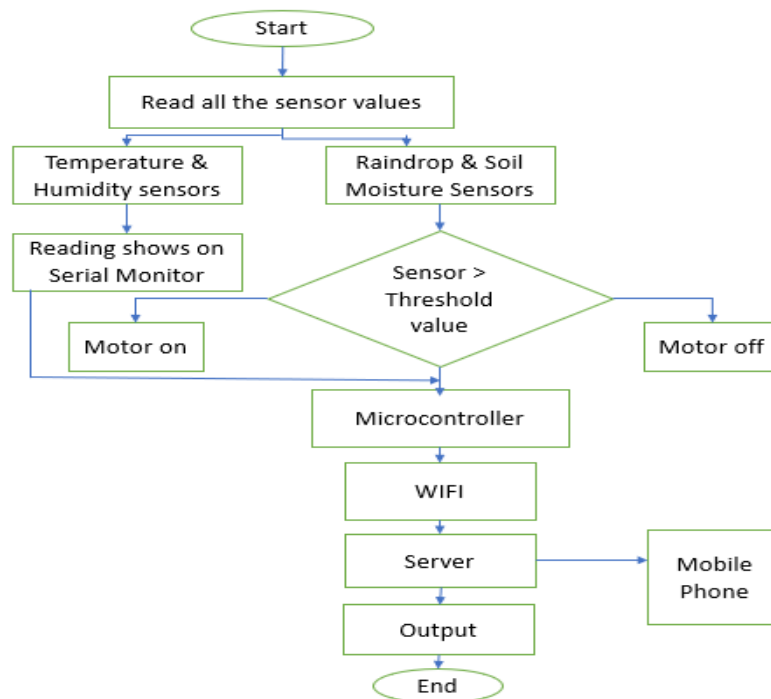
Step 6: Send the data to node mcu.

Step 7: Analyze the data and compare it with the threshold values.

Step 8: Check the availability of water.

Step 9: If water available is above the level (or) less than minimum level end the process.

Step 10: End.



6.6.4 Flow chart of entire process

# CHAPTER 7

## RESULTS, CONCLUSION&FUTURE SCOPE

### 7.1 Conclusion

We've created an automated Smart Agriculture solution that saves time and resources as compared to doing it manually. The Internet of Things technology is used in this system. Smart agriculture using IoT will revolutionise the world of farming, increasing productivity, improving quality, and maybe saving farmer's lives. A technology that makes the agricultural process easier and less burdensome for farmers is urgently needed. With recent technological advancements, it has become important to improve our country's annual crop production output, as India is an entirely agro-centric economy. One of the primary goals of implementing such technology into the country's agricultural domain is to save natural resources while also providing a significant boost to crop productivity. Water and time have been the most significant considerations in order to save farmers' time and effort. The technology can also detect soil moisture and water levels in fields. When the conditions are good, such as proper illumination or lightning, this method works well, and it may be improved further when the conditions are not ideal. Based on our findings and a review of the literature, we discovered that the technology and materials we used to produce our prototype allowed us to create a cost-effective, efficient, and accurate product for farmers. For farmers, it was also cost-effective and simple to install. As a result, we can infer that with the user-friendly app and other alarm mechanisms, this prototype will undoubtedly assist small-scale farmers in successfully monitoring their crops.

These systems allow farmers to monitor the condition of the soil and the growth of the crop in it, as well as solve irrigation, temperature, and humidity issues. The availability of sensors for agricultural parameters and microcontrollers can be easily interfaced with each other, and the challenges faced by farmers can be reduced with the help of Internet of Things, wireless sensor networks communication, and a better communication path for the transfer of useful data can be achieved between various nodes. As a result, farmers may use their Smartphones or laptops to control various agricultural equipment and monitor their harvest. These systems

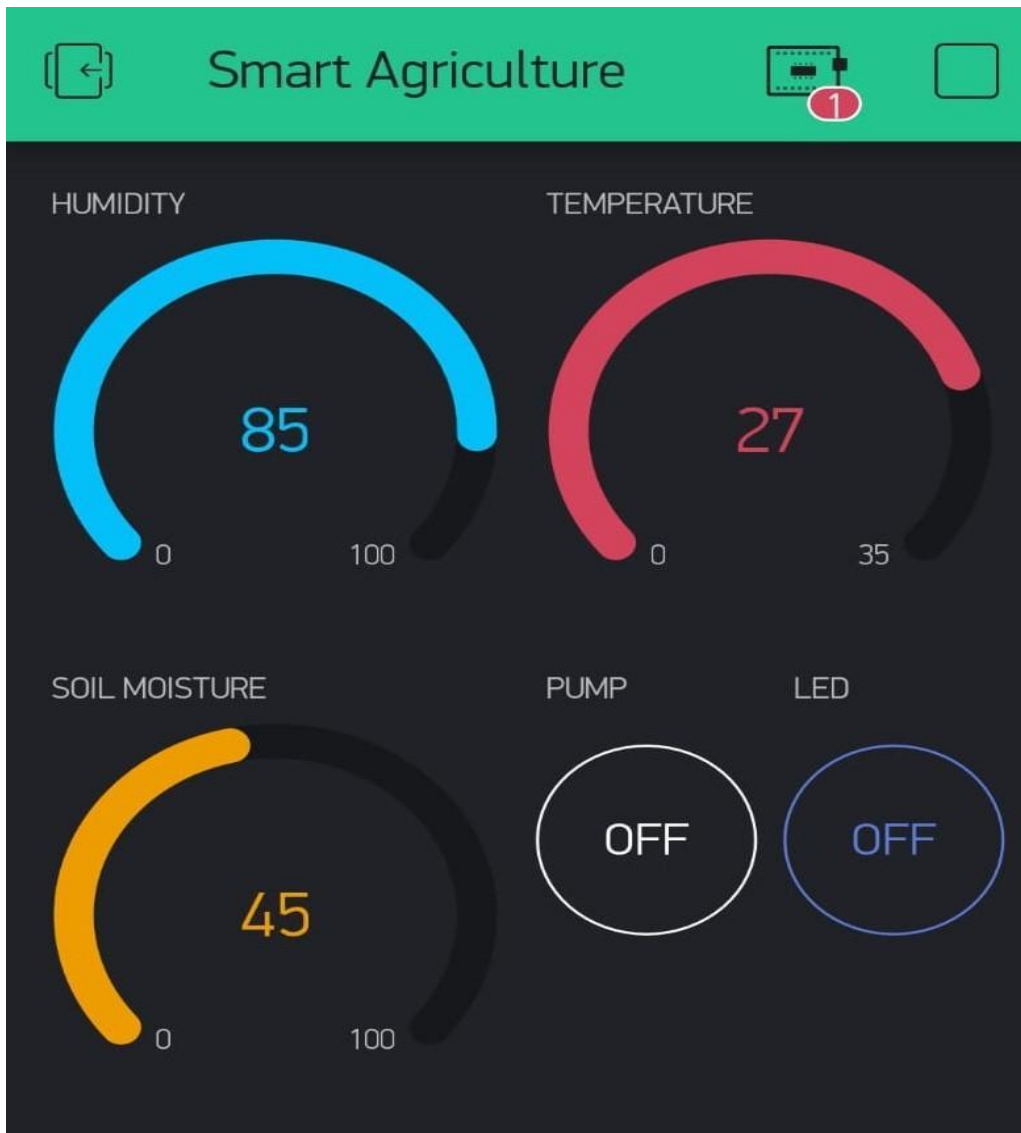
provide a wide range of applications for users to increase their skills and crop productivity. In the near future, these methods will aid in increasing rice, wheat, maize, and other agricultural productivity in India. With the help of IOT, it is possible to regulate the state of the yield and growth, as well as check soil, temperature, and humidity.

## 7.2 Output Graphs

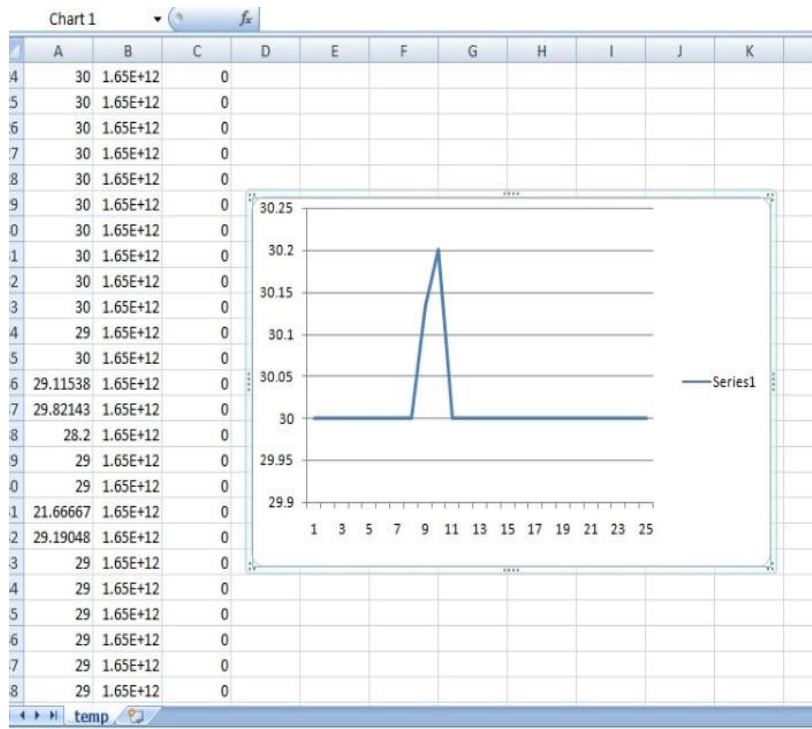


Fig7.2.1 Live data of Temperature, humidity and soil moisture

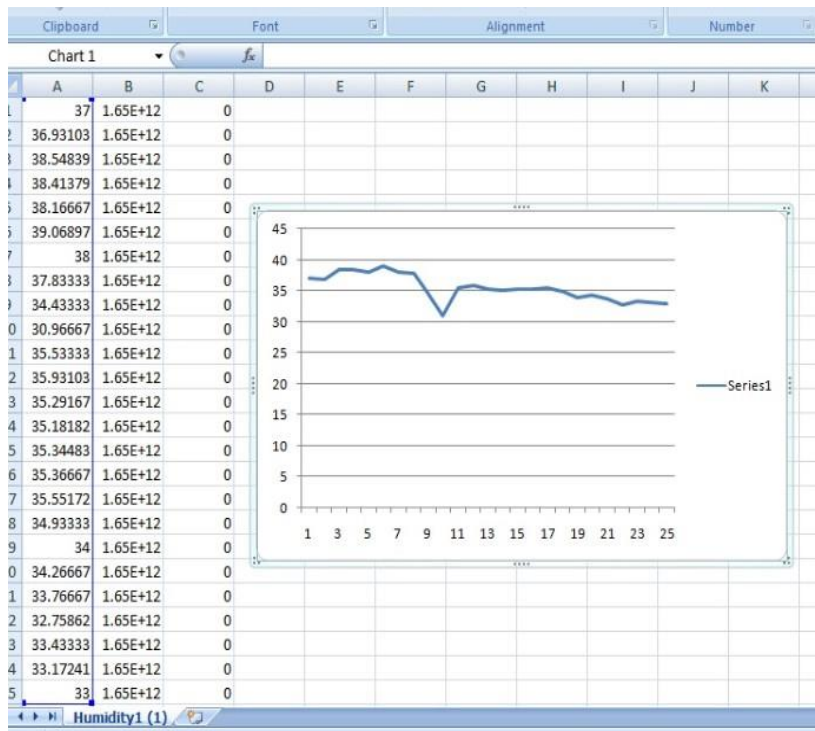




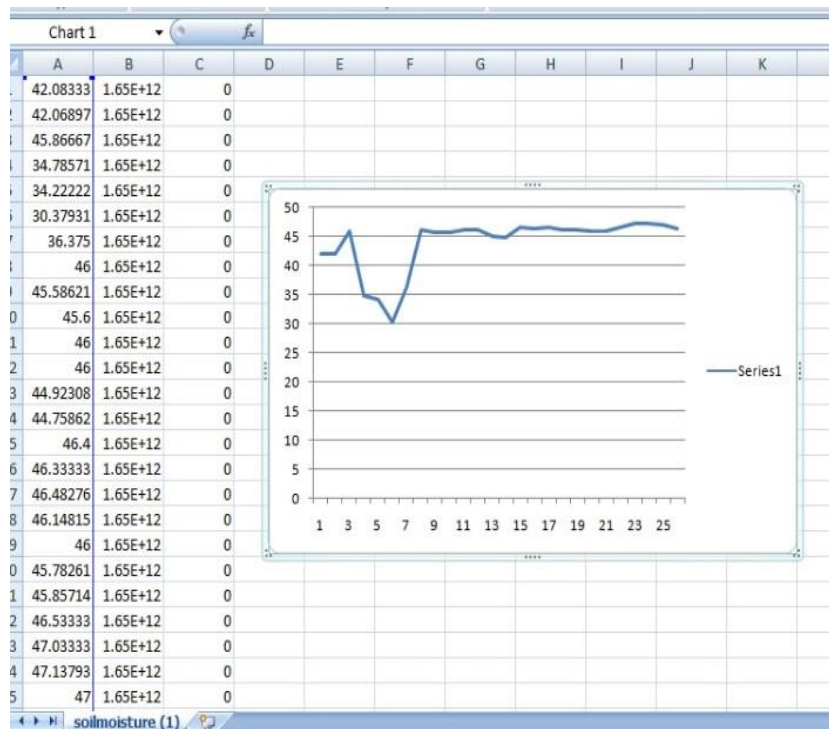
**Fig 7.2.2** Live feed of Temperature, humidity and soil moisture human alert from BLYNK APP.



**Fig7.2.3 Live feed of Temperature using CSV file from BLYNK APP**



**Fig7.2.4 Live feed of Humidity using CSV file from BLYNK APP**



**Fig7.2.5 Live feed of Soil Moisture using CSV file from BLYNK APP**

### 7.3 Future scope

Smart farming is gaining popularity. Smart farming is a notion that is rapidly gaining traction in the agriculture industry. There are certainly many advantages a networked farm has to offer, such as high-precision crop control, relevant data collecting, and automated farming practises. IoT technologies help growers and farmers to reduce waste and increase output. Smart agriculture sensors, agricultural drones, livestock tracking and geofencing, smart greenhouses, and predictive analytics for smart farming all contribute to the data collected. According to a BI Intelligence survey, the adoption of IoT devices in the agriculture business will reach 75 million by 2020, expanding at a rate of 20% each year. Simultaneously, the global smart agricultural market is predicted to treble in size by 2025, to \$15.3 billion. It is safe to call this sort of farming smart in the future, with efficient, data-driven, and extremely precise farming methods. We may anticipate the Internet of Things to forever alter the way we raise food.

## **PAPER PUBLICATION DETAILS**

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