AUTOMATED POT IRRIGATION AND IOT BASED MONITORING SYSTEM

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

Submitted by

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY AND SCIENCES
(UGC AUTONOMOUS)
(*Permanently Affiliated to AU, Approved by AICTE and Accredited by NBA & NAAC with 'A' Grade*)
Sangivalasa, bheemili mandal, visakhapatnam dist.(A.P)

2022-2023

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PRAGNANAM BRAHMA

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CERTIFICATE

This is to certify that the project report entitled **"AUTOMATED POT IRRIGATION AND IOT BASED MONITORING SYSTEM"** submitted by **Mr. V. Aravind Babu (319126512122)** ,**Mr. T .Vamsi (319126512123), Mr. P.Manikanta (319126512107)** , **Mr. M. Sai Anurag (319126512099)** in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in **Electronics & Communication Engineering** of Anil Neerukonda Institute of Technology and Sciences(A), Visakhapatnam is a record of bonafide work carried out under my guidance and supervision.

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ABSTRACT

Water is the most important resource for crop production and due to high demand of agricultural sector scarcity of water is increasing day by day. Water scarcity is becoming a major problem for sustainable crop production as it is over-used to meet the high demands of agriculture. Clay pot irrigation consists of baked unglazed clay pots buried up to the neck in the soil and filled with water. This method is one of the most efficient irrigation systems known and is ideal for many small farmers. Clay pot irrigation, commonly referred as Pitcher irrigation is a conventional method of irrigation and is the latest development and effective revolution in local irrigation methods, this has been found sustainable for areas where scarcity of water is major problem on crop production. Using this method improves soil physical properties, like soil fertility, soil structural condition, and soil organic carbon.

This project presents an Automated Pot Irrigation & IoT based monitoring system for irrigation using a Node MCU. The aim of this project is to explore the concept of a pot-based irrigation system using IoT, i.e., to develop a system that uses a Node MCU that processes data from an ultrasonic sensor that detects the water level in the pots and fills the pots automatically with water from the storage tank using an automatic solenoid valve and analyze the real-time water consumption of the plants and moisture content of soil using a smartphone with an internet connection. Research focuses mainly on crops and horticulture. In this project we use IOT to monitor the water level of pots using an ultrasonic sensor and to monitor the moisture content of soil. The limitations of this project as a whole is that the distance between the plants must be as large as possible to fit a pot between them, placing ultrasonic sensors on each plant can be expensive, to solve this problem in this project we connect the bottom of the pots to maintain a consistent water level in each pot, reducing complexity.

Keywords: Soil organic carbon, Node MCU, Ultrasonic sensor, IOT, Solenoid valve.

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CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

Irrigation is the most important input for growing crops that require high water supply in agriculture. Clay pot irrigation, a traditional system of irrigation alternative to drip method is the latest advancement and effective innovation of localized methods of irrigation and found suitable where water scarcity becomes major stress for crop production. Pitcher irrigation is a self-regulative, low cost and eco-friendly technique of irrigation having a high potential of energy saving, water saving and very much efficiency in orchard planting.

Automated Pot Irrigation and IoT-Based Monitoring System is a modern solution to the age-old problem of efficiently irrigating plants while minimizing water wastage. With the advancement of technology, automated irrigation systems have become more popular and accessible to farmers and hobbyists alike. These systems use various sensors and IoT devices to monitor the moisture levels of the soil and the environmental conditions around the plant and adjust the irrigation accordingly.

This documentation aims to provide a comprehensive overview of the Automated Pot Irrigation and IoT-Based Monitoring System, its components, and its implementation. It will cover the benefits of using such a system, the components of the system, how to set it up, and how to monitor and control the irrigation process remotely. Additionally, it will discuss various case studies and examples of successful implementation of this technology in different settings.

By automating the irrigation process and using IoT-based monitoring, farmers and hobbyists can save water, reduce labor costs, and increase crop yields. This technology has the potential to revolutionize the way we irrigate plants, making it more efficient, sustainable, and profitable. With the information provided in this documentation, readers can gain a better understanding of Automated Pot Irrigation and IoT-Based Monitoring System and how it can be implemented in their own settings.

1.2 CLAY POT IRRIGATION

Clay pot irrigation is a time-tested method of delivering water to plants that has been used for centuries in many parts of the world. The process involves burying unglazed clay pots or vessels filled with water in the soil near the roots of the plants. The clay pots are porous, meaning they allow water to slowly seep out, providing a consistent supply of moisture directly to the plant's roots. It is also known as Pitcher Irrigation.

The basic principle behind clay pot irrigation is based on capillary action, which is the ability of water to move through small spaces. When a clay pot is buried in the soil, the water inside the pot moves through the tiny pores in the clay and is drawn towards the roots of the plant, where it is absorbed. This process continues until the water inside the pot is used up or until the soil around the pot is fully saturated.

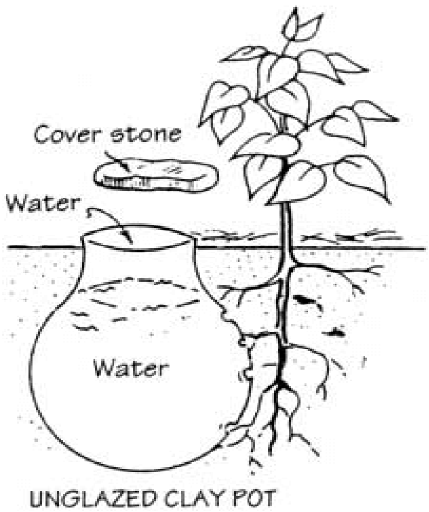


Fig 1.1 Clay Pot Irrigation.

One of the main benefits of clay pot irrigation is that it can be an efficient use of water. Since the water is delivered directly to the plant's roots, it is not lost to evaporation or runoff, which can occur with other watering methods. This also helps to reduce the frequency of watering needed, as the soil around the plant can retain moisture for longer periods of time.

Another benefit of clay pot irrigation is that it can help to reduce the risk of overwatering, which can be harmful to plants. With traditional watering methods, it can be difficult to control the amount of water delivered to the plant, leading to the risk of overwatering. However, with clay pot irrigation, the water is delivered slowly and consistently, reducing the risk of overwatering and waterlogging.
Clay pot irrigation can also be a low-cost and sustainable solution for gardeners, as the clay pots can be reused for many years. Additionally, it can be a particularly useful method of watering for areas with water scarcity, as it can help to conserve water and ensure that plants receive the moisture they need to thrive.

In summary, clay pot irrigation is a simple and effective method of watering plants that has been used for centuries. By delivering water directly to the roots of the plant and reducing the risk of overwatering, this method of irrigation can help to conserve water and promote healthy plant growth.

1.2.1 Conditions for Clay Pot Irrigation

i. **Soil type:** Clay pot irrigation is suitable for a variety of soil types, including sandy, loamy, and clay soils. However, it is important to ensure that the soil is well-drained to prevent waterlogging, which can be harmful to plants.

ii. **Climate:** Clay pot irrigation is suitable for a variety of climates, including hot and dry climates. However, in areas with high humidity or heavy rainfall, the water inside the clay pot may not be able to evaporate, leading to waterlogging.

iii. **Plant type:** Clay pot irrigation is suitable for a variety of plants, including vegetables, flowers, and trees. However, it may not be suitable for plants that require very dry conditions, such as cacti and succulents.

iv. **Pot type and size:** The type and size of the clay pot used for irrigation can impact its effectiveness. Unglazed clay pots are recommended, as they allow water to slowly seep out of the pot. The size of the pot should also be appropriate for the size of the plant being watered, as larger pots will deliver more water than smaller pots.

v. **Water source:** The water used for clay pot irrigation should be clean and free from contaminants, such as chemicals or bacteria. Rainwater or well water is often a good choice for clay pot irrigation.

vi. **Frequency of watering:** The frequency of watering with clay pot irrigation will depend on a variety of factors, including the climate, soil type, and plant type. In general, it is recommended to water plants with clay pot irrigation once a week or as needed, depending on the soil moisture level.

vii. **Placement of pots:** The placement of the clay pots in the soil is important for effective irrigation. The pots should be buried in the soil near the roots of the plant, with the top of the pot at or slightly above the soil level. This will ensure that the water is delivered directly to the plant's roots.

viii. **Maintenance:** Regular maintenance is important for effective clay pot irrigation. This may include cleaning the pots, checking the water level in the pots, and replacing the water as needed.

Adopting clay pot irrigation requires consideration of a variety of conditions, including soil type, climate, plant type, pot type and size, water source, frequency of watering, placement of pots, and maintenance. By carefully considering these factors, gardeners can effectively use clay pot irrigation to promote healthy plant growth and conserve water in areas with water scarcity.

1.2.2 Advantages of Clay Pot Irrigation

i. **Efficient use of water:** Clay pot irrigation delivers water directly to the plant's roots, reducing the amount of water lost to evaporation or runoff. This makes it an efficient use of water and can help conserve water in areas with water scarcity.

ii. **Reduces the risk of overwatering:** With traditional watering methods, it can be difficult to control the amount of water delivered to the plant, which can lead to overwatering and waterlogging. However, with clay pot irrigation, the water is delivered slowly and consistently, reducing the risk of overwatering and promoting healthy plant growth.

iii. **Saves time and effort:** Since clay pot irrigation delivers water directly to the plant's roots, it reduces the need for frequent watering and can save time and effort for gardeners.

iv. **Low cost and sustainable:** Clay pots can be reused for many years, making clay pot irrigation a low-cost and sustainable solution for watering plants.

v. **Suitable for a variety of plants:** Clay pot irrigation can be used for a variety of plants, including vegetables, flowers, and trees. It is particularly useful for plants that require consistent moisture, such as tomatoes and peppers.

vi. **Prevents weed growth:** Since clay pot irrigation delivers water directly to the plant's roots, it can help prevent weed growth by reducing the amount of moisture in the soil that weeds require to germinate.

vii. **Improves soil structure:** Clay pot irrigation promotes healthy soil structure by delivering water directly to the plant's roots. This can help prevent soil erosion and improve soil fertility.

viii. **Reduces the risk of disease:** By reducing the amount of water on the leaves of the plant, clay pot irrigation can help reduce the risk of disease caused by fungal or bacterial infections.

ix. **Can be combined with other watering methods:** Clay pot irrigation can be used in conjunction with other watering methods, such as drip irrigation or sprinklers, to provide plants with a consistent supply of moisture.

1.2.3 Drawbacks

i. **Limited coverage:** Clay pot irrigation is suitable for small areas and individual plants, but it may not be practical for larger gardens or agricultural fields.

ii. **Time-consuming setup:** Setting up clay pot irrigation can be time-consuming, as each pot must be buried in the soil and filled with water.

iii. **Risk of clogging:** The small pores in the clay pots can become clogged with dirt or other debris, reducing their effectiveness and requiring more frequent cleaning.

iv. **Risk of breakage:** Clay pots can be fragile and may break if they are not handled carefully during installation or maintenance.

v. **Inconsistent water delivery:** The rate of water delivery with clay pot irrigation can vary depending on factors such as soil type, pot size, and placement, leading to uneven moisture levels in the soil.

vi. **High initial cost:** Although clay pot irrigation is a sustainable solution, the initial cost of purchasing clay pots and setting up the irrigation system can be higher than other irrigation methods, such as sprinklers or drip irrigation.

vii. **Susceptibility to freezing:** In colder climates, clay pots may be susceptible to freezing during the winter, which can damage the pots and reduce their effectiveness.

viii. **Maintenance requirements:** Regular maintenance is required to keep the clay pots clean and free from clogs, which can be time-consuming for larger gardens or agricultural fields.

Clay pot irrigation has some drawbacks that may limit its use in certain situations. However, for small gardens or individual plants, clay pot irrigation can be a sustainable and efficient way to deliver water directly to the plant's roots while conserving water. By carefully considering the limitations and maintenance requirements of clay pot irrigation, gardeners can determine if it is a suitable irrigation method for their needs.

1.2.4 Installation and Setup

A step-by-step guide for the installation and setup of clay pot irrigation.

Materials needed:

1. Clay pots (the number and size will depend on the area you are irrigating and the size of the plants)
2. Hose or other water source
3. Watering can or bucket

Steps to Follow:

i. **Choose the right pots:** Select clay pots that are porous and unglazed, with a hole in the bottom for water to flow out. The size of the pot will depend on the size of the plant you want to irrigate.

ii. **Prepare the pots:** Soak the pots in water for at least 30 minutes before installation. This will help prevent air pockets in the soil and ensure the pots are fully saturated before planting.

iii. **Dig holes:** Dig holes in the soil where you want to place the pots. The holes should be slightly larger than the pots to allow for easy placement.

iv. **Place the pots:** Place the pots into the holes and bury them up to the neck of the pot, leaving the top of the pot exposed. The soil should be packed tightly around the pot to prevent air pockets.

v. **Fill the pots with water:** Fill the pots with water using a watering can or bucket. The water will slowly seep through the pores of the clay and irrigate the soil around the plant. Make sure to fill the pots regularly to maintain a consistent water supply.

vi. **Check the water level:** Check the water level in the pots regularly to make sure they do not dry out. Refill the pots with water as needed to maintain a consistent water supply.

vii. **Adjust the watering frequency:** The frequency of watering will depend on the climate, soil type, and the size of the pot. For hot and dry conditions, the pots may need to be filled more frequently. In cooler and more humid conditions, the pots may need to be filled less often.

viii. **Adjust the placement of the pots:** If the plants are not getting enough water, try adjusting the placement of the pots. Move them closer to the plants or place additional pots around the area to provide more water.

ix. **Maintenance:** Regularly check the pots for clogs or damage, and clean them as needed. The pots may become clogged with soil or debris over time, reducing their effectiveness. Cleaning the pots can help ensure that they continue to deliver water to the plants effectively.

By following these steps, you can install and set up a clay pot irrigation system to efficiently and sustainably irrigate your plants. Remember to monitor the pots regularly and adjust the watering frequency as needed to maintain optimal plant growth and health.

1.2.5 Maintenance

i. **Clean the pots regularly:** Over time, clay pots can become clogged with soil or debris, reducing their effectiveness in delivering water to the plants. To prevent this, it is important to clean the pots regularly. Use a brush or cloth to gently scrub the inside and outside of the pots, removing any buildup of dirt or sediment.

ii. **Check the water level:** Regularly check the water level in the pots to make sure they do not dry out. Refill the pots with water as needed to maintain a consistent water supply. The frequency of filling the pots will depend on the climate, soil type, and the size of the pot.

iii. **Check for clogs or damage:** Check the pots for any signs of damage or clogs. If a pot is cracked or broken, it may need to be replaced. If a pot is clogged, use a small wire or toothpick to remove any debris that may be blocking the flow of water.

iv. **Adjust the watering frequency:** Adjust the frequency of watering as needed, based on changes in weather or other factors. In hot and dry conditions, the pots may need to be filled more frequently. In cooler and more humid conditions, the pots may need to be filled less often.

v. **Adjust the placement of the pots:** If the plants are not getting enough water, try adjusting the placement of the pots. Move them closer to the plants or place additional pots around the area to provide more water.

vi. **Monitor plant growth and health:** Regularly monitor the growth and health of the plants to ensure that they are receiving adequate water. If the plants are showing signs of stress or wilting, they may not be getting enough water and adjustments may need to be made to the clay pot irrigation system.

vii. **Winter storage:** If you live in a cold climate, you may need to store the clay pots during the winter months to prevent them from cracking due to freezing temperatures. Clean the pots thoroughly and store them in a dry, protected area until the weather warms up again.

1.2.6 Tips for Successful Clay Pot Irrigation

i. **Choose the right pots:** Use unglazed clay pots that are porous and have a hole in the bottom for water to flow out. Make sure the size of the pot is appropriate for the size of the plant.

ii. **Soak the pots before installation:** Soak the pots in water for at least 30 minutes before installation. This will help prevent air pockets in the soil and ensure the pots are fully saturated before planting.

iii. **Install the pots correctly:** Bury the pots up to the neck, leaving the top of the pot exposed. Pack the soil tightly around the pot to prevent air pockets.

iv. **Fill the pots with water:** Fill the pots with water using a watering can or bucket, and make sure the water level is maintained at all times.

v. **Monitor plant growth and health:** Regularly monitor the growth and health of the plants to ensure that they are receiving adequate water. Adjust the watering frequency as needed, based on changes in weather or other factors.

vi. **Use a cover crop:** Plant a cover crop around the pots to help retain moisture and prevent the soil from drying out.

vii. **Consider adding fertilizer:** Clay pot irrigation can be more effective when combined with a slow-release fertilizer, which can be added to the soil before planting.

viii. **Use mulch:** Mulch around the base of the plant to help retain moisture and reduce evaporation.

ix. **Position the pots correctly:** Place the pots close to the plants that need to be watered, and position them in areas that receive adequate sunlight.

x. **Clean the pots regularly:** Regularly clean the pots to prevent clogs and blockages in the water flow.

1.3 COMPARISON TO OTHER METHODS

i. **Drip Irrigation:** Drip irrigation systems use a network of tubes or pipes with small holes or emitters to deliver water directly to the plant roots. Unlike clay pot irrigation, drip irrigation systems require a larger initial investment and can be more complex to install. However, they can be more efficient in water usage, as they allow for more precise control over the amount of water delivered to each plant.

ii. **Sprinkler Irrigation:** Sprinkler irrigation systems spray water over a large area, similar to rainfall. They are often used for larger agricultural or landscape irrigation projects, and can be less efficient in water usage than other methods. Unlike clay pot irrigation, sprinkler systems can be prone to evaporation, which can reduce their effectiveness in delivering water to the plants.

iii. **Flood Irrigation:** Flood irrigation involves flooding a field or area with water and allowing the water to seep into the soil. This method can be less efficient in water usage and can lead to soil erosion and nutrient loss. Unlike clay pot irrigation, flood irrigation can also be difficult to control, which can result in overwatering or underwatering.

iv. **Manual Watering:** Manual watering involves using a watering can or hose to deliver water to plants. While this method is simple and easy to use, it can be time-consuming and may not be as efficient in water usage as other methods. Unlike clay pot irrigation, manual watering also requires regular monitoring and can be prone to overwatering or underwatering.

Compared to these other irrigation methods, clay pot irrigation is relatively simple and low-cost to install and maintain. It is also an effective way to conserve water and deliver it directly to the plant roots. However, it may not be as efficient in water usage as other methods like drip irrigation, and may not be as effective for larger agricultural or landscape irrigation projects. Ultimately, the choice of irrigation method will depend on a variety of factors, including the size of the project, the type of plants being grown, and the local climate and soil conditions.

1.4 AUTOMATED POT IRRIGATION

This project presents an Automated Pot Irrigation & IoT based monitoring system for irrigation using a Node MCU. The aim of this project is to explore the concept of a pot-based irrigation system using IoT, i.e., to develop a system that uses a Node MCU that processes data from an ultrasonic sensor that detects the water level in the pots and fills the pots automatically with water from the storage tank using an automatic solenoid valve and analyze the real-time water consumption of the plants and moisture content of soil using a smartphone with an internet connection. Research focuses mainly on crops and horticulture. In this project we use IOT to monitor the water level of pots using an ultrasonic sensor and to monitor the moisture content of soil. The limitations of this project as a whole is that the distance between the plants must be as large as possible to fit a pot between them, placing ultrasonic sensors on each plant can be expensive, to solve this problem in this project we connect the bottom of the pots to maintain a consistent water level in each pot, reducing complexity.

CHAPTER 2
HARDWARE REQUIRED

2.1 COMPONENTS REQUIRED

- Node MCU esp8266
- Relay module
- Ultrasonic Sensor
- Capacitive Moisture Sensor
- Solenoid Valve
- 12V DC adapter
- PVC pipes
- Connecting Jumper wires

2.2 NODE MCU:

2.2.1 About Node MCU:

NodeMCU is an open-source firmware and development board designed for IoT applications. It is based on the ESP8266 Wi-Fi module and features an easy-to-use interface for prototyping IoT projects. The NodeMCU board has built-in Wi-Fi connectivity, with IEEE 802.11 b/g/n support and a range of up to 100m in open space.

Fig 2.1 Node_MCU ESP8266

It can be programmed using Lua scripting language or the Arduino IDE, making it ideal for beginners and professionals alike. The board has 11 digital input/output pins and one analog input pin, which can be used to interface with sensors, actuators, and other electronic components. Additionally, the NodeMCU board has an integrated USB-to-serial converter, making it easy to program and interface with a computer. The board can be powered using a USB cable or an external power supply, with a voltage range of 4V to 9V. It also has a built-in voltage regulator that allows it to operate from a wide range of power sources.

The NodeMCU board has 4MB flash memory, which can be used to store firmware and data, and 80KB of RAM for program execution. It supports OTA (Over-The-Air) programming, allowing firmware updates to be performed remotely. Other specifications include clock speed of up to 80MHz, 3.3V logic level, SPI, I2C, and UART communication protocols, and support for SSL/TLS encryption for secure communication. The board also has a micro-USB port, a reset button, and an LED indicator. It can be used with a variety of sensors and actuators, such as temperature and humidity sensors, motion detectors, and relay modules. Overall, the NodeMCU board is a versatile and powerful platform for building IoT applications due to its ease of use, flexibility, and low cost. It is an ideal choice for hobbyists, students, and professionals looking to create innovative IoT projects.

2.2.2 Pin Configuration of Node MCU

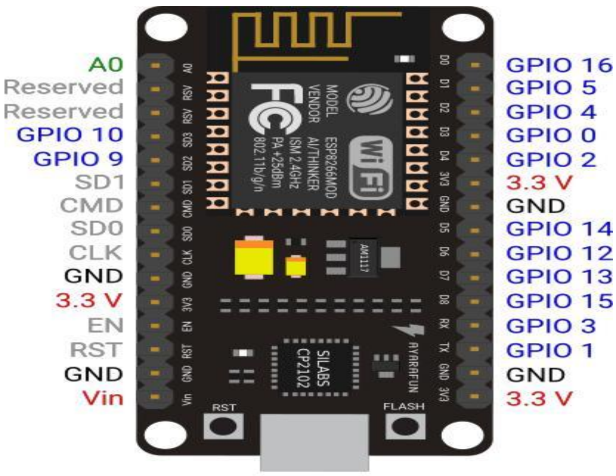


Fig 2.2 Node_MCU Pin diagram

1. **Power Pins:**

NodeMCU has two power pins, labeled as 3V3 and GND. The 3V3 pin provides a regulated output of 3.3 volts, which is used to power the board and connected peripherals. The GND pin is the ground connection for the board and connected peripherals.

2. **Analog Pins:**

NodeMCU has one analog input pin, labeled as A0. This pin can be used to read analog signals from sensors, such as light sensors, temperature sensors, and more. The analog input pin has a maximum input voltage of 3.3V.

3. **Digital Pins**

NodeMCU has 17 digital pins, labeled as GPIO0 to GPIO16. These pins can be configured as inputs or outputs, and can be used to interface with a wide range of electronic components, such as sensors, LEDs, relays, and more. These pins operate at a voltage of 3.3V, which is compatible with most electronic components.

4. **ADC Channel**

NodeMCU has one analog input pin, A0, connected to a 10-bit resolution ADC module. It is used to read analog signals from sensors, and can measure voltage levels from 0 to 3.3V. The analogRead() function can be used to read the input voltage on the A0 pin. A low-pass filter or averaging can be used to improve measurement accuracy due to possible introduced noise by the ADC module.

5. **I2C pins**

NodeMCU has SDA (data line) and SCL (clock line) pins for I2C communication, connected to GPIO4 and GPIO5 respectively. The I2C protocol allows for two-wire communication between microcontrollers and other devices, such as sensors. The SDA pin is used for data transmission, while the SCL pin is used for clock synchronization. The I2C interface supports multiple devices on the same bus using different addresses, and can be configured using the Wire library in Arduino IDE or the corresponding Lua functions.

6. **UART Pins**

NodeMCU has two pins, labeled TXD (transmit) and RXD (receive), which are used for UART communication. They are connected to GPIO1 and GPIO3, respectively, on the ESP8266 module. The UART protocol is used for asynchronous serial communication between devices, such as microcontrollers and computers, using two wires for data transmission. The TXD pin is used for transmitting data, while the RXD pin is used for receiving data. The UART pins can be configured using the Serial library in Arduino IDE or the corresponding Lua functions.

7. **Control Pins**

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

8. **EN pin**

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

9. **RST pin**

RST pin is used to reset the ESP8266 chip.

10. **WAKE pin**

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

2.2.3 Power Requirement

The power requirements of NodeMCU depend on various factors, such as the power source, the connected peripherals, and the operating conditions. However, in general, NodeMCU requires a voltage supply between 4.5V to 9V, and a minimum current of 500mA. The NodeMCU board includes a built-in voltage regulator that can handle input voltages up to 12V, but it is recommended to use a stable power supply to avoid voltage fluctuations that can cause issues with the board's performance. When operating the NodeMCU with Wi-Fi enabled and connected to a network, it can consume up to 200mA of current, depending on the signal strength and the data transfer rate. Therefore, it is important to use a power supply that can provide sufficient current to avoid stability issues or resets. It is also recommended to avoid connecting high-power peripherals directly to the NodeMCU's GPIO pins, as this can cause voltage drops and affect the stability of the board. Instead, it is recommended to use external power sources or voltage level shifters, if needed.

2.2.4 NodeMCU ESP8266 Specifications & Features:

Specifications

- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106, ESP8266EX
- Clock Speed: 80MHz
- Flash Memory: 4MB
- Wi-Fi Protocol: 802.11 b/g/n
- Wi-Fi Frequency: 2.4 GHz
- Operating Voltage: 3.3V
- GPIO Pins: 17
- Analog Input Pins: 1 (maximum input voltage 3.3V)
- I2C Interface: Yes
- SPI Interface: Yes
- UART Interface: Yes

- ADC Resolution: 10-bit
- Maximum Current: 500mA

Features

- Operating Voltage: 3.3V
- Built-in Wi-Fi module with antenna
- Support for TCP/IP protocols
- Built-in Lua interpreter for easy programming
- Support for Arduino IDE, MicroPython, and Node.js
- Easy access to GPIO, I2C, SPI, and UART interfaces
- Support for PWM (Pulse Width Modulation) output
- Support for one-wire interface
- USB interface for power and programming
- Integrated voltage regulator
- Breadboard-friendly design
- Low cost and easy to use

2.2.5 Applications of Node MCU

- Prototyping of IoT devices
- Low power battery operated applications
- Network projects
- Projects requiring multiple I/O interfaces with Wi-Fi and Bluetooth functionalities.
- Smallest IoT Home Automation using ESP8266 – 01 with Vide
- Geolocation using ESP8266.
- ESP8266 Projects: Wireless Web Server. ...
- World's smallest IoT project. ...
- Air Pollution Meter. ...
- Humidity and temperature monitoring.

2.3 RELAY MODULE

2.3.1 About Relay Module

The relay module is an electrically operated switch that can be turned on or off deciding to let current flow through or not. They are designed to be controlled with low voltages like 3.3V like the ESP32, ESP8266, etc, or 5V like your Arduino.

Fig 2.3 Relay Module

Relay is one kind of electro-mechanical component that functions as a switch. The relay coil is energized by DC so that contact switches can be opened or closed. A single channel 5V relay module generally includes a coil, and two contacts like normally open (NO) and normally closed (NC)

2.3.2 Pin Configuration

Fig 2.4 Pin Configuration of Relay Module

1) **VCC:** This pin is used to supply power to the relay module. It is typically connected to the positive terminal of the power supply, and can accept a voltage between 5V and 12V, depending on the module.

2) **GND:** This pin is connected to the ground terminal of the power supply and provides the ground reference for the entire circuit.

3) **IN:** This pin is used to control the relay. It accepts a logic-level input signal from a microcontroller or other control circuit and is used to switch the relay on and off.

4) **COM:** This pin is the common pin of the relay and is connected to one end of the load that needs to be switched. When the relay is activated, the COM pin is connected to either the NO or NC pin, depending on the type of relay.

5) **NO/NC:** These pins are the output pins of the relay and are connected to the other end of the load that needs to be switched. The NO (Normally Open) pin is connected to the COM pin when the relay is activated, and the NC (Normally Closed) pin is disconnected from the COM pin when the relay is activated.

2.3.3 Working of Relay Module

A relay module is an electronic device that is used to switch high-voltage or high-current circuits using low-voltage or low-current control signals. The relay module consists of a relay, a driver circuit, and some additional components for protection and isolation. The relay itself is an electromagnetic switch that consists of a coil and one or more contacts. When a current is applied to the coil, it generates a magnetic field that attracts the contacts and closes the circuit. When the current is removed from the coil, the contacts return to their original position and open the circuit. The driver circuit in the relay module is responsible for controlling the current to the relay coil based on the control signals received from a microcontroller or other control device. The driver circuit typically consists of a transistor or a solid-state relay that can handle the current required by the relay coil. The additional components in the relay module provide protection and isolation between the control circuit and the high-voltage or high-current circuit being controlled. These components may include diodes for protection against voltage spikes and optocouplers for electrical isolation. To use a relay module, you would typically connect the control signal to the input pins of the module and connect the high-voltage or high-current circuit to the output pins of the module. When the control signal is activated, the relay module will switch the high-voltage or high-current circuit on or off depending on the configuration of the module.

2.3.4 Specifications of Relay Module

- Input voltage: 5V DC
- Input current: 70mA
- Maximum switching voltage: 250V AC / 30V DC
- Maximum switching current: 10A
- Maximum switching power: 1200W
- Relay lifespan: 100,000 cycles
- Operating temperature range: -40°C to +70°C
- Dimensions: 25mm x 34mm x 25mm
- Weight: 14g

2.3.5 Features of Relay Module

- Easy to use: Relay modules are designed to be easy to use and can be integrated with a variety of microcontrollers or other control circuits.
- Low power consumption: Relay modules typically have low power consumption, making them ideal for use in battery-powered applications.
- High switching capacity: Relay modules are capable of switching high voltages and currents, making them ideal for controlling larger loads such as motors and lights.
- Multiple channels: Many relay modules have multiple channels, allowing you to control multiple loads simultaneously.
- Opto-isolation: Relay modules often use opto-isolation to protect the control circuit from voltage spikes or other electrical noise that can damage sensitive components.

- LED indicators: Most relay modules have LED indicators to show the status of the relay, making it easy to troubleshoot and debug your circuit.
- Small size: Relay modules are often compact and easy to integrate into your projects, making them ideal for use in space-constrained applications.

2.4 ULTRASONIC SENSOR

2.4.1 About Ultrasonic Sensor

Ultrasonic sensors are devices that use sound waves to measure distance and detect objects. They emit high-frequency sound waves and then detect the waves that bounce back. By measuring the time it takes for the sound waves to bounce back, the sensor can determine the distance to the object. Ultrasonic sensors are commonly used in a wide range of applications, including robotics, automation, and automotive industry.

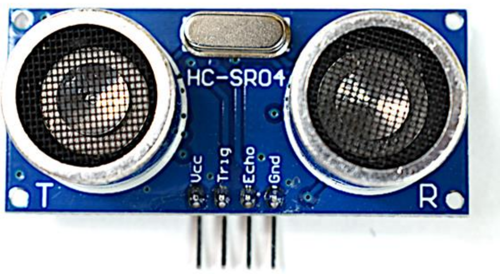


Fig 2.5 Ultrasonic Sensor

2.4.2 Principle of Ultrasonic Sensor

Ultrasonic sensors operate by emitting high-frequency sound waves that bounce back from objects in their path. The sensor measures the time it takes for the sound waves to return to the sensor and uses this information to calculate the distance to the object. The ultrasonic sensor consists of a transducer and a receiver. The transducer emits the sound waves and then switches to receive mode to detect the waves that bounce back. The receiver then sends a signal to a microcontroller, which calculates the distance to the object based on the time it takes for the sound waves to travel to and from the object.

Ultrasonic sensors typically consist of several components, including the transducer, receiver, and control circuit.

The transducer is the heart of the ultrasonic sensor, as it converts electrical signals into sound waves. It is typically made of piezoelectric material, which generates an electric charge when subjected to pressure or mechanical stress.

The receiver, also known as the detector, is responsible for receiving the sound waves that bounce back from objects. It is typically placed adjacent to the transducer and converts the sound waves into electrical signals.

The control circuit processes the signals from the receiver and calculates the distance to the object. It also controls the timing and frequency of the sound waves emitted by the transducer.

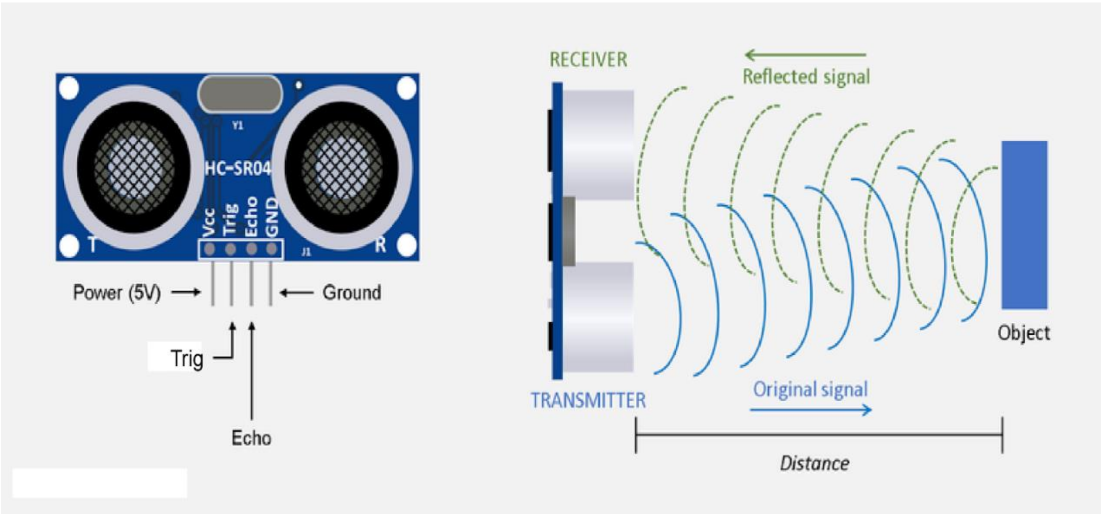


Fig 2.6 Pin Diagram and Working of Ultrasonic Sensor

2.4.3 Pin Configuration and Features

1) **Vcc** - The Vcc pin powers the sensor, typically with +5V
2) **Trigger** - Trigger pin is an Input pin. This pin has to be kept high for 10us to initialize measurement by sending US wave.

3) **Echo** - Echo pin is an Output pin. This pin goes high for a period of time which will be equal to the time taken for the US wave to return back to the sensor.
4) **Ground** - This pin is connected to the Ground of the system.

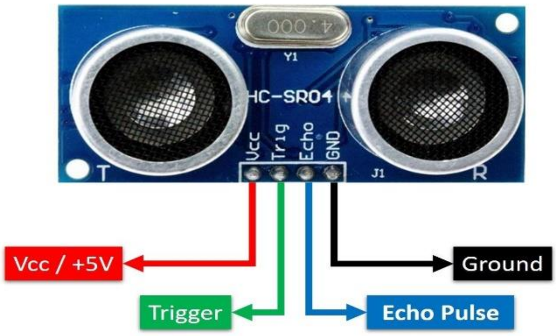


Fig 2.7 Pin Diagram of Ultrasonic Sensor

Features

- Operating voltage: +5V
- Theoretical Measuring Distance: 2cm to 450cm
- Practical Measuring Distance: 2cm to 80cm
- Accuracy: 3mm
- Measuring angle covered: <15°
- Operating Current: <15mA
- Operating Frequency: 40Hz

2.4.4 Applications of Ultrasonic Sensor

Ultrasonic sensors are used in a wide range of applications, including robotics and automation, automotive industry, distance measurement, level sensing, medical imaging and diagnostics, industrial automation, and security systems.

In the automotive industry, ultrasonic sensors are commonly used for parking sensors and collision avoidance systems. In the medical industry, they are used for medical imaging and diagnostics, such as ultrasound imaging. In industrial automation, they are used for detecting objects on conveyor belts.

2.4.5 Advantages and Limitations

Advantages:

One of the main advantages of ultrasonic sensors is their ability to detect objects without physically touching them. This makes them ideal for applications where contact with the object could cause damage or where physical contact is not possible.

Ultrasonic sensors are also highly accurate, with the ability to measure distances with a high degree of precision. They can be used in a wide range of environments, including harsh and hazardous environments, and have low power consumption, making them suitable for battery-powered applications.

Limitations:

Despite their many advantages, ultrasonic sensors also have some limitations that should be considered when designing systems that use them. One limitation is their limited range, with maximum ranges typically between 5 and 10 meters.

They are also sensitive to sound waves and interference from other ultrasonic sensors, which can lead to false readings.

2.5 CAPACTIVE SOIL MOISTURE SENSOR

2.5.1 About Capacitive Soil Moisture Sensor

A Capacitive soil moisture sensor is a device that measures the moisture content in soil by using the principle of capacitance. It consists of two electrodes that are inserted into the soil. The amount of moisture present in the soil affects the dielectric constant of the soil, which in turn affects the capacitance between the two electrodes.

The capacitive soil moisture sensor can be used in agriculture, horticulture, and environmental monitoring to determine when to water plants or crops. It is used to improve irrigation efficiency, optimize crop yield, and reduce water usage, leading to a more sustainable use of water resources.

One advantage of the capacitive soil moisture sensor is that it can measure moisture content at different depths of soil, providing a more comprehensive picture of soil moisture. Moreover, it is relatively easy to use and can be installed with minimal equipment and maintenance.

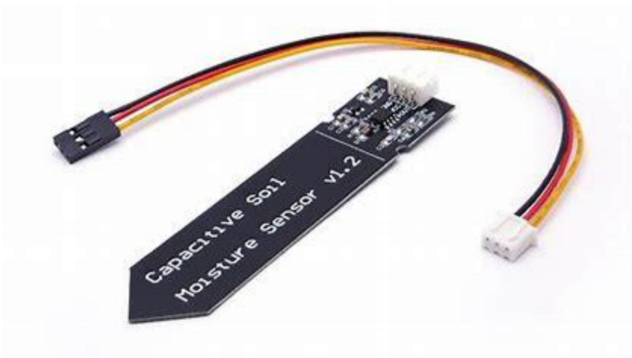


Fig 2.8 Capactive Moisture Sensor

2.5.2 Pin Configuration

The pin configuration of a capacitive soil moisture sensor typically consists of three pins:

1) **VCC** - This pin is connected to the positive supply voltage, usually 3.3V or 5V.
2) **GND** - This pin is connected to the ground or negative supply voltage.
3) **OUT** - This pin is the output pin, which provides an analog or digital signal indicating the soil moisture level. The output signal may vary depending on the sensor model and the circuit design. Some sensors may provide a voltage output, while others may use a frequency or pulse-width modulation (PWM) output.

2.5.3 Working of Sensor

A capacitive soil moisture sensor works by measuring the dielectric constant of soil, which is related to the amount of moisture or water content in it. The sensor consists of two electrodes or plates, which are usually parallel to each other and are separated by a small distance. When the sensor is inserted into the soil, the soil acts as a dielectric medium between the two electrodes.

The capacitance of the sensor changes depending on the water content or moisture level in the soil. When the soil is wet or has high moisture content, the dielectric constant is high, and the capacitance of the sensor is also high. Conversely, when the soil is dry, the dielectric constant is low, and the capacitance of the sensor is low.

The sensor is connected to a microcontroller or a computer, which reads the capacitance value and translates it into a corresponding moisture level or water content in the soil. This information can be used to control irrigation or watering systems, monitor plant health, and optimize crop yields.

2.5.4 Specifications of Sensor

- **Moisture measurement range:** The soil moisture sensor should be able to measure moisture levels across a wide range, typically from 0% to 100%.
- **Accuracy:** The accuracy of the sensor is the measure of how close the sensor's output values are to the actual soil moisture levels. The accuracy of a capacitive soil moisture sensor can range from +/- 2% to +/- 5%.
- **Response time:** This is the time it takes for the sensor to detect changes in moisture levels. Response times for capacitive soil moisture sensors can range from a few seconds to several minutes.
- **Output signal:** Capacitive soil moisture sensors may provide either analog or digital output signals. Analog signals are continuous and provide a range of values while digital signals are non-continuous and typically provide a binary on/off output.
- **Power consumption:** Capacitive soil moisture sensors typically require low power and can run on batteries or solar power.

- **Material:** The sensor's material should be durable and able to withstand harsh environmental conditions. Common materials include plastic, ceramic, and metal.
- **Operating temperature range:** The sensor's operating temperature range should be listed to make sure it can withstand the environment it will be placed in.
- **Cable length:** The length of the sensor's cable can range from a few inches to several feet, allowing placement options in various soil depths.
- **Calibration:** Some capacitive soil moisture sensors may require calibration to ensure accuracy of measurements. Calibration instructions should be provided by the manufacturer.

2.5.5 Applications of Sensor

- **Agriculture:** In agriculture, capacitive moisture sensors are used for measuring the moisture content of soil to determine the optimal time for planting, irrigating, and fertilizing crops.
- **Construction:** Capacitive moisture sensors are also used in the construction industry to test moisture levels in building materials like concrete, wood, and drywall, which can help prevent structural damage caused by moisture.
- **Food Processing:** Capacitive moisture sensors are used in food processing plants to measure the moisture content of food products such as grains, vegetables, and meat. This helps to maintain the quality and freshness of the food products.
- **Environmental Monitoring:** Capacitive moisture sensors are useful in monitoring the moisture content of the air, soil, and water, thereby helping to predict weather patterns, detect natural disasters, and monitor water levels in rivers and lakes.

2.6 Solenoid Valve

A solenoid valve is an electromechanical device used to control the flow of fluids or gasses in a variety of industrial and commercial applications. It works by using an electromagnetic coil to actuate a plunger or piston, which opens or closes a valve.The basic components of a solenoid valve include an electromagnetic coil, a plunger or piston, a valve seat, and a fluid or gas port. When the coil is energized, it creates a magnetic field that causes the plunger or piston to move, which opens or closes the valve seat and allows or blocks the flow of fluid or gas through the port.

Solenoid valves can be used for a wide range of applications, including controlling water, gas, oil, and other fluids in pipelines, controlling the flow of air in pneumatic systems, and controlling the flow of refrigerant in air conditioning and refrigeration systems. They can also be used in medical equipment, automotive systems, and industrial automation.

When selecting a solenoid valve, it is important to consider factors such as the type of fluid or gas being controlled, the pressure and temperature of the system, and the required flow rate. Solenoid valves are available in a variety of materials, including brass, stainless steel, and plastic, to meet the needs of different applications.

Fig 2.9 Solenoid Valve

In summary, a solenoid valve is an electromechanical device used to control the flow of fluids or gases in various industrial and commercial applications. It works by using an electromagnetic coil to actuate a plunger or piston, which opens or closes a valve. Solenoid valves come in different configurations and materials to meet the needs of different applications, and their selection depends on factors such as the type of fluid or gas being controlled, the pressure and temperature of the system, and the required flow rate.

In this project a 12v DC solenoid valve is used to control the water flow to pots from the overhead tank.

2.7 12v DC Adapter

A 12-volt DC adapter is an electronic device that provides a constant 12-volt direct current (DC) output to power or charge a variety of devices that require 12 volts. This adapter usually consists of a small, compact box that is plugged into an AC power outlet and has a cable or cord with a connector on the end that plugs into the device. 12-volt DC adapters are commonly used to power a wide range of electronics, including routers, modems, gaming consoles, and small appliances. They can also be used to charge batteries, such as those found in smartphones and tablets. The voltage output of the adapter must always match the input voltage requirement of the device being powered to prevent damage to the device.

CHAPTER 3

SOFTWARE REQUIRED

3.1 BLYNK CLOUD

3.1.1 About Blynk Cloud

Blynk is an IoT platform for iOS or Android smartphones that is used to control Arduino, Raspberry Pi and NodeMCU via the Internet.

3.1.2 Block Diagram of Blynk IOT

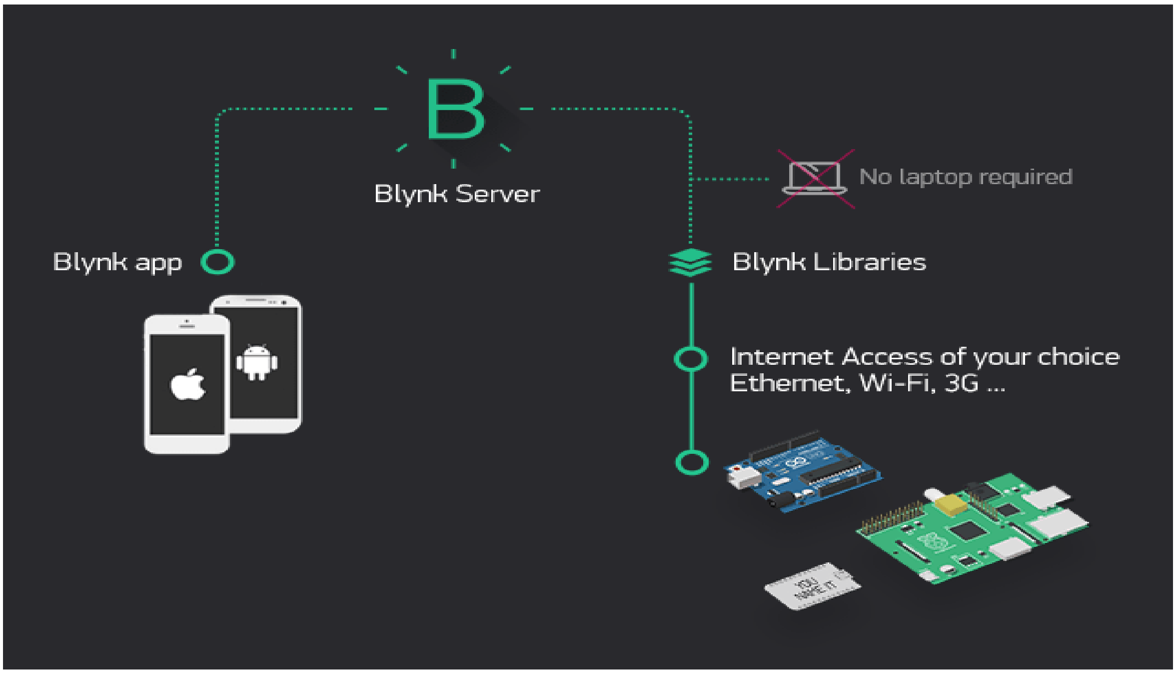


Fig 3.1 Block Diagram of Blynk IOT

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 cool things.

3.1.3 COMPONENTS OF BLYNK IOT

There are three major components in blynk IOT

1. Blynk App
2. Blynk Server
3. Blynk Libraries

Blynk App: – It allows you to create amazing interfaces for your projects using various widgets which are provided.

Blynk Server: – It is responsible for all the communications between the smartphone and hardware.

Blynk Libraries: – It enables communication, for all the popular hardware platforms, with the server and process all the incoming and outcoming commands.

TEMPLATE: Template is a set of elements and configurations, used to display all Devices of a particular type. Templates are created by Developers and can be published to be accessible globally.

CREATE PROJECT

1. Go to create project.
2. Enter the device name.
3. Select the hardware device and connection type.
4. Then the project is created

ELEMENTS OF TEMPLATE:

1. Template ID
2. Data streams
3. Events and notification setup
4. Metadata

5. Web Dashboard
6. Mobile Dashboard

Fig 3.2 Elements of Template

Template-ID

The most important element of the template is TemplateID. This is a unique identifier for every template which should be specified in the code on your device. If you check the code, will be generated for your device.

Datastreams

Datastreams is a way to structure data that regularly flows in an out from device. Use it for sensor data, any telemetry, or actuators.

There are 3 pins in Datastreams

1. Virtual pin
2. Location
3. Enumerable

Virtual Pin:

Virtual Pin is a concept invented to provide exchange of any data between hardware, web and mobile app. Virtual pins allow you to interface with any sensor, any library, any actuator.

it's a very powerful feature to display and send any data from your hardware to the application.

Location:

It can be useful to collect Device coordinates data to view the places it was working at or to represent movements detailed data by building a GPS track in Map Widget.

Enumerable:

This datastream accepts a fixed set of values and transforms them into desired outcomes.

WEB DASHBOARD

A set of UI elements (widgets) to visualize the data from the device accessible for the users in Blynk.Console – a web-based application.

MOBILE DASHBOARD

Metadata is a set of UI elements (widgets) to visualize the data in Blynk mobile apps for iOS and Android. Mobile apps also contain a template of how device is represented in the list of devices (tiles).

METADATA

Metadata is a set of `key:value` data attached to every device. `Keys` are static, and `values` are related for each device.

Metadata can be edited by users based on their access level.

Default value can be set to each Metadata, be changed during Add Device procedure and edited any time later.

There are 5 info present in metadata.

1. D**evice Name** – here you can type default Device name.
2. **Device Owner** – here you can type default Device Owner name or Email.
3. **Location** – here you can type default Location name.
4. **Device Timezone** – select actual or preferred Timezone from the dropdown list
5. **Hotspot Name** – here you can type default Hotspot name.

3.2 Arduino sketch for Node_MCU:

3.2.1 About Arduino IDE:

Arduino IDE is software for progaming Arduino Board / Node_MCU. This software is used as a **text editor** to create, open, edit, and validate Code for Arduino. The Code or Program in Arduino is called "**sketch**".

3.2.2 INSTALLING ARDUINO IDE IN WINDOWS 10:

Step 1: Download Arduino IDE Installation file

Download from the Official Arduino Website

1. Go to the official Arduino website: https://www.arduino.cc/en/software/
2. Click on the "Windows Installer" button to download the installer for Windows.
3. Once the download is complete, run the installer and follow the on-screen instructions to complete the installation process.

Step 2: Options of Installation

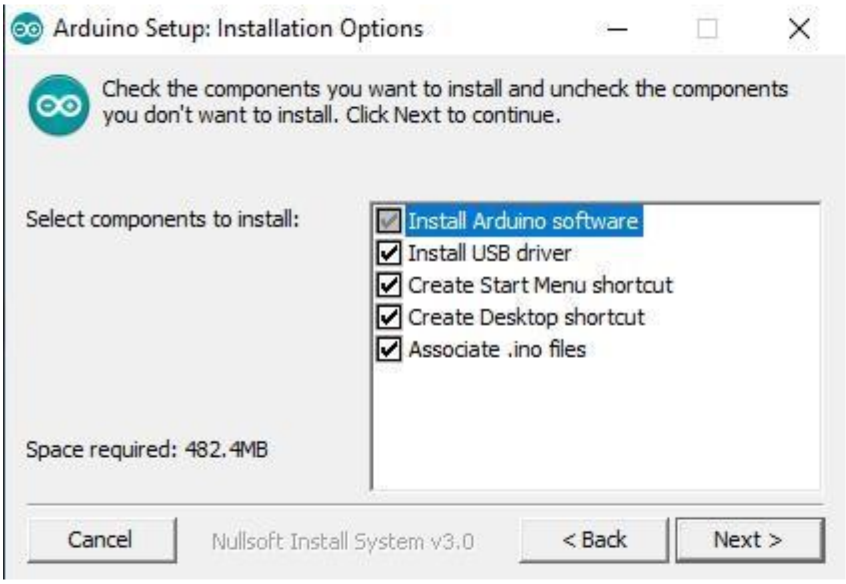


Fig 3.3 Installation Options

Step 3: Selection of Installation Folder

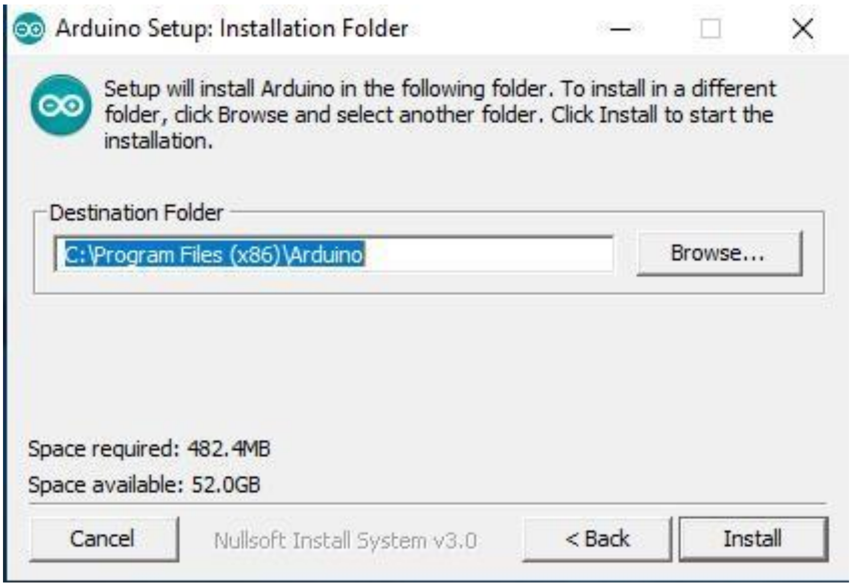


Fig 3.4 Installation Folder Selection

1. In the "Choose Install Location" screen, you can either accept the default installation path or click on "Browse" to select a different folder location.
2. If you choose to select a different installation folder, navigate to the folder location where you want to install the Arduino IDE.

3. Once you have selected the installation folder, click on "OK" to confirm the selection.
4. Finally, click on "Install" to begin the installation process.

Step 4: Progress of Installation

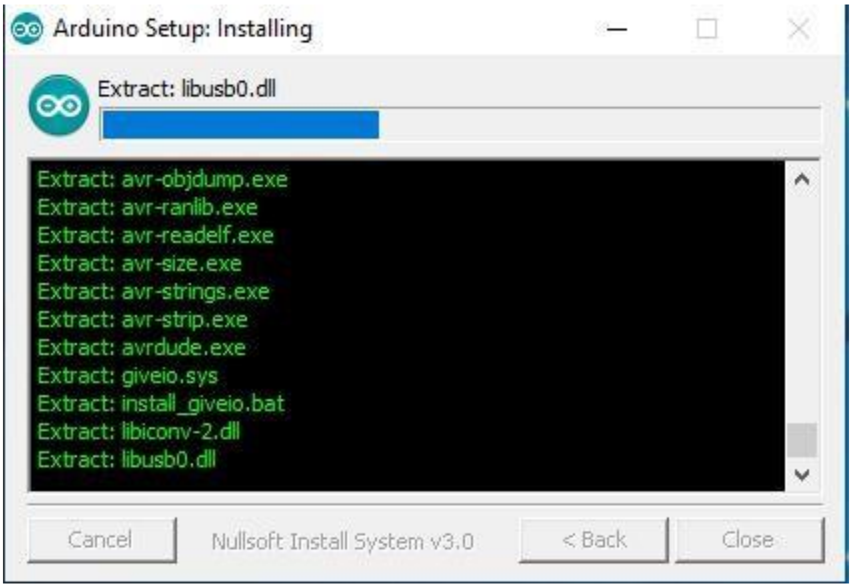


Fig 3.5 Arduino Setup Installing process window

Step 5: Installation Complete

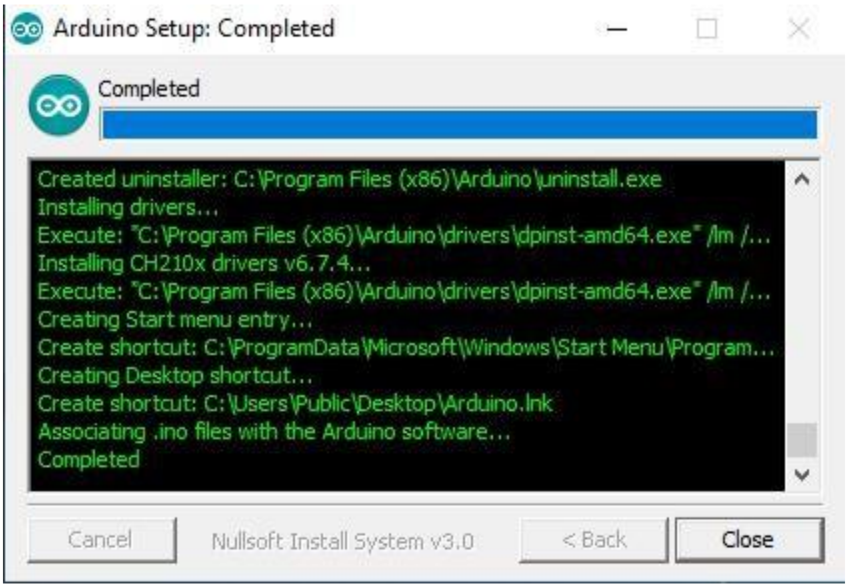


Fig 3.6 Arduino Installation Complete Window

Step 6: Open Arduino IDE

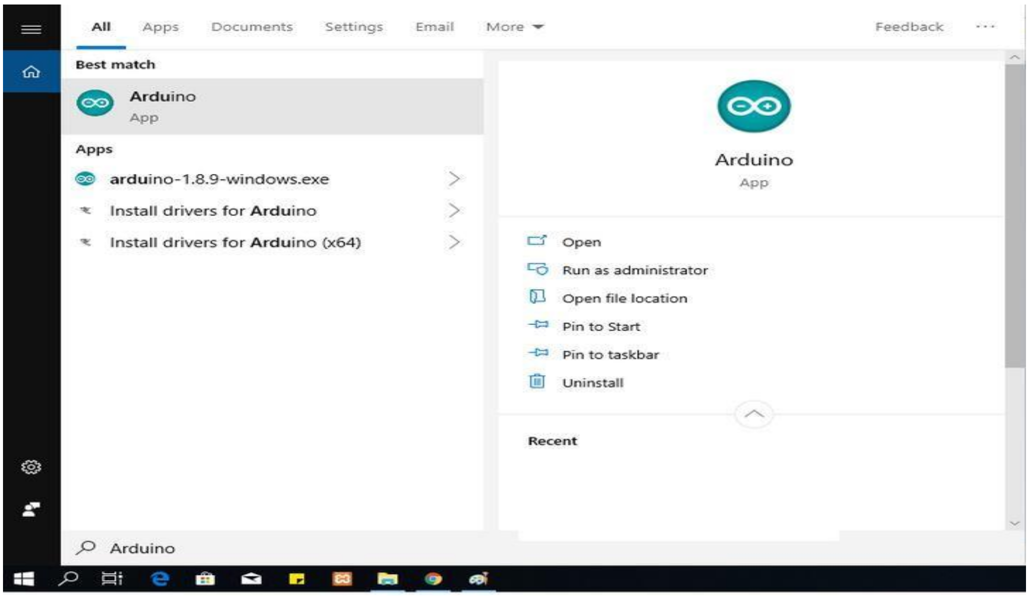


Fig 3.7 Open Arduino IDE

After installing Arduino IDE software open it by clicking the Arduino icon on the Start Menu or Desktop if not found click on search and type "Arduino”. Run the application.

Step 7: Arduino IDE Display Window

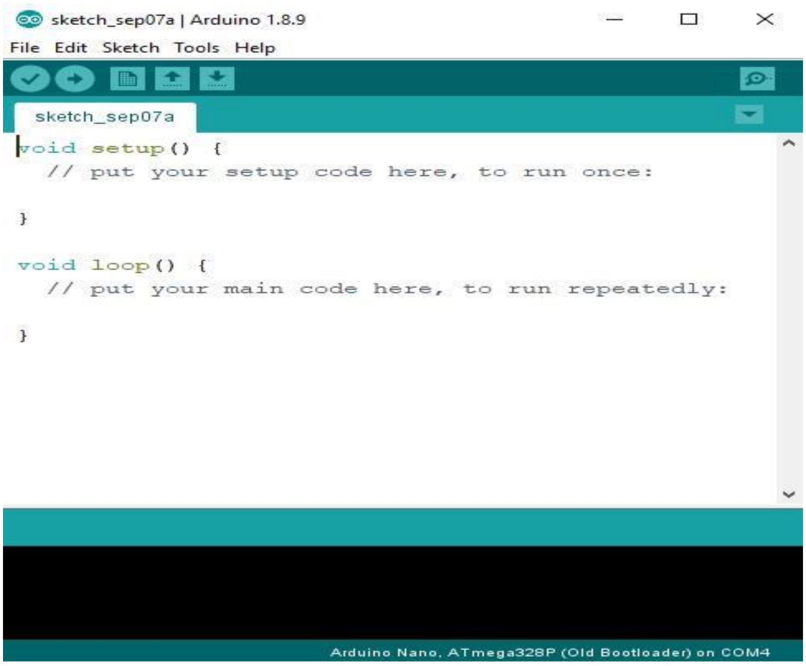


Fig 3.8 Arduino IDE Display Window

3.2.3 Programming NodeMCU using Arduino IDE

Step 1.

1. Connect your NodeMCU to your computer using a USB cable.
2. Open the Arduino IDE and go to "File" > "Preferences".
3. In the "Additional Boards Manager URLs" field, enter the following URL and click "OK":
   http://arduino.esp8266.com/stable/package_esp8266com_index.json

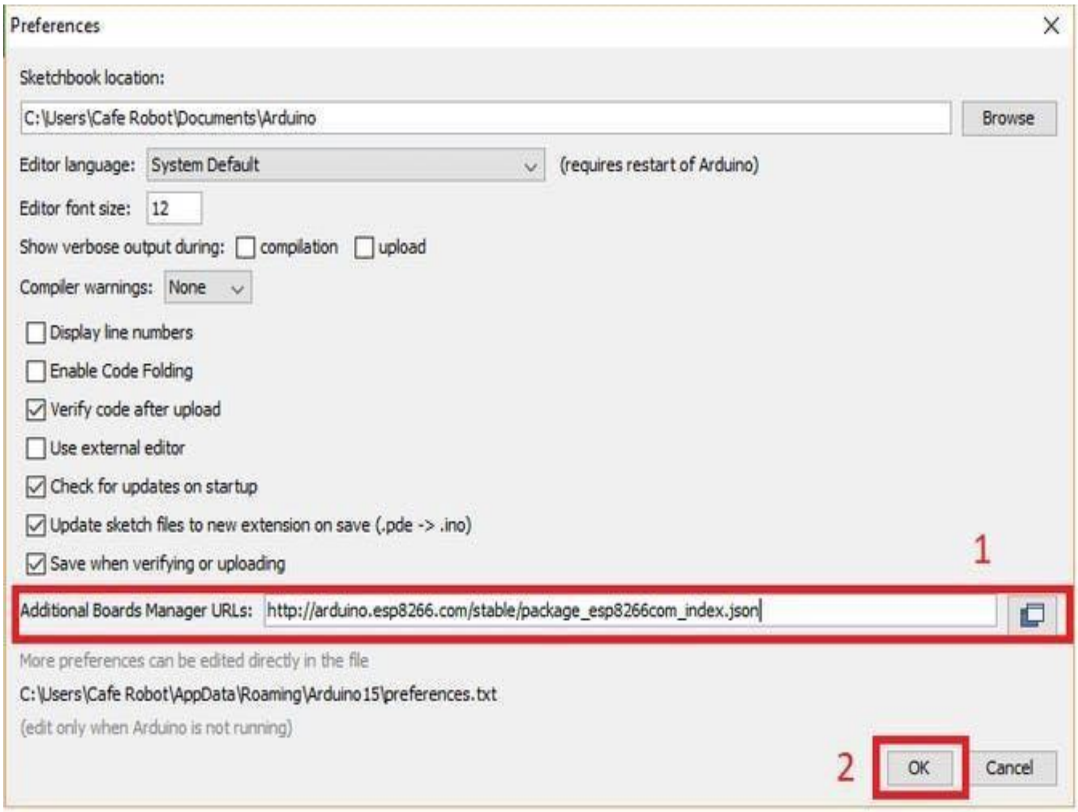


Fig 3.9 Program NodeMCU using Arduino IDE

Step 2:

1. Go to "Tools" > "Board" > "Boards Manager".
2. In the "Boards Manager" window, search for "esp8266" and click on the "esp8266" option.

3. Click on the "Install" button to install the ESP8266 boards package.

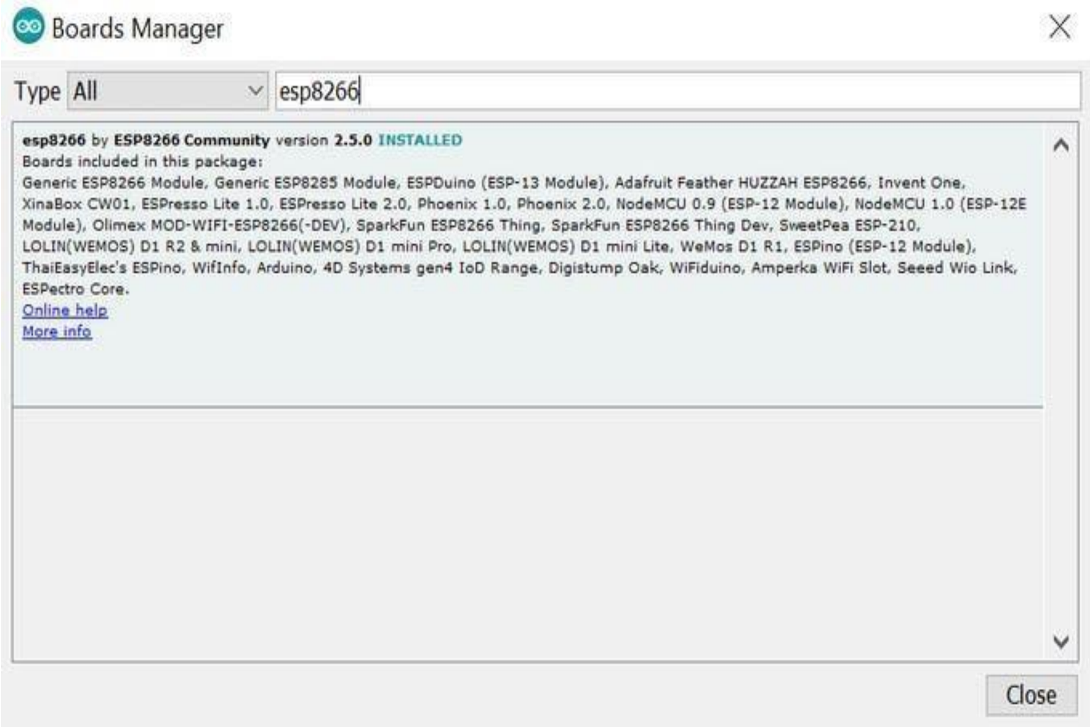


Fig 3.10 Installing Esp8266 Packages

Step 3:

1. Go to "Tools" > "Board" and select "NodeMCU 1.0 (ESP-12E Module)" as your board.
2. Go to "Tools" > "Port" and select the COM port to which your NodeMCU is connected.
3. Write your code in the Arduino IDE.
4. Click on the "Upload" button to upload your code to the NodeMCU.

CHAPTER 4
METHODOLOGY

4.1 Automated Pot Irrigation and IOT Based Monitoring System

4.1.1 Block Diagram

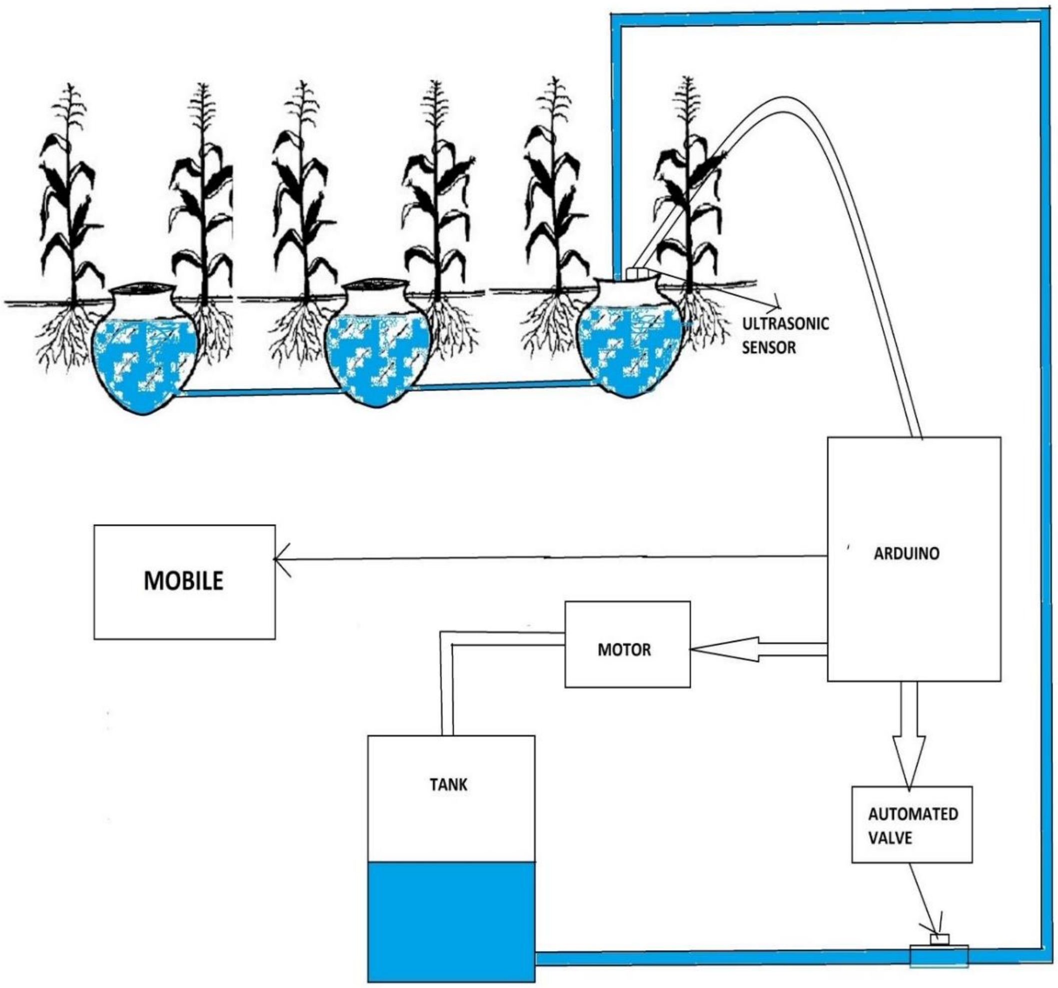


Fig 4.1 Block Diagram of Automated Pot Irrigation System

4.1.2 Working Principle

The working principle of Pot irrigation is based on the principle of **capillary action**. Capillary action refers to the ability of a liquid to flow in narrow spaces without the assistance of, and sometimes in opposition to, external forces like gravity. In the case of pitcher irrigation, the porous walls of the clay pot create narrow spaces that allow water to flow through them due to capillary action.

The water in the pots is drawn out by the dry soil surrounding the pots, and the moistened soil forms a cone of wetness around the pots. This cone of wetness extends downwards and outwards as the soil dries out, providing a steady supply of water to the plants' roots.

4.1.3 Implementation of Automated Pot Irrigation System

Initial Arrangement at Farm

As the project is based on pitcher irrigation it is necessary to bury pots before planting crops. The number of pots required, arrangement and the spacing between pots depends upon the type of crop that is planted. Apart from the number of pots required and spacing between them, the burred pots should be connected at bottom and as farms are even land all the pots should be burried upto constant level so that the water in pots can be filled simultaneously and evenly [8]. This arrangement facilitates detecting water levels of all pots in one measurement from single pot at a time.

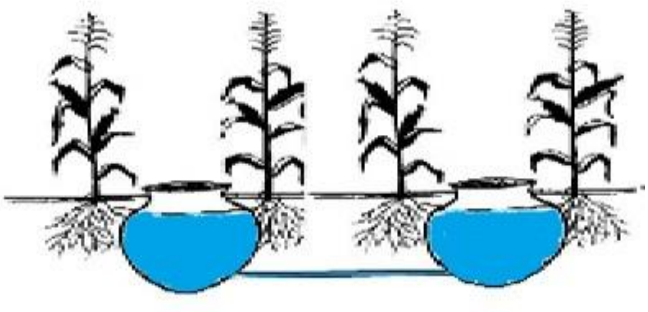


Fig 4.2 Initial Pots Arrangement Setup.

Hardware Implementation

Fig 4.3 shows the hardware implementation diagram of IoT based water level controlling system. This hardware system consists of a capacitive soil-moisture sensor, a microcontroller, a solenoid valve, an adapter, an ultrasonic sensor, a pump, and a relay module that controls the solenoid valve of the hardware. The microcontroller in the picture uses a NodeMCU which is based on ESP8266 wifi module, this microcontroller creates trigger that causes the relay-controlled switch to close and open.

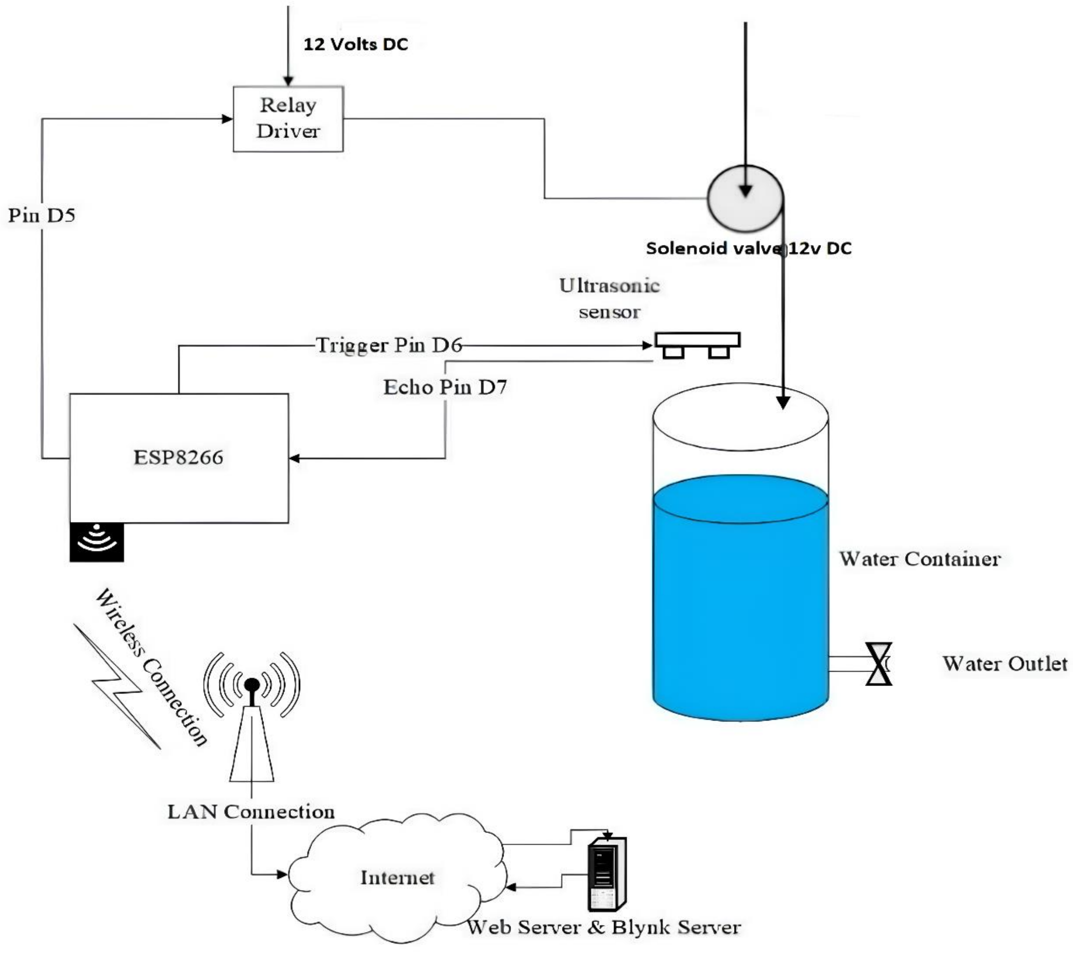


Fig 4.3 Hardware Implementation of water level detection in pots

Circuit Diagram of Hardware setup

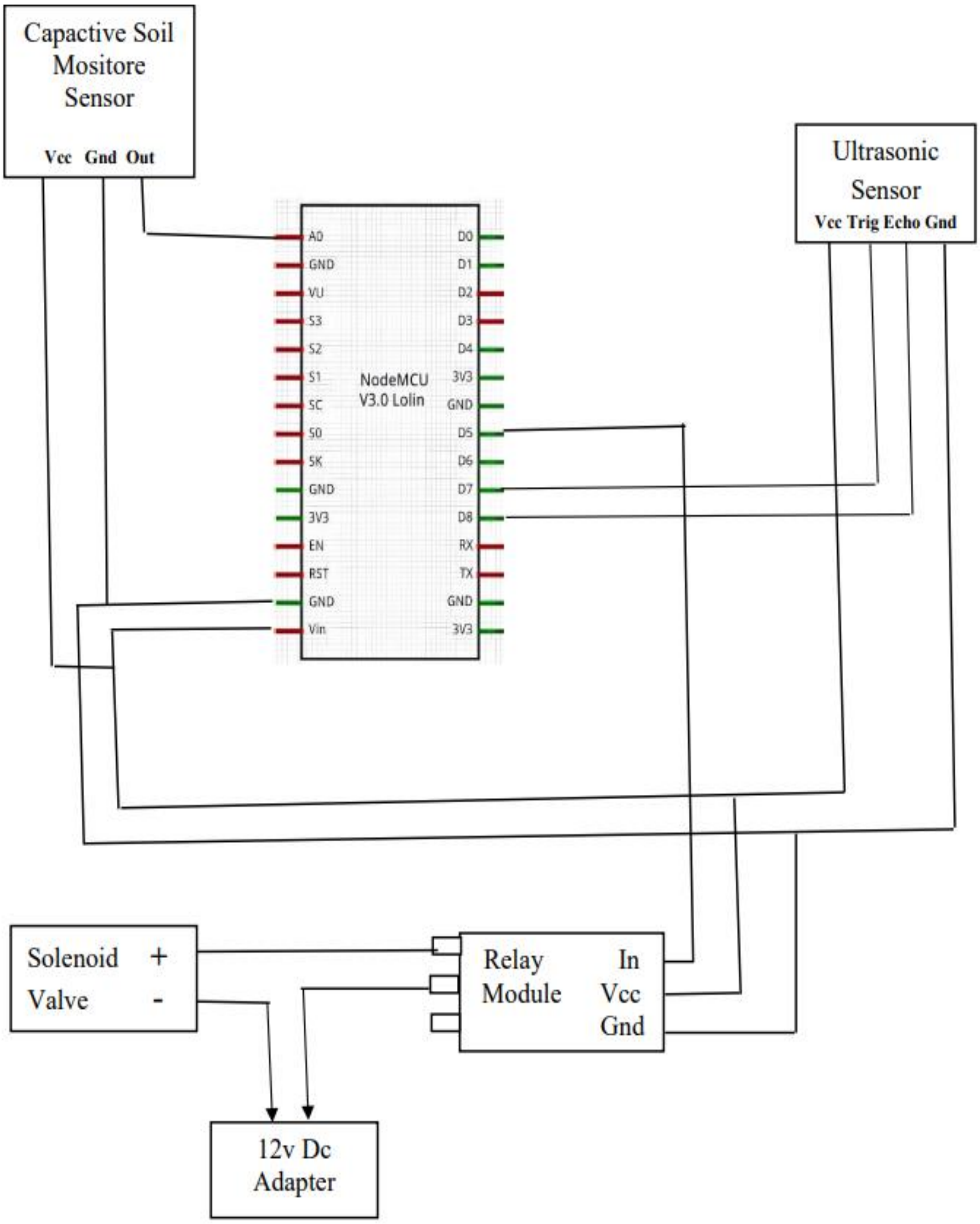


Fig 4.4 Circuit Diagram of Hardware setup

An ultrasonic sensor is placed on top of the container that reads water-level inside tank, level read by the ultrasonic sensor determines whether the solenoid valve is working or not. The ultrasound sensor has two cables to trigger the ultrasound sensor and receive the ultrasound echo.

In Addition to this a Capacitive Soil Moisture Sensor is also integrated to Node_MCU which is used to measure the moisture content present in the soil. These sensed values are monitored using Blynk mobile application.

IOT Integration

The Integration Between Node_MCU and Blynk App makes the project an IOT based project. The code is dumped to Node_MCU board using Arduino IDE by connecting it to computer. A new Authentication Token is generated when a new project is created in Blynk App. The Auth Token and Wi-Fi credentials in Arduino sketch are replaced with the ones obtained from the Blynk app.

In Blynk App new templates and Datastreams are created depending upon the requirement. Here in this project one template is created for single device and two datastreams are created. One datastream is for water level monitoring at the pots and another datastream is for monitoring the moisture content present in soil. Depending upon the user’s convenience, dashboard is created for monitoring the created datastreams.

All the data sensed by sensors are updated to created datastreams present in the blynk server through internet. This datastream values are shown in dashboard using gauges and super charts.

4.1.4 Working Process

The system can be controlled remotely via a smartphone using Blynk mobile application, allowing users to monitor and adjust the watering schedule as needed.

The working process of smart pot irrigation can be broken down into the following steps:

1. Installation: The system is installed by burying the porous clay pots in the soil near the roots of plants and connecting them to a water source. The pots are fitted with sensors that measure soil moisture levels, temperature, and other environmental conditions.

2. Sensor data collection: The sensors collect data on soil moisture levels and other environmental conditions and transmit this data to a controller or hub.

3. Data analysis: The controller or hub analyzes the sensor data to determine the optimal watering schedule for the plants based on factors such as the type of plants, the local climate, and the soil type.

4. Watering schedule creation: The controller or hub creates a watering schedule based on the sensor data analysis and sends this information to the system's pump or valve, which controls the flow of water to the pots.

5. Watering: The pump or valve waters the pots according to the watering schedule, delivering the appropriate amount of water to the plants' roots.

6. Remote monitoring and adjustment: The system can be monitored and adjusted remotely via a smartphone app or other web-based interface. Users can view data on soil moisture levels, temperature, and other environmental conditions, as well as adjust the watering schedule as needed.

7. Maintenance: The system requires regular maintenance to ensure proper operation. The pots should be checked regularly for damage or clogging, and the sensors should be calibrated periodically to ensure accurate readings.

Overall, connecting pot irrigation to iot offers a more efficient and effective way to irrigate plants, especially in areas with limited water resources. The system can be customized to meet the specific needs of different plants and can be adjusted as needed to adapt to changing environmental conditions. With proper maintenance, it can help to conserve water and promote healthy plant growth.

4.2 Results

4.2.1 Testing Setup

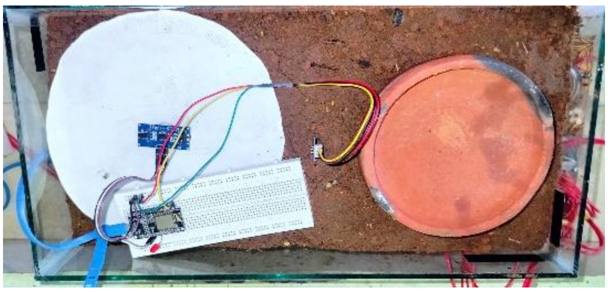
For monitoring and testing of Automated Pot Irrigation system we arranged an aquarium setup with two pots in it connected at the bottom filled with soil.

Fig 4.5. Testing Setup

4.2.2 Fenugreek Harvesting

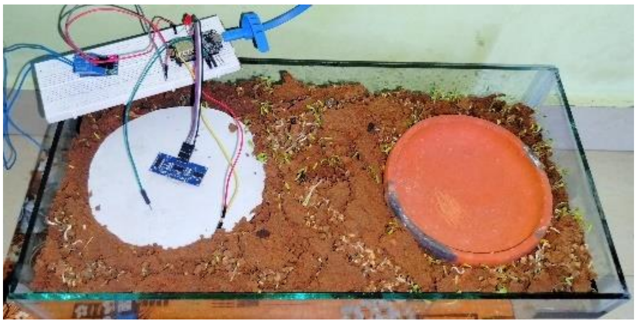
For testing purposes, we planted Fenugreek seeds, the water level inside pots and the moisture level of soil is monitored for over a period of 4 days. The results of monitoring plant growth, water level and moisture level from day 1 to day 4 are shown below in the form of graphs and images.

Day 1



Day 2

Day 3



Day 4

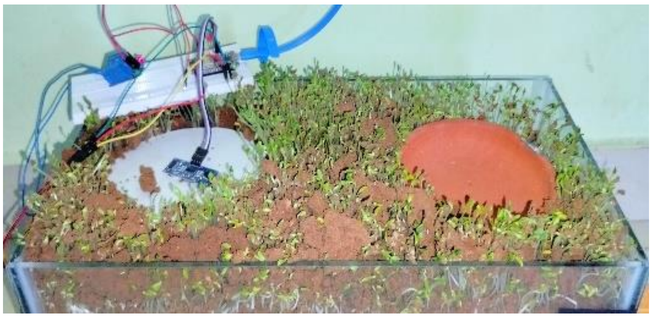


Fig 4.6. Plant Growth Images form Day1 to Day 4.

Monitoring of water level at pots and Moisture level of soil is done in mobile through Blynk App. Two gauges are used to display the water level and Moisture level and two super charts are used which give the data of monitoring for over a long period of time like period ranges from 1 day to 3 months.

Mobile Dashboard for monitoring these datastreams is shown below.

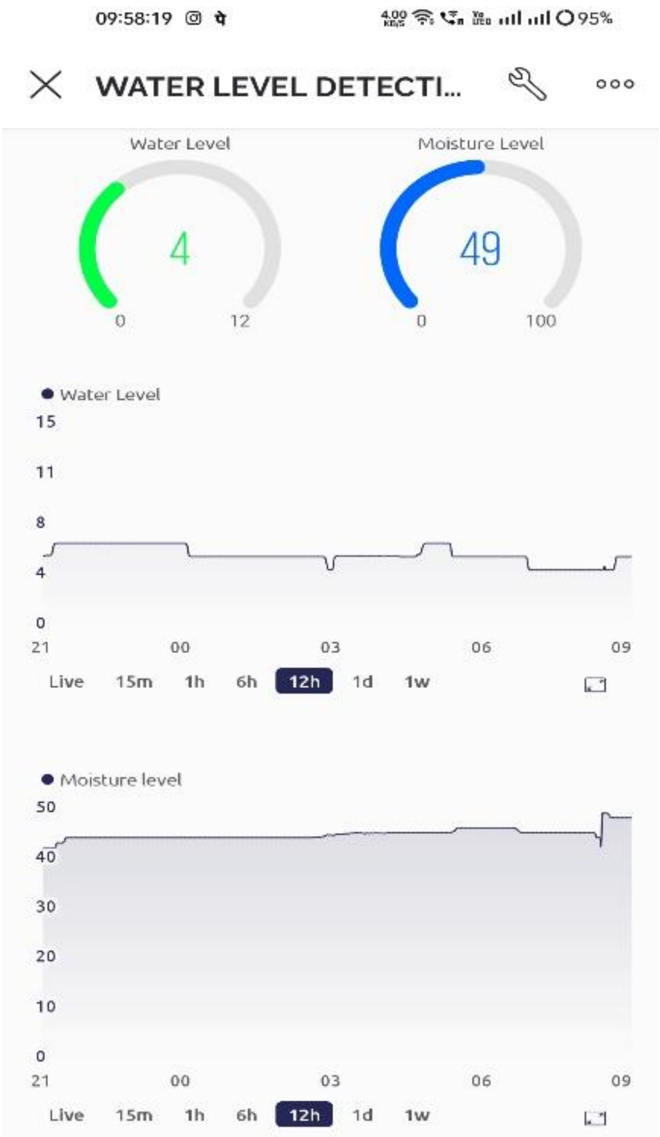


Fig 4.7. Blynk Mobile App Monitoring Window

4.2.3 Graphical Results

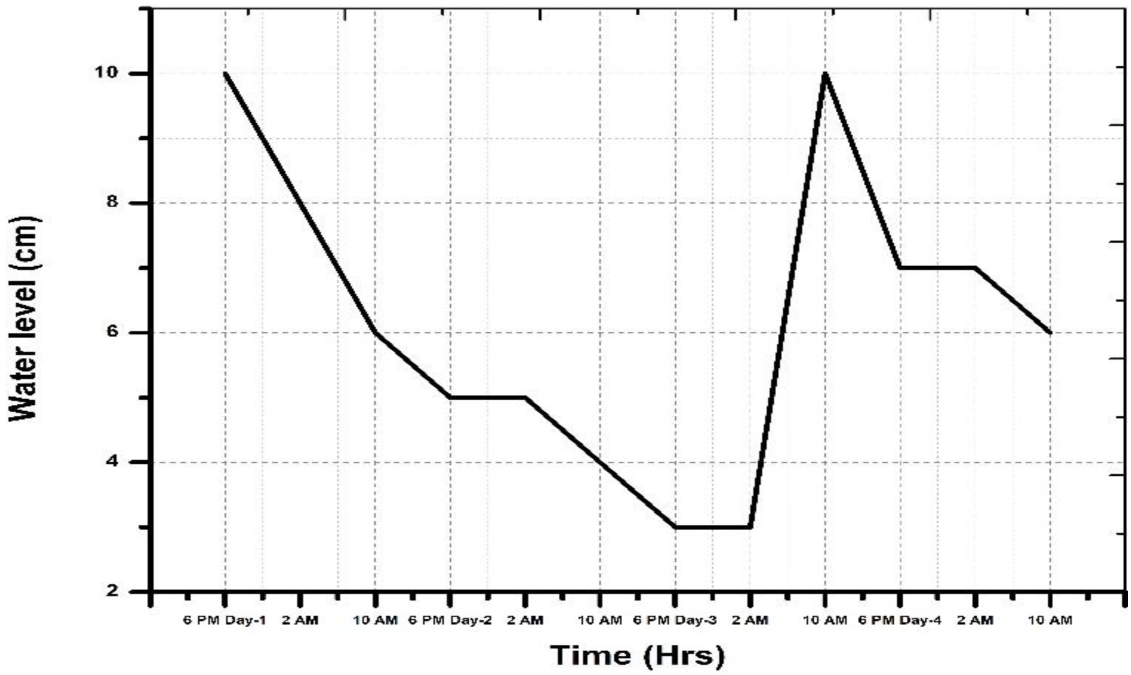


Fig 4.8. Water Level vs Time.

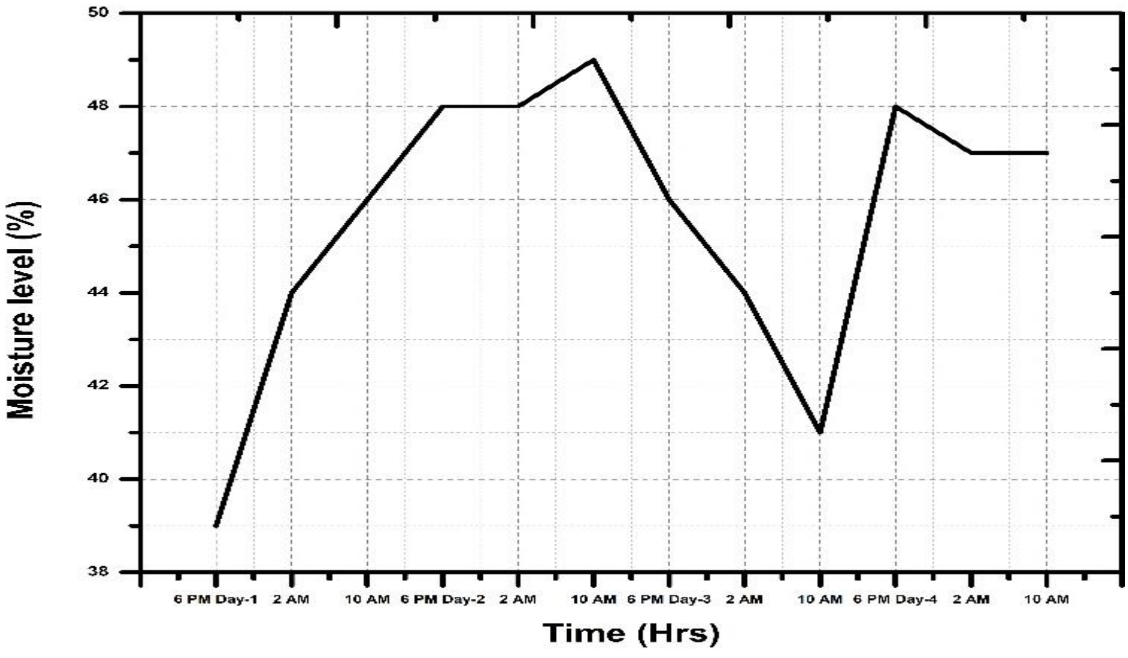


Fig 4.9. Moisture Level vs Time.

From the graphs above we can observe that water level in pots reduces in course of time. This occurs when the water splits out form the pores of unglazed clay pot due to which the soil surrounding the pots gets moisture.

- It is clearly observed from the graphs, as the water level in pots reduces the moisture content of soil increases gradually.
- The Moisture content is maintained at maximum level until the water level is greater than or equal to half of the pots water capacity.
- When the water level is below 30% of pots water capacity the moisture content of soil gets gradually decreased.

When the Water level falls less than 20% of pot capacity the relay module turns on and solenoid valve powers up, the water is drawn from overhead tank and water is filled in pots until the water level reaches 80% of pot capacity, when water level reaches above 80% relay module turns off and this process continues.

CHAPTER 5
CONCLUSION

Watering plants is the most important cultivation technique and the most labor-intensive task in daily plant cultivation. There may be some situations when the farmer himself cannot assist the crops. Automated Pot Irrigation System is one of the best solutions to monitor the crops far away. Through pot irrigation the problems faced by areas where there is a shortage of water are solved.

This project Automated Pot Irrigation & IoT based monitoring system for irrigation is designed to help the regions where water scarcity is present, to reduce wastage of water and to help the farmers to monitor the crops when they are away from the field.

- By implementing this project, we can save up to 50 –70% of water.
- The complexity of imparting many sensors can be decreased.
- Evaporation of water is minimum in this method.
- The effective cost of the whole framework is diminished.
- The wastage of water is reduced as only the required amount of water is drawn by plants.

Future Scope:

Only soil moisture and water absorption are monitored in this project. An additional advancement should be added to this project through which the plant growth and soil health can also be monitored.

In order to monitor the soil health different factors should be taken into consideration such as temperature of soil, pH level, Nitrogen-Phosphorus-Potassium (NPK) content and various others.

CHAPTER 6

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