IoT ENABLED ADVANCED IRRIGATION SYSTEM

A Minor project

Submitted by

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1. OBJECTIVES:

- To design and implement an “IoT Enabled Advanced Irrigation System’’.
- To investigate strategies for efficient water usage and resource conservation.
- To assess scalability and integration considerations for broader agricultural applications.
- To evaluate the effectiveness of advanced irrigation control mechanisms.
- To analyze the impact of the system on crop yield and quality.

2. ABSTRACT:

In modern agriculture, the integration of IoT technology has become increasingly prevalent, revolutionizing traditional farming practices. This project explores the development and implementation of an IoT-enabled Advanced Irrigation System aimed at optimizing water usage, conserving resources, and maximizing crop yield. The project begins with an overview of the system architecture, detailing the essential components such as microcontrollers, sensors, actuators, and communication modules. Emphasis is placed on the utilization of cloud-based platforms for data storage and analysis, facilitating informed decision-making in irrigation management. Sensor deployment strategies and data collection methods are discussed, highlighting the importance of accurate environmental data in irrigation scheduling. The system's capability for advanced irrigation control is demonstrated, leveraging sensor data to automate irrigation processes and enable remote monitoring and control via advanced phone or web interfaces.

The combination of automation and Internet of Things (IoT) improves agricultural practices. These technologies help farmers understand their crops, minimize their impact on the environment, and preserve resources. They also enable efficient monitoring of the weather, water resources, and soil. This research proposes an intelligent, low-cost field irrigation system. The proposed prototype can measure soil moisture, rain status, wind speed, water level, temperature, and humidity using a hardware sensor and unit. To decide whether to turn on or off the motor, a variety of sensors are used to get a range of readings and conclusions. They enable automatic watering when soil moisture levels are below a certain threshold, and if soil moisture is equal to the required moisture, then the irrigation process stops.[1] Despite challenges such as reliability and data security, the project envisions a future where IoT technology continues to drive advancements in advanced agriculture.

3. INTRODUCTION:

In the dynamic realm of modern agriculture, where innovation meets tradition, the integration of cutting-edge technology has become paramount in revolutionizing age-old farming practices. This project embarks on a journey to explore and implement an IoT Enabled Advanced Irrigation System, a ground breaking initiative poised to redefine irrigation management in agriculture. By leveraging IoT's capabilities, farmers can access real-time data insights, enabling them to make informed decisions and optimize water usage with unprecedented precision. This introduction not only encapsulates the essence of the project but also serves as a testament to the endless possibilities that lie ahead in the realm of precision agriculture.

As a result, various technologies are being integrated into the agricultural industry, especially in regard to the use of energy and water, to improve the yield of crops or maintain the good health of plants. These technologies, such as cloud computing, wireless sensor networks, the Internet of Things (IoT), big data, machine learning, and fog computing, play an important role. For a plant to successfully grow, it is necessary to monitor the plant's health parameters and take corrective actions when needed. The plant's health deteriorates due to environmental conditions, i.e., high temperatures, abnormal humidity factors and bad soil conditions Using IoT technology, the initial conditions of the plant can be analyzed by monitoring the environmental factors of a plant.[2]

4. WORKING:

The IoT-enabled advanced irrigation system uses the ESP8266, Arduino UNO and Blynk app. This system operates by integrating various sensors and a microcontroller to monitor and manage the environment for the irrigation system. The system consists of sensors such as humidity, moisture, and temperature sensors, which are strategically placed in the root zone of the plants. These sensors continuously collect data about the environmental conditions crucial for plant growth. The ESP8266 module serves as a gateway device that interfaces between the sensors and the Blynk app. It collects data from the sensors and communicates this information wirelessly to the Blynk cloud server using Wi-Fi connectivity. The ESP8266 module is programmed to transmit sensor data at regular intervals to ensure real-time monitoring of plant weather conditions. The Blynk app serves as the user interface for monitoring and Arduino UNO controls the irrigation system automation. Users can access the Blynk app from their advanced phones or tablets, providing convenience and accessibility. Through the app, users can view real-time

data collected by the sensors, including temperature, humidity and soil moisture levels. Additionally, if required users can customize to their needs like thresholds to receive alerts on their mobile app notification. The system's operation is straightforward: the sensors collect data, the ESP8266 module transmits this data to the Blynk app, and users can monitor and effectively manage the plant growth. The Blynk app also allows users to visualize sensor data through graphs and charts, facilitating easy analysis of plant health trends over time. [4]

4.1 SOURCE CODE:

ESP8266 code: (NODE MCU Wi-Fi module)

```
#define BLYNK_TEMPLATE_ID "XXXXXXXXXXXXXXXXXX"
#define BLYNK_TEMPLATE_NAME "Advanced Irrigation System"
#define BLYNK_PRINT Serial
#include <SPI.h>
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include <DHT.h>
#define BLYNK_PRINT Serial
#include <OneWire.h>
#include <DallasTemperature.h>
#define ONE_WIRE_BUS D2
OneWire oneWire(ONE_WIRE_BUS);
DallasTemperature sensors(&oneWire);
char auth[] ="XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX";
char ssid[] = "XXXXXXXXXXXX";
char pass[] = "XXXXXXXXXXXX";
int sensorState = 0;
int lastState = 0;
```

```
#define DHTPIN 2 // D4 temperature humidity sensor
#define DHTTYPE DHT22
DHT dht(DHTPIN, DHTTYPE);
BlynkTimer timer;
void sendSensor()
{
  float h = dht.readHumidity();
  float t = dht.readTemperature();
  if (isnan(h) || isnan(t)) {
      Serial.println("Failed to read from DHT sensor!");
      return;
  }

  Blynk.virtualWrite(V5, h);   //V5 is for Humidity
  Blynk.virtualWrite(V6, t);   //V6 is for Temperature
}
void setup()
{
  Serial.begin(9600);
  Blynk.begin(auth, ssid, pass);
      dht.begin();
  timer.setInterval(1000L, sendSensor);
  Serial.begin(115200);
  Blynk.begin(auth, ssid, pass);
   sensors.begin();
  }
int sensor=0;
```

```
void sendTemps()
{
sensor=analogRead(A0);   // A0 soil sensor analog out
sensors.requestTemperatures();
float temp = sensors.getTempCByIndex(0);
Serial.println(temp);
Serial.println(sensor);
Blynk.virtualWrite(V1, temp);
Blynk.virtualWrite(V2,sensor);
delay(1000);
}
void loop()
{
  Blynk.run();
  timer.run();
  sendTemps();
  float h = dht.readHumidity();
  float t = dht.readTemperature();
  float soil_moisture;
  soil_moisture = ( 100.00 - ( (analogRead(sensor)/1023.00) * 100.00 ) );
  Serial.print("Soil Moisture = ");
  Serial.print(soil_moisture);
  Serial.println("%");
  Serial.print("Temperature = ");
  Serial.println(t);
  Serial.println(" c");
  Serial.print("Humidity = ");
```

```
  Serial.println(h);
  delay(1000);
}
```

Arduino UNO code:

```
int relayPin = 4;
int sensor_pin = A0;
int output_value ;
void setup ()
      {
      Serial.begin(9600);
      pinMode(relayPin, OUTPUT);
      pinMode(sensor_pin, INPUT);
      Serial.println ("Reading From the Sensor ...");
      delay(2000);
      }
void loop()
      {
      output_value = analogRead(sensor_pin);
      output_value = map (output_value, 550, 10, 0, 100);
      Serial.print ("Moisture : ");
      Serial.print (output_value);
      Serial.print ("%");
      if (output_value < 20)
            {
            digitalWrite (relayPin, LOW);
            }
```

```
else {
      digitalWrite (relayPin, HIGH);
      }
delay (1000);
}
```

5. SYSTEM COMPONENTS:

5.1 NODE MCU ESP8266:

The NodeMCU ESP8266 is a versatile and cost-effective development board based on the ESP8266 WiFi module. It combines the capabilities of a microcontroller with WiFi connectivity, making it ideal for IoT projects. It features a Lua-based firmware that allows for easy programming and prototyping. With its GPIO pins, it can interface with various sensors, actuators, and other peripherals, making it popular for home automation, IoT applications and prototyping. Its compact size and affordability make it a favorite among hobbyists and professionals alike.

5.2 ARDUINO UNO:

The Arduino UNO is one of the most popular microcontroller boards for hobbyists and professionals alike. It features an ATmega328P microcontroller and a user-friendly development environment, making it easy to program and prototype various electronic projects. It has a range of digital and analog I/O pins, which can be used to connect sensors, actuators, displays, and other peripherals. The UNO is versatile and can be used for a wide range of applications, from simple LED blinking projects to more complex robotics and automation systems.

5.3 SOIL MOISTURE SENSOR:

A soil moisture sensor is a device used to measure the moisture content in soil. It typically consists of two electrodes that are inserted into the soil. The sensor works by measuring the electrical conductivity or resistance between these electrodes, which changes depending on the moisture level of the soil.

These sensors are commonly used in agriculture, gardening, and landscaping to help optimize watering schedules and prevent over or under-watering of plants. By providing real-time feedback on soil moisture levels, they enable users to make informed decisions about when to water their plants, thereby conserving water and promoting healthy plant growth.

Soil moisture sensors come in various designs, including analog and digital types, and can be interfaced with microcontrollers like Arduino or Raspberry Pi for data logging and automation purposes. They are valuable tools for both hobbyists and professionals involved in plant cultivation and irrigation management.

5.4 DHT22 (TEMPERATURE & HUMIDITY SENSOR):

The DHT22 is a digital temperature and humidity sensor that provides accurate and reliable measurements in various environments. It uses a capacitive humidity sensor and a thermistor to measure relative humidity and temperature, respectively.

Key features of the DHT22 sensor include:

- **High Accuracy**: The sensor offers high accuracy and stability, making it suitable for applications where precise measurements are essential.
- **Wide Operating Range**: It operates over a wide range of temperatures (-40°C to 80°C) and humidity levels (0% to 100% RH), making it versatile for different environments.
- **Digital Output**: The DHT22 communicates with a microcontroller via a digital signal, simplifying interfacing and integration into projects.
- **Low Power Consumption**: It consumes very little power, making it suitable for battery-powered applications and IoT devices.
- **Robust Design**: The sensor is encased in a protective housing, making it durable and resistant to environmental factors such as dust and moisture.

The DHT22 sensor is commonly used in weather stations, environmental monitoring systems, HVAC systems, and various IoT applications where monitoring temperature and humidity levels is crucial. It's compatible with popular development platforms like Arduino and Raspberry Pi, making it easy to integrate into projects.

5.5 RELAY 5V:

A 5V relay module is an electromechanical switch that is commonly used in electronics projects to control high-power devices with low-power microcontrollers like Arduino. Here's a brief description of its key features:

- **Switching Capability:** The relay module can switch high voltage and current loads (usually AC mains voltage) using a low voltage (typically 5V) control signal from a microcontroller.
- **Isolation:** It provides isolation between the control circuit (low voltage side) and the load circuit (high voltage side), ensuring safety and protecting the control circuit from voltage spikes.
- **Coil:** The relay coil is energized when the control signal is applied, causing the contacts to switch positions. It's often rated for 5V DC operation.
- **Contacts:** The relay typically has one or more sets of contacts (normally open, normally closed, and common), which can be connected to the load circuit to control its operation.
- **LED Indicator:** Many relay modules include an LED indicator to show when the relay is energized.
- **Screw Terminals:** It often comes with screw terminals for easy connection to external devices or circuits.

Relay modules are commonly used in home automation, robotics, industrial control systems and various other applications where there's a need to control high-power loads using low-power microcontrollers. They provide a safe and reliable way to switch on/off devices like lights, motors, heaters, and pumps.

5.6 SUBMERSIBLE DC WATER PUMP:

A 6V submersible water pump is a type of pump designed to be submerged in water for pumping purposes. Here's a brief description of its key features:

- **Submersible Design:** This pump is designed to operate while fully submerged in water, making it suitable for applications such as aquariums, fountains, hydroponic systems, and water features.
- **Voltage:** The pump operates at a voltage of 6V, which is typically supplied by batteries, solar panels, or low-voltage power supplies.
- **Flow Rate**: The flow rate of the pump refers to the volume of water it can move per unit of time, usually measured in gallons per hour (GPH) or liters per hour (LPH). The flow rate of a 6V submersible water pump can vary depending on its design and specifications.
- **Height:** This refers to the maximum vertical distance that the pump can lift water. It's an important consideration, especially for applications where water needs to be pumped to a certain height.
- **Construction:** Submersible water pumps are typically constructed with materials that are resistant to corrosion and water damage, such as plastic, stainless steel, or aluminum.
- **Noise Level:** Some pumps may produce noise while operating, so it's important to consider the noise level if the pump will be used in a quiet environment.

Application:

These pumps are versatile and can be used in various applications, including irrigation, drainage, circulation, and transfer of water. Overall, a 6V submersible water pump is a compact and efficient solution for pumping water in a wide range of indoor and outdoor applications.

5.7 BREADBOARD:

A breadboard is a fundamental tool used in electronics prototyping and experimentation. It provides a convenient way to create and test circuits without the need for soldering. Here's a brief description:

- **Reusable Platform:** A breadboard is a reusable plastic board with a grid of holes into which electronic components and wires can be inserted to create circuits.
- **Connection Points:** The holes on the breadboard are connected internally in a specific pattern, typically arranged in rows and columns. This allows components to be easily connected together without soldering.
- **Tie Strips:** Along the sides of the breadboard are rows of tie strips, which are used to provide power and ground connections to the circuit.

- **Versatility:** Breadboards come in various sizes and configurations, ranging from small, portable ones to larger ones for more complex circuits. They are suitable for both beginners and experienced electronics enthusiasts.
- **Temporary Setup:** Circuits built on a breadboard are temporary and can be easily modified or dismantled, making it an ideal platform for experimenting and prototyping.

Overall, breadboards are indispensable tools for anyone working with electronics, allowing for quick and hassle-free circuit design and testing.

5.8 JUMPER WIRES:

Jumper wires are essential components in electronics prototyping and circuit building. Here's a brief description:

- **Conductivity:** Jumper wires are flexible wires typically made of copper or other conductive materials coated with insulation. They conduct electrical signals between components on a breadboard or between different points on a circuit.
- **Connectivity**: Jumper wires come in various lengths and colors, with male or female connectors on each end. Male connectors have protruding pins that fit into the holes of a breadboard or connect to female headers, while female connectors have receptacles that fit onto pins or headers.
- **Versatility:** Jumper wires are versatile and can be used to create connections between components on a breadboard, such as integrated circuits (ICs), resistors, capacitors, and LEDs. They can also be used to connect components on a breadboard to external components or module
- **Ease of Use:** Jumper wires are easy to use and can be quickly inserted or removed from a breadboard or connected to other components. They allow for rapid prototyping and experimentation in electronics projects without the need for soldering.
- **Organization:** Using jumper wires of different colors can help organize and differentiate between different connections in a circuit, making it easier to understand and troubleshoot.

Overall, jumper wires are indispensable tools for anyone working with electronics, providing a simple and effective means of making electrical connections in prototyping and experimentation.

5.9 BATTERY 9V:

- **Voltage:** A 9V battery provides a nominal voltage of 9 volts. This relatively high voltage makes it suitable for powering various electronic devices that require higher voltage levels.
- **Size and Shape:** 9V batteries typically have a rectangular shape with dimensions around 48.5 mm x 26.5 mm x 17.5 mm. They are relatively compact and convenient for use in portable devices.
- **Chemical:** The most common chemistry used in 9V batteries is alkaline, although rechargeable nickel-metal hydride (NiMH) and lithium-ion variants are also available.
- **Connector:** One or both ends of a 9V battery usually have a snap-style connector, making it easy to connect and disconnect from devices without the need for soldering.
- **Capacity:** The capacity of a 9V battery varies depending on its chemistry and manufacturer. Alkaline 9V batteries typically have capacities ranging from around 400 to 600 milliampere-hours (mAh), while rechargeable NiMH variants may have higher capacities.

Applications:

9V batteries are commonly used in a wide range of electronic devices, including smoke detectors, remote controls, electronic toys, guitar pedals and various portable audio devices.
Overall, 9V batteries are versatile power sources suitable for powering a variety of electronics, offering a convenient combination of voltage, size, and portability

5.10 BLYNK APPLICATION :

The Blynk application is a popular platform for developing IoT (Internet of Things) projects, allowing users to easily build advanced phone-controlled projects and prototypes. Here's a brief description of Blynk's IoT interface:

i) User-Friendly Interface: Blynk provides a user-friendly interface that allows users to create custom IoT applications without writing extensive code. It offers a drag-and-drop interface for designing the user interface of the application, making it accessible to beginners and experienced developers alike.

ii) Hardware Compatibility: Blynk supports a wide range of hardware platforms, including Arduino, Raspberry Pi, ESP8266, ESP32, and more. This compatibility allows users to easily connect their hardware to the Blynk platform and control it remotely via the internet.

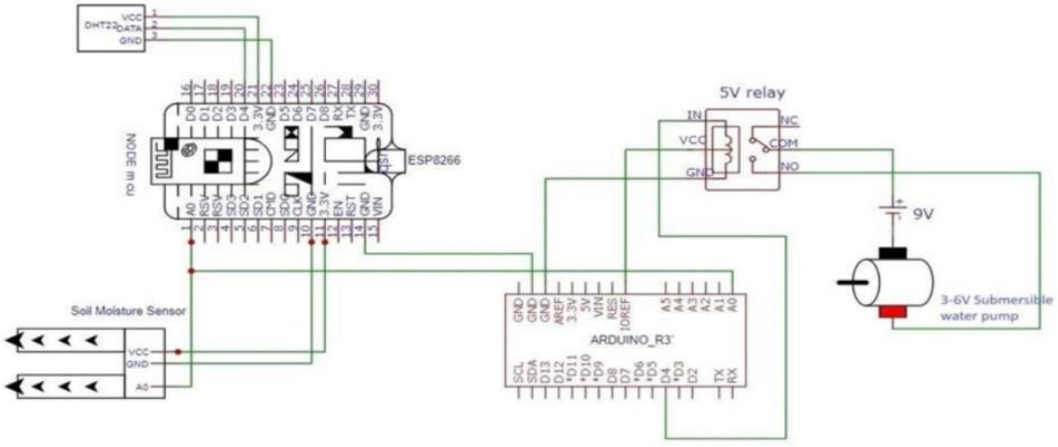
iii) Cloud Connectivity: Blynk provides cloud connectivity, allowing users to remotely monitor and control their IoT devices from anywhere with an internet connection. This feature enables real-time data monitoring, notifications and remote control of connected devices.

iv) Widgets and Functionality: Blynk offers a variety of widgets and functionality that can be added to the user interface of the IoT application. These include buttons, sliders, gauges, graphs, and more, allowing users to create custom interfaces tailored to their specific project requirements.

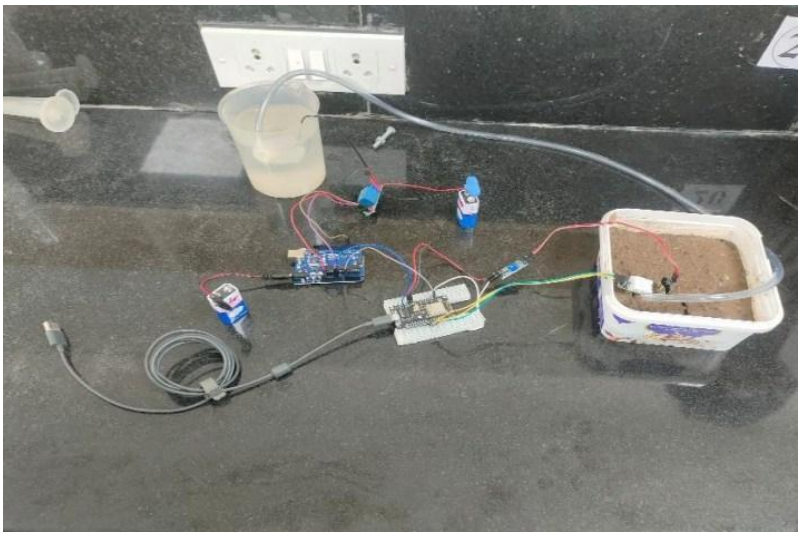
v) Security: Blynk prioritizes security by using industry-standard encryption protocols to protect data transmission between the IoT device and the Blynk cloud servers. Users can also implement additional security measures, such as authentication tokens, to further secure their projects.

Overall, Blynk provides a powerful and flexible platform for developing IoT applications, enabling users to create custom advanced phone-controlled projects with ease. Its intuitive interface, hardware compatibility, cloud connectivity, and security features make it a popular choice among IoT enthusiasts and developers.

6.CIRCUIT DIAGRAM:

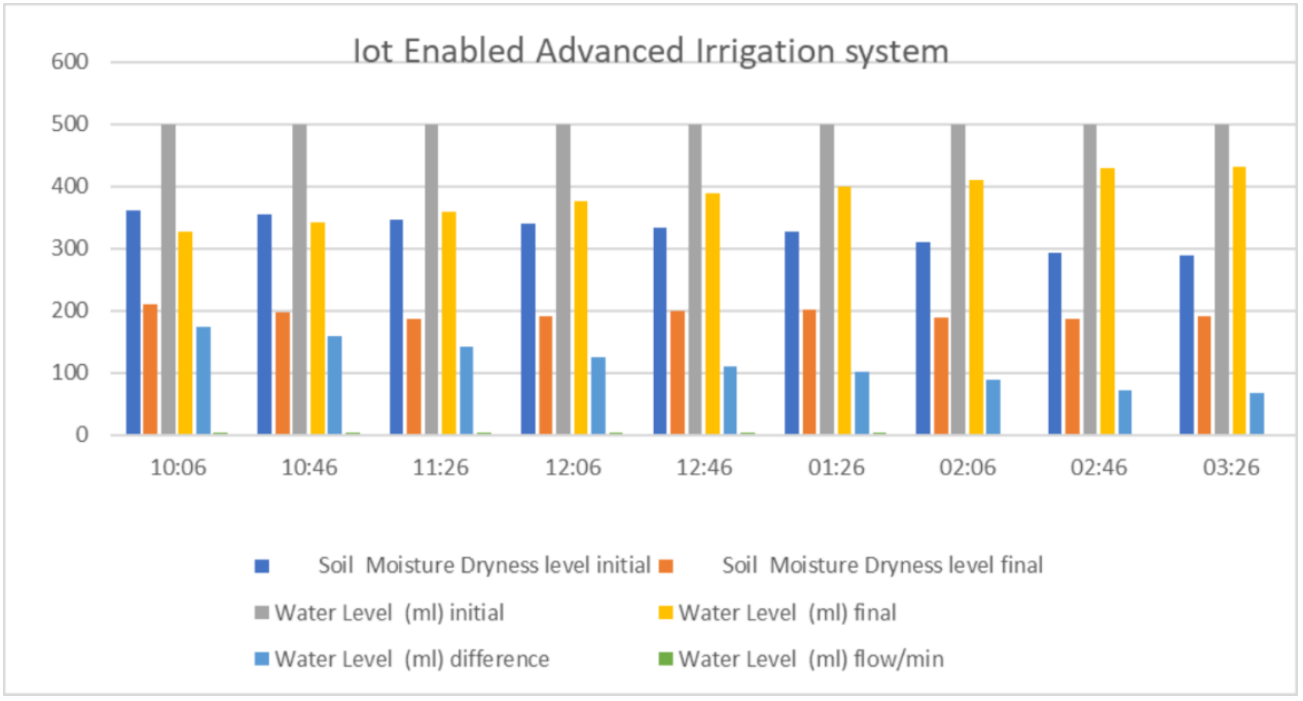


Experimental-Setup (Circuit):



7. RESULTS AND DISCUSSIONS:

Time	Soil Moisture Dryness level		Water Level (ml)					
	initial	final	initial	final	difference	flow/min		Soil Status
10:06	362	211	500	327	173	4.33		Soil Completely Dried out
10:46	355	198	500	342	158	3.95		
11:26	346	187	500	359	141	3.53		
12:06	340	192	500	376	124	3.10		
12:46	334	199	500	389	111	2.78		Soil Partially Dried Out
01:26	327	201	500	399	101	2.53		
02:06	311	189	500	411	89	2.23		
02:46	293	187	500	429	71	1.78		
03:26	290	191	500	432	68	1.70		



8. CONCLUSION:

This system saves manpower and efficiently utilizes the water resources available ultimately leading to more profit. The feedback provided by the system will improve the implementation of the gardening process. A system to monitor temperature, humidity, moisture level in the soil was designed and the project provides an opportunity to study the existing systems, along with their features and drawbacks. Agriculture is one of the most water-consuming activities.The farm owner can monitor the process online through an android App. Though this project can be concluded that there can be considerable development in farming with the use of IOT and automation.[2]

9. FUTURE DIRECTIONS:

- **Improved Data Analytics:** Enhancing insights into crop health and water usage for better resource allocation.
- **Precision Agriculture**: Further integrating precision techniques for efficient resource use based on crop and soil characteristics.
- **Remote Monitoring Expansion:** Making system management easier from anywhere with enhanced remote monitoring.
- **Sustainability Focus:** Prioritizing sustainability through renewable energy integration and water conservation.
- **Scalability and Accessibility:** Ensuring accessibility across farms of all sizes and regions with interoperability support.
- **Collaborative Innovation:** Collaborating among stakeholders to drive innovation, develop standards, and promote adoption.

10. REFERENCES:

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