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Smart Irrigation System using IOT

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Abstract

The majority of nations rely heavily on agriculture to power their economies. A nation's growth is mostly dependent on agriculture, notably for people's livelihood and the production of food and other raw resources. The rise of agriculture is the main driver of a nation's economy. One type of irrigation system that is frequently utilized in the agricultural industry is the smart irrigation system. In areas of farming where water is scarce, irrigation is used. This intelligent irrigation system is designed with farmers in mind. In this paper, the proposed smart irrigation system uses NodeMCU ESP8266. This system reads the values using sensors and waters the plants based on those values. Also, the system will send notification as well as email to the owner for a certain interval of time depending on the owner specification. The owner can also remotely monitor values by using the mobile application or web application. It is very easy to implement, and will save manpower, leading to a cost-effective solution for efficient water management in agriculture. This system harnesses the power of a microcontroller to monitor and control irrigation process, ensuring optimal water usage.

Keywords: Agriculture, Internet of Things (IoT), Real-time monitoring, Sensor Technology, Smart Irrigation.

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1. Introduction

This research paper regards the potential of the smart irrigation system. Irrigation is the application of providing controlled amounts of water to plants, assisting the growth of agricultural crops with efficient water management. Our research's aim is to create an automated irrigation system that is both cost-effective and time-saving, using a Node microcontroller. The NodeMCU (Node Microcontroller Unit) is an open-source hardware and software development environment that is built around a very cheap System-on-a-Chip (SoC) called the ESP8266.If there is an insufficient amount of moisture in the soil detected by the soil moisture sensor, the proposed system will water the plants automatically. Our goal is to connect the system to the internet, enabling a smart phone app to monitor it from anywhere at any time.
The concept of this research is to allow the owners of fields to monitor the moisture level and in their farms remotely. Real-time information is provided and water flow can be controlled based on soil moisture using a smart platform of IoT. It is straightforward to use for anyone with a smart phone and does not require any maintenance once set up. This research was created to monitor irrigation systems in farms without the necessity of manual checking. For example, if you are staying in any place in the world, and have your farm at your home and it is not possible for you to go to the farm every time to maintain a close watch on the plants. Instead, this research offers the opportunity to check up on your plants with a simple IoT system. The water pump can be controlled by the node used to connect the system to your smart device, which is a positive aspect of this research

2. Related Works

M. Priyanka et.al [1] developed the smart irrigation system using both Arduino and NodeMCU. They used various sensors like soil moisture sensor, ultra sonic sensor. The readings can be seen by the farmer remotely

using the application. The irrigation is automated based on the readings from the sensors. They can also see the readings in the form of a graph instead of values. So that a track of those values also maintained.

S.Shobana et.al [2] developed a IOT based smart irrigation system using soil moisture sensor and NodeMCU. In this system they used they integrated Arduino and other sensors like soil moisture sensor, photo cell sensor. They used the thing speak application to monitor the values read by the sensors. The Water saving may be achieved by utilizing a wireless network to enhance irrigation systems. The goal of this research is to automate agriculture watering by tracking the water content in the soil.

C K.Gomathy et.al [3] proposed the smart irrigation system using IOT. This system is to automate the irrigation process using Arduino and WIFI module. They used various sensors like soil moisture sensor, rain sensor and DHT11 sensor. They developed the system in such a way that if the water level is less than 30% the motor gets on. They also keep the status of the motor in their application. If the motor is turned on, they put the status as on and if the motor is off then they put the status as off in their application. This may be more cost in integration Arduino and WiFi.

Ashwini B V et. al., [4] presented a study on smart irrigation system using IoT for surveillance of crop-Field. Irrigation can be automated by using sensors, microcontroller, Bluetooth, android application. The low-cost soil moisture sensor and temperature and humidity sensor are used. They continuously monitor the field. The sensors are connected to Arduino board. The sensor data obtained are transmitted through wireless transmission and are reached to the user so that he can control irrigation. Since the Bluetooth is used it works for short range applications only.

Nor Adni Mat Leh et.al., [5] presented an IoT Based Smart Irrigation System at ICSEngT 2019.Their system is based on Internet of Things (IoT) technology using Arduino to optimize irrigation in agricultural fields. By integrating sensors, the system monitors soil moisture levels in real-time. Through data analysis and decision-making algorithms, it automates irrigation. The study exhibit effectiveness of the IoT-based approach in maintaining water resources while maximizing crop yields.

N. Divya et.al [6] introduced a Smart Irrigation system using Internet of Things at ICCPC 2022. Their system leverages IoT to improve the irrigation efficiency in agricultural fields. They used ATMEGA328P on Arduino UNO platform. Through data analysis it enhances water usage and irrigation scheduling, hence improving crop productivity and conserving water resources.

A. Anitha et.al [7] presented a Smart Irrigation system using IoT at IC-ETITE 2020. They used Arduino and other sensors like water level sensor, etc to make this system. They used a wifi module. Their system integrates IoT technology with irrigation management to optimize water usage in agricultural fields.

Tushar Rathor et.al., [8] proposed a Smart Irrigation system using IoT at ICSCCC 2023. Their system utilizes IoT technology to improve irrigation in farms as well as gardens. By integrating sensors and actuators, the system observes soil moisture levels, weather conditions, and crop features in real-time.

M. Benedict et.al [9] developed an Automated Smart Irrigation System using IoT with Sensor Parameter at ICEARS 2022. Their system integrates IoT technology with sensor gauges to enhance irrigation in agricultural farms. Through data analysis and decision-making algorithms, it automates scheduling and control, ensuring precise water delivery to crops.

C.H. Chavan, and P.V. Karande [10] presented Wireless monitoring of soil moisture, temperature & humidity using zigbee in agriculture. They used AVR micro controllers and zigbee in their methodology. A general method to quantify the factors in an agricultural environment betokened individuals manually taking quantifications and checking them at sundry times. This paper investigates a remote monitoring system using Zigbee.

Suresh et.al [11] have proposed a methodology predicated on the capabilities of current and next-generation microcontrollers and their application requisites. They used GSM and LPC2192 master controller also used max232 to interface them.

Gautam and Reddy [12] proposed an innovative GSM Bluetooth predicated remote controlled embedded system for irrigation. They also used various sensors and micro controllers to develop this system.

From this we have proposed a Smart Irrigation system based on the concept of Internet of Things. It is based up on only ESP8266 and sensors are DHT11 and Soil moisture sensor. We used a Blynk server which was fully automated. If the water is low in the field, it automatically turns on the water pump. If the water is sufficient then the pump will automatically turn off. And it also sends an email as well as notification to the owner. The owner can remotely monitor the soil moisture sensor, temperature and humidity values through Blynk mobile application and web application. This system is easy to install and need not to maintain again and again. It saves a lot of time. Water is not wasted. Farms are not over irrigated and not effects the crop yield also.

2.1. Existing Methodology

Traditionally the irrigation is done by the farmer manually. It requires more manpower, also a lot of water is wasted by over irrigation to the plants since the farmer is not at the crop for every time, the farmers just keep the motor turn on and leave the fields. Then other system is developed using GSM which is more cost that need a sim card to be inserted in it. But there is no data driven decision making and there was only limited automation. Remote monitoring was not there in the existing systems. Traditional methods are in efficient that makes a lot of water wastage and high-power consumption. So that there was no use. And in traditional there was manual observation only. In traditional system sometimes the farmers also need to travel at night time to their crops for watering it. On those night time the farmer may also die if any snake bite may happen. So traditional methods also keep farmers life in risk. There was also system that developed using Arduino but there was no much automation. So, the concept of IoT is necessary in irrigation. There are many benefits by introducing the field of IoT in irrigation.

In the existing system there are some disadvantages or draw backs. Especially in traditional methods of irrigation the farmer needs more work to be done. A lot of water is wasted and there was no automation. The farms get over irrigated, also it effects on the crop yield. Sometimes the farmers also need to go at night times to irrigate their farms which is risk. Later there are some systems that are developed using GSM but there was no fully automation. In some systems the farmers don't come to know about the status of the water pump. And later their where system developed by Ardunio with other micro controllers. But that was high cost and here also the owner doesn't come to know the status of their water pump whether it is in on or off. So, we proposed a system that is based on IoT with various advantages.

2.2 Proposed Methodology

Our proposed system is a combination of hardware and software. We used the concept of IoT.The hardware part consists of different sensor like soil moisture sensor, DHT sensor, relay, NodeMCU ESP8266.The software we used in our system in Blynk mobile application as well as web application. All the hardware components are connected to the NodeMCU. This device is connected to the internet. Once it connected to the internet it connects to the Blynk server. And the values read from the sensors are sent to the server. The user can monitor those readings from the mobile or web application of Blynk remotely. In our proposed system the water pump is automatically turned on or off based on the reading from soil moisture sensor. We have used the digital value to control the water pump. If the value is low, it automatically turns on the water pump. If the value is high then tuns off the motor. Our system is set in such a way that it sends an email to the owner and can also receive a notification from Blynk application for a certain time interval for both the conditions

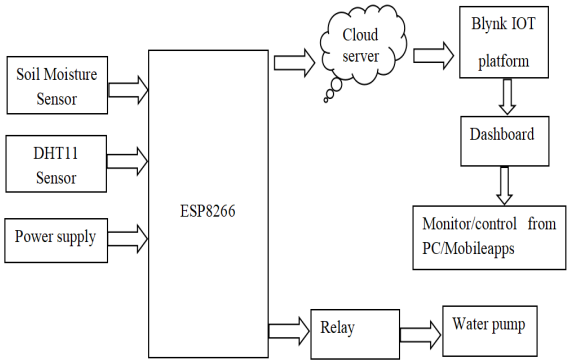

Figure 1. Architecture of the proposed system

Our proposed system has various benefits over existing system. No manpower required. It requires very low manpower. No water is wasted. It is easy to setup. Once the system is installed successfully, no need to maintain again and again. It is also affordable by poor farmers. There is no over irrigation to the crops, therefore there is no effect on the crop yield. The system is built in such a way that the owner also gets notification and email regarding the status of the soil moisture. Our system is completely automated. If the soil moisture is low, it automatically turns on the water pump. If the soil moisture is high, it automatically turns off the water pump. It also keeps track of all the notifications regarding the soil moisture in the Blynk application itself.

The following are the principal parts utilized in the research:

The ESP8266 Node MCU Wifi Module: it is a highly adaptable and popular microcontroller module. Because to its inexpensive price, integrated Wi-Fi, and simplicity of use, it has become extremely well-liked within the maker and electronics communities. The ESP8266 was designed to be a basic Wi-Fi module, but it has developed into a potent microcontroller platform that can run stand-alone apps. A flexible and reasonably priced micro controller module, the ESP8266 has made several applications possible, from robotics and smart devices to home automation and Internet of Things devices. Its affordability, simplicity of use, and Wi-Fi connection have made it a mainstay in the maker community and the preferred option for IoT and wireless communication applications.

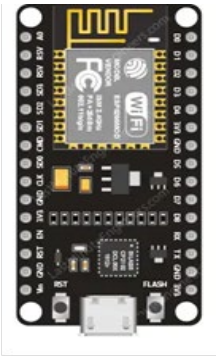

Figure 2. NodeMCU ESP8266

2) **Relay Module:** An electromechanical device called a relay is used to regulate the flow of electricity inside a circuit. It is composed of an iron core with a coil of wire wound around it. When an electrical current is sent through it, the iron core produces a magnetic field. An armature or switch mechanism is moved by this magnetic field, opening or shutting electrical connections inside the relay. The relays are very easy to use.

Figure 3. Relay Module

3) **Soil Moisture Sensor:** An instrument used to gauge the amount of moisture in the soil, a soil moisture sensor is an essential tool for both gardening and agriculture. It provides useful information about soil conditions, enabling decision-making about water management and irrigation schedules. Soil moisture sensors come in a variety of forms and designs, but they all function by measuring the electrical conductivity or resistance of the soil, which varies depending on the moisture content.

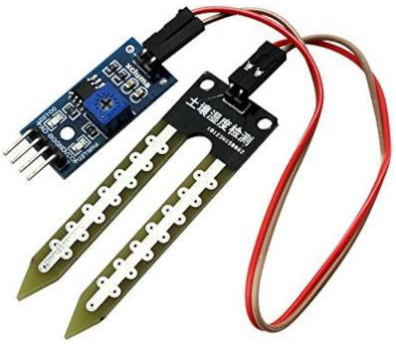

Figure 4. Soil moisture sensor

4) **Blynk:** Blynk is specially designed for Internet of Things. With help of Blynk we can remotely operate the hardware devices, we can monitor the sensor data, it can store data, it can visualize data in different ways and can do many more things. We can create dashboards and add widgets to dashboards in the Blynk applications. We can set it easily just by drag and drop. We need to add data streams for each widget. Data streams are the channels that are required to transfer data. Blynk makes easy to transfer data with help of these data streams. Blynk is the easiest way to build our IOT products

5) **Arduino Integrated Development Environment (IDE):** It is used to write and upload the code in the NodeMCU, Arduino and other boards. The code is called as sketch and saved with the extension ino. It is easy to upload the code to the board just by connecting the board to our laptop via USB cable. We can write the code in c++ and other languages. It has a vast library and many boards. We also need to install specific drivers for uploading the code like cp210x.Overall it is easy to setup the Arduino.

3. Implementation

The smart irrigation system can be installed very easily by following the steps below

1) Give the connections to hardware components as shown below in Figure 5.
2) Create the data streams and dashboards in the Blynk.
3) Connect the NodeMCU to laptop using USB and upload the code.
4) Now connect the NodeMCU to the WiFi.
5) The system is installed successfully

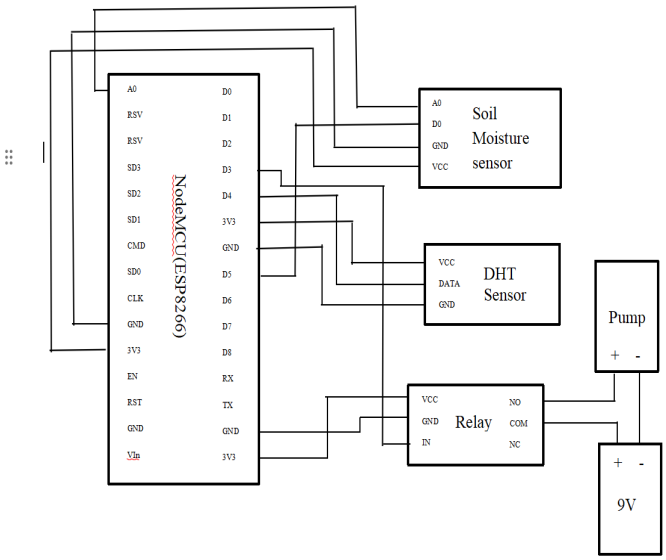

Figure 5. Wiring Diagram of Smart Irrigation System

Creating data streams:
Data streams are the channels that are used to transfer the data.
1) Login to Blynk account and open the device.
2) Click on data streams and click on new data stream.
3) First create data stream for soil moisture. And select virtual data stream. Give data type as integer, set min and max value as 0 and 100.Set virtual pin to V5.
4) Next create data stream for Temperature. Select virtual data stream. Give data type as double, set min and max value as 0 and 100 without decimals. Set virtual pin to V1.
5) Next create data stream for Humidity. Select virtual data stream. Give data type as double, set min and max value as 0 and 100 without decimals. Set virtual pin to V0.
6) We have created the data streams successfully.

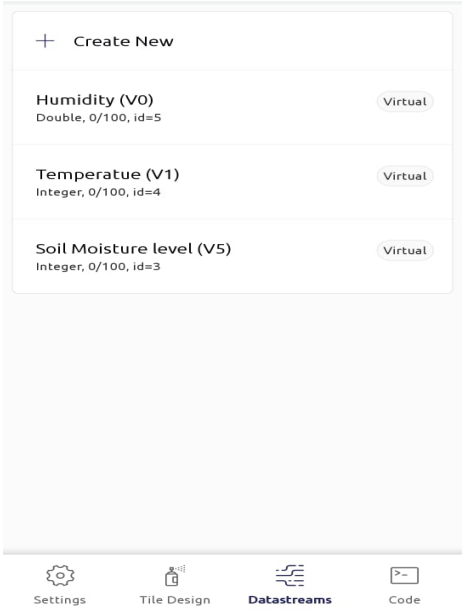

Figure 6. Data streams

Creating dashboards:

Dashboards can be created very easily just by drag and drop the widgets.
1) After opening our device in Blynk, click on Web Dashboard.
2) Then select the gauge, drag and drop that into dashboard.
3) Drag the gauge three times for soil moisture, temperature and humidity.
4) Click on the first gauge and select the soil moisture data stream.
5) Click on the second gauge and select the temperature data stream.
6) Click on the third gauge and select the humidity data stream.
7) We can also set colors to those data streams.
8) Similarly, we can create the dashboard for mobile also.
We can see the dashboards in Figure 8 and Figure 9.

How the system works:

1) Once the NodeMCU is connected to WiFi, it connects to the server of Blynk.
2) The sensors are activated and the data from the sensors is collected.
3) This data is sent to the server.
4) Our mobile application is connected to that server.
5) We can monitor the values read by the sensors in our mobile application or web application of Blynk.
6) The water pump automatically turns on or off based on the digital value of the soil moisture sensor. If the value is 0 the pump gets on and vice versa.
7) The email and notification regarding the soil moisture and pump status is sent to the owner for a specific interval of time that is set by the owner.

4. Result Analysis

We have successfully created and installed a smart irrigation system using Internet of Things. This automates the irrigation based on the soil moisture values, using an intelligent system. This saves a lot of time, requires less manpower and easy installation. The sensor values can be remotely monitored. All the components to make this research are low cost so a poor farmer can also set up this in their fields or gardens. Once the system is installed successfully no maintenance is required.

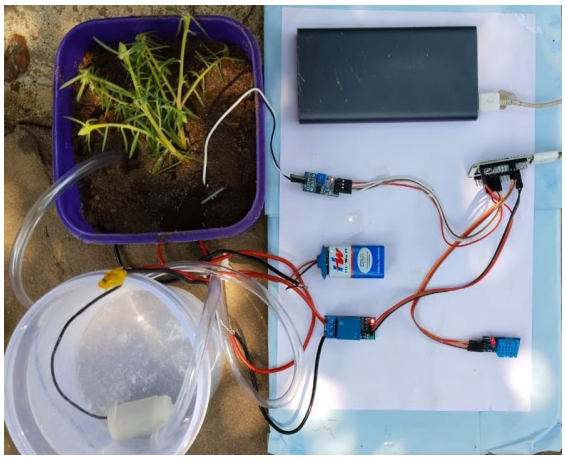

Figure 7. Smart irrigation research kit

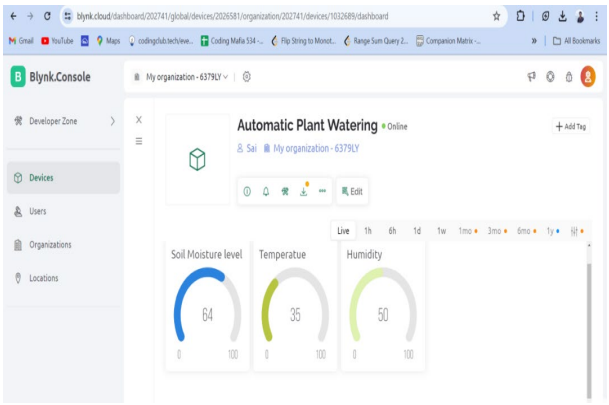

Figure 8. Web dashboard

Fig 8 shows the web dashboard of our research. It can be accessed by any web browser. We can see the same thing in the mobile dashboard Figure 9.

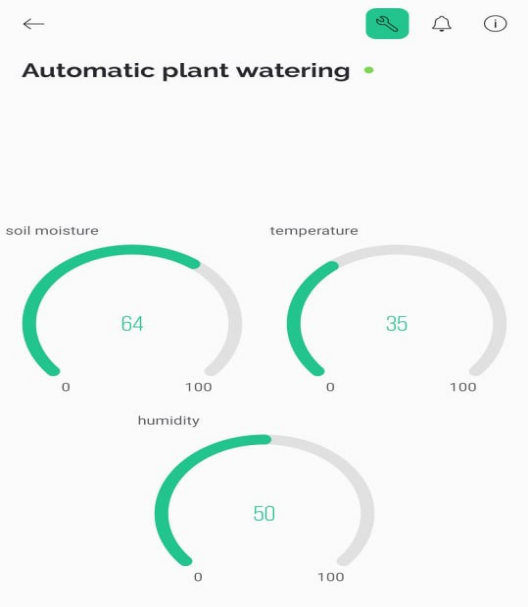

Figure 9. Mobile dashboard

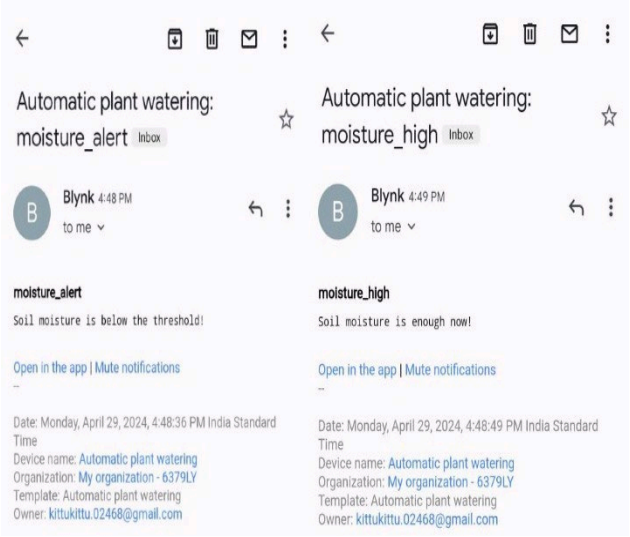

Figure 10. Email of moisture alert and moisture high

Figure 10 are the emails received to the owner regarding the information of soil moisture level for a specific interval of time. The emails are regarding the soil moisture level whether it is low or high.

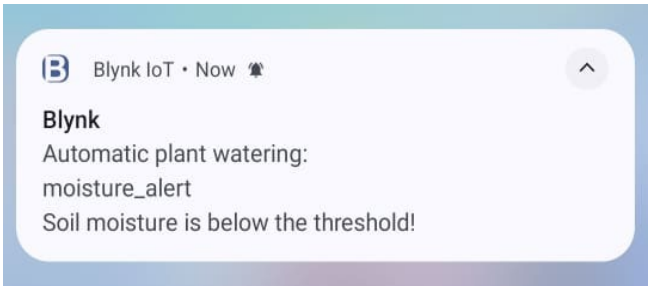

Figure 11. Blynk app notification of moisture alert

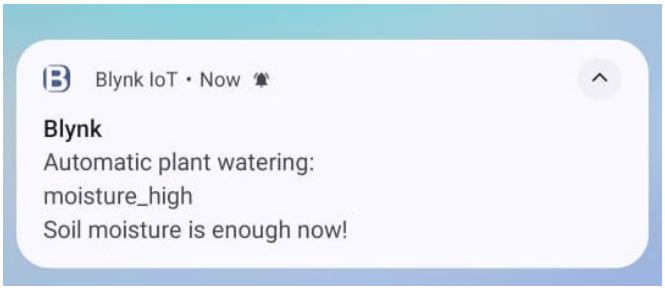

Figure 12. Blynk app notification of moisture high

Figure 11 and Figure 12 are the notifications received to the owner regarding the information of soil moisture level for a specific interval of time. It is from the blynk app.

Figure 13. Timeline of events and notifications.

Figure 13 is the timeline of events and notifications. All are saved in the Blynk app itself. It shows at what time an event occurred.

5. Conclusion

The implementation of Smart irrigation system using IoT offers various advantages like resource optimization and efficiency. The combination of these sensors and micro controller enables us to sharply monitor and control the water usage in fields and gardens. The smart irrigation system continuously collects the data from the sensors and based on that data only the irrigation is done. It is very easy to setup this system. Once we setup the system need not to maintain the system again and again. This is low cost, a poor farmer can also set this in their fields, saves a lot of water. No over watering to the plants. Manpower is reduced. A lot of energy is saved. Therefore, it should be implemented everywherehe remote monitoring and automation features of IoT based smart irrigation system make the farmers and gardeners easy to manage irrigation processes conveniently, even from a far distance. This not only reduces water usage but also improves crop health and yields. It can also save farmers life from risk when they travel at night time in the fields for watering their crops. Overall, the implantation of smart irrigation technologies using IoT bears great promise for the ffollowing agriculture, offering a solution to the challenges of lack of water, increasing demand for food production, and environmental sustainability. As technology continues to develop, we can assume even greater efficiency, accuracy, and environmental management in agricultural practices through the continued evolution and implementation of smart irrigation systems based on IoT.

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