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IOT Based Automatic Plant Watering System

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Abstract: This paper demonstrates how to use the Efficient water management is crucial for healthy plant and growth and sustainable agriculture.
This paper presents the design and implementation of (IOT)-based automatic plant watering system. The system continuously monitor soil moistures levels and automatically irrigates the plant when the soil becomes dry. Experimental results demonstrate that the proposed of system ensures timely irrigation, reduce water wastage, and provides an effective solution for automated plant care.
Keywords: IOT, automatic irrigation, soil moisture sensor, ESP32, water conservation, smart irrigation.

I. INTRODUCTION

It's hard to establish a routine in our fast-paced society. For busy people who may not have agricultural background it may be difficult to establish or maintain a routine for regular plant care.
To address this task, we designed an IoTbased automated plant watering system, several beneficial technologies which will help bring together technology and the outdoors. The smart system uses real-time data from soil moisture sensors to determine when the plants need watering and will activate the pump to hydrate them.
The result is a system that takes care of your plants and analyses data so that you can achieve your plants' optimal condition with almost no human effort. It is based on the ESP32 microcontroller, one of the most- supported microcontrollers for IoT, and integrates with cloud platforms such as Blynk or ThingSpeak to allow monitoring from wherever you are, control from your mobile device, and saves water in the process. Our system is designed to promote smart farming and home automation concepts plus contributing to sustainable living by less way to provide a seamless blend of technology, convenience and sustainability in our modern gardening habits.

II. RELATED WORK

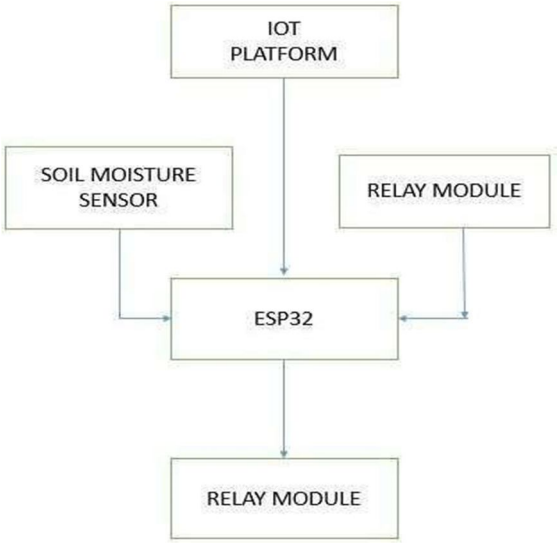
This paper has a primary goal of developing an IoT based automatic plant watering system, a system that: be able to monitor soil moisture in real time and automatically initiate irrigation when needed so that management of the plants will be reduced, improve water conservation and maximize plant growth through smart technology.
Additionally, the system can allow users to not only monitor the system, but to control the system remotely through a mobile app or web interface.
This will ensure an efficient and sustainable plant care system.

1) Proposed an IoT-based irrigation system that automates watering using real-time soil moisture data.
2) Designed an ESP32-based smart irrigation system with wireless monitoring and control through IoT.
3) Developed an automated irrigation system using ESP32 and soil moisture sensors for efficient water usage.
4) Implemented remote monitoring and control of irrigation using an IoT platform for improved plant care.
5) Presented a Blynk-integrated ESP32 irrigation system enabling smartphone-based control of watering.
6) Introduced a low-power IoT automatic watering system focusing on energy-efficient operation.
7) Developed a relay-based motor control system using ESP32 for automated plant watering. water consumption and doing less work. It's the [8] Designed a soil moisture sensor-based irrigation system perfect using ESP controllers for precise watering.
8) Reviewed various IoT-based irrigation automation techniques highlighting smart farming advancements.
9) Analyzed soil moisture-based irrigation control using microcontroller and relay switching mechanisms.

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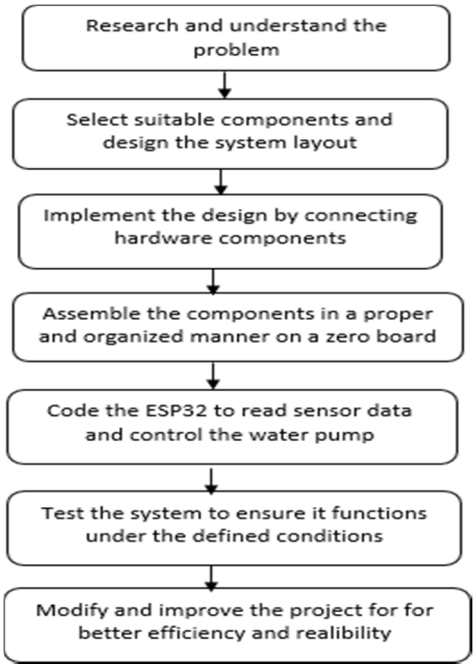
III. METHODOLOGY

Fig.3.1 - Block Diagram of the proposed system



The block diagram of the IoT-based automatic plant watering system is composed of several main components that are working together as one coherent system. The power supply component comprises the AC to 5V DC converter, and the rechargeable battery, which provides power to the system. The ESP32 acts as the central controller and receives data from the soil moisture sensor. Once the ESP32 receives the information it needs from the moisture sensor, it can turn on the relay module which will activate the water pump, only when the soil moisture is dry. The ESP32 has a built-in Wi-Fi connection which allows the ESP32 to connect to the IoT network of your choice, such as Blynk or ThingSpeak, allowing you to monitor the moisture of the soil and control the device with a few commands, even on remote locations. This makes for seamless smart integration of the automatic plant watering system where watering is efficient, automatic, and controlled without any wires.

Fig.3.2 –Flowchart of the proposed System



The ESP32 plays an important and vital role in an IoT-based automatic plant watering system. It is an affordable and powerful microcontroller that has built-in Wi-Fi capabilities making it a good choice for smart agricultural, and home automation. Within the automatic plant watering system, the ESP32 acts as the brain that controls the soil moisture sensor, water pump, and user interface. ESP32 built-in Wi- Fi allows it to connect to the internet and generate real-time data tranfer to cloud platforms (site) or mobile applications like Blynk or Firebase. Through these platforms users can see the readings for the soil moisture.

In IoT-based automatic plant watering system, emphasizing the critical role of a reliable power supply. It outlines the process of converting 220V AC mains to 5V DC using an AC to DC converter, which is essential for powering key components such as the ESP32, relays, and sensors. Furthermore, the integration of a rechargeable battery (Li-ion or Li-Po) provides backup power during outages or for portable outdoor usage. The inclusion of a charging module, like the TP4056, ensures the battery is safely recharged. The combination of these elements guarantees uninterrupted power, enabling the system to function continuously without manual intervention. This design enhances the system's reliability, portability, and efficiency, making it well-suited for automated plant care.

The relay module is wiring up the motor or water pump in the system. It performs as an electronic switch controlled by the ESP32 microcontroller. When the soil moisture is low, the ESP32 sends a signal to the relay module. The relay then activates the motor, and the watering of the plant begins. It isolates the low voltage ESP32 and high voltage motor circuit. The relay will work with AC pumps or DC pumps in some designs. Most relay modules usually operate on a 5V input, but can also switch higher voltages. Some relay modules will have opto-isolators to separate power switching. Once watering the plant is completed, the ESP32 will signal the relay to turn the motor off. The circuit is automated and allows the pump circuit to be controlled safely.

In the IoT-based automatic plant watering system. The soil moisture sensor is used to determine the amount of water in the soil. It will help decide if the plant needs watering or not. The sensor has two probes that are inserted into the soil. The soil moisture sensor measures the resistance between the two probes; wet soil has greater conductivity, so it will have relatively much lower resistance than dry soil. The soil moisture sensor will send either an analog or digital signal to the ESP32 microcontroller. The schematic is simple: low moisture means high resistance between the probes (thus low signal), while high moisture means low resistance. The ESP32 will read this value and determine when to start watering. The soil moisture sensor offers two important aspects in the routine of watering. Firstly, plants will only be watered when necessary, leading to improved plant health, productivity, and aesthetic appearance. Secondly, the soil moisture sensor ensures our system is just as efficient, smart, and water saving. Overall, the soil moisture sensor is a fundamental component of smart irrigation.

A. Arduino IDE

The Arduino Integrated Development Environment (IDE) is a free software platform essential for coding, compiling, and uploading programs to microcontrollers such as the ESP32. It primarily supports the C/C++ programming languages, making it user-friendly for developing Internet of Things (IoT) applications. In the context of a plant watering system project, the Arduino IDE is instrumental in programming the ESP32 to manage sensor readings and motor control for irrigation.

B. Blynk

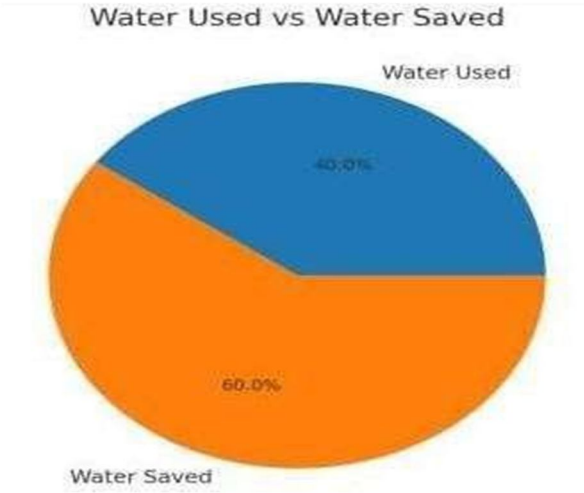
Blynk is an Internet of Things platform which provides drag and drop features for representation of results on it. This platform is used to make the mobile application. The application requires the **ssid** (the network name), password of the network and also need Wifi module where we use (ESP32) in it its just having ON and OFF option which automatic works within the respective conditions and the authorization token issued by the Blynk platform.

IV. RESULT AND DISCUSSIONS

A. Site

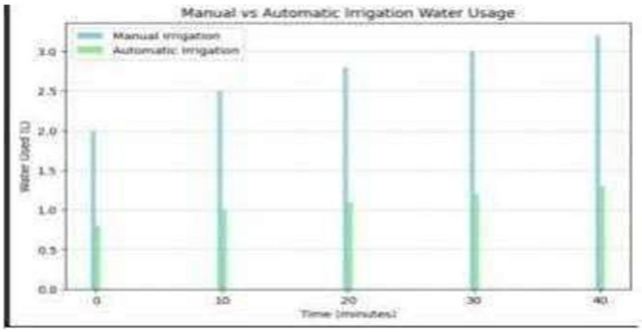
1) Result

We have built a smart website that supports our IoT-based automatic plant watering system. The ESP32 collects live weather data from the soil moisture sensor and transmits it to the cloud over Wi-Fi. This live data is integrated into the smart website and shown on a user-friendly, interactive dashboard. The website provides users with the ability to monitor live soil moisture data, pump status, and alerts. Users can also remotely manipulate the water pump from the interface of the website. This online control system, combined with real-time monitoring, ensures that users are using water efficiently and can remotely monitor the pump system for their plants, enabling smart, efficient, automated, and easy plant care.



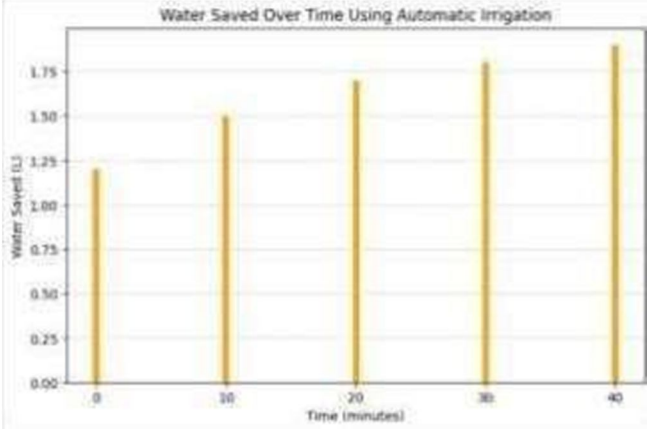
2) Result

The graph shows how soil moisture (%) changes with time (minutes). Initially, the soil moisture is 80%, and it keeps decreasing as time passes. At 4 minutes, the soil moisture reaches 60%, which is the minimum threshold. The dashed line at 60% indicates the point where the pump turns ON to irrigate the soil. Conclusion: The pump starts working automatically when soil moisture drops below 60%.



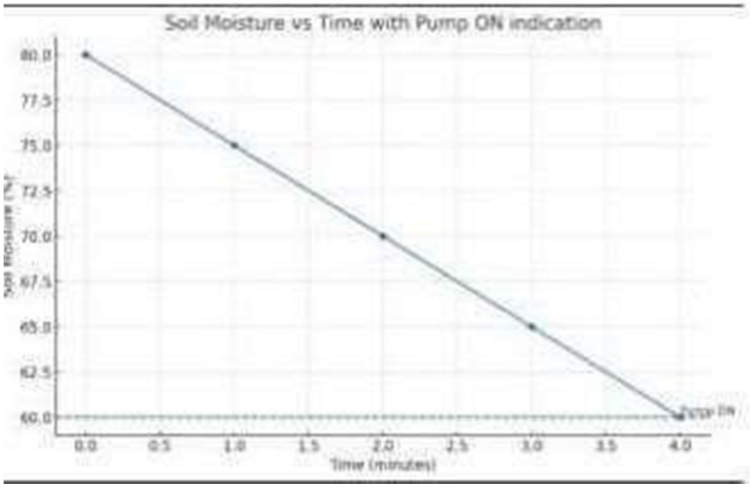
3) Result

This is a bar graph comparing manual irrigation (blue bars) with automatic irrigation (green bars). At different times (0, 10, 20, 30, 40 minutes), manual irrigation always uses more water than automatic irrigation. Example: At 20 minutes, manual irrigation uses around 3 L, while automatic irrigation uses only about 1 L. Conclusion: manual irrigation uses around 3 L, while automatic irrigation uses only about 1 L. Conclusion: Automatic irrigation saves water compared to manual irrigation.



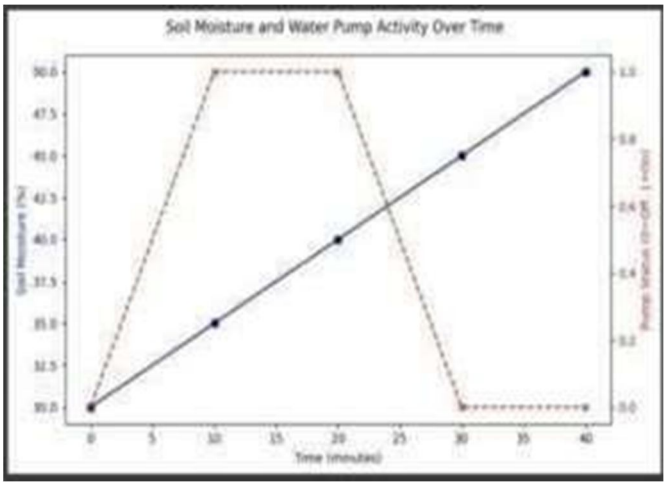
4) Result

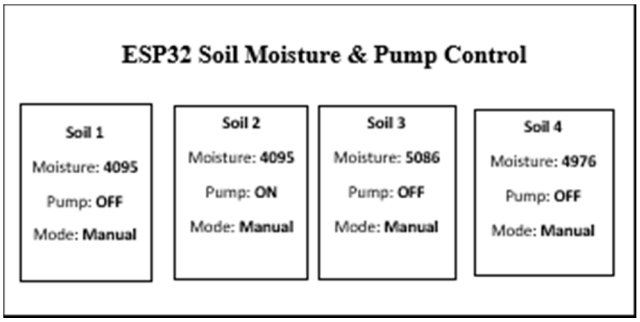
This bar graph shows how much water is saved when using automatic irrigation. Over time (0 to 40 minutes), the amount of water saved increases gradually. At 0 minutes, water saved is 1.2 L, and at 40 minutes it increases to about 1.9 L. Conclusion: Automatic irrigation continuously saves water as time passes.



5) Result

This graph has two parameters: Blue line: Soil Moisture (%) Red dashed line: Pump status (0 = OFF, 1 = ON) Initially, soil moisture is 30% and the pump is ON . As time increases, soil moisture rises (because the pump adds water).At about 30 minutes, soil moisture reaches 50% and the pump turns OFF (0). Conclusion: The pump turns ON when soil is dry (low moisture) and turns OFF when soil moisture reaches the required level.





V. WORKING

The IoT (Internet of Things)-based automatic plant watering system works by continuously checking soil moisture using a sensor attached to an ESP32 microcontroller. Once the soil moisture sensor detects when the moisture level drops below a minimum threshold level, ESP32 sends a signal to the relay to turn on the water pump to water the plant. After the soil moisture sensor detects it has reached the correct moisture level, the water pump will automatically be turned off. The ESP32 also sends live data to an IoT platform such as Blynk or ThingSpeak, allowing end-users to monitor and control the automatic plant watering system using a mobile app, while also allowing them to work remotely on a web-based dashboard. This system ensures that plants are smartly, efficiently and hands-free cared for.

VI. CONCLUSION

IoT-enabled automated plant irrigation systems can provide viable and reliable solutions to today's agricultural problems. Using an ESP32 microcontroller and a soil moisture sensor, these systems perform real-time irrigation monitoring and automated irrigation control by monitoring the soil moisture level.

In tests of the automatic irrigation system, the system maintained adequate soil moisture levels while reducing water waste significantly. By automating irrigation, the consumption of water has been found to channel between 35% and 40% less than the consumption of water through labor- intensive manual irrigation practices. By automating the irrigation process with an IoT system, the amount of labor involved in the irrigation process will be minimized, making the automatic irrigation system a great solution for both residential and agricultural purposes.

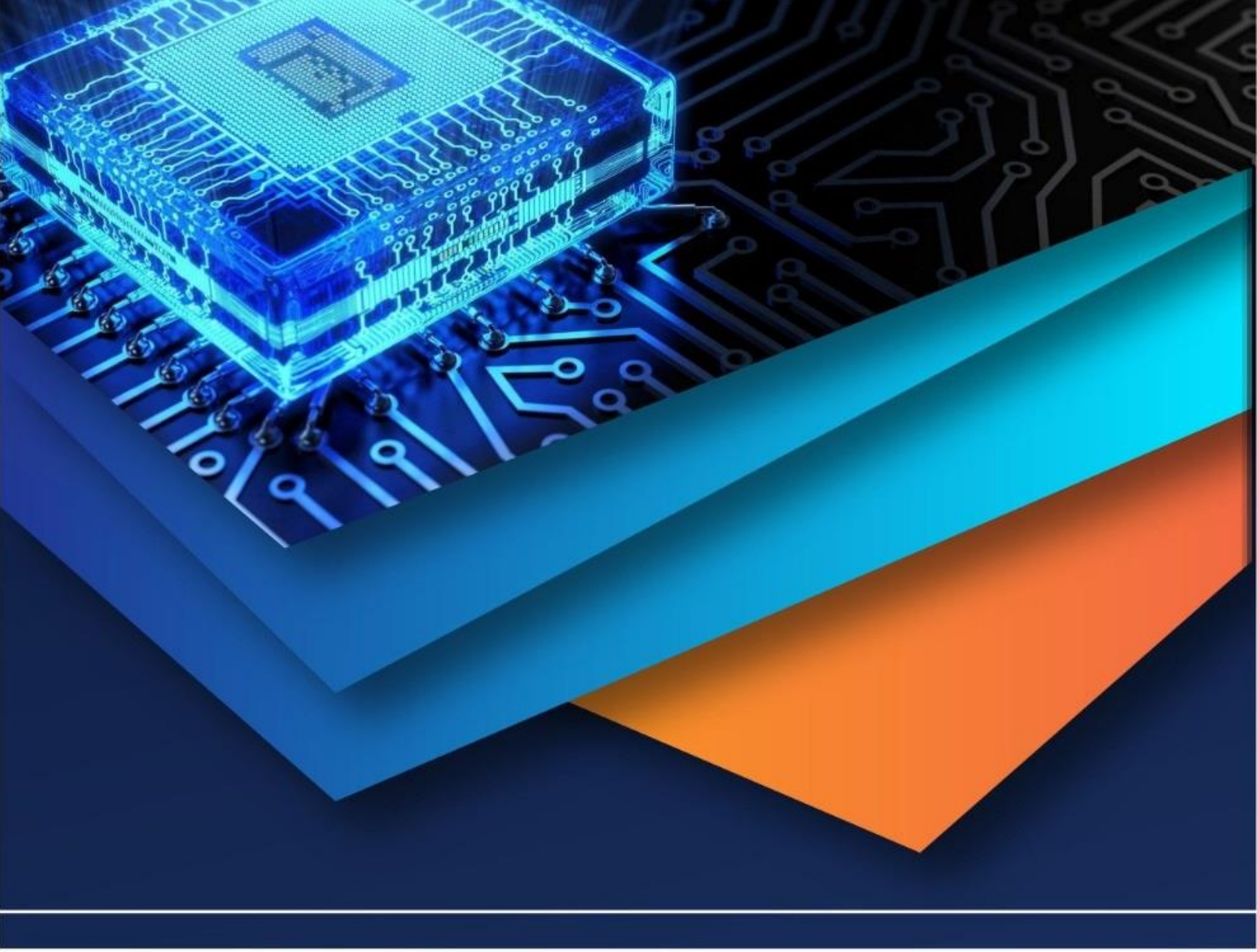
In addition, IoT systems are also cost-effective and easy to install, allowing for adaption to many plant types and environmental conditions. The IoT-enabled capabilities of the system will also allow for the enhancement of the system through the potential for remote monitoring of irrigation systems or through creating additional smart agriculture solutions.

In conclusion, the automatic irrigation system developed has provided a sustainable, scalable solution to the management of irrigation systems and continues to support plant health and conservation of water. Future enhancements to the system can be made by adding weather forecast integration, mobile application capabilities, and decision support systems utilizing artificial intelligence (AI).system minimizes manual intervention, ensures timely watering, and reduces water wastage. By integrating IoT platforms, users can remotely monitor and control the system, promoting sustainable agriculture. This approach demonstrates the potential of IoT in smart farming and can be scaled for larger agricultural applications. The IoT-based automatic plant watering system successfully addresses the problem of irregular irrigation by automating the process of watering plants according to soil moisture conditions. By using sensors, a microcontroller, and IoT connectivity, the system ensures that water is supplied only when required, thereby preventing both overwatering and underwatering. The integration of IoT platforms further enables real- time monitoring and remote control, providing flexibility and convenience to users.

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