IOT-BASED SMART WATERING SYSTEM USING MOBILE APPLICATION

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ABSTRACT

Water management has become a critical issue in modern agriculture due to increasing water scarcity and inefficient irrigation practices. Traditional irrigation methods rely on manual control and fixed schedules, often leading to excessive or insufficient watering. This paper presents an IoT -based smart watering system that automates irrigation using real-time soil moisture data and enables remote monitoring through a mobile application. The system integrates sensors, a micro controller, cloud connectivity, and a user interface to optimize water usage and improve plant health. The proposed solution reduces human intervention, minimizes water wastage, and provides an efficient and scalable approach to smart irrigation.

KEYWORDS: IoT, Smart Irrigation, Soil moisture Sensor, Automation, Mobile Application, ESP8266

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1. INTRODUCTION

Water is one of the most essential resources in agriculture, yet it sim proper usage leads to significant wastage and reduced crop productivity. Conventional irrigation systems depend largely on manual labor and predetermined schedules, which do not consider real-time soil conditions. As a result, plants may receive either too much or too little water, affecting their growth and health. With the advancement of Internet of Things (IoT) technology, it has become possible to monitor environmental parameters and automate irrigation processes intelligently. The proposed IoT- based smart watering system aims to address these challenges by continuously monitoring soil moisture levels and automatically controlling water supply. Additionally, the integration of a mobile application allows users to remotely monitor and manage the system, making it more efficient and user-friendly.

2. LITERATURE SURVEY

Recent developments in smart irrigation systems have demonstrated the potential of combining sensor technology with automation. Earlier systems based on wireless sensor networks improved data collection but lacked direct user interaction and real-time control. GSM-based irrigation systems introduced remote operation capabilities; however, they were limited in terms of data visualization and responsiveness. Cloud-based IoT solutions further enhanced scalability and data accessibility, although they increased system complexity and cost. Low-cost microcontroller-based systems using plat-forms such as Arduino provided affordable solutions but often lacked seamless mobile application integration. These studies highlight the need for a system that combines automation, real-time monitoring, and mobile-based control in a simple and cost-effective manner. The proposed system addresses these limitations by integrating all these features into a unified platform.

3. PROPOSED SYSTEM

The proposed system is designed to automate irrigation by integrating sensing,

Research Paper

processing, and communication technologies. It consists of a soil moisture sensor that continuously measures the water content in the soil and sends the data to an ESP8266 micro controller. The micro controller processes this data and determines whether irrigation is required based on a predefined threshold. A relay module is used to control the water pump, which supplies water to the plants. The system is connected to a cloud server, allowing real-time data transmission and storage. A mobile application is used as the user interface, enabling remote monitoring and manual control of the irrigation system. This integrated approach ensures efficient water management and ease of operation.

4. WORKING PRINCIPLE

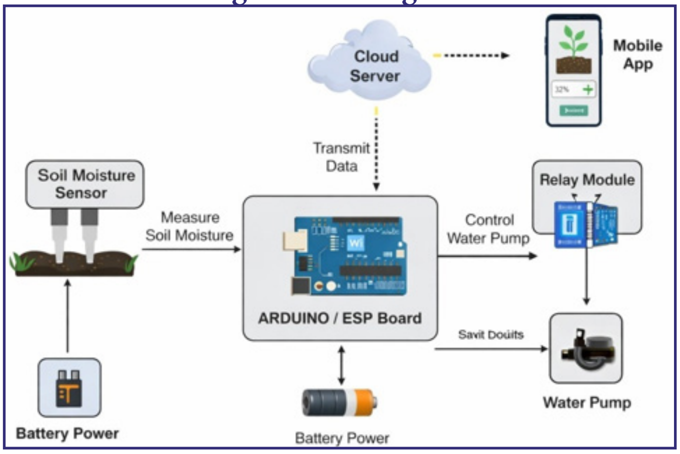
The working of the system is based on continuous monitoring and intelligent decision-making. The soil moisture sensor detects the amount of water present in the soil and sends an analog signal to the micro controller. The ESP8266 processes this signal and compares it with a predefined threshold value. If the moisture level is below the threshold, indicating dry soil, the microcontroller activates the relay module, which turns on the water pump. As the soil absorbs water and reaches the desired moisture level, the sensor updates the data, and the microcontroller automatically switches off the pump. At the same time, all sensor data is transmitted to a cloud platform, where it is stored and displayed in the mobile application. The user can view real-time data and manually control the irrigation system if required. This closed-loop system ensures efficient and automated watering.

5. METHODOLOGY

The main objectives of the proposed IoT-Based Smart Watering System are described as follows:

1. **Design of Automated Irrigation System:** The system is developed using IoT technology by integrating sensors and a microcontroller such as ESP8266/ESP32 to auto-mate the irrigation process without manual intervention.

Fig.1: blockdaigram

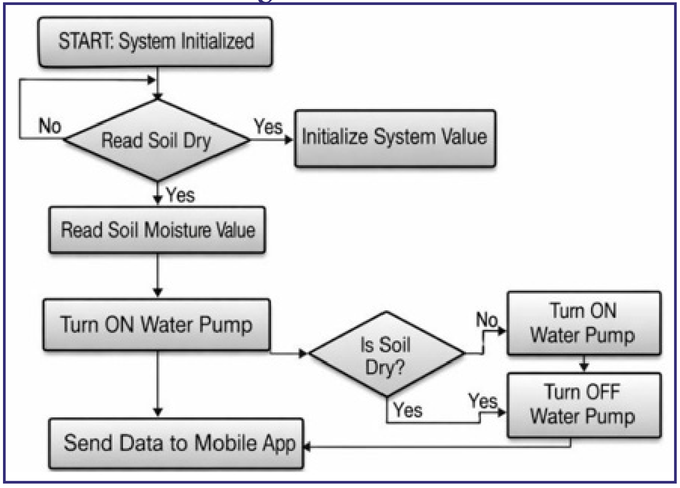


2. **Real-Time Monitoring of Soil and Environment:** Sensors such as soil moisture sensor, DHT11 (temperature and humidity), and water level sensor are used to continuously collect real-time data and transmit it to the mobile application through the cloud.
3. **Automatic Pump Control:** The system automatically controls the water pump based on soil moisture levels. When the soil becomes dry, the pump is switched ON, and it is turned OFF once the required moisture level is achieved.
4. **Remote Monitoring and Control:** A mobile application is used to monitor live sensor data and manually control the water pump from any location using internet connectivity.
5. **Water Conservation:** The system ensures efficient use of water by supplying it only when required, thereby reducing wastage and promoting sustainable irrigation practices.
6. **Reduction of Manual Effort:** Automation reduces the need for continuous human supervision, saving time and effort, especially in large agricultural fields.
7. **Improvement in Plant Growth:** By maintaining op-timal soil moisture levels, the system supports better plant health, improved growth, and higher agricultural productivity.

5. HARDWAREREQUIREMENTS

A. ESP32/NodeMCU(ESP8266) Microcontroller

Fig. 2: flowchart



The ESP32 or Node MCU (ESP8266) microcontroller acts as the central processing unit of the IoT-based smart watering system. It is responsible for collecting sensor data, processing information, and controlling system operations. The ESP32 offers advanced features such as dual-core processing, Blue-tooth, and Wi-Fi connectivity, while the ESP8266 provides a cost-effective solution with built-in Wi-Fi capabilities. These microcontrollers are widely used due to their low power consumption and ease of programming using Arduino IDE or Micro Python. The controller continuously monitors soil moisture

Fig.3: ESP32/NodeMCU(ESP8266) Microcontroller

values and compares them with predefined thresholds. Based on this comparison, it controls the relay module to switch the water pump ON or OFF. Additionally, it communicates with the cloud and mobile application, enabling remote monitoring and manual control. Its support for deep sleep mode also enhances energy efficiency in battery-powered systems.

B. Soil Moisture Sensor

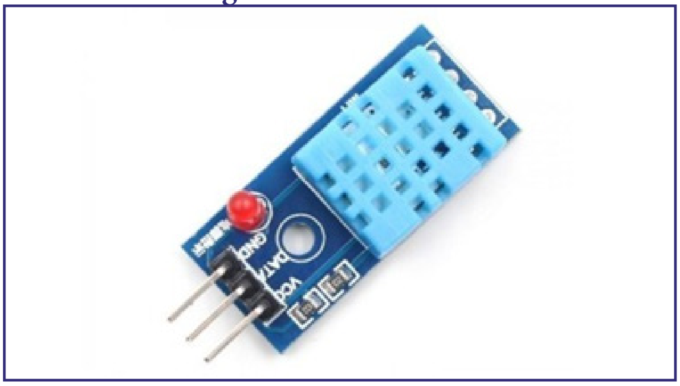
The soil moisture sensor is a key component that measures the water content in soil. It provides analog signals to the microcontroller, allowing the system to determine whether irrigation is required. There are two main types: resistive and capacitive sensors. Capacitive sensors are preferred due to their durability and resistance to corrosion. The sensor works by detecting electrical properties of soil, which vary with moisture levels. This enables precise irrigation, preventing both overwatering and underwatering. It plays a vital role in automation by providing real-time soil condition data.

Fig. 4: Soil Moisture Sensor

C. DHT11Sensor

The DHT11 sensor is used to measure temperature and humidity. It consists of a capacitive humidity sensor and a thermistor for temperature measurement. The sensor provides digital output and communicates with the microcontroller using a single-wire interface. It operates within a humidity range of 20% to 90% and temperature range of 0°C to 50°C. The DHT11 helps in monitoring environmental conditions, which can influence irrigation decisions in smart agriculture systems.

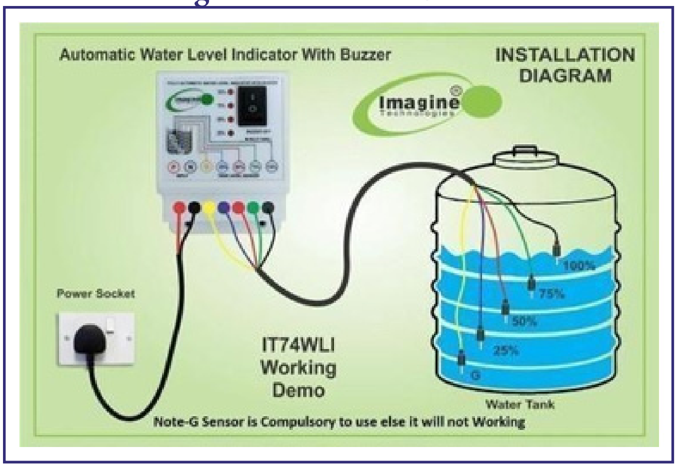
Fig. 5: DHT11 Sensor



D. Water Level Sensor

The water level sensor is used to detect the amount of water available in a tank or reservoir. It ensures that the system has sufficient water before activating the pump and prevents overflow or dry running. Different types of sensors such as float-type, capacitive, resistive, and ultrasonic sensors are

Fig. 6: Water Level Sensor



E. Relay Module

Their module acts as a switching device that allows the micro controller to control high-power devices such as the used depending on the application. These sensors improve system reliability and automate water management effectively.

Fig. 7: Relay Module

water pump. Since the micro controller operates at low voltage, the relay provides electrical is olation and safe switching. When

F. DC Water Pump

The DC water pump is responsible for supplying water to plants. It operates on DC power and converts electrical energy into mechanical energy to move water. The pump is controlled by the relay module and is activated when the soil moisture level drops below a threshold. It ensures efficient water delivery and is suitable for small-scale irrigation systems.

Fig. 8: DC Water Pump

G. PowerSupply

The power supply provides the required electrical energy to all components. Typically, 3.3V or 5V is used for microcon-trollers and sensors, while 12V is used for the water pump.

Proper voltage regulation is essential to ensure stable oper-ation. Components such as voltage regulators and protection circuits help prevent damage due to voltage fluctuations.

H.USB Cable

AUSB cable is used to connect the microcontroller to a computer for programming and debugging. It allows code uploading through Arduino IDE and facilitates communication between the system and the computer. During development, it Also provides temporary power to the system. connections between components such as sensors, microcontroller, and relay module. They are essential for circuit prototyping and testing. Different types of jumper wires (male-to-male, male-to-female, female-to-female) are used depending on connection requirements. They enable flexible and easy circuit design.

Fig. 9: USBCable

I. Jumper Wires

Jumper wires are used to establish electrical con-nections between components such as sensors, mi-crocontroller, and relay module. They are essential for circuit prototyping and testing. Different types of jumper wires (male-to-male, male-to-female, fe-male-to-female) are used depending on connec-tion-requirements.Theyenableflexibleandeasycircuitde-sign.

Fig. 10: JumperWires

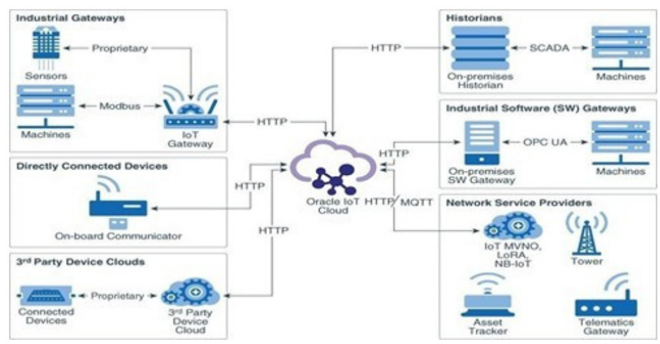
6. SOFTWAREREQUIREMENTS

A. IoT Cloud Platform

An IoT Cloud Platform is a fundamental component of the smart watering system as it acts as the central hub for data storage, processing, visualization, and remote control. Unlike traditional irrigation systems, which operate locally without connectivity, the integration of a cloud platform enables real-time monitoring and intelligent automation from any location. Sensor data collected from the soil moisture sensor and other environmental sensors is transmitted to the cloud via the ESP32/NodeMCUusingWi-Ficonnectivity. Thecloudplat- form provides essential services such as data storage, device communication, and remote access. It stores sensor readings and presents them through dashboards, graphs, and reports, allowing users to analyze environmental conditions over time. It also supports automation rules, such as activating the pump when moisture levels fall below a threshold and turning it off when sufficient moisture is achieved. Popular platforms like Blynk and ThingSpeak are widely used due to their ease of integration and real-time visualization capabilities.

Communication between the microcontroller and the cloud typically occurs using protocols such as HTTP or MQTT. MQTT is particularly efficient due to its low bandwidth and publish–subscribe model. Security features such as authenti-cationto kens,APIkeys,andencryptedcommunicationensure safe data transmission. Overall, the cloud platform enhances system intelligence, scalability, and remote accessibility.

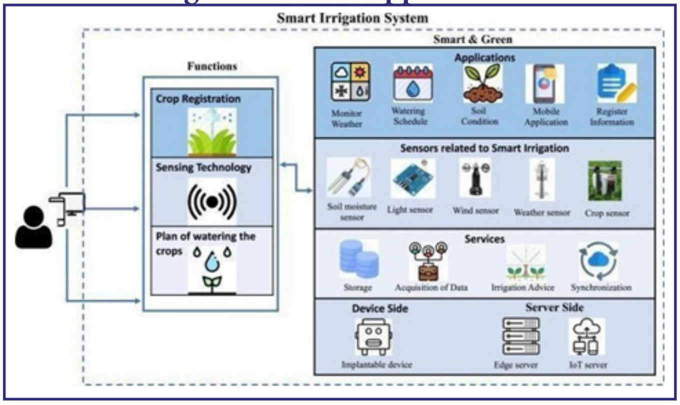
Fig. 11: IoT Cloud Platform



B. Mobile Application

The mobile application serves as the user interface of the IoT-basedsmartwateringsystem, enabling remote monitoring and control.It acts as a bridge between the userandthecloudserver,allowingreal-timeinteraction with the system from anywhere. The application provides a simple and user-friendly interface for accessing system data and controlling operations. Theapplicationincludesmonitoring,control,and configuration function alities. Users can view real-time data such as soil moisture levels, temperature, humidity, and pump status. It also allows manual control of the water pumpthrough buttons or toggles. In addition, an automatic modecan be enabled, where irrigation is controlled based on sensor readings. Users can adjust threshold values and configure system parameters, making the solution flexible for different environments.

Fig. 12: Mobile Application



C. Arduino IDE

Arduino IDE (Integrated Development Environment) is the primary software tool used for programming the ESP32/ESP8266 microcontroller. It supports C and C++ pro-gramming languages and provides a simple interface for writing, compiling, and uploading code to the hardware. The IDE includes a wide range of libraries that simplify development. Libraries such as WiFi. h, HTTP Client.h, DHT.h, and Pub Sub Client.h enable easy implementation of Wi-Fi connectivity, sensor data acquisition, and communication with cloud platforms. The Serial Monitor feature helps in debugging by displaying real-time data and system status, allowing developers to identify and resolve issues efficiently.

Fig. 13: ArduinoIDE

D. BlynkPlatform

Blynk is a widely used IoT platform that provides an easy way to connect hardware devices to a mobile application without complex app development. It offers a cloud-based infrastructure along with a customizable mobile interface using widgets such as buttons, sliders, gauges, and graphs. In the smart watering system, Blynk acts as a communication interface between the hardware and the user. Sensor data is transmitted to the Blynk cloud and displayed in real time on the mobile application. Users can monitor environmental parameters and control the water pump remotely using virtual controls. Blynk also supports notifications, automation, and event-based actions, making it highly suitable for smart agriculture applications.

Fig. 14: Blynk Platform

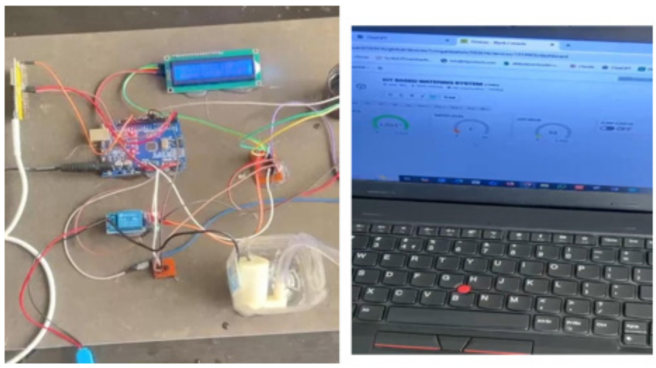
7. SYSTEMDESIGN

The system design consists of both hardware and software components working together to achieve automation. The hardware includes the soil moisture sensor for detecting water levels, the ESP8266 microcontroller for processing and communication, a relay module for switching operations, and a water pump for irrigation. On the software side, the system uses embedded programming through the Arduino IDE to control operations. A cloud platform such as Firebase or Blynk is used for data storage and communication, while the mobile application provides a graphical interface for monitoring and control. The integration of these components results in a reliable and efficient smart irrigation system.

8. RESULTSANDDISCUSSION

The system was tested under different soil conditions to evaluate its performance. It was observed that the system successfully detected variations in soil moisture and responded accordingly by controlling the water pump. The automation reduced the need for manual intervention and ensured that The system was tested under different soil conditions to evaluate its performance. It was observed that the system successfully detected variations in soil moisture and responded accordingly by controlling the water pump. The automation reduced the need for manual intervention and ensured that

Fig. 15: resultanddiscussion



9. CONCLUSION

The IoT-based smart watering system provides an efficient and intelligent solution for modern irrigation challenges. By integrating sensors, microcontrollers, cloud technology, and mobile applications, the system ensures optimal water usage and reduces wastage. It offers convenience, reliability, and scalability, making it suitable for various applications such as agriculture, home gardening, and greenhouse management. The project demonstrates the potential of IoT in transforming traditional irrigation practices into smart and automated systems. Future enhancement scan include the integration of weather forecasting and artificial intelligence to further improve efficiency and decision-making.

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