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Smart Irrigation System

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Abstract: *Smart Irrigation System using IoT technology are gaining significant attention as an efficient solution to the water scarcity challenge in agriculture. These systems consist of sensors, controllers, and a cloud-based platform that collects real-time data about soil moisture content, weather conditions, and plant water requirements. The data is analyzed and used to regulate water supply to the crops, resulting in reduced water consumption and significant savings in water resources. Field experiments have shown that* Smart Irrigation System *can increase crop yields by 25% and reduce water consumption by 40%. This system is designed to be automated and allows users to monitor and control the irrigation process remotely through a smartphone app or a web interface, making it easy for farmers or gardeners to manage their irrigation systems from anywhere, at any time. The* Smart Irrigation System *helps to conserve water by using only the required amount of water and preventing over-watering, leading to a significant reduction in the cost of irrigation. The system has the potential for large-scale deployment and can benefit farmers worldwide, making it a powerful tool to optimize irrigation processes, conserve water, and improve crop yields.*

Keywords: IoT Technology, Water Optimization, Smart Irrigation, Water Conservation, Precision Agriculture

I. INTRODUCTION

The demand for water is increasing rapidly due to population growth and industrialization, and agriculture is the largest consumer, accounting for about 70% of total water consumption worldwide. To address this issue, smart irrigation systems using Internet of Things (IoT) technology have gained significant attention in recent years. These systems consist of sensors, controllers, and a cloud-based platform that collects real-time data about soil moisture content, weather conditions, and plant water requirements. Based on this data, the system can be automatically controlled to optimize water usage and improve crop yield. This thesis report aims to provide an overview of the smart irrigation system using IoT and its benefits in agriculture. The system uses sensors, weather data, and machine learning algorithms to optimize water usage based on the current needs of plants. These sensors measure the soil moisture level, temperature, humidity [1], and other environmental factors that affect plant growth. The system is connected to the internet, allowing for remote monitoring and control. Users can access the system from their smartphones or computers to check the status of their plants and adjust the settings if needed.

The benefits of a smart irrigation system using IoT are increased water efficiency, reduced costs, and improved crop yields. By reducing water wastage and optimizing irrigation, the system helps to conserve water resources and minimize water bills. The system also enables farmers and landscapers to better manage their irrigation schedules, reducing the risk of over or under-watering, which can damage crops and plants. Additionally, the smart irrigation system can be remotely controlled through a smartphone app or web-based interface, providing convenience and flexibility to users.

II. LITERATURE REVIEW

Smart irrigation systems have become an essential innovation in modern agriculture, aiming to improve water use efficiency, reduce wastage, and increase crop yield. Traditional irrigation methods often lead to overwatering or

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underwatering due to the lack of real-time data and control. In contrast, smart irrigation combines advanced technologies such as sensors, wireless communication, and automated controllers to deliver precise irrigation based on actual crop and soil needs.

Several studies highlight the effectiveness of using soil moisture sensors to determine the exact water requirements of crops. These sensors, when integrated with microcontrollers, allow irrigation to occur only when necessary, which helps in conserving water and energy. Research also shows that incorporating weather forecasting systems further enhances irrigation accuracy by adjusting water delivery based on expected rainfall, humidity, and temperature.

Wireless Sensor Networks (WSNs)andInternet of Things (IoT) technologies are commonly used to monitor field conditions remotely. These systems collect data from the field and transmit it to a centralized system, which analyzes the information and activates irrigation accordingly. According to various case studies, such smart systems can reduce water usage by up to 30–50% compared to conventional systems, while also improving crop productivity.

Machine learning and artificial intelligence are also being explored to predict irrigation schedules and optimize water distribution. These models learn from historical data and environmental conditions to make smarter decisions over time.

Despite the advantages, there are challenges such as high initial costs, technical complexity, and the need for internet connectivity, especially in rural areas. However, recent advances in low-cost microcontrollers and open-source platforms like Arduino and Raspberry Pi are making smart irrigation more accessible to small and medium-scale farmers.

III. HARDWARE DESIGN

There are two functional components in this project:

1.The Sensors (Soil Moisture Sensor, Temperature and Humidity Sensor) and the Motor/Water pump. The moisture sensors measure the moisture level (water content) of the different plants. If the moisture level is found to be below the desired level, the moisture sensor sends the signal.

2.The sensors and the water pump is connected to the microcontroller NodeMCU ESP8266.

3.On receiving the signal the Microcontroller triggers the Water Pump to turn ON and supply the water to respective plant. When the desired moisture level is reached, the system halts on its own and the Water Pump is turned OFF. The Temperature and Humidity Sensors measure temperature and humidity to provide data for data logging and deciding intervals for watering.

A. Hardware Specifications

These are the main components used in the project:

1) Node MCU (ESP8266) Wifi Module: NodeMCU [5] is an advanced Application Programming Interface for hardware input/output device. It uses a code like Arduino but rather is an interactive script named Lua. It is an open source IoT platform. It is implemented on a firmware of ESP8266 WiFi Soc produced by Espressif systems. NodeMCU has 16 input/output pins and hence 16 nodes can be connected to a single node. The ESP8266 is Wi-Fi Soc which is integrated with a Tensilica Xtensa LX106 core which is widely used in IoT applications.” NodeMCU” refers in default to the firmware rather than the development kits. ESP8266 is an inbuilt WiFi module.

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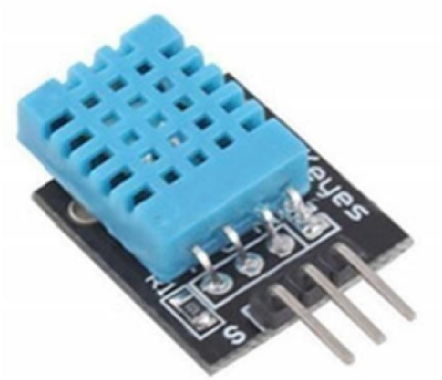
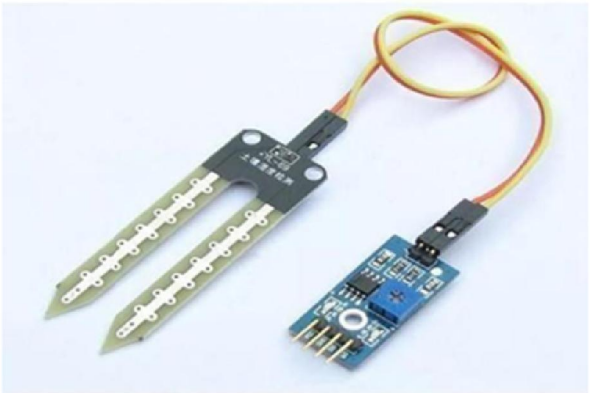
2) Relay Module: A relay is an electrically operated switch that can be turned on or off, letting the current go through or not, and can be controlled with low voltages, like the 5V provided by the Arduino pins.

3) DHT11 (Temperature and Humidity Sensor): The DHT11 [6] is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and provides a digital signal on the data pin (no analog input pins needed). It is simple to use, but requires careful timing to collect data.



4) Soil Moisture Sensor: The soil moisture sensor is used to measure the volumetric content of water within the soil. It measures loss of moisture over time due to evaporation and plant uptake. It consist of two probes which are used to measure the volumetric content of water. The probes allow the current to pass through the soil and then it gets the resistance value to measure the moisture value. When there is more water the soil will conduct more electricity which means that there will be less resistance, therefore moisture level will be higher and vice- versa for dry soil.



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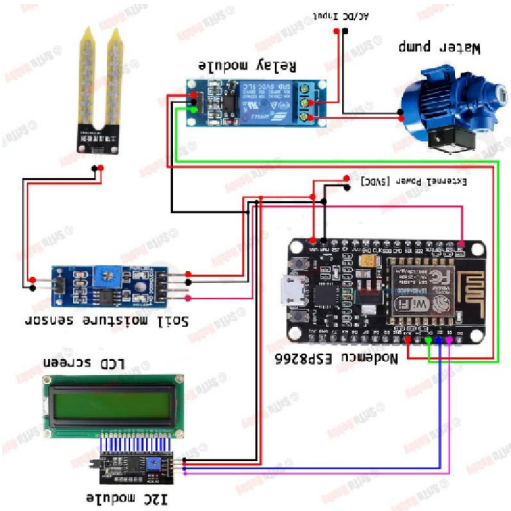
IV. SOFTWARE IMPLEMENTATION

A. Data Collection: Sensors send data to the cloud platform.
B. Data Analysis: Cloud-based algorithms analyze data and determine irrigation needs.
C. Automated Decision-Making: Cloud platform sends commands to actuators to control irrigation.
D. Remote Monitoring: Users can monitor and control the system remotely through a web or mobile app.

V. CIRCUIT DIAGRAM



VI. EXISTING SYSTEM

In the existing method the farming is done manually by farmer, before moving to the topic farmers can't predict the weather conditions and do farm in there land. There came a new technology to calculate soil moisture level, humidity and temperature belonging to the land condition. A sprinkler and a water pump is used and for displaying the calculated value microcontroller or led is used. This is very effective but in rural and urban areas there is no internet connection to connect with the led display, sometimes there may be power fluctuations also occurs. For overcoming the method new technology is used in this irrigation system.

Disadvantages:

- It is consume more work.
- It consumes more Manpower
- It needs internet connectivity
- Data is stored in the Arduino
- Accurate data is not known
- Water consumption is high

VII. PROPOSED SYSTEM

In our Proposed system of smart irrigation system using soil moisture sensor ESP8266 NODE MCU is a combination of hardware and software components. The hardware part consists of different sensor like soil moisture sensor, photocell sensor etc. An Arduino board and other components using Internet of Things(IOT) . The android based application consists of signals and a database in which readings are displayed from sensors and are inserted using the hardware. The improvement in irrigation system using a wireless network is a solution to achieve Water conservation as well as improvement in the irrigation process. This research tries to automate the process of irrigation on the farmland by monitoring the soil water level.

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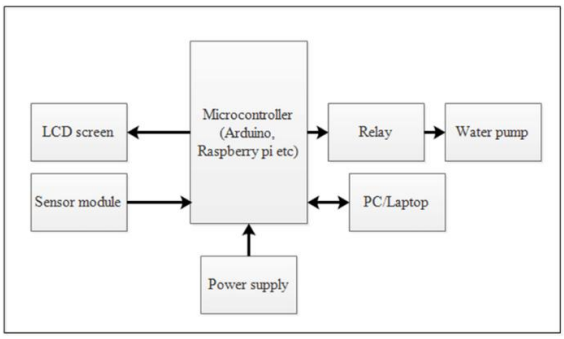
Advantages:

- Less power consumption
- Direct water to the land
- No water is wasted
- Efficient for farmers technically

VIII. IMPLEMENTATION WORK

System Architecture



The implementation of irrigation system the soil moisture sensor and ESP266 NODEMCU is compulsory. Connect the hardware components to breadboard and jump wires are used to connect the positive and negative ends of the soil moisture sensor. Wi-Fi is connected with the help of Thinkspeak server and run the program . The values of temperature, humidity, moisture are known in Arduino Uno Board.

VIII. CONCLUSION AND THE FUTURE ENHANCEMENT

Currently, farmers control irrigation metho by manually and irrigate their area at a systematic period of time. These mechanisms deplete high amount of water and the outcome is water less. While dry area's have less rainfall and irrigation is challenging. Therefore,ESP8266 Wi-Fi based communication system has been taken because of the ease of application, maintenance and price. The gadget is automated that will accurately monitor and control the water requirement and reliable. The communication through the website authorised the user to interact with sensor from anywhere in the world in nanosecond which is fruitful for the user to interact with sensor from anywhere in the Arduino that diminish power consumption by ascending the system life executes on large for relatively small investment. The system can also be designed for temperature sensor based cooling system. Even after then they need to wait until the field is properly watered, which makes them to stop doing other activities. Here is an idea which helps not only farmers even for watering the also, which senses the soil moisture and switch the pump automatically when the power is ON.

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