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Smart Plant Irrigation System Using ESP32

Akash Chowdhury
Department of CSE
Leading University
Sylhet, Bangladesh
akashchowdhury9386@gmail.com

Sandipon Chakrabarty
Department of CSE
Leading University
Sylhet, Bangladesh
sandiponchakrabarty1@gmail.com

Anna Rani Dey
Department of CSE
Leading University
Sylhet, Bangladesh
annadey899@gmail.com

Md Rafiur Rahman Sarkar
Department of CSE
Leading University
Sylhet, Bangladesh
m.raafi.raahman@gmail.com

***Abstract*—Agriculture is one of the most fundamental resources of food production and also plays a vital role in keeping the economy of every nation by contributing to the Gross Domestic Production (GDP). But there are several issues related to traditional methods of agriculture such as excessive wastage of water during irrigation of field, dependency on non-renewable sources such as petroleum coal, time, money, human resource etc. Now-a-days the increasing demand of non renewable power sources, automation and digitization, SMART agriculture is believed to be most expected food production sector in country. This paper aims at developing the Smart Irrigation System using IoT (Internet of Things) technology. The primary objective of the present work is to automate the total irrigation system in terms of water requirement of the crop by monitoring the moisture of soil and climate condition and also to prevent the wastage of water resource. The paper also highlights remote access of the irrigation system from home using IoT technology. Thus the system will provide convenient access of the system and protect the farmer from scorching heat & severe cold.** **Keywords: ESP32, Relay Module, 9V Battery, Soil Moisture Sensor, Water Pump, LCD Display, Jumper Wires .**

I. Introduction

In today’s world, we all are relying on farmers. But anyone knows who farmers rely on? Nobody, they suffer from various irrigation difficulties like over-irrigation, under irrigation, depletion of underwater, floods, etc. To overcome some of the problems we are trying to make a project which can help farmers to overcome the difficulties. Over irrigation occurs because of poor distribution or the lack of management wastes water, chemicals, and may lead to water pollution. Under irrigation is giving only just enough water for the plant which gives poor soil salinity which leads to increased soil salinity with a consequent build-up of toxic salts in soil surface in areas with high evaporation. This requires either leaching to remove these salts and a method of drainage to carry the salts away. To overcome these irrigation difficulties we have made a project by the use of IoT (internet of things) . The hardware consists of various sensors like temperature sensor, humidity sensor, ph sensor, pressure sensor operated by Arduino module and bolt IOT module. Our temperature sensor will predict the weather condition of that area through which farmer will make less use of water in the fields. Our ph sensor will sense the ph of the soil at a regular interval and predict whether that soil needs more water or not. Our main target is to make an irrigation system automatically and to save water for the future purpose. The current trends in the smart irrigation market include the following techniques which are: • Drip Irrigation: allows for precise control of the application of water and fertilizer, which can greatly reduce the amount of water needed for crop irrigation. • Measuring Water Flow: Precise measurement of water usage with water flow meters can prevent overwatering and reduce costs for farmers. • Data Analytics: New software products that crunch large amounts of data can provide farmers with important information that they previously didn’t have access to. • Drilling More Wells: Farmers are relying more on groundwater sources for irrigation and as the water table falls due to unsustainable level for pumping.

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II. Literature Review

Irrigation systems have evolved significantly over time, moving from fully manual methods to automated and sensor-based solutions. Traditional irrigation techniques, such as manual watering and timer-based systems, do not consider real-time soil conditions. These approaches often result in inefficient water usage and inconsistent plant care.

Several studies have shown that soil moisture–based irrigation systems can greatly improve water efficiency. By using moisture sensors, irrigation can be controlled according to the actual needs of plants rather than fixed schedules. With the introduction of IoT technologies, many modern systems now allow remote monitoring and control through mobile applications or web platforms.

ESP32-based irrigation systems have become popular in recent research due to their affordability and wireless communication capabilities. However, many existing designs focus on large-scale agricultural use, making them less suitable for individual users or small gardens. This project addresses that gap by providing a simple, compact, and low-cost smart irrigation system that is easy to build and maintain while still delivering reliable performance.

III. Methodology

The proposed smart irrigation system is designed to automatically water plants based on soil moisture levels. The system consists of four main parts: sensing, control, actuation, and display.

A. Overview

The sensing unit uses a soil moisture sensor placed in the soil to continuously measure moisture content. The control unit is built around the ESP32 microcontroller, which reads sensor data and compares it with predefined threshold values. If the soil is found to be dry, the ESP32 activates the irrigation process. The actuation unit includes a relay module and a water pump, while an LCD display shows system information such as moisture level and pump status.

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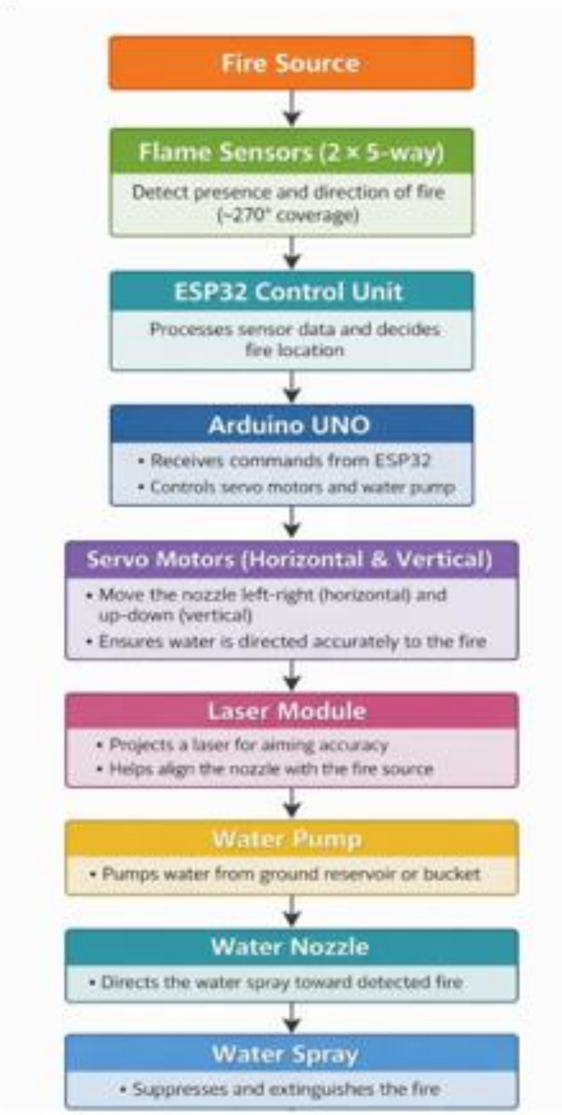
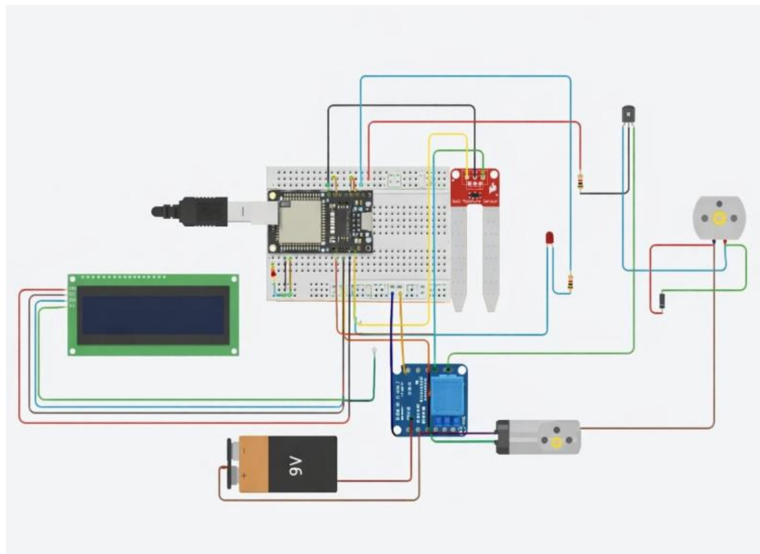


B. Hardware Components

The soil moisture sensor provides analog output based on the water content of the soil. This data is read by the ESP32 and processed in real time. A relay module is used to safely control the water pump since the pump operates at a higher voltage than the microcontroller. The LCD display allows users to monitor soil conditions and system operation easily. All components are powered using a battery supply and connected through a breadboard for easy prototyping.



C. System Operation

When the soil moisture level drops below the set threshold, the ESP32 turns on the relay, which activates the water pump. Water is supplied to the plant until the sensor detects sufficient moisture in the soil. Once the desired level is reached, the ESP32 turns the pump off automatically. This process ensures that plants receive only the amount of water they need, preventing both overwatering and water wastage.

IV. Results and Discussion

A. Results

The system was tested under different soil moisture conditions to evaluate its performance. During testing, the soil moisture sensor accurately detected dry and wet soil states. The ESP32 responded quickly by turning the water pump on and off as required. The LCD display provided clear and real-time updates on soil moisture levels and pump activity. The system successfully maintained proper soil moisture without any manual intervention.

B. Discussion

The results show that the proposed system is effective for small-scale irrigation. It reduces human effort and ensures efficient use of water. One limitation of the system is its reliance on sensor calibration, which may vary depending on soil type. Additionally, using a battery as the power source limits long-term operation. Despite these limitations, the system performed reliably and demonstrated the practicality of automated irrigation using simple embedded components.

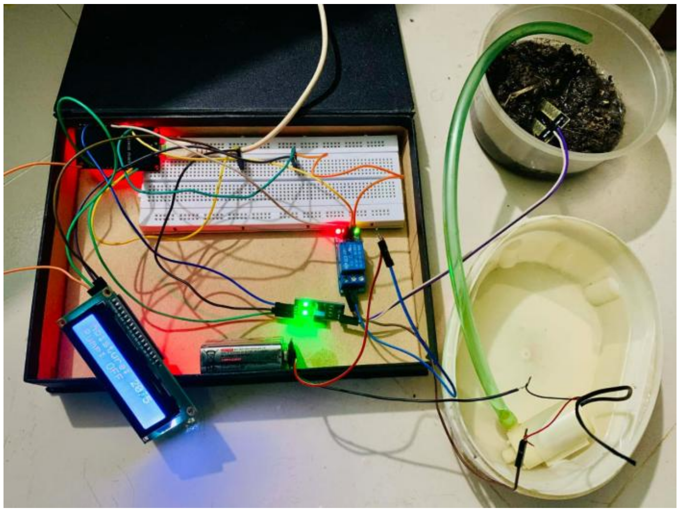
V. Future Work and Conclusion

A. Future Work

Future improvements can make the system even more efficient and user-friendly. Integrating Wi-Fi-based IoT features would allow users to monitor and control the system remotely using a mobile application. Solar power can be added to support long-term and outdoor use. Additional sensors, such as temperature and humidity sensors, may also be included to make irrigation decisions more accurate.

B. Conclusion

This paper presented a human-friendly and practical ESP32-based smart plant irrigation system that uses soil moisture sensing to automate watering. The system successfully reduces manual effort, conserves water, and improves plant care by delivering irrigation only when needed. Due to its low cost, simple design, and reliable performance, the proposed system is well suited for home gardens, small greenhouses, and educational purposes. The project highlights how embedded systems and IoT technologies can be applied to solve real-world problems in a simple and effective.



References

1. Espressif Systems, “ESP32 Technical Reference Manual.”
2. Soil Moisture Sensor Datasheet.
3. Studies on IoT-based smart irrigation systems.