IoT-Based Smart Irrigation System Using Arduino

Dr. D Narendar Singh[1], Dr.Chaudhuri Manoj Kumar [2], D. Kaveri[3], D. Sravanthi[4], T. Reethika[5], G. Shailaja[6], Jasmeen[7], D. Divya[8]
Department of ECE, School of Engineering, ANURAG University, Hyderabad

Abstract: **Efficient water management is essential for sustainable agriculture and smart irrigation systems. This project outlines the design of a smart irrigation system based on an Arduino UNO microcontroller, a soil moisture sensor, and other electronic devices to automate the irrigation process. The system constantly monitors soil moisture levels and activates the water pump when moisture levels fall below a predetermined level, delivers optimal watering to plants. A liquid crystal display (LCD) device gives real – time status information, while visual and audio indications, such as LED'S and buzzer, give system monitoring. Automating irrigation based on environmental conditions, this system saves water, minimizes manual labor, and ensures sustainable agricultural practices, making it an efficient and cost-effective solution for modern farming and home gardening purposes.**

Keywords: **Smart irrigation, Soil Moisture sensor, Automation, Water conservation, Sustainable agriculture**

1. INTRODUCTION

Water management is an essential aspect of contemporary agriculture, aimed at maximizing crop growth while economizing on resources. Conventional irrigation techniques result in wastages like overconsumption of water,human error, and irregular watering. With the passage of time and advancements in technology, automation of irrigation systems is the need of the hour to increase productivity, reduce wastage, and reduce dependence on labor. With the aid of embedded systems and sensor – based technologies, intelligent irrigation systems are now advanced enough to offer real-time monitoring and automatic control on the basis of environmental conditions. These developments render farming operations sustainable, maximizing crop yield while optimizing water usage. This project entails the design and development of an Arduino UNO-based intelligent irrigation system that automates the watering system based on the moisture content in the soil. The system employs a soil moisture sensor to monitor the soil moisture in real time and activates the water pump when the moisture content drops below a set threshold. A real – time information display in an LCD display, LED indicators, and a buzzer are used as alarm systems. Compared to conventional irrigation systems, the system eliminates manual control, where plants are watered only when necessary. Its application in agriculture and gardening can significantly enhance water conservation, making irrigation more intelligent, efficient and environmentally – friendly.

2. LITERATURE SURVEY

Srishti Rawal et al. proposed an automated irrigation system is designed to monitor and maintain optimal soil moisture levels through automatic watering. The system employees an ATMEGA328P microcontroller on the Arduino UNO platform as the control unit, utilizing soil moisture sensors to precisely measure soil conditions so that it will be helpful for farmers to grow the crops.[1]

K.Lokesh krishna et al. Smart Agricultural systems enhance crop yield with effective utilization of resources, but most farmers are unaware of recent technologies. This article introduces an IOT based wireless mobile robot with sensors and Raspberry pi 2 Model B for agricultural field operation. It can do a task such as sensing moisture, controlling pests, and real-time monitoring through a wireless camera. The system has been tested successfully and shown its efficiency to smart farming.[2]

Sharma et al. designed an Arduino-controlled irrigation system that automatically manages water supply with soil moisture sensors and solenoid valves. The system greatly reduces the amount of manual labor needed to ensure that farmers can use water more efficiently. [3]

Raj & Mehta et al. evaluated the use of smart irrigation with DHT11 (humidity), DS18B20 (temperature), and YL-69 (soil moisture) sensors. The study proved that using IoT technology can enhance irrigation systems efficiency by 40% and minimize water loss.[4]

Gupta et al. proposed using of LoRa and Wi-Fi communication channels for data transfer in larger scale farms. The results were that long-range communication methods can facilitate the growth and use of IoT-based irrigation systems.[5]

Verma et al. created an AI-based Arduino system that uses soil and weather historical data to estimate the most suitable time to irrigate the crops. Adoption of this system provided 35% water savings without hindering the growth of crops.[6]

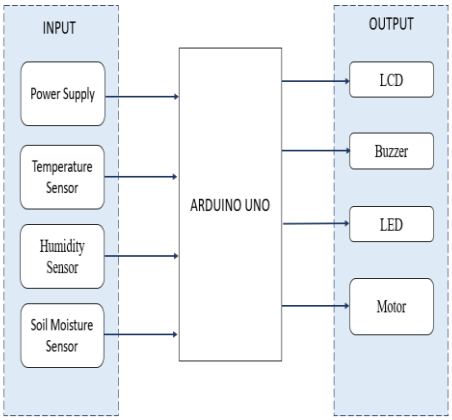
3. METHODOLOGY

The Smart Irrigation System is designed based on an Arduino Uno acting as the controller, integrating multiple sensors and units to automate watering in relation to soil conditions in real time. The system involves various modules working in harmony to ensure maximum usage of water and effective watering.

The Sensor Module is made up of a Soil Moisture Sensor, which constantly monitors the moisture levels of the soil and provides signals to the Arduino. A Temperature Sensor (TMP36) also monitors the surrounding temperature, an important parameter in determining irrigation. These sensors maintain the soil at the best levels by providing plants with sufficient water.

In the Control and Processing Module, the Arduino Uno interprets the sensor reading and determines whether irrigation is necessary. If the soil moisture is below a specified level, the system automatically switches on the water pump to supply water to the field. A potentiometer is included to adjust the contrast of the LCD display to allow for easy viewing of real-time updates.The Notification and User Interface Module enhances the awareness of users by showing the system status and sensor readings on an LCD Display. Red and green LED indicators also show the soil conditions visibly, and a buzzer provides an audible alarm when the level of moisture gets critically low. These features guarantee that users receive immediate responses to changes in the field conditions.To make it even more user-friendly, the Automation and Emergency Control Module has a Panic Button whereby farmers can turn on irrigation manually whenever necessary. The system may also be equipped with wireless communication, such as WiFi or Bluetooth, to facilitate remote monitoring and control via a mobile app or web server. Lastly, the Power and Connectivity Module provides smooth performance through an external power source. Expansion options may include the installation of a motorized water valve to automate control of water flow, further raising efficiency. By incorporating IoT, automation, and real-time monitoring, this system maximizes irrigation, conserves water, and reduces manual intervention, making agriculture efficient and sustainable.

4. ARCHITECTURE



5. RESULT

The Smart Irrigation System works effectively to automate water supply based on real soil moisture levels. The soil moisture sensor also effectively detects low moisture levels, automatically turning on the water pump through Arduino. The LCD display provides real-time feedback, and LED lights and a buzzer provide warnings to users about extreme soil conditions.

The system provides effective water use, minimizing wastage and use of manual intervention. The panic button enables farmers to manually initiate irrigation where needed. The installation can further be supplemented with wireless communication for remote monitoring.

Overall, the system enhances the productivity of agriculture, reduces labor, and optimizes irrigation, thereby making it a cost-saving and efficient one for smart farming.

6. OUTPUTS

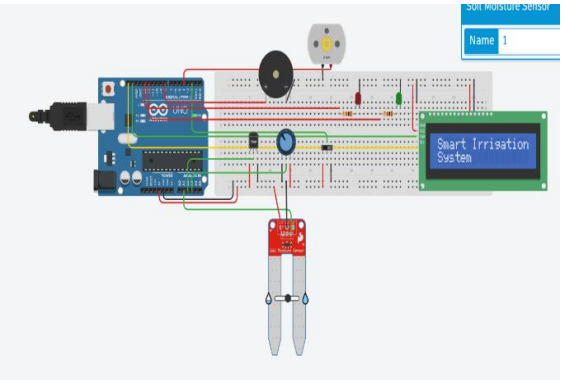


Fig 6.1: Smart Irrigation System Using Arduino

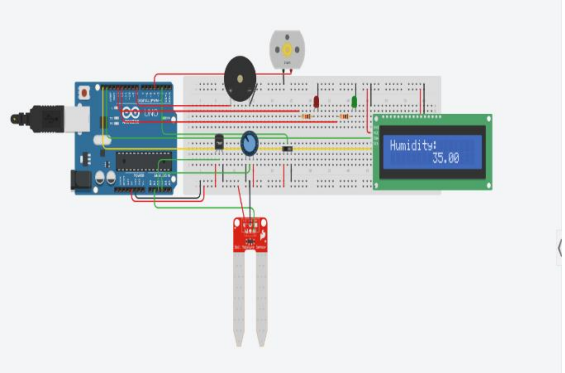


Fig 6.2: Displaying humidity level in LCD

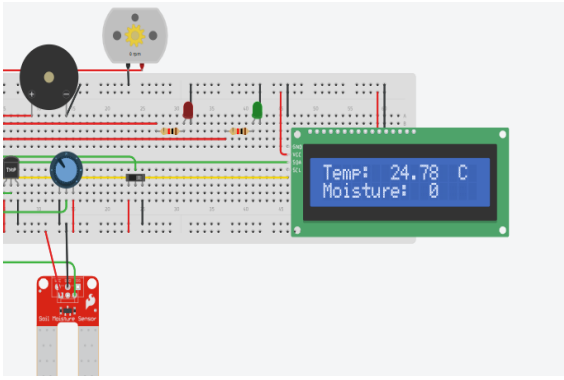


Fig 6.3: Displaying Temperature and moisture levels

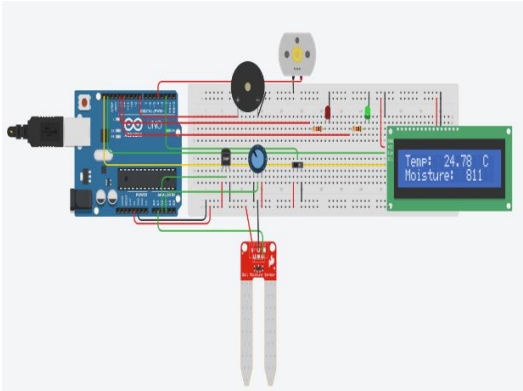


Fig 6.4: Smart Irrigation System Displaying Temperature and Soil Moisture Levels

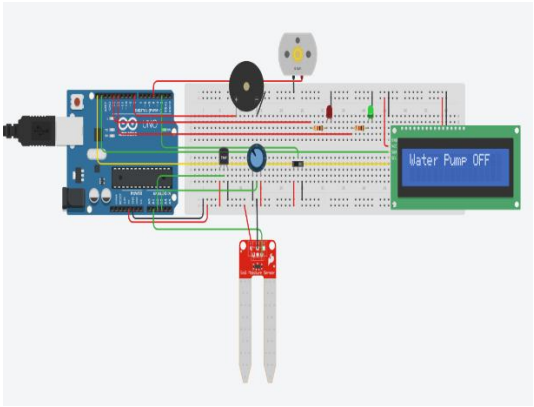


Fig 6.5: Water pump off as moisture level is high

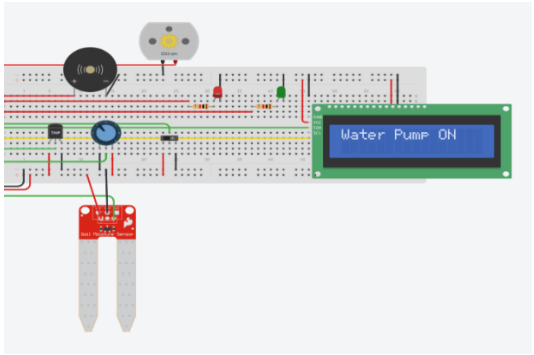


Fig 6.6: Water pump turned ON when moisture level is low.

7. CONCLUSION

The Arduino Uno-based Smart Irrigation System is efficient in automating irrigation using real-time measurement of soil moisture content. Deployment of a soil moisture sensor, LCD display, LED indicators, and buzzer provides efficient management of water and timely notification. The system conserves a great amount of water, optimizes irrigation, and minimizes human intervention, making it a reliable and sustainable approach to modern agriculture.

With other enhancements such as wireless connectivity for remote monitoring and motorized automated valves, the system can be expanded to cover larger areas of agriculture. The project demonstrates the potential for IoT automation to revolutionize traditional methods of agriculture to save resources and produce more.

8. REFERENCE

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