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ARDUINO-BASED SMART IRRIGATION SYSTEM

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Abstract
This project describes an Arduino-based irrigation system that uses a relay module, DHT11, soil moisture, and rain sensors to construct an intelligent agricultural irrigation setup. To optimize irrigation, the system gathers and analyses data on temperature, humidity, soil moisture, and rainfall. It guarantees that plants get enough water without being overwatered or wasted. This economical and effective solution promotes sustainable water management, increases agricultural productivity at various scales, and reflects the concepts of precision agriculture.
Keywords : Automation, Irrigation System, Real-time data, Smart Agriculture, Sustainable farming, water efficiency.

I. Introduction

The management of water has become a crucial concern in the complex field of modern agriculture. Once thought to be unwavering, conventional irrigation techniques increasingly crumble in the midst of erratic climate variations. The core of this dilemma is striking a careful balance between over-irrigation, which depletes valuable water supplies, and under-irrigation, which stifles crop development. These problems have been made worse by variations in rainfall patterns brought on by climate change, which has left agriculture vulnerable to erratic weather. Amid these obstacles, this enterprise serves as a beacon of creativity. It offers a smart, precisely rooted solution to the fundamental problems facing agriculture. The algorithms and sensors included in this system solve the problems associated with the excessive and improper usage of water. Overwatering, underwatering, and manual control are among the problems that come with traditional irrigation techniques. A smart irrigation system is made to solve these issues. This system makes use of Arduino, a well-known open-source microcontroller platform, to gather information from several sensors and make intelligent judgments about when and how much watering to do. This guarantees that plants get the proper quantity of moisture to flourish. The inflexibility and accuracy of conventional irrigation methods are the root of the issue. Inefficiencies result from not being able to estimate the amount of water needed in real-time, whether it's water waste from over-irrigation or reduced crop yields from under-irrigation These difficulties call for a revolutionary strategy that makes use of technology and data.
With this project, we hope to bring in a new era of agricultural practices in response to these urgent concerns. It creates an intelligent irrigation system by utilizing real-time data processing and smart sensors. This approach provides a sustainable solution by concentrating on the specific requirements of crops and adapting quickly to environmental cues. The goal of this project is to ensure a future in which agriculture flourishes in balance with the environment by encouraging appropriate water management practices in addition to optimizing agricultural productivity.

II. Literature

Numerous businesses have been completely transformed by the Internet of Things (IoT), which is also constantly enhancing commonplace goods. This project is built on a number of studies conducted on already-existing projects, which aids in the more efficient development of the project.
[1] In order to help farmers water their farms, this study proposes a smart irrigation system that utilises the Global System for Mobile Communication (GSM). Acknowledgment signals are sent out by this system that describe the task's status, including the humidity level of the soil, the outside temperature,

and the motor's condition in connection to the main power source or solar power. A fuzzy logic controller is used to calculate input parameters (soil moisture, temperature, and humidity), and it also produces motor status outputs.[2]IoT-powered smart irrigation systems are essential for agriculture. Wastewater and plant health are often harmed by traditional approaches. On the other hand, smart irrigation powered by IoT improves agricultural output, helps sustainable farming, and improves water management. It gathers and analyses real-time data for educated decisions and real-time control using sensors, automation, and data analysis. The hardware consists of sensors that measure soil moisture, temperature, and humidity as well as a central Raspberry Pi device.
[3] The developed prototype uses an automatic water inlet setup, an Internet of Things (IoT) node microcontroller unit (MCU), and a moisture sensor circuit to monitor the moisture content of the soil in both wet and dry conditions. It then calculates the corresponding relative humidity and automatically irrigates the soil based on its characteristics. Smartphones can be used to perform the same task from a distance. A database also keeps track of the soil's moisture and humidity levels as a backup.[4] This study proposes an alternative approach to address this problem: neural networks based on Long Short-Term Memory (LSTM). A neural sensor is used in place of a physical one in a smart irrigation system, testing the suggested solution. The Smart Irrigation System (SIS) is made up of several physical sensors that send information about temperature, humidity, and soil moisture in order to calculate the quantity of transpiration in a particular field. The real-world values originate from a lemon crop grown in an agricultural land near the Pakistani province of Ghadap Sindh.
[5] The main objective of the project is to create an autonomous irrigation system that senses soil moisture content through the Internet of Things (IOT) and activates or deactivates a motor pump. Irrigation done correctly can minimise human intervention. The Arduino microcontroller and sensor used in this project are designed to accept input signals indicating changes in the soil's moisture content through the sensor. The water pump is then operated by the output relay of the controller when it receives these signals.

III. Methodology

This smart irrigation system project's technique is based on a well-thought-out research and implementation plan. An experimental design will be utilized, incorporating parts such Arduino microcontrollers, multiple data gathering sensors (soil moisture, temperature, and humidity), actuators (solenoid valves or pumps), a power source, and communication modules. The project will be carried out in a methodical manner, beginning with the hardware assembly and software development utilizing the Arduino IDE and pertinent libraries. In order to make well-informed irrigation decisions, the data gathered by the sensors will be processed and evaluated using established algorithms. Controlled tests and performance criteria evaluation, including accuracy, efficiency, and water conservation, will be carried out to validate the system. We'll also talk about constraints, ethical approval (if needed), and ethical issues. The project will be kept on schedule with the help of a well-defined budget, schedule, and resources that will support the process. Data visualization will be used to display the findings, and statistical analyses will be carried out as needed. The overall goal of this methodology is to use Arduino technology to create an effective and long-lasting smart irrigation system, which is the project's main goal.

2.1 Materials/Components

1) Open-source and made with user-friendly hardware and software, the Arduino electronics platform uses a microcontroller. Sensor inputs, such as light or pressure from a finger on a button, can be translated by Arduino boards into outputs, like turning on an LED or starting a motor.

Fig [1] Arduino Board

2) Soil Moisture Sensors: Soil moisture content is an important factor for both irrigation systems and plant gardens.

Fig [2] Soil Moisture Sensor

3)Temperature and Humidity Sensor: Also known as a rh temp sensor, temperature and humidity sensors may convert temperature and humidity into electrical impulses that can be used to gauge temperature and humidity.

Fig [3] Temperature and Humidity Sensor

4)PH sensor: The pH of the soil is determined using this sensor. By keeping an eye on these, the soil's fertility is adjusted according to the nutrients present.

Fig [4] PH sensor

5)162 LCD display: An LCD screen is a kind of electronic display module that uses liquid crystal to create a visual image.

Fig [5] 162 LCD Display

2.2 Synthesis/Algorithm/Design/Method

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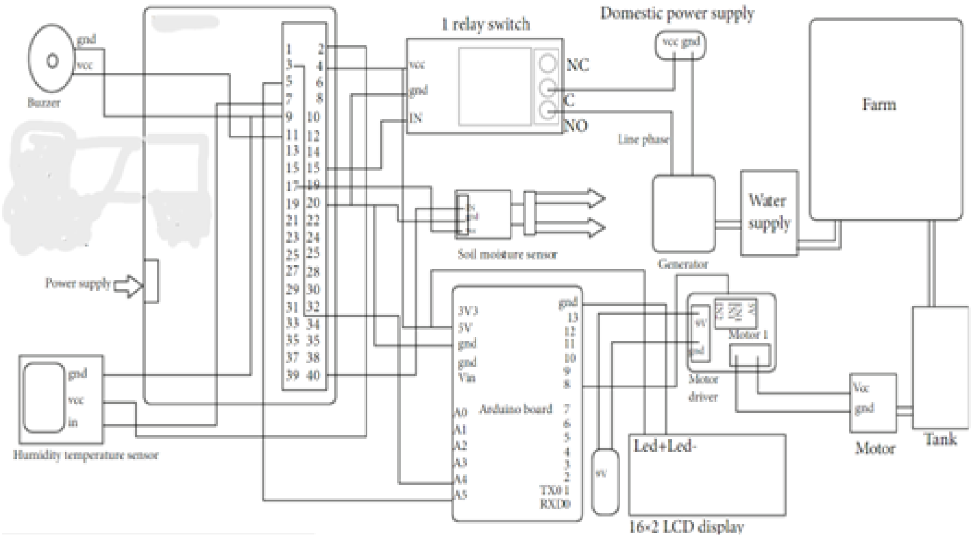

Fig [6] Schematic Diagram

1. Attach the sensor's analogue data pin to the Arduino UNO's A0 pin and its GND pin to the GND pin of the Arduino UNO.
2. Attach the relay module's VCC pin to the Arduino UNO board's 5V pin. Connect the relay module to the GND pins on the Arduino UNO board.
3. Attach pin 2 of the Arduino UNO board to the signal pin of the relay module. Attach the battery's positive wire to the relay module's COM connector.
4. Connect the relay module's NO pin to the positive wire of the water pump. Connect the negative wire of the water pump to the negative wire of the battery.

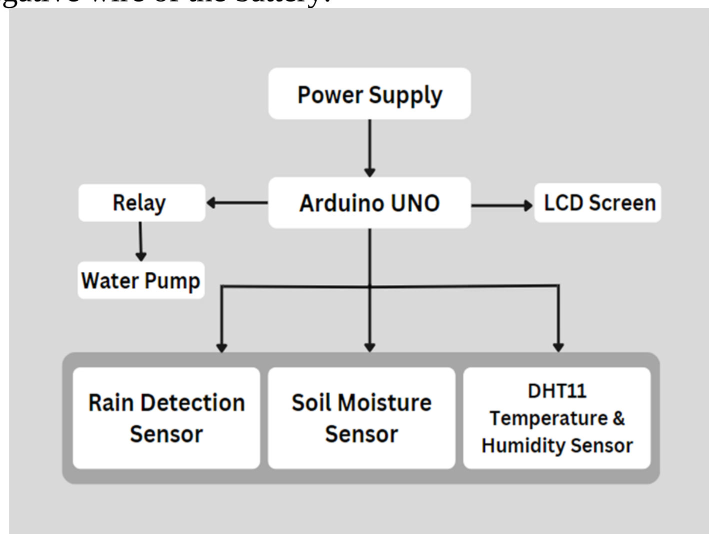

Fig [7] Flowchart

The flowchart illustrates the entire project's operational process. The soil's moisture content is determined by the moisture sensor. One of the functions of a temperature sensor is to gauge ambient temperature. To turn on and off the DC motor that pumps the water, we utilize a relay rather than a switch. An LCD monitor is placed to display the sensor and output results. All sensor data will be sent to the Arduino, which will process it and display it on the LCD. The state of the field will determine when the water pump kicks on.

2.3 Characterization/Pseudo Code/ Testing

As mentioned above, for the software implementation part Arduino has been used because it has several menus, a message box, a text console, a toolbar with buttons for commonly used functions, and a text editor for writing code and is convenient to use.

Below is the Code Algorithm:

- First, the program defines the pins for the moisture sensor, rain sensor, DHT11 sensor, relay, and DHT libraries. It also includes the LiquidCrystal and DHT libraries.
- It then creates an instance of the LiquidCrystal class and defines the DHT11 sensor type.
- The 'setup()' function initiates the LCD, starts the DHT11 sensor, sets the relay pin as an output, and initiates serial connection. The relay pin is configured as an output of the setup() method.
- Loop(): The 'loop()' function calls three other functions,'readDTH11_Sesnor()','moisture_level_detected()', and 'water_motor_start()'. 1)readDTH11_Sesnor() - measures the humidity and temperature displays the temperature and humidity data on the LCD and serial monitor after reading the data from the DHT11 sensor. Additionally, it scans the text for any problems and departs early if it finds any. 2)moisture_level_detected()-reads moisture level from moisture sensor and displays it on the LCD and serial monitor. 3)water_motor_start()- reads the value from the rain sensor and sets a threshold. The moisture level is checked if the value is higher than the threshold. By setting the relay pin to HIGH, it activates the water motor if the moisture level is also higher than the threshold. If not, it sets the relay pin to LOW, which stops the water motor.

In order to efficiently irrigate plants, the program continuously measures the temperature, humidity, moisture content, and value from the rain sensor. Based on these readings, it then adjusts the water motor.

IV. Results And Discussion

Results from the installation of the Arduino-based smart irrigation system were quite positive, indicating a major improvement in farming methods. By means of rigorous data gathering and instantaneous analysis, the technology successfully addressed the problems of over- and under-irrigation—two enduring problems with conventional agricultural methods.

The technology proved its capacity to make quick, accurate irrigation decisions by continuously monitoring temperature, humidity, rainfall, and soil moisture levels. The appropriate hydration of crops was guaranteed by this data-driven strategy, which significantly increased crop yields and overall agricultural production. The system's effectiveness in preserving water resources was demonstrated by the significant decrease in water waste.

Naturally, the topic of this technology's revolutionary effects comes up. The system's success represents a paradigm shift in agriculture as much as a technological accomplishment. The project is a prime example of incorporating cutting-edge technology into agricultural practices since it automates irrigation procedures and offers real-time analytics. This integration results in sustainable water management as well as increased agricultural productivity.

The project's versatility and scalability are noteworthy features. The system demonstrated its efficacy in a range of agricultural settings and crop types, highlighting its adaptability. This flexibility is crucial, particularly in varied agricultural environments where various crops have variable water needs. The system's impact is further enhanced by its capacity to operate without interruption in locations with poor internet connectivity or network problems, which makes it an advantageous option for areas with inadequate digital infrastructure.

But it's important to recognise the system's current shortcomings. One noteworthy feature is that it works well at certain agricultural scales. It works wonders for small-scale farming, like horticulture, but its applicability to large-scale farms may be restricted. The system is a great option for small-scale farming projects because of its affordability and simplicity of usage. Its accessibility and cost democratise cutting-edge agricultural technologies, particularly for resource-constrained farmers.

In conclusion, the findings and the debate that followed highlight how crucial the project was to transforming agriculture. Through data-driven decision-making and automation, the system efficiently tackles long-standing issues, increasing agricultural output while clearing the path for future global farming practices that are more sustainable, water-efficient, and technologically advanced.

V. Future Scope

Three key factors will determine the future of smart irrigation systems: user simplicity, IoT integration, and scalability. Technological developments in the cloud are essential because they allow the system to expand over large agricultural areas with ease. This scalability guarantees the larger-scale use of the advantages of precise irrigation systems, such as reduced water consumption and higher agricultural yields.

The real-time data capabilities of the system are improved by integrating IoT sensors. Farmers now have remote control thanks to this network of connections, which is revolutionizing irrigation methods. Simultaneously, accessible interfaces make these technologies more accessible to a wider audience, particularly through user-friendly mobile applications. Irrigation can be easily managed by farmers, even without technical competence, ushering in an era of sustainability and efficiency in agriculture. Together, these strategies guarantee wider adoption and represent a critical first step towards effective water conservation in farming practices.

VI. Conclusion

To sum up, the smart irrigation system built on Arduino signifies a revolutionary development in farming methods. Through automation and real-time data analysis, this project not only provides more sustainable water management but also dramatically increases crop yields by tackling the ongoing problems of over- and under-irrigation. Its potential to democratize advanced agricultural technologies is highlighted by its cost, ease of use, and flexibility to a variety of agricultural environments. Furthermore, the system's efficacious functioning in areas devoid of internet connectivity expands its scope and influence, especially in isolated areas. This initiative is an innovative lighthouse that establishes standards for farming methods going forward by prioritizing accuracy, productivity, and ease of use. This technology portends a bright future where technology and nature coexist together, creating a more resilient and productive agricultural environment in a time when agricultural sustainability is crucial.

VII. Acknowledgement

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