SMART GREEN HOUSE

Enhancing Crop Yield and Environmental Sustainability

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Abstract **—To tackle the challenges and challenges created by inadequate water resource management in the advancing agricultural sector, the adoption of smart greenhouses and IoT-powered smart irrigation systems is a promising solution. These cutting-edge technologies have the potential to greatly increase agricultural production throughout the world. The suggested solution entails the installation of an irrigation system that is essential to agriculture. The Smart Irrigation System revolutionizes the agriculture sector by utilizing parts like the Arduino Uno R3, soil moisture sensors, SPDT relay, LED indicators, and manual controls. It encourages sustainable farming techniques, increases crop yields, and optimizes water use.**

Keywords**—soil moisture sensor; IoT; smart irrigation system; cost-effective, practical**

I. Introduction

The adoption of various advanced technologies is rapidly increasing in the world. For the plants to be of high quality and productive in today's greenhouse, it is crucial to monitor and control a variety of characteristics. However, certain factors, such as temperature, humidity, soil moisture, and light intensity, are crucial for improved plant growth in order to get the intended results. (Bhujbal, Shubham, et al.). The green revolution movement has been fueled by technological advancements in agriculture. (Tripathy et al., 2021)

In order to maximize crop development, water availability is crucial, hence water scarcity poses a threat to global food security. Because of this, reducing water use is crucial for reducing water scarcity and raising crop yields. (Ardiansah, I. *et al*. 2022)

II. Literature Review

A. *Internet of Things(IoT):*

The words "Internet" and "Things" were combined to create the Internet of Things, a paradigm change in IT. The Internet of Things (IoT) is a growing network of everyday objects, including consumer goods and industrial devices, that can exchange information and carry out tasks while you are busy with other duties. (Osita, K. 2022) It is a huge global network of connected computer systems that uses the TCP/IP protocol family to service billions of users. Efficiency, convenience, and new opportunities are all increased because of the Internet of Things (IoT)'s ability to automate, monitor, and control physical objects. The greenhouse is used to produce the highest-quality plants and fruits in a distinct environment that gives a huge impact on a country's economic development. (Shanto, S.S. *et al.* 2023)

The "automated greenhouse" concept put forth by J. T. H. Yao and T. Bhuvaneswari intends to automate and monitor greenhouse environmental conditions. The suggested system has a microcontroller for processing detected data and taking appropriate action to activate output modules, as well as an input sensor module to sense various environmental conditions. (Sakpal, O. *et al*. 2022)

B. *Security:*

Though smart farming is now more widespread, when it comes to its practically marketed form, smart farming is still the technology that has been used the most. Due to the widespread use of the Internet of Things (IoT), cloud, and big data technologies in smart farms, including TCP/IP-based wired networks and wireless networks like

Zigbee and Wireless LAN, there is a chance that existing cyber-attacks against information and communication (Cho, S.-H. *et al.* 2020). For a long time, the United States has supported research and development (R&D) for technologies connected to smart agriculture, such as big data and precision agriculture, and it has strengths in the stratification of field agriculture and the collection of data libraries.

In today's world, crime rates are rising. Numerous incidents, including theft, burglary, and unwanted intrusions, take place without warning. Installing a security system that can stop unauthorized access to the greenhouse is necessary (Anwar, S. *et al.* 2022).

C. *Innovation:*

Although there is general agreement that smart greenhouses are sustainable in terms of water use, they continue to be the area of activity where irrigation water consumption is particularly intensive (Obaideen, K. *et al.* 2022).

The development of IoT-based smart greenhouses is a recent development that approaches to maintain and monitor greenhouse conditions that have been dramatically transformed by contemporary techniques like sensor networks, cloud computing, and machine intelligence.

The IoT's integration in smart greenhouses, which offers great prospects for efficient and environmentally friendly food production, must benefit sustainable agriculture. The Internet of Things (IoT) will eventually take control of our daily activities and improve the efficiency of business, agriculture, and other industries. Numerous critical elements will be significantly reduced, including the amount of time wasted due to unanticipated system or equipment failures, energy usage, and the effort required to go to the place of employment (Tawfeek, M.A., Alanazi, S. and El-Aziz, A.A. 2022).

D. Current and future trends:

The applied research approach is the bibliometric analysis, which aims to achieve the desired study objective and provide answers to the questions given. In order to recognize, group, and analyze the key components of a knowledge field, Garfield created bibliometric analysis in the 1950s (Aznar-Sanchez, J.A. et al. 2020).

Additionally, technology has made it possible to diversify the sources of water used for irrigation in areas where this resource is the main constraint, such as through the use of recycled water, desalinated seawater, or rainwater collection. Therefore, environmental factor forecasting technology development is essential for smart greenhouse systems to increase agriculture sector management effectiveness and resistance to potential dangers (Jin, X.-B. *et al*. 2021).

III. TECHNICAL DEVELOPMENT

All life forms on Earth depend on water, making it a crucial natural resource. Its relevance arises from its special ability to operate as a solvent, a platform for biological activities, and an essential element of numerous ecosystems. One excellent illustration of how smart technology has changed the agricultural sector is the Smart Irrigation System. It makes informed decisions regarding watering schedules, flow rates, and distribution techniques by using sensors to continuously analyze soil moisture levels, weather patterns, and plant needs. This efficient water management has led to improved crop yields, enhanced water conservation, and sustainable farming practices. Agriculture's water management has been altered by smart irrigation technology, which has given modern farmers an invaluable tool for maximizing resource use, increasing yields, and promoting environmental sustainability.

A. Product aim:

The purpose of this study is to develop automated and personalized irrigation schedules based on plant requirements and environmental circumstances to enable smart greenhouses. This would optimize water usage, preserve resources, and increase sustainability.

B. Working mechanism of the system:

A Soil Moisture Sensor, Relay SPDT, Green LED, Resistor, DC Motor, Power Supply, Red LED, Pushbutton,

Switch, and Output are just a few of the parts included in the Smart Irrigation System built using an Arduino Uno R3 microcontroller board. The technology uses sophisticated soil moisture monitoring and water flow management to automate and enhance the irrigation operation. As the main controller, the Arduino Uno R3 receives real-time data from the soil moisture sensors. Water flow is regulated by an SPDT relay operating a DC motor. While push buttons and switches allow manual management of the system's automatic watering function, red and green LEDs serve as warning and operational status indicators.

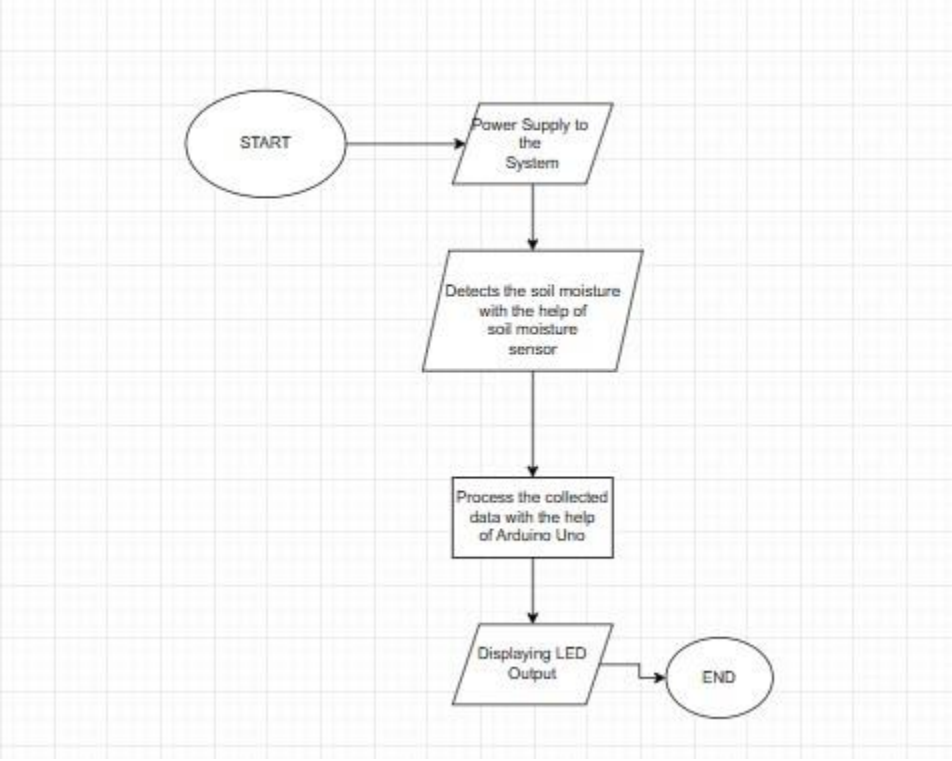

Fig 1. Flow Chart of the system.

C. Truth Table:

Table 1. TRUTH TABLE of system

Power Supply	Switch	Soil Moisture Sensor	Output

0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

The inputs and outputs of the system are represented by the truth table, where 0 denotes a low/off state and 1 denotes a high/on state. In the table, it shows the different working mechanisms of the sensor when a power supply is passed and when a power supply is cut is off. The table gives the following Boolean algebra:

Boolean Equation:

Q=A.B.C

D. Logic Circuit:

From the equation we can derive the following logic gate diagram:

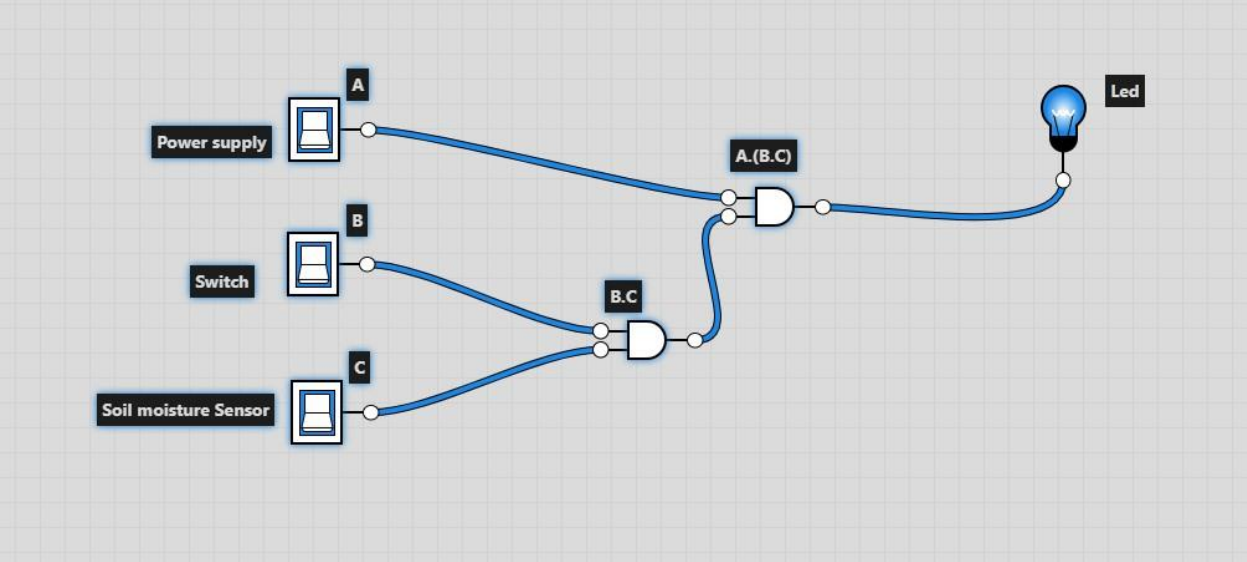

Fig 2. Logic gate of a product made from Logic.ly

From the above figure, When the power supply (A), the switch (B), and the soil moisture sensor (C) are all turned on, the logic circuit arrangement ensures that the output will be 1 (ON). If not, the output will be zero (OFF). The circuit uses NOT gates to invert the input signals, AND gates to combine them according to the formula A.B.C., and a further NOT gate to invert the output.

IV. Hardware Requirements:

Name	Quantity	Component
U1	1	Arduino Uno R3
SEN1	1	Soil Moisture Sensor
K1	1	Relay SPDT
D1	1	Green LED
R1 R2	2	330 Ω Resistor
M1	1	DC Motor
P1	1	5 , 5 Power Supply
D2	1	Red LED
S1	1	Pushbutton

FIG 3. Components used in Tinkercad.

A soil moisture sensor, an SPDT relay, a resistor for controlling current flow, green and red LEDs for status indication, a DC motor for controlling valves and pumps, a power supply for providing electricity, a pushbutton for manual operation, and a switch for overall system control are all included in the above table.

1. Arduino Uno R3: The ATmega328P microprocessor serves as the foundation for the Arduino Uno R3 microcontroller board. It acts as the Smart Irrigation System's main control component. It offers an interface for attaching different sensors, actuators, and other parts, enabling the system to process information, make choices, and manage irrigation.

2. Soil Moisture Sensor: The Soil Moisture Sensor measures the moisture content in the soil. It offers useful information for figuring out the plant's water needs. The system can monitor the soil moisture levels and alter the watering schedule as necessary to maintain the ideal moisture levels for plant growth.

3. SPDT relay: The SPDT relay is an electromagnetic switch that enables the system to regulate the flow of electricity to other components. The DC Motor or other actuators in the Smart Irrigation System that control the water flow are controlled by the Relay SPDT.

4. Green LED: The Smart Irrigation System uses a Green LED (Light-Emitting Diode) as a visual indicator to show the operational status. It can be used to show certain system circumstances or to demonstrate that the system is operating properly.

5. Resistor: A resistor is a type of electrical component that restricts how much current can pass through a circuit. A resistor may be incorporated into the Smart Irrigation System's LED circuit to regulate brightness or into other circuitry to shield components from excessive current.

6. 11. DC Motor: The irrigation system's DC Motor is an electromechanical device that regulates water flow. The Arduino Uno R3 and the Relay SPDT can control it to manage the opening and closing of valves or the functioning of pumps, ensuring the plants receive the right amount of water.

7. 12. Power supply: The Smart Irrigation System's power supply provides the electrical energy required to run it. The power source provides the necessary voltage and current to power the components and circuits which could be a battery or an external power source.

8. 15. Red LED: The Red LED is another visual indicator in the system, much like the Green LED. It could work as a warning signal to alert users to certain system situations, like a low battery or failure, and encourage or alert them to take the necessary action.

9. 16. Pushbutton: The Pushbutton is an instantaneous switch that enables manual irrigation system operation. It can be used to override automated procedures and set off particular activities, including manually starting irrigation or turning on specific system modes.

10. Switch: A switch is an electrical component that has two states that may be switched between, usually ON and OFF. A switch can be used in the Smart Irrigation System to manage the overall power supply or enable/disable particular system functionalities.

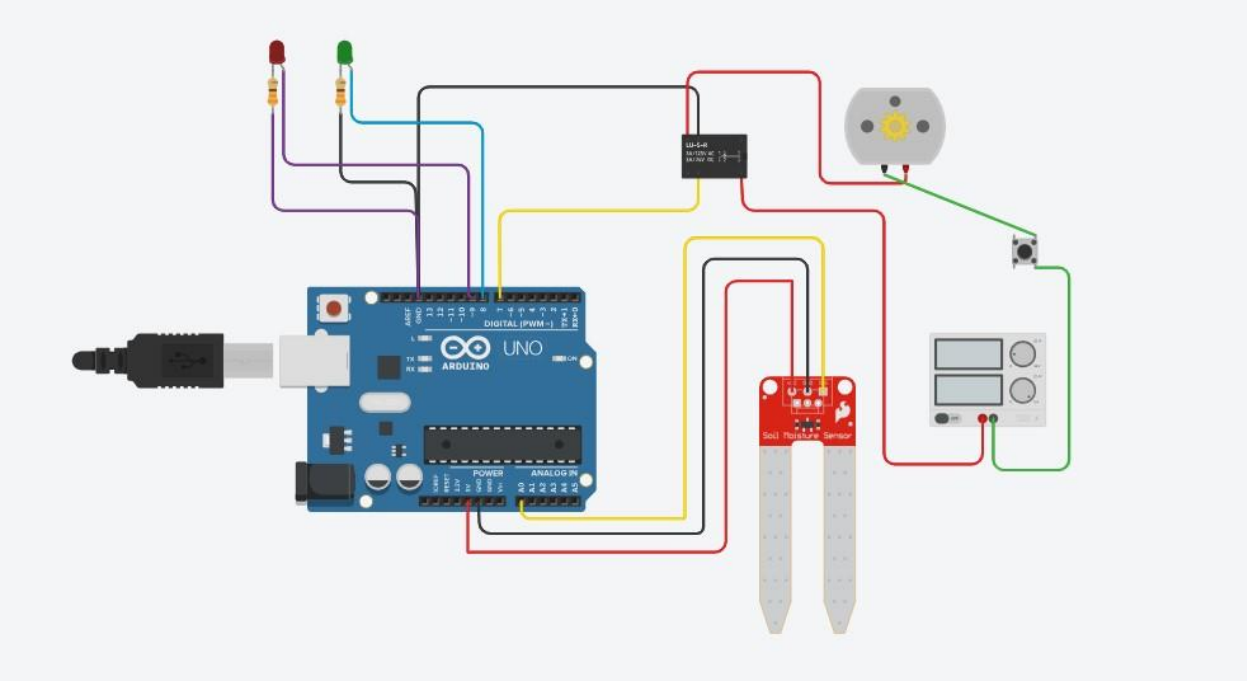

FIG 4. Arduino configuration of the system.

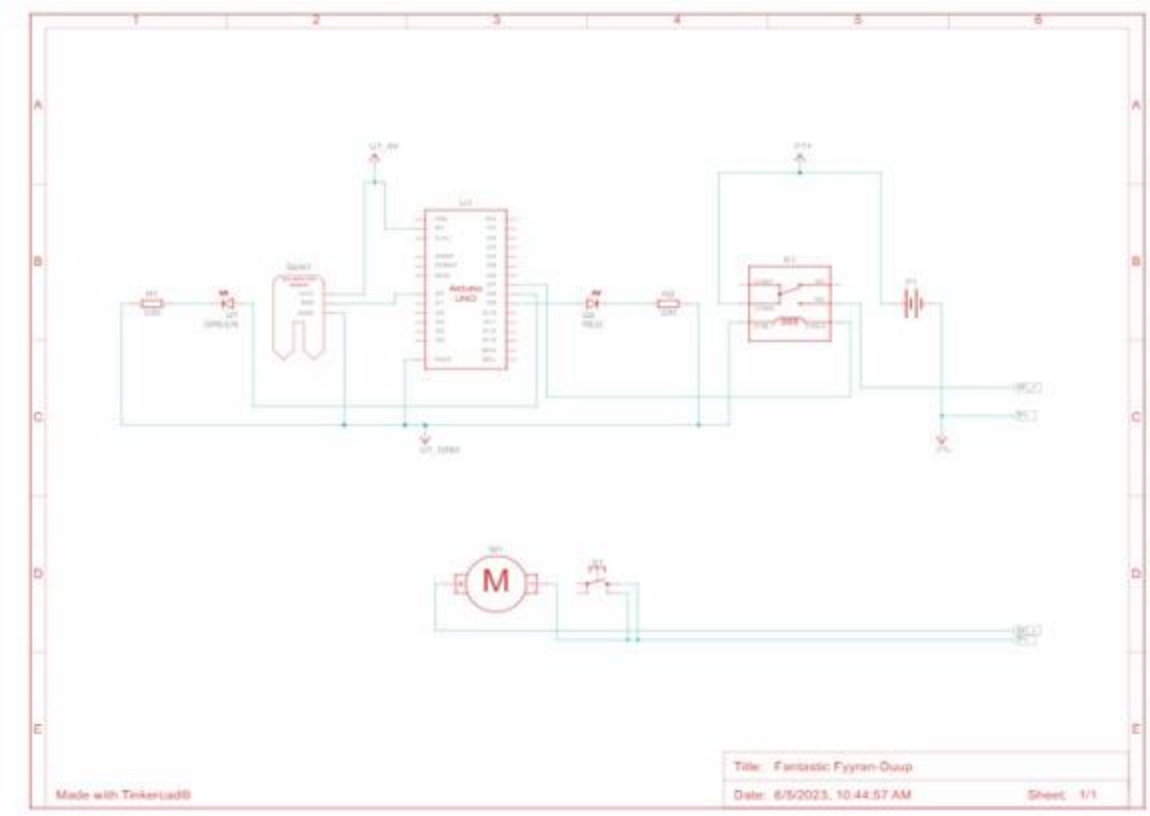

Fig 5. Schematic view of a system made from Tinkercad

The linkages and interactions between the parts of the Smart Irrigation System are depicted in this figure 4 and 5. The system is powered by the power source, and the Arduino Uno R3 microcontroller receives that energy. The

SPDT relay and Arduino work together to regulate the DC motor in charge of operating the valve and pump. The Red LED acts as a warning indication, while the Green LED shows whether the system is operating. While the pushbutton and switch allow for manual operation and system functionality, the resistor controls the current flow.

In general, the Smart Irrigation System provides preventative measures, including automated watering depending on soil moisture levels, visible indicators for system issues, and human control options. It promotes sustainable gardening techniques, increases water efficiency, streamlines irrigation management, and makes plants healthier while conserving resources.

V. Conclusion and recommendation

The product completes by using different ideas and technologies. A striking illustration of how technology is transforming the agricultural industry is the Smart Irrigation System. This technology optimizes water use, boosts agricultural yields, and promotes sustainable farming methods by utilizing cutting-edge capabilities. It accomplishes this by continuously monitoring the climatic conditions and soil moisture levels, allowing for precise irrigation schedules that efficiently deliver water to plants while conserving water. As a result of the system's flawless operation and the incorporation of parts such as the Arduino Uno R3, soil moisture sensor, SPDT relay, LED indicators, and manual control choices, farmers are provided with a dependable and effective solution. The Smart Irrigation System is strongly advised for wider application in agricultural activities due to its many advantages and capabilities. Farmers stand to gain greatly from increased agricultural yields, decreased water waste, and improved water efficiency.

In conclusion, the Smart Irrigation System has a lot to offer in terms of water management and crop output, but there are still some things that may be done better. It is crucial to optimize energy consumption through alternate sources or reduce component energy usage as well as improve the system's sensing capacity to identify a larger variety of pollutants. In order to develop the product and make it more effective in addressing issues like water conservation, sustainable agriculture, and environmental concerns, collaborative efforts.

VI. Security Consideration

To shield the Smart Irrigation System from weaknesses and maintain its integrity, it is essential to ensure its security. Several security issues must be taken into account in order to accomplish this. Strong authentication systems, including strong passwords or biometric verification, must be put in place to stop unauthorized access and alteration.

Encryption techniques can be used to protect data transit between components and the central control unit, addressing data privacy issues by preventing illegal interception or manipulation. To immediately fix any discovered vulnerabilities, routine software upgrades, and security patches should be applied. Farmers can fully rely on the Smart Irrigation System to protect their crops and ensure the ongoing success of their farming operations by giving priority to these security precautions.

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