Indoor Plant System Smart Irrigation Controller

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INDOOR PLANT SYSTEM SMART IRRIGATION CONTROLLER

***Abstract*-Agriculture is a vital part of the Bangladeshi economy since it creates jobs and fuels expansion. But water shortage during the growing season is a serious problem for many farmers in different parts of the world. Low agricultural yields caused by insufficient water availability have a deleterious effect on farmers' incomes and the local economy. In addition, multi-story farming facilities on terraces are crucial in metropolitan areas, where land is rare, to supply the rising demand for agricultural products. However, some people may not be able to commit to terrace gardening because to their lifestyle or work schedule. That's why an effective multi-tiered automated water irrigation system that can keep plants from drying out is so crucial. In order to solve this pressing problem, this study suggests collecting and utilising rainwater efficiently. The suggested technique makes use of sensor technology to equally distribute water according to the individual needs of the location and crop type, reducing water waste and labor expenses. Particularly in metropolitan locations where access to farmland is restricted, this approach has the potential to greatly improve agricultural output and sustainability. The suggested multilayer autonomous water irrigation system has the potential to significantly contribute to the growth of agricultural output while also fostering more environmentally friendly methods of production.**

***Index Terms*— Indoor, Automatic Palting, Moisture Sensor, GNL (General Public License)**

I. INTRODUCTION

The agricultural sector plays a pivotal role in the economy of Bangladesh, serving as a crucial foundation for employment generation and propelling economic advancement. The issue of water scarcity during the cultivation season poses a significant challenge for numerous farmers across diverse geographic locations. The dearth of water resources frequently culminates in diminished agricultural productivity, thereby exerting an adverse influence on the subsistence of cultivators and the broader populace. Moreover, in metropolitan regions, where the availability of land is limited, the implementation of multilevel farming infrastructures on terraced landscapes is imperative to satisfy the increasing need for agricultural yields. Notwithstanding its agricultural advantages, terrace cultivation may prove impracticable for certain individuals on account of their frequent travel or occupational obligations. Hence, an exigent requirement exists for a sophisticated, multi-tiered automated water irrigation mechanism that can effectively regulate moisture levels and avert the demise of flora. The present manuscript posits a resolution to tackle this pressing concern, with a particular emphasis on optimizing the employment of precipitation-derived water resources while minimizing any associated squandering. The method under consideration integrates sensor technology to mitigate water wastage and labor expenses, while also ensuring equitable water distribution in accordance with the distinct needs of the region and crop variety. The implementation of this system holds the potential to substantially augment agricultural productivity and sustainability, particularly in urban regions where the availability of arable land is constrained. The proposition of a multilevel automatic water irrigation system holds significant potential in augmenting agricultural yield and fostering eco-friendly methodologies. Soil moisture gauges are used to measure the volumetric water content of the soil by looking at things like the soil's electrical resistance, dielectric constant, or contact with neutrons. This is a roundabout way of figuring out how wet the soil is. This method is needed because the straight gravimetric measurement of free-soil wetness necessitates collecting a soil sample, letting it dry, and then weighing it, which is not useful for a system that keeps track of things all the time. The main goal of the project is to make an automatic system for watering plants that works quickly, correctly, and with little help from people. By reaching this goal, the method lowers the amount of work needed to water plants and helps them grow and produce at their best.

II. LITERATURE REVIEW

Intelligent agriculture has revolutionized the farming industry by utilizing state-of-the-art technologies such as the Internet ofThings (IoT) to maximize yield and minimize waste. This has resulted in the optimization of crop yield and reduction of wastage. The integration of technological resources in agricultural practices has facilitated the enhancement of crop productivity, and farmers have capitalized on this phenomenon. The present research introduces a computational framework aimed at optimizing indoor agriculture practices. The framework leverages historical context analysis to offer intelligent and versatile services to farmers. The primary aim of this study is to construct a computational framework for indoor agriculture that incorporates past contextual data on crops and utilizes it to furnish farmers with intelligent and universal services. The fourth section of the paper details the methodology employed in developing the prototype, and assesses the model's capabilities through a range of scenarios. Subsequently, a survey is conducted with the aim of identifying potential avenues for future investigation. The Indoor Plant model considers the plant parameters obtained from prior cultivations, in conjunction with the annotations furnished by farmers, to ascertain the most advantageous parameters for cultivating a specific plant. The assessments of the Indoor Plant were carried out utilizing the Greenhouse Controller (Cultiva Fácil Hidroponia) and the Indoor Server, which possess the features mentioned earlier. This novel methodology for indoor agriculture holds the potential to augment efficiency and curtail wastage in the agricultural sector, thereby facilitating the adoption of sustainable and effective farming techniques. [1]

The exigency of contemporary agriculture is the emergence of astute and economical techniques for irrigation. One of the foremost quandaries in the realm of agriculture pertains to the optimal exploitation of freshwater reservoirs with high sucrose content. As a retort, there has been a proliferation of sensor-driven irrigation systems catering to horticultural enthusiasts and modest agricultural operations, as well as an ingenious smart tunnel farming mechanism. Utilizing the optimal irrigation method can result in 80 to 90% water savings under favorable conditions. An intelligent approach to efficient plant irrigation has been proposed that uses a database of daily water requirements for different plant types, enabling the system to determine the appropriate amount of water for each plant. The smart irrigation system for tunnel farming was implemented using MATLAB. It is worth noting that a typical moisture sensor is capable of reading moisture content within a diameter of 10–15 cm around the probe, and the use of 30 to 36 sensors is adequate for this purpose. [2]

Effective and intelligent approaches to irrigation have become a crucial aspect of contemporary agriculture. Historically, farmers would intermittently inspect their fields to assess soil moisture levels and manually operate watering machines to irrigate their fields. This process can be laborious and time-intensive, particularly when managing multiple fields dispersed across diverse geographical areas. The utilization of internet-connected systems has facilitated farmers to remotely oversee the irrigation status of their fields, encompassing the direction of water flow and the operational status of irrigation motors. The prototype under consideration integrates multiple sensor nodes strategically positioned across the agricultural expanse to gauge the levels of moisture. Subsequently, the system independently initiates the motor and determines the watering direction by analyzing the sensor data. This methodology enables a reduction in water wastage and obviates the necessity for human involvement. Furthermore, the system provides irrigation status updates to the farmer, irrespective of their physical presence at the field. The autonomous control of the smart irrigation system is facilitated through the utilization of soil moisture sensors. These sensors are equipped with a comparator (LM393) and a pair soil probes that are capable of detecting the moisture content present in the soil. [3]

Costly commercial sensors for agricultural irrigation systems hinder the adoption of this system by smaller farmers. Numerous manufacturers now offer cost-effective sensors that can be coupled with nodes to implement inexpensive systems for managing irrigation and agriculture monitoring. Recent technological advancements in IoT and WSN can be applied to the establishment of these systems. In order to summarize the present state of the art about intelligent irrigation systems, an inquiry has been conducted. This survey focuses on the water quantity and quality, soil characteristics, and climate variables monitored in irrigation systems. In addition, difficulties with implementation and best practices for sensor-based irrigation systems are discussed. The scarcity of potable water is a developing concern, especially in the Mediterranean and southern regions. The management of water can be influenced by a variety of factors, such as the water demand from various sectors or the effects of global warming on hydrological assets. As one of the most important economic resources in these nations, agriculture emphasizes the importance of managing the available water resources efficiently to ensure continued productivity. The data collected by sensors tracking the environment, soil, and water are able to be used to figure out the present condition of the water and the likelihood of meeting all freshwater demands. Some countries with greater financial resources are already employing water management and reuse systems intended for optimizing water usage and minimizing the environmental impact triggered by the use of large quantities of water. The study provides a breakdown of the most prevalent nodes and wireless solutions used to implement WSN and Internet of Things-based smart irrigation systems. [4]

Current agricultural commercial trends suggest a rise in the proportion of farmers who choose to engage in direct product sales and pursue intelligent approaches to maintain ongoing oversight of the variables that impact product quality. In recent times, there has been a growing trend towards the utilization of cloud-based methodologies for the implementation of smart irrigation systems. Satisfying the demands of farmers in the workplace yields benefits such as expedited response times, optimized networks, and strengthened data ownership. The scholarly article titled "Cloud of Things in Smart Agriculture: Intelligent Irrigation Monitoring by Thermal Imaging" suggests the adoption of Cloud of Things technology to facilitate the management of water source-related information. Cloud-based methodologies offer advantages for intelligent agriculture, such as the ability to disseminate crop information to external entities beyond the network's periphery.

The cultivation and consumption of strawberries is prevalent, and farmers employ intelligent strategies such as Sensor-based Irrigation Networks (SINs) to manage water supply and minimize crop wastage. Therefore, it is imperative for farmers to regularly monitor the temperature within their greenhouses as well as the moisture levels of the soil in order to effectively manage and provide water resources. [5]

III. METHODOLOGY AND MODELING

The system under consideration operates on the fundamental principle of utilizing a moisture sensor to ascertain the present moisture content of the soil and to discern the water needs of the vegetation. The placement of the moisture sensor at an optimal depth within the soil is crucial for the accurate detection of the moisture level. Upon detection of moisture level by the sensor, an analysis of the data is conducted to ascertain the water requirements of the plant. The designed system is intended to initiate a relay mechanism that subsequently activates a motor, thereby facilitating the provision of the requisite amount of water required by the plant. The relay functions as a mechanism that facilitates the activation or deactivation of the water supply to the flora.

In order to optimize the performance and functionality of the system, the utilization of an Arduino Uno board is implemented for programming objectives. The Arduino Uno microcontroller board possesses the ability to execute diverse codes and programs for the purpose of regulating system functionality. The design of the board prioritizes compactness, energy efficiency, and multifunctionality. The device possesses a variety of input and output pins that can be programmed to establish connections with a diverse range of sensors, modules, and actuators. The system under consideration presents a multitude of advantages in comparison to traditional irrigation systems. The implementation of a system that supplies plants with the appropriate amount of water in accordance with their specific requirements serves to mitigate water waste. Furthermore, it is beneficial for enhancing the general well-being and development of the vegetation through the provision of an ideal quantity of water. The implementation of a moisture sensor facilitates the provision of water solely as needed, thereby mitigating the risk of excessive watering of the flora. The system's installation and operation are simple and customizable.

IV. STEPS OF IMPLEMENTATION

In order to initiate the procedure, the requisite hardware and equipment were acquired. Modifications are then made to the code using the Arduino Integrated Development Environment (IDE). Proteus is used to execute the simulation after observing the results.

Fig. 1. Visual Representation of the Process.

Flowchart:

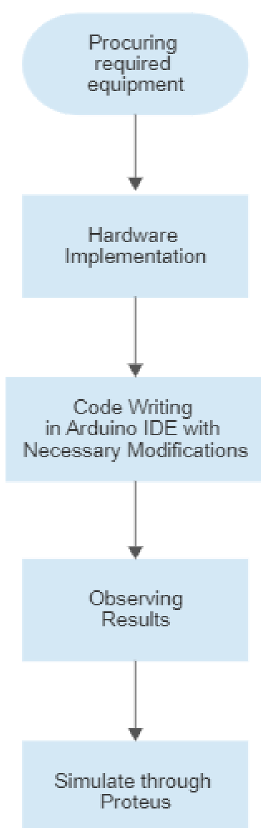

Fig. 2. Flowchart of Working Procedure.

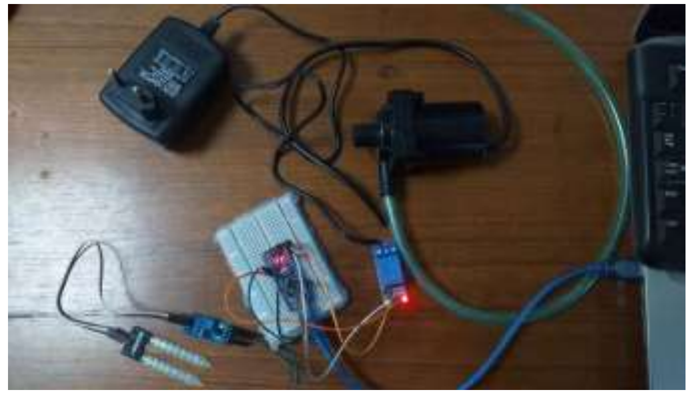

Fig. 3. Hardware Setup.

An Arduino Nano board is used in the suggested system, and it communicates with a relay and a moisture sensor. The relay controls the motor and the adapter, while the moisture sensor monitors the plant's moisture levels. The plant is linked to the motor, which then delivers water as needed.

V. RESULTS AND DISCUSSION

A. SIMULATION AND NUMERICAL ANALYSIS

To guarantee the precision and reliability of the results, we took care to obtain the simulation libraries for the Arduino and sensor from credible and verified sources. Through this approach, we were able to procure outcomes that were devoid of any plausible inaccuracies or prejudices that could potentially undermine the credibility of our research. The following image is presented to offer a visual depiction of the simulation module utilized in our research.

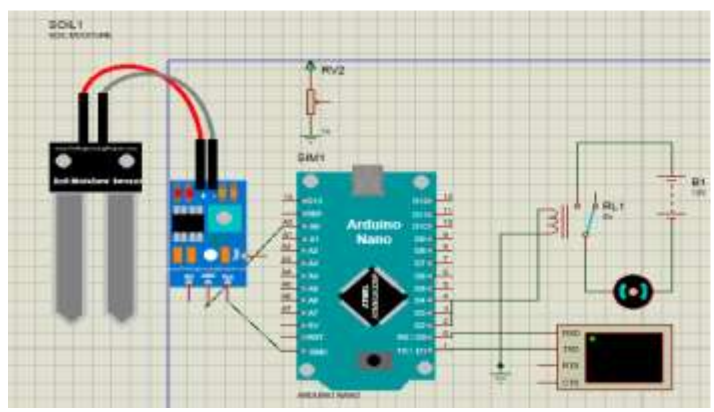

Fig. 4. Simulation by Proteus.

Fig. 5. Serial Monitor Reading from Proteus.

In this simulation, the software application used was Proteus 8 Professional. The simulation was designed such that the moisture value of the soil is displayed on the serial monitor in percentage format. For instance, a moisture value of 99.00% would be displayed on the serial monitor.

B. MEASURED RESPONSES

As per the observations presented in the serial monitor, in the event that the soil's humidity level falls below 600, the relay switch is triggered, and the serial monitor reports that the plant needs watering. Upon activation, the motor is initiated, and the serial monitor displays its operational status as active. In contrast, when the humidity value surpasses 600, the relay deactivates, and the serial monitor exhibits that the plant is not in need of water, leading to the subsequent shutdown of the motor.

```
Output    Serial Monitor ×

13:13:06.649 -> Motor ON
13:13:06.649 -> Humidity: 569
13:13:06.649 -> plant needs water
13:13:06.670 -> Motor ON
13:13:06.670 -> Humidity: 570
13:13:06.703 -> plant needs water
13:13:06.703 -> Motor ON
13:13:06.736 -> Humidity: 587
13:13:06.736 -> plant needs water
13:13:06.769 -> Motor ON
13:13:06.769 -> Humidity: 618
13:13:06.802 -> plant doesn,t need water
13:13:06.802 -> Motor OFF
13:13:06.836 -> Humidity: 655
13:13:06.836 -> plant doesn,t need water
13:13:06.869 -> Motor OFF
13:13:06.869 -> Humidity: 681
13:13:06.901 -> plant doesn,t need water
13:13:06.936 -> Motor OFF
13:13:06.936 -> Humidity: 692
13:13:06.936 -> plant doesn,t need water
13:13:06.969 -> Motor OFF
13:13:07.002 -> Humidity: 720
13:13:07.002 -> plant doesn,t need water
13:13:07.035 -> Motor OFF
13:13:07.035 -> Humidity: 776
13:13:07.069 -> plant doesn,t need water
```

Fig. 6. Result of Serial Monitor

A comparison between the numerical and experimental findings reveals that during the simulation phase, solely an estimated percentage value of moisture content is exhibited. As an illustration, the visual representation exhibits the statement "The level of moisture is recorded as 99.00%".

Unfortunately, the simulation does not allow for the demonstration of plant watering via DC motor rotation. However, in the practical execution of the project, the precise moisture measurement is displayed alongside corresponding remarks.

C. LIMITATIONS

- The operation of a DC motor is contingent upon the availability of a stable power source. The effective operation of the proposed project is contingent upon a dependable power supply.
- The project entails the incorporation of water and electrical components. The exposure of electrical components to water can result in either irreversible damage or complete annihilation.
- It is imperative to exercise prudence while carrying out installation and maintenance activities in order to avert the possibility of water infiltration.
- There is a lack of an LED screen for displaying the humidity value.
- In order to display data, it is imperative to establish a connection between the device and a personal computer to access the serial monitor.
- Reliable electricity, thorough installation and maintenance, and a personal computer interface to show humidity levels are crucial to the project's success.

VI. CODES

```
void setup() { Serial.begin(9600);
pinMode(2,OUTPUT);
        }
void loop() {
        int value = analogRead(A0);
         if (value > 600) {
        digitalWrite(2, LOW); Serial.print("Humidity: ");
Serial.println(value);
Serial.println("plant doesn,t needwater");
Serial.println("Motor OFF");
        }

        else {
digitalWrite(2, HIGH); Serial.print("Humidity: ");
Serial.println(value); Serial.println("plant needs water");
Serial.println("Motor ON");
        }
      }
```

VII. CONCLUSION

The primary objective of the project is to devise an autonomous irrigation mechanism through the utilization of an Arduino microcontroller and a moisture sensing device, thereby obviating the requirement for human involvement. In order to achieve cost-effectiveness, an adaptor is utilized, thereby decreasing the initial investment cost. Prospective improvements to the project could involve the creation of a mobile application, which would allow for remote monitoring of the system's performance and facilitate remote control of its on/off functions. The mobile application has the capability to exhibit the proportion of crucial constituents, along with the moisture content, that are necessary for the ideal development of plants, thus enabling the cultivation of robust vegetation.

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