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SMART FARMING 2.0 WITH WATER QUALITY MONITORING SYSTEM

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Abstract— **This study introduces a smart plant watering system using an Arduino Uno that increases the utilization of water resources in agriculture and provides real time quality monitoring of soil constantly. In order to provide optimal performance, the system uses automation for watering plants by monitoring the moisture levels of soil using a dual electrode soil-moisture sensor and activating a for irrigation pump through a relay module when the water content of the soil fall below a certain level from the set threshold. Additionally, it is integrated with some water quality monitoring systems like TDS sensors (Total Dissolved Solids), turbidity sensors, and pH sensors to check the quality of water which will be used in farming. An automatic water refilling system has been incorporated with water level detector to provide fully automatic system. An LED panel has been used to provide visual feedback to the user on the pumping status. This automation-enabled technology optimizes the use of water management and improves plant growth by offering a range of adjustments according to the parameters for watering different types of plants. It showcases the potential to improve productivity and sustainability by combining such low-cost technologies with automation.**

Keywords: — *Auto irrigation, Arduino, Soil moisture, quality of water, turbidity, TDS, pH, automation.*

I. INTRODUCTION

Nowadays, one of the biggest issues faced by the world is the lack of usable water. Water conservation is achieved by the integration of numerous techniques. Quality water is necessary for all living things, including humans, animals, plants, and other beings. One such field where a large amount of water is needed is agriculture. Water waste is a big issue in agriculture since the fields are frequently given too much water. Farming needs proper quality of water. This problem is especially common among gardeners, who have a tendency to overwater their plants, wasting water needlessly and sometimes damaging the plants. Also, using water containing excessive amount of dissolved salts and pH which is not in neutral range, can damage not only crops but also causes permanent damage to the farmlands. Using water resources sustainably and addressing these issues require effective water management techniques with quality monitoring systems.

Hriday Chawla et al. proposed that in their system automates irrigation by using a soil moisture sensor to measure soil humidity. The Arduino Uno reads the moisture levels and controls the water pump, turning it on when moisture is low and off when it is sufficient. This method reduces human labour and enhances water use efficiency, hence leading to increased yield of the crop [1]. Neha Singh et al. describes an automation of irrigation system based on Arduino with incorporated humidity and moisture sensors. This pump would be automatically lit on whenever the plants need water; hence with very little human intervention ensures that the plants grow healthily and quite literally conserve the resources [2]. According to Drashti Divani et al., this system consists of two major components: a water pump and a moisture sensor, thus forming an Arduino-based irrigation system. As far as controlling is concerned, the system is based on an Arduino board that is programmed with the help of Arduino IDE. In the system, the ATmega328 microprocessor turns the pump on once the moisture sensor detects a drop in the level of the soil moisture below a specific threshold. A smartphone app provides activity statistics to users, guaranteeing effective watering [3]. Bishnu Deo Kumar et al. developed an AtMega328 microcontroller is connected to a soil moisture sensor located in the root zone of the plant in the system described in their paper It uses GSM to communicate data and pump status to the farmer, automatically turning off the pump when the moisture content is appropriate. Their system is for large fields and their requirements are different from ours, ours is for household purposes, so it will consist of fewer complicated, inexpensive, and more straightforward to assemble parts [4]. Abhinav Rajpal et al. proposed a Microcontroller-based Automatic Irrigation System to optimize the utilization of water. This is mainly composed of microprocessor-based control, soil moisture-measuring sensors, relay, and a water pump. It automatically turns on the water pump when soil moisture falls to a lower level and hence ensures sufficient and proper irrigation [5]. Pavithra D. et al. in their paper have designed an irrigation system which makes use of a GSM sensor-based approach for monitoring the conditions of the soil and controls the flow of water through mobile messages. The integration of this with Bluetooth allows remote monitoring and reduces SMS expenses and GSM problems. It also includes smoke sensors that would trigger the alarm in case of catching fire by its engine [6]. Priyanka Aishwarya et al. mentions the automate irrigation based on soil moisture levels, a PIC16F877A microcontroller is used. When the soil becomes dry, sensors identify it and alert the microcontroller to turn on the water pump. Fields are ranked according to the system's hierarchy of water requirements. It is intended for regular plant maintenance; it waters plants twice a day to keep them hydrated even when users are not there or are busy [7]. Vaidehi Deshpande et al. discuss the use of the Embedded Control for programming the irrigation schedule via a touch screen or a smartphone. The system is operated by an 8051-microprocessor device and a Real-Time Clock to ensure that the user receives the on-time disruptions and the present status for uniform irrigation. When plants are consistently watered, this method helps to maintain their health [8]. Pooja Ramkumar et al. in their article proposed an IoT-based automation solution. Sensors are used to monitor humidity, temperature, and moisture. This system provides automatic water management, saving a large amount of waste and hence increasing yield. Farmers can identify and manage water in the field, increasing agriculture's overall profitability and sustainability [9]. J.N. Kagewa et al., in their research, looked at three crops: beans, peppers, and potatoes, also their moisture thresholds. Irrigation is done when soil moisture falls below the threshold and stopped when soil moisture rises above the threshold. Furthermore, the concept of machine learning increases the cost-effectiveness of IoT-based smart irrigation systems by reducing the need for network communication [10].

Our present work presents a smart plant watering system designed to address these challenges by leveraging modern technologies. To ensure optimal water utilization and plant health, the system uses an Arduino Uno to automate the watering operation. A dual electrode soil-moisture sensor to detect dryness in the soil and sensors for total dissolved solids (TDS), turbidity, and pH to check the quality of the water. An automatic ground water refiling system is there to provide full automation of water irrigation technology.

II. METHODOLOGY

The working mechanism of the model can be explained by the working of different sensors (soil moister, TDS, turbidity, pH), and finally combining everything with a simple Arduino Uno microcontroller-based dissection making system. On the other hand, the entire setup can be divided into three parts-automatic ground water refiling system, water quality monitoring checking & drainage system and soil moisture checking & irrigation system.

To run this setup properly two water tanks are needed. One is for ground water reserve and quality checking, and another is for irrigation purpose.

A basic transistor-based continuity detector has been developed for the water level detector. It has three submergible ends, one is for the highest water level detection second is for the lowest water level detection and third one is (+5v) rail. This three ends have to be submerged into the tank water.

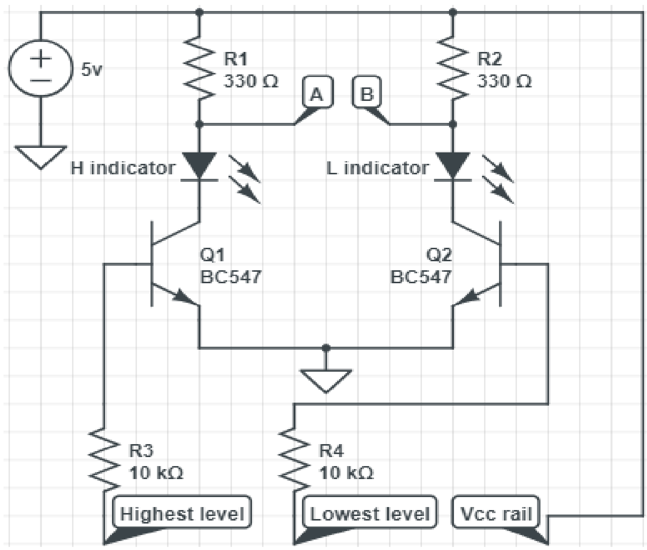

Fig 1: Water Level Detector

Similarly, it has two outputs denoted by A & B from where the signal has been taken and fed into Arduino. This sub part work is based on this truth table —

Lowest water level	Highest water level	A	B	Refill pump
Yes	Yes	low	low	Off
Yes	No	low	high	Off
No	No	high	high	On

In this same tank, water quality monitoring also took place and this process includes checking turbidity, TDS and pH.

The TS-300b turbidity sensor measure the amount of un-dissolved solid particles present in the water. The sensor emits light through the water and measure the amount of reflection reflecting back by hitting the suspended partials. Then the sensor module converts this into voltage signal. Murkier water lowers the voltage.

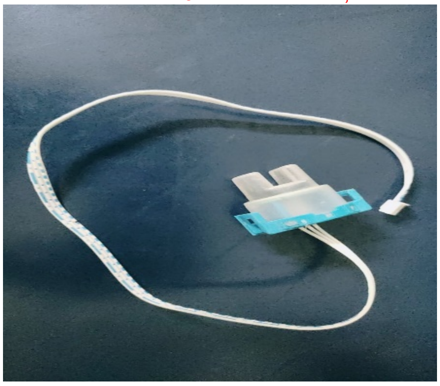

Fig 2: Turbidity Sensor

For TDS measurement a MW-TDS101 sensor has been utilized. TDS is nothing but the amount of total dissolved salt particles into the water which signifies the hardness of water.

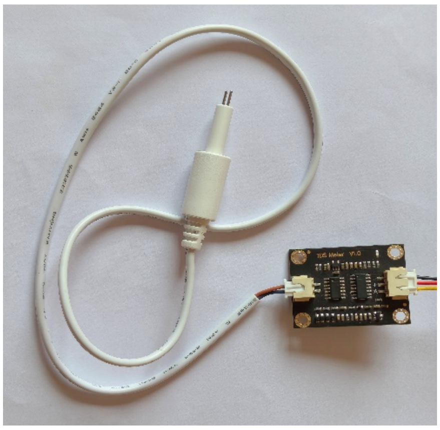

Fig 3: TDS Sensor

The sensor has two electrodes by which it measures the conductivity in between the space. Higher the TDS value, higher the conductivity.

On the other hand, digital pH meter maintains a crucial role in this project. Because little bit higher or lower pH can destroy the entire crops and farmland. The sensor has a glass electrode filled with a buffer solution. It works with I2C communication so it directly generates data according to the pH.

Fig 4: pH Sensor

Only, if three of these parameters have satisfied then the water will be transferred to the next tank or if any of them are not in proper quality the water will go to the drainage tank.

The system works following this truth table —

TDS	turbidity	pH	Transfer pump	Drainage pump
ok	ok	ok	On	Off
ok	ok	Not ok	Off	On
ok	Not ok	ok	Off	On
ok	Not ok	Not ok	Off	On
Not ok	ok	ok	Off	On
Not ok	ok	Not ok	Off	On
Not ok	Not ok	ok	Off	On
Not ok	Not ok	Not ok	Off	On

For soil moisture measurement a dual electrode sensor has been utilized. Those electrodes are made of nickel alloy and has a fixed surface area, length and spacing.

Fig 5: Dual Electrode Soil-Moisture Sensor

When it is buried into the ground it measures the conductivity between two electrodes. The sensor comes with an additional LM331 based comparator module which converts the conductivity into analog voltages. By processing this data soil moisture can be determined accordingly.

Finally, the Arduino process all sensors data and decide whether the pH of the water is in between 6 to 8 or not, TDS is less than 1000ppm or not and Turbidity is less than 200NTU or not. If every parameter has passed into the test the water will be transfer to the next storage tank and if the water is not safer it will drain the water. on the other side it checks the soil is dry or not, if it is less than 30%, the irrigation pump starts the irrigating the water until it riches 90%.

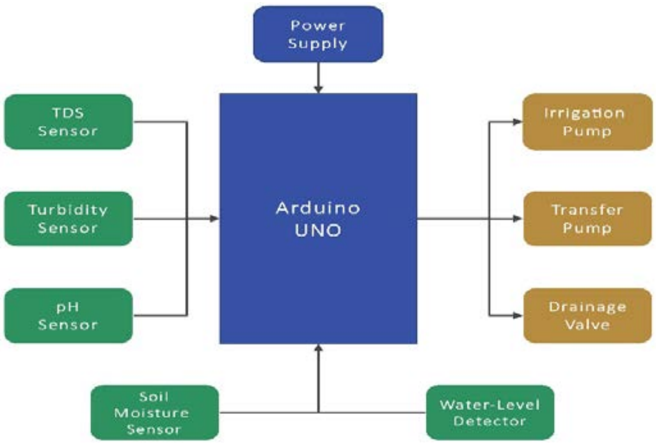

Fig 6: Setup Connection

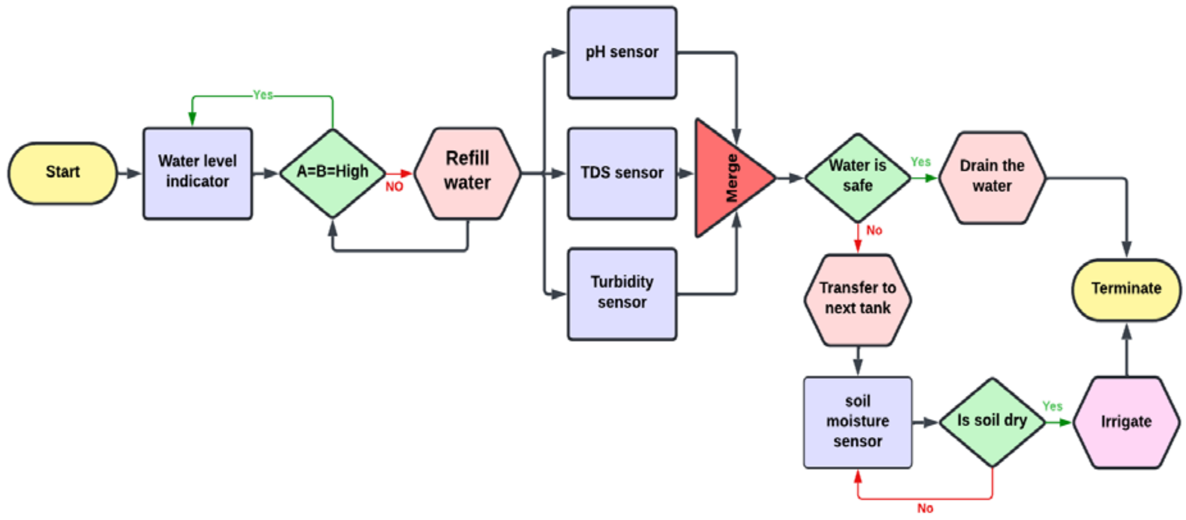

Fig 7: Working Flow Diagram

Fig 8: Setup Image

III. RESULT AND ANALYSIS

The fabricated device has been tested by adding some impurities into the water to test pH response and TDS response of the sensor. for testing purpose, we used de-ionized, having pH-7 and very minimum TDS and turbidity.

For pH response we have conducted a test where 10µL, 1M HCl solution has been added dropwise into the water for acidic pH. And the same test has been conducted with 1M NaOH solution for basic pH.

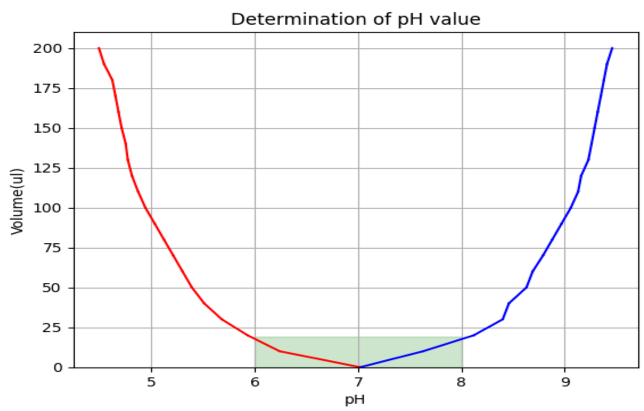

Fig 9: Added Impurity (HCl / NaOH) vs pH

Adding HCl keep decreasing the pH and reaches approximately pH-3.5 after 20th drop and similarly adding NaOH keep increasing the pH and reaches approximately pH-9 after 20th drop. The threshold value of pH has been set in between 6 to 8. So, when the pH exceeds the limit, the pump started draining the water.

For testing TDS sensor response, a 1:1 ratio of NaCl and KCl has been taken. The test has been conducted by adding this salt mixer 50mg at a time into the newly taken water.

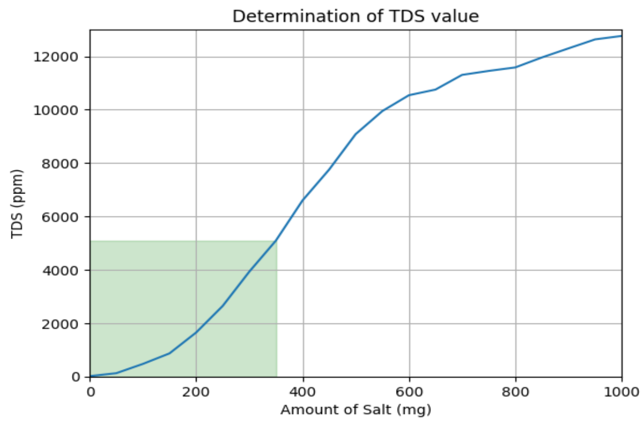

Fig 10: Added Salt (NaCl + KCl) vs TDS

Adding more salt keep increasing the TDS value. The threshold value of TDS value has been set at 5000ppm. When the TDS exits the threshold the same pump start draining the water.

IV. CONCLUSION

In conclusion, the proposed smart farming system uses an Arduino Uno with sensors and automation to automatically water plants and maintain suitable water quality based on various factors like pH, turbidity, TDS, and soil moisture. In order to prevent crop damage from insufficient watering and poor water quality, this technique maintains plant growth while increasing the total water efficiency and productivity. The system demonstrates how such low-cost sensor technologies and automation can be used to highlight the potential of smart farming solutions for the agricultural industry

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