Arduino based irrigation monitoring system using Node microcontroller unit and Blynk application

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ABSTRACT

In the case of traditional irrigation systems, irrigation is done manually by the user. Since the water is irrigated directly into the land, plants undergo high stress from variations in soil moisture, and therefore plant appearance is reduced. The objective is for remote monitoring and controlling devices, which are controlled using a Wi-Fi module, and to optimize water consumption. The sensors collect and evaluate data regarding changing weather, soil moisture levels, and water levels before sending timely notifications to the user's phone and desktop. The system also contains a device application (Blynk) that runs on various devices and may be used to monitor plant conditions at the user's workplace. It constantly monitors the situation and notifies the user of any developments that necessitate urgent action. It combines the sensor devices, Node microcontroller unit (NodeMCU), and Arduino to work together to meet the system's objectives.

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1. INTRODUCTION

In many parts of the world, traditional irrigation systems are used to bring water to crops. These systems typically have a network of canals, ditches, and other channels that transport water from a water source to the fields where crops are grown. In some cases, the water is gravity-fed; in others, it is pumped using a variety of mechanisms. Traditional irrigation systems are typically composed of three key components: a water source, a network of canals and channels, and a controller. The water source can be anything from an underground river to a lake or reservoir. It is well known that irrigation is vital for plant growth. However, what is not as well known is that irrigation can also lead to plant stress. Plant stress can have several negative impacts on plant growth, including reduced photosynthesis, stunted growth, and even death. There are several factors that can lead to plant stress from irrigation [1], [2]. One of the most common is improper irrigation technique. If irrigation water is applied too quickly or too heavily, it can cause the plant to experience water stress. Additionally, irrigation can also lead to salt buildup in the soil, which can also be stressful for plants.

Overall, water scarcity is a major problem facing many countries today [3]. It has negative effects on crop production and groundwater resources as well as social and economic stability [4]–[6]. The main cause of water scarcity is population growth, which is increasing at a faster rate than the available water resources. This growth is particularly evident in countries with limited water resources and poor economic conditions. However, traditional irrigation systems are still in use in many countries, due to their effectiveness at delivering water where it is needed most. Improvements need to be made so that these systems can better cope with future water shortages. As a result, managing water scarcity has become a major challenge for these countries. The history of automation in irrigation systems has allowed for more efficient irrigation and greater crop yields. The benefits of automation are that it can precisely deliver water to crops, minimizing the amount of water wasted and allowing for uniform watering patterns across a field. Additionally, automated systems are often more accurate in terms of delivering water to specific areas, meaning that they are more efficient in terms of water use. This increased efficiency has led to an increase in the market for automation in irrigation systems, which means that there is a greater variety of options available to farmers seeking to improve their irrigation practices. While automation can be complex and require some adjustment on the part of the farmer, it ultimately allows for more efficient and effective irrigation of crops.

2. THEORETICAL BACKGROUND

Auto irrigation application for crop monitoring has evolved into an important tool for farmers. Today, it is a popular way to monitor and irrigate crops. Auto irrigation applications for crop monitoring systems can be used to water plants automatically or to provide information about the health of the plants [7]. They can also be used to monitor soil moisture levels and temperature [8]–[11]. The use of global system for mobile communication (GSM) technology for auto irrigation systems can have several potential benefits, specifically in terms of saving water and improving crop yields [12]–[14]. As a receiver unit, GSM uses a general packet radio service (GPRS) module. The GPRS module receives data from the wireless sensor networks. The GPRS unit uses a cellular internet interface for duplex communication, which is common in 2G and 3G cellular GSM. Although GSM has a greater range and is more practical for larger areas, it costs money to send data each time, whereas Zonal intercommunication global-standard (ZigBee) is a free solution. Furthermore, the GSM band requires authorization to use, but ZigBee has a license band that anyone can use without requesting permission.

Rathod *et al*. [15] developed an agriculture stick based on the internet of things (IoT) that will help farmers get live data on temperature, soil moisture, and other factors for efficient environment monitoring. It will help them do smart farming and increase their yield productivity. This project uses Arduino technology and a GSM module to notify the user of the current state of several parameters that must be monitored. While other researchers developed a monitoring system for soil moisture content and an automatic irrigation system [16]–[18]. As an example Narasimhulu *et al.* [12] implemented two sensors to measure soil moisture content for different soils. The soil moisture value was recorded and displayed on a web page for live monitoring through the GSM module. Aside from that, researchers [19]–[21] use a ZigBee module as a tool for wireless data transfer. Due to its low battery consumption, low cost, and ability to handle up to 65,000 nodes connected in a network, its application is more beneficial and advantageous in developing a low-cost automatic irrigation system.

There is also a research project that designed an Arduino-based controlled system using the ESP8266 WiFi module [22]–[25]. The developed system used a moisture sensor, a pH sensor, and a temperature sensor to detect soil moisture content, pH level, and temperature. With the soil's moisture level determined, irrigation can be performed; if the moisture level drops below a predetermined threshold, a signal is sent from the moisture sensor to the Arduino board, which then notifies the IoT platform. It is more effective and cheaper than previous techniques. Shun *et al*. [23] designed a monitoring system to deploy to the room exhaust ventilation system (REVS), which included 3G technology and allowed the stand-alone REVS system to be monitored remotely via the web or mobile application at low cost. It also uses a NodeMCU ESP8266, which records current parameters automatically and allows the user to interact with the wireless monitoring system. Temperature and humidity are the variables used in this study. This application can also be used to keep track of precision agriculture.

Based on the previous research about auto irrigation systems, this project implements the same main objective with the use of a similar sensor, but there is an extended form of the project where the system is equipped with an automatic water level controller. This system will alert the user if the water level in the tank falls below a certain level, as well as use the Wi-Fi module to make a connection to the Blynk apps via phone.

3. RESEARCH METHOD

The designed controller employs a closed-loop system with Arduino as the primary controller. The Arduino controller design is realized using Proteus software. It is essential to perform a simulation to check that the designed circuit works and functions properly before beginning to build the prototype. The project block diagram is depicted in Figure 1. Temperature, rain, ultrasonic, and soil moisture sensors were used as input devices in this project. A direct current (DC) motor water pump and a traffic light emitting diode (LED) were two of the output devices involved. Node microcontroller unit (NodeMCU) was used as a wifi module, connecting signals from Arduino and Blynk Apps.

The project flowchart, which shows the whole project's design operation, is shown in Figure 2. The initial step in this project is to configure the specific pin for each input and output device. Rain, soil moisture, and temperature sensors were connected to the Arduino Nano's analogue input pin, while LEDs and a DC motor relay were connected to the digital output pin.

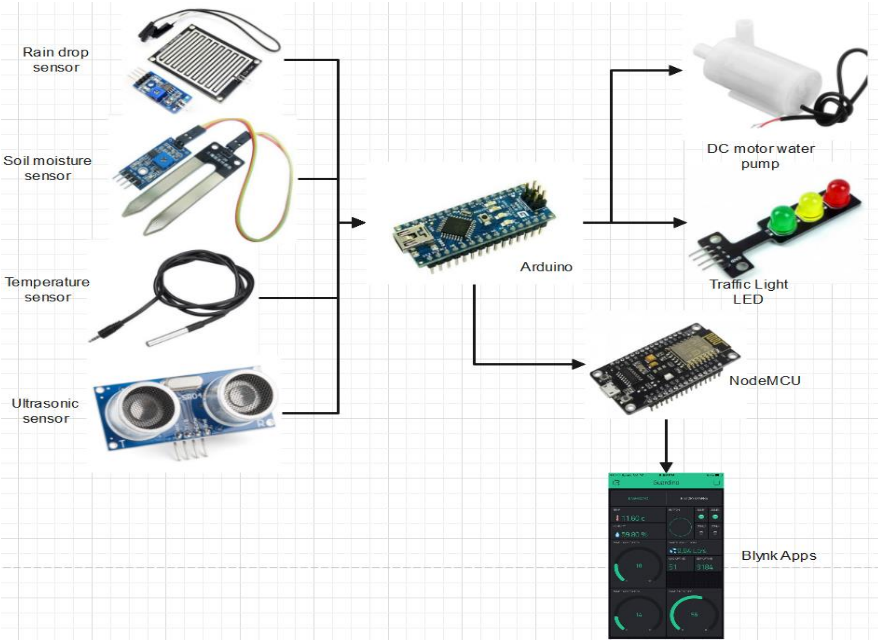

Figure 1. The architecture of project developed

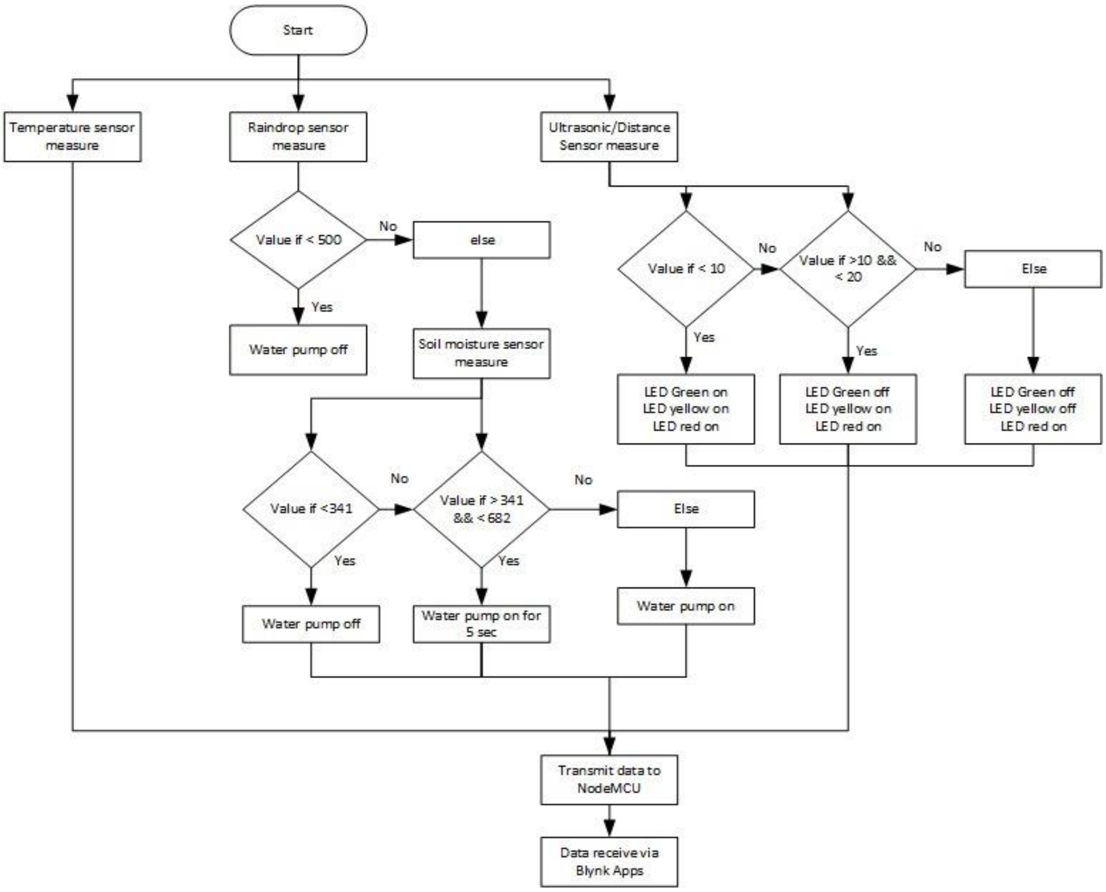

Figure 2. Process flowchart

In this project, the ambient temperature was monitored by the temperature sensor, and the raindrop water volume was determined using the rain sensor. The rain sensor and moisture sensor values are used to control the water pump. To activate the water pump, two condition values from the sensors must be met. The temperature sensor in this project was used to monitor the ambient temperature, while the rain sensor was used to measure the volume of water in a raindrop. The water pump is reacted to by the value of the rain sensor and moisture sensor. To turn on the water pump, it must meet two conditional values from the sensors. The pump will turn on if the rain sensor value is more than 500 and the soil moisture sensor value is more than 682. If the soil sensor moisture value is more than 341 but less than 682, the water pump will also turn on, but only for about 5 seconds because the soil moisture condition is 60%. The pump will then turn off if the soil moisture value is less than 341. It shows the plants get enough water.

This prototype, on the other hand, is outfitted with a water tank that will automatically notify the user of the water level status. The ultrasonic sensor measured the tank's water level. If the measured value is less than 10 cm, the water level is full, and all LEDs will turn on. If the water level value is greater than 10 cm but less than 20 cm, it means that the water level has dropped to about half of the tank's capacity, causing the green LED to turn off while the yellow and red LED remain illuminated. When the measured value exceeds 20 cm, only the red LED illuminates, indicating that the tank is nearly empty and needs to be refilled.

4. RESULTS AND DISCUSSION

This project was intended to establish a systematic irrigation system that would meet the daily needs of the plants. The Arduino and NodeMCU are powered by two batteries in this design. After turning on the battery, all sensors will read the value and send it to the output water pump and LED to start the process, and then all data from the sensor will be sent to the NodeMCU as a Wi-Fi module, and data from the NodeMCU will be sent to the Blynk, which will display all data from the sensor.

The complete prototype was tested as shown below. Figure 3 shows the smartphone display status for a plant condition and the prototype indicator status from the first prototype testing. The temperature reading displayed on the Blynk interface is 29 °C, and the rain sensor measurement is 373, indicating that the plant still has enough water, so the water pump status remains off. When the ultrasonic sensor reads 23 cm, the red LED illuminates to alert the user that the water tank is nearly empty. Finally, the soil moisture value displayed a value of 1 due to sufficient water content measured earlier by the raindrop sensor. The initial testing went as planned.

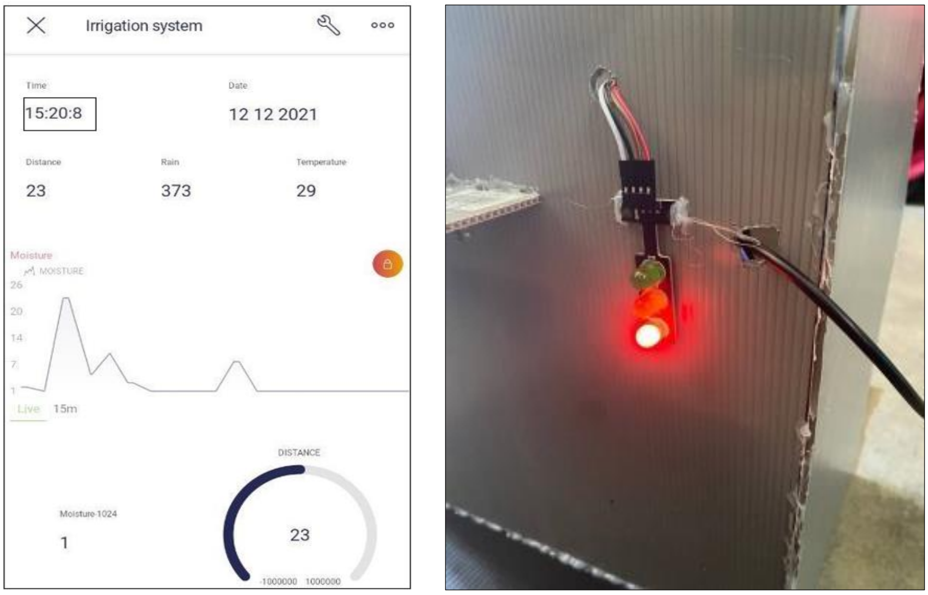

Figure 3. First prototype testing result

The second prototype testing was performed to ensure the functionality of all sensor and output devices if the plant's condition did not have enough water, as shown in Figure 4. The rain sensor reading is greater than 500, according to the Blynk interface. It indicates that the plant requires water and that the water pump should be turned on. The soil moisture reading of 648 indicates that it falls under the second condition, in which the pump only needs to turn on for about 5 seconds. These two sensor conditions must be met in order for the pump to start and irrigate the plant. The water level value of 11 cm indicates that the tank capacity is half full, and the red and yellow LEDs illuminate as designed. The second round of testing was a success.

The third testing condition as in Figure 5 same with the first testing but it is different result for water level measurement. The distance obtained was 4 cm, all LED illuminates and it indicates the water tank is full. Based on the results presented above, the prototype was fully functional within the scope of the project. The prototype works as expected, and Figure 6 shows the front and back views of the entire prototype.

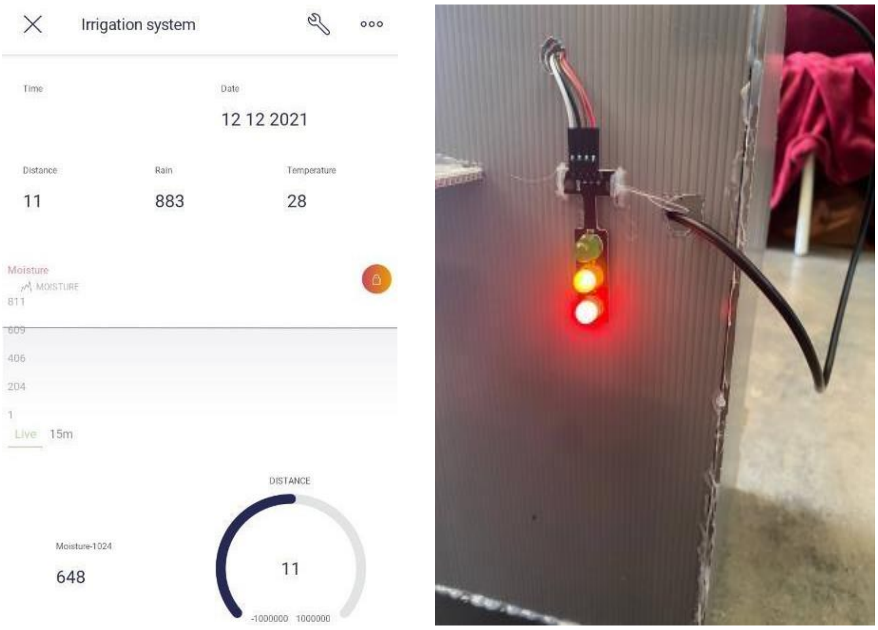

Figure 4. Second prototype testing result

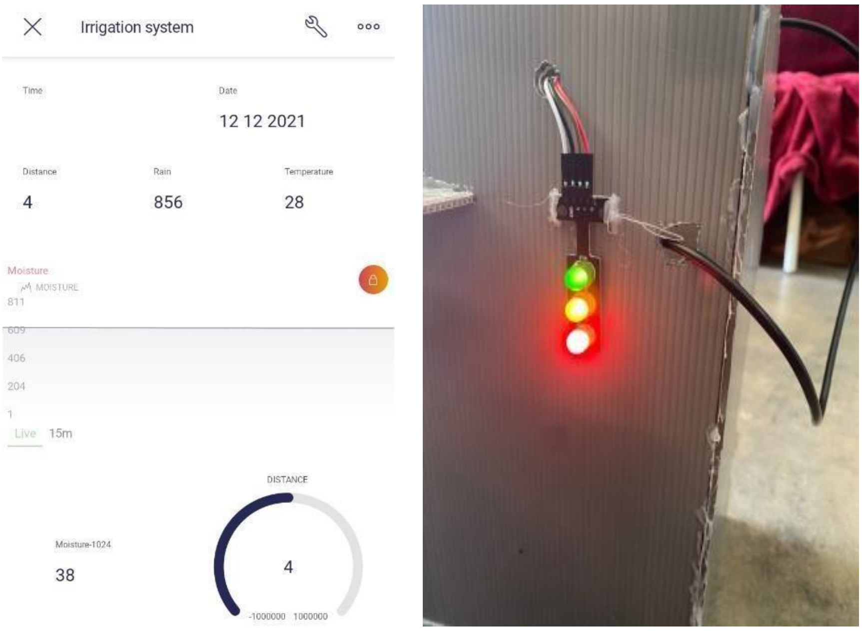

Figure 5. Third prototype testing result

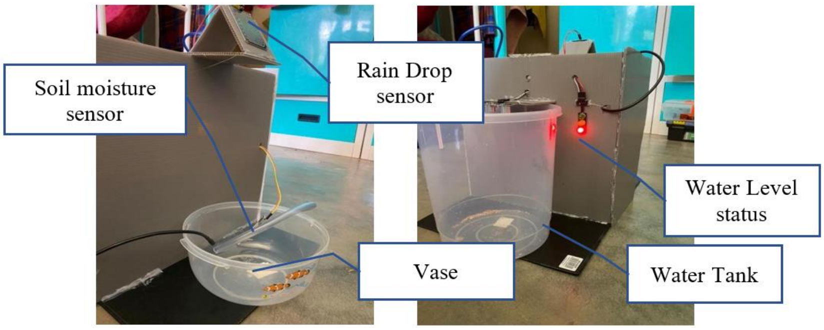

Figure 6. The final prototype

5. CONCLUSION

Precision agriculture benefits greatly from the integration of an automation system for monitoring and controlling irrigation systems. This small-scale model prototype has performed admirably in accordance with the project's objectives. If this project be then applied in a farm, it would give so much benefit to the farmer in managing their farm to monitor the condition of their crop so that the productivity can be maintain. The built smart irrigation system is cost-effective in terms of conserving water for garden produce. The system design allows for the water flow to be turned on and off based on soil moisture levels and rain sensors, making the process more user-friendly. The ultrasonic system was then used to control and monitor the water supplies. This project has shown that irrigation can benefit from IoT and automation. Thus, this system is a solution to the problems encountered in the current irrigation process. Future work would be focused more on increasing sensors on this system to fetch more data especially regarding pest control and fertilization schedule.

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