

Smart Crop Adaptability and Monitoring (SCAM)

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Abstract. The integration of the Internet of Things (IoT) has become increasingly important in the agricultural sector, especially with regards to smart irrigation and farming systems. The objective of this study is to develop a model that can automate the process of irrigating, cooling, and providing artificial lighting for growing plants. This is achieved by monitoring key plant characteristics such as light intensity, humidity, moisture, and temperature through the use of three sensors. The system comprises of a NodeMCU ESP32 board, lamp, voltage regulator, and relay that manages the motor and cooling fan. The board is programmed to activate the hardware if any of the values measured by the sensors deviate from the standard. The Blynk application informs the user about the status of the crop or plant. The sensors feed data to the NodeMCU ESP32 board, which uses if-else conditions and Blynk control to regulate the relay and manage the hardware accordingly. The main benefit of this approach is that it reduces the physical labor required for farming and ensures the growth of healthy plants by providing adequate lighting, maintaining temperature and humidity levels, and automating the watering process. This system can be easily operated even by elderly individuals, making farming more accessible. The study successfully demonstrated this approach by growing a pepper plant using automated procedures and monitoring. The implementation of IoT in agriculture not only improves the health of the plants but also contributes to the overall economic development of the nation.

Keywords: Smart Plant, IoT, ESP32

1. Introduction

Agriculture is one of the essential to provide food, and each has its challenges. Recently, with the advancement of technology, there appears to be an opportunity for development, even in agriculture. Temperature, humidity, soil moisture, and light are the essential elements for plant growth quality and productivity. Now this, toward to modern and urban farming, the role and engagement of new technologies are becoming increasingly vital. Hence there is important technology to involve with internet of Things (IoT). The IoT is a type of technology that allows multiple devices to be connected

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and data collected through system. The data is mainly collected by the sensor then utilize microcontroller to display each parameter of plants and response back such as waters the plant if there is lack of water. It is used in conjunction with IoT frameworks to process and interact with data. Users can utilize the sensors to collect data and process it to obtain information in this system. With the collected data, Modern agriculture can be achieved by combining old practices with emerging technology like IoT. This decreases the amount of manual labor required in the sector. Farmers do not have to exert lot of effort in preserving the plants. Both electricity and water are saved because of this. Farmers sometimes fail to turn off the motor, resulting in water and electricity waste. With the help of this paper, these drawbacks can be readily overcome.

This system includes automated moisture, humidity, temperature and light intensity monitoring, automatic feedback when needed and can be respond by user. Small-scale terrace gardening can also benefit from this approach. This can also be used in farmlands where access to the land is problematic on a regular basis. For a start, the project will apply the system to a smaller scope first, which is using a Chili plant.

Table 1 comparison of previous project

Title	Advantage	Disadvantage	Technology Used	Comments
SMART IRRIGATION SYSTEM [1]	Development of basic automatic irrigation system	Use resistive soil moisture sensor known for corrosion at the sensor probes.	Smart Irrigation IoT Monitoring	Show how automatic irrigation system that must have in the system
IoT Enabled Smart Farming and Irrigation System [2]	Use three sensor as automated watering objective. Use high voltage with voltage regulator to prevent current drop.	Use resistive soil moisture sensor known for corrosion at the sensor probes. Require SMPS as AC-DC converter	Smart Irrigation IoT Monitoring	This project purpose a basic system for smart irrigation with some safety feature
IoT-based Automatic Brightness and Soil	This project has light sensor and Dimmer module to	Use resistive soil moisture sensor known for corrosion at the sensor probes.	Brightness Control	This project has shown ways to control the light intensity with the light sensor.

Moisture Control System for Gerbera Smart Greenhouse [3]	control ambient and brightness of LED.	Use 12V DC pump that may lead to heat dissipation.	Soil Moisture Control	IoT used is by using Google Sheet storage
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Integration of Water with a Drip Irrigation System for Agricultural Application [4]	Detail in water control and usage with a Drip Irrigation System for Agricultural Application [4]	Use two microcontroller each for functioning the sensor and robot movement. Large area effect	Robotic Smart Irrigation IoT monitored	This project specifically controls the water usage based on the given sensor using the dripping system instead.
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IoT Based Temperature Control System of Home by using an Android Device [5]	Use NodeMCU-ESP32 as the microcontroller and embedded Wi-Fi	System objective is controlling AC	AC Appliances Voltage control via IoT Automatic Cooling System	This journal shows how to control AC hardware
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2. Materials and Methods

Smart Crop Adaptability and Monitoring utilizes automation, monitoring, and IoT concepts. The system comprises of the following components: NodeMCU ESP32 board, sensors, DC motor pump, DC cooling fan, and LED lamp.

2.1 Materials

The aim of this design is to create a model for plants that maintain desired conditions with a few essential components. The modified pot or vase includes the following items:

- NodeMCU ESP32

- DC motor pump
- DC cooling fan
- LED lamp
- DHT22 sensor
- Capacitive Soil Moisture sensor
- LDR sensor
- 3.7V Rechargeable Battery

2.2 Block Diagram

Figure 3.1: Project Block Diagram illustrates the execution of the project. The ESP32 Board is activated first, followed by the three sensors which measure humidity, temperature, soil moisture, and light intensity. The hardware is activated and reset when a threshold is reached. The DC motor pump activates when the soil moisture sensor reads below 1700 until the soil moisture meets the desired threshold. The DHT22 humidity and ambient air temperature sensors also control the DC fan. The LED lighting is regulated by the sunlight intensity. The Blynk app receives data from the NodeMCU (ESP32) board and allows the user to monitor the crop status and manually operate the devices in case of emergencies.

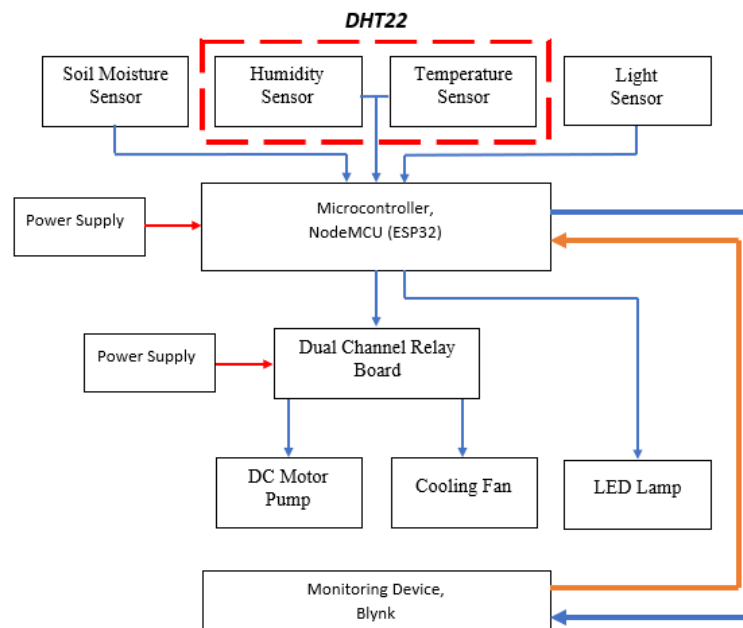


Figure 1: Block Diagram Smart Crop Adaptability and Monitoring system

2.2 Program Flowchart

A flowchart is a graphical representation that depicts the individual steps of a process in a sequential manner. It is a versatile tool that can be used to describe a wide range of processes, such as manufacturing systems, organizational or service processes, or project plans. Flowcharts are widely used across various fields for analysis, design, documentation, or management of a process or program.

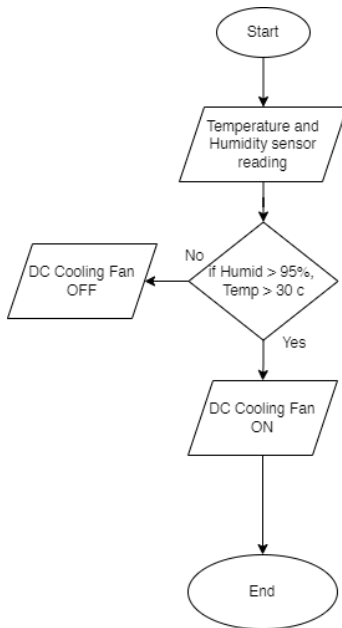


Figure 2: DHT22 sensor flowchart

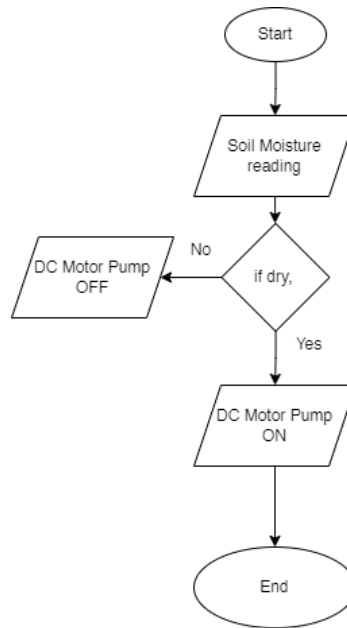


Figure 3: Soil Moisture sensor flowchart

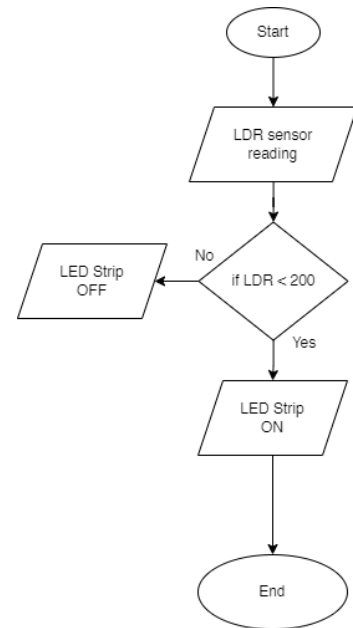


Figure 4: LDR sensor flowchart

Figure 2 shows the activation of a DC cooling fan by the DHT22 sensor. The DC cooling fan is activated based on the humidity and temperature readings from the DHT22 sensor. The fan starts when the temperature reaches 28 degrees Celsius and turns off at normal temperatures. It also starts when the humidity exceeds 95% and turns off below that. The Blynk app receives data from the sensor and switches the DC cooling fan accordingly.

Figure 3 shows the activation of the DC motor pump by the Soil Moisture sensor. The DC motor pump starts when the soil moisture readings from the capacitive soil moisture sensor exceed a threshold. If the moisture drops below 1700 units, the DC motor pump runs. The Blynk app displays the percentage readings from the sensor and allows the user to manually turn on the DC motor pump.

Figure 4 shows the LED lamp that is controlled by the light sensor. The Light Dependent Resistance (LDR) converts the ambient light intensity into a resistance value and turns on the LED lighting when the resistance exceeds a threshold. When the resistance exceeds 1700 units, the LED bulb turns on. The Blynk app displays the percentage readings from the sensor and allows manual activation of the LED lamp.

3. Results and Discussion

This part will explain finding and results from this project. This section will go over all of the data that was collected, including how the problem was solved and the outcome.

3.1 Results



Figure 5: Actual Product



Figure 6: DC Motor Pump Triggered

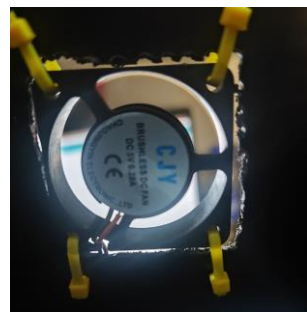


Figure 7: DC Cooling Fan Triggered



Figure 8: LED lamp Triggered

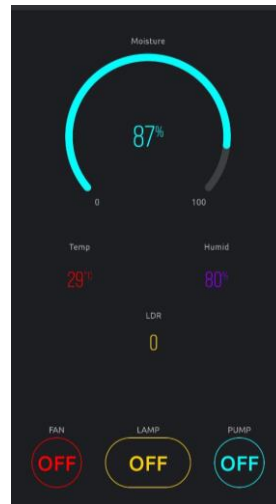


Figure 9: Bynk Application Interface

3.2 Discussions

Due to several unexpected issues, the programming of the SCAM had to be adjusted and reprogrammed multiple times until it was functioning properly. The testing of the SCAM resulted in a significantly different outcome than expected, which initially caused confusion and concern. However, upon further evaluation, it was determined that the product actually performed better than predicted. The difficulties encountered were caused by programming and hardware conditions, such as the DHT22 overheating in its own circuit, the LDR readings being affected by sunlight and circuit load, and the soil moisture sensor not detecting accurately due to unbalanced soil moisture. The hardware also suffered from lag due to low internet connection, voltage, and current decreases.

To ensure proper operation, the SCAM underwent extensive testing. The final examination went smoothly as planned. This issue impacted the Blynk interface, which has some bugs. Programmable issues are common in products that run programs automatically, and testing is necessary to identify any faulty components. Each part must be thoroughly checked prior to use. After testing, data must be collected for the thesis.

4. Conclusion

In conclusion, this project aims to improve agriculture by utilizing IoT and automation technology to build containers that help plants grow. The objective is to reduce human manpower and improve safety through remote monitoring and control of the chili plant's watering, chilling, and artificial light systems. The system operates using Wi-Fi or hotspot and is capable of adapting to unforeseen conditions to prevent fungal growth and stunt in the plant's growth. The study was successful in assessing the potential of smart agriculture and will help the nation in its efforts to go green. By automating the daily upkeep of plants, it frees up people's time and resources, making agriculture more efficient and sustainable.

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