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Development of an Automated Indoor Plant with IoT System

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Abstract: Gardening is the practice of cultivating and tending to plants, typically in a designated area such as a backyard, balcony, or community garden. It is a popular hobby enjoyed by many people around the world and can range from small-scale container gardening to large-scale landscapes. Sometimes, people tend to forget watering their plant, and commonly busy doing their work. Thus, this project is built dedicated to monitor real time condition of humidity, temperature, soil moisture, and light while that using IoT based technology that can control the system using Blynk application to verify the system for an efficient and healthy plant production. An example of rubber plant, the best temperature is between 15 and 27 degrees Celsius which are most ideal temperature of most homes and apartments. The humidity level will be around 45 to 50 level to have the best conditions for the plant while for the soil moisture must consistently moist but never soggy. While the light intensity is used to give the plant most of the time the light needed when at night. As a result, the project successfully able to do the condition needed from objective given that allow to automatically run the system that also can be interrupt that can be controlled in Blynk application. Although this project is set at smaller scale, which is indoor, it also can be used outside which those have more space for gardening with the use of automated system that can help to watering plant automatically while also be able to see the parameters of the designed purposed on their smartphone.

Keywords: IoT, Automation, Monitoring, Control, Plant

1. Introduction

Technology is constantly evolving to make human work easier and more efficient. The current era, known as the Industrial Revolution 4.0, emphasizes the Internet of Things (IoT) as a key component of industrial development. IoT enables remote control and monitoring through the internet [1]. This technology has been developed to facilitate daily tasks and will continue to be used extensively in the future. Many people spend long hours working away from home and seek activities to relax and refresh

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their minds afterward, such as raising animals, exercising, or farming [2]. However, these activities require regular attention even when people are not at home. Therefore, a remote control and monitoring technology like IoT is necessary [3].

Urban farming, particularly in home settings, is a popular hobby nowadays. Some people grow plants directly in pots, while others utilize greenhouses. IoT devices can be installed in these greenhouses to control and monitor various factors that affect plant growth, such as light intensity, air humidity, and soil moisture. For instance, if the soil moisture falls below the desired level, IoT devices can automatically water using sensors and automation tools. This research builds upon previous work involving machine learning models embedded in a system called greenhouse. The goal is to assist individuals who may not have the ability to monitor their plants constantly [4].

The IoT connects objects to the internet, allowing real-time monitoring and remote control. It originated from the invention of the internet in 1989. In 1990, a researcher named John Romkey created a toaster that could be controlled via the internet, like the IoT concept. Sensor technology, popularized by Paul Saffo in 1997, plays a significant role in IoT applications. Today, IoT is experiencing rapid growth, and many companies are investing heavily in IoT projects [5].

Rubber plants live in temperatures between 15°C-27°C and prefer slightly moist, well-draining soil. They do well in bright, indirect light but should be protected from direct sunlight. Moderate to high humidity levels are beneficial, and measures like using a humidifier or misting the leaves can help. Maintaining these conditions will support the health and vitality of rubber plants, ensuring their glossy, dark green leaves remain vibrant and beautiful [6].

This research aims to design and develop a system that operates in the automatic system that can be monitored and controlled through smartphone. It intended to be able to control actuator such as fan, LED, and water pump if the sensor is damaged from various factor. The automated system is built to flow water to the vase, turn on the light when at night and turn on the fan when the temperature become too hot for a better environment for the plant. Various relevant information is used to obtain the result for the automated system to be created. Table 1 summaries the survey result that have been obtained from previous research.

Table 1: Summary results from previous research

No.	Title	Features
1	Smart Green House for Controlling & Monitoring Temperature, Soil & Humidity Using IoT [7]	• Monitor parameter of sensor through application • Have a fertilizer pump that can distribute fertilizer toward plant
2	Green House System Design Using IoT [8]	• Have rain drop sensor to detect rain that can close and open roof of the greenhouse. • Use LCD to display parameter at the greenhouse
3	A Hybrid Green House Management by Power Intelligent Device / Wireless Networking (Polyhouse Automation System) [9]	• ZigBee microcontroller as the brain of IoT module for the system • Polyhouse system for a better display that can be seen at a small scale.
4	Green House Based on IoT and AI For Societal Benefit [10]	• Have a weather forecasting that connected to IoT module to display weather forecast.

		• A raindrop sensor are uses to detect rain and able to move roof with the use of servo motor when rain detected. • A solar panel is used to save electricity.
5	Smart Greenhouse Monitoring System using Wireless Sensor Networks [11]	• Can view the graph of temperature and humidity for collecting data. • Using AC pump that can cover large area of greenhouse for watering plant.

2. Materials and Methods

2.1 System flowchart

This part will show how the flow for this project will become as the power supply has been turn on. It can be seen on the Figure 1. After the power has been turn on, ESP32 module will connect to Wi-Fi to transfer the data of each sensor on the Blynk application. When the program has started, all the sensor is started to obtain the value of each of the sensor that have been programmed. When temperature values go higher than 35 degrees Celsius, fan will turn on blow out hot air around the box that use to cool down the temperature value. Although the ideal for the rubber plant is around 18 to 30 degrees, it also can go higher than 30 degrees as it can sustain to hot temperature but not lower than 18 degrees as it can make the plant go wither. For the value of soil moisture is set below 25, the water pump will give water to the plant as rubber plant must have a moist soil to live. For LDR value, when it goes above 30, which the condition around will become darker, the LED will turn on to give light to the plant. Then, all the sensor parameters will be shown on Blynk application that can be seen on user smartphone.

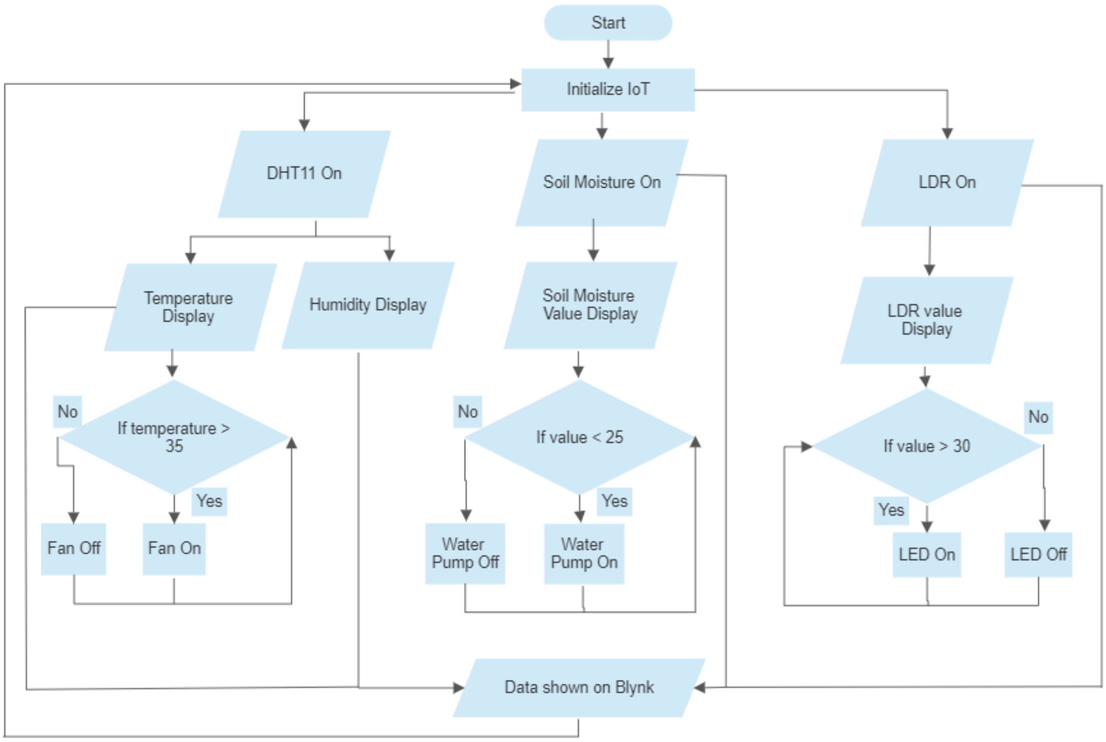

Figure 1: System flowchart

2.2 System block diagram

The block diagram in Figure 3.2 shows the mechanism of the project will work. There are three input which is DHT11, soil moisture, and LDR will be connected to ESP32 and three output which is fan, led, and water pump that have its own relay that act as a switch to turn it on or off. The condition of each output will be as shown on figure 3.1 that will be displayed the parameter of the three sensors on the Blynk application. ESP 32 will act as the receiver data of each input and output to transmit data to the Blynk application.

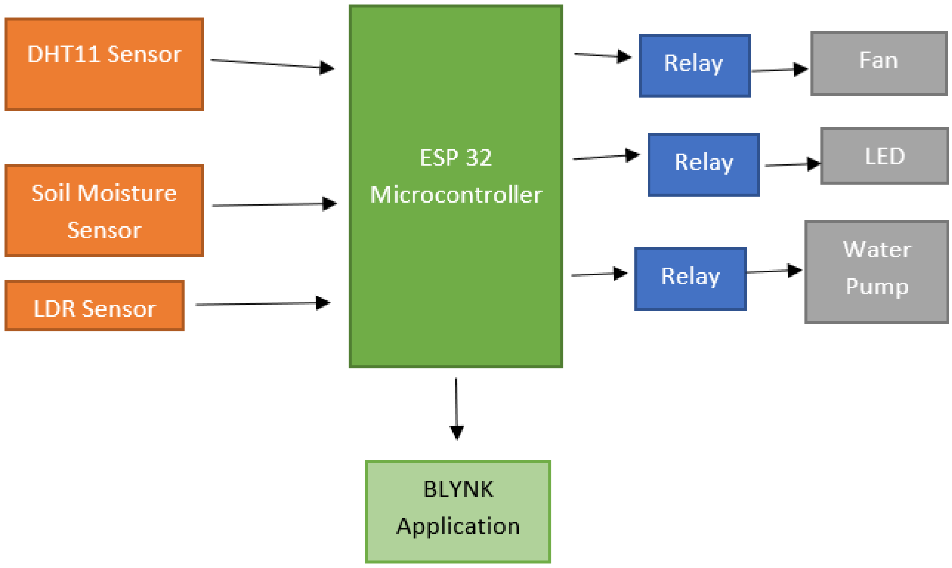

Figure 2: System block diagram

2.3 Circuit Diagram

Proteus 8 professional is used as the illustration of the circuit diagram that is shown in Figure 3, according to which the connection of the working model is connected.

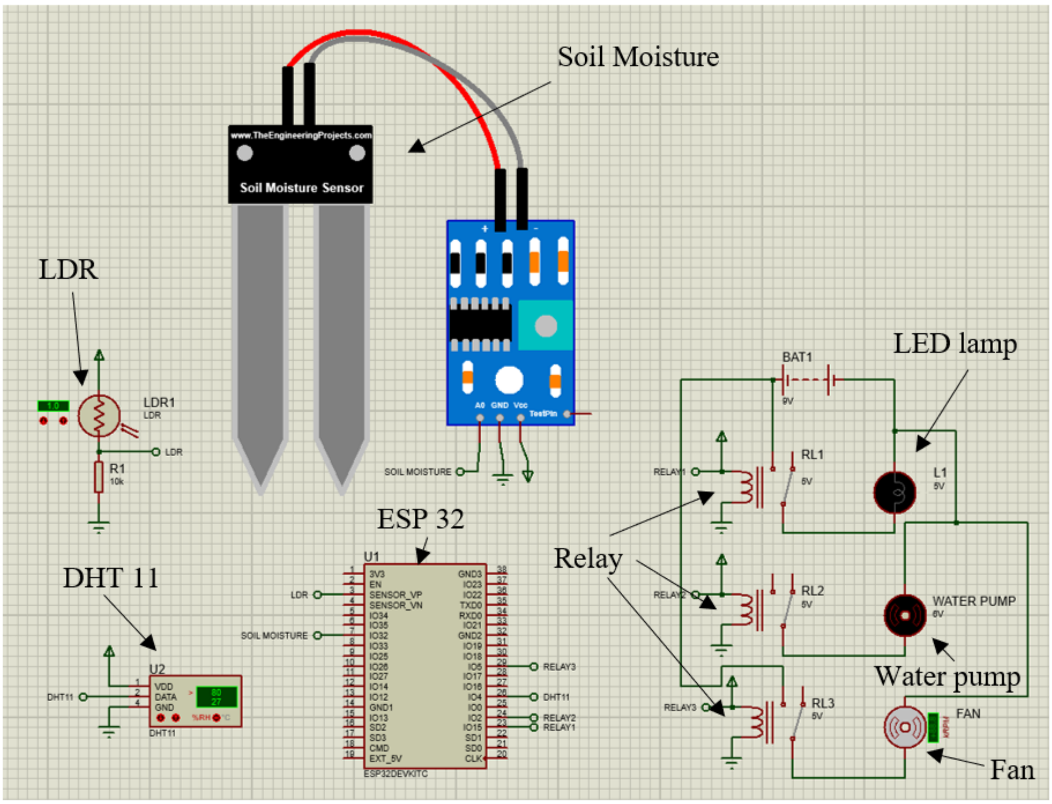

Figure 3: Circuit diagram

2.4 Prototype Design

This part show about how the design will be of the prototype for the system going to be. The design from Figure 4 is sketch using Sketchup software that is easier to see the design of it.

Figure 4: Layout design

3. Results and Discussion

This section presents the evaluation of the results and the discussion of this project. The result of the indoor plant system will be shown here about the synchronize between sensor, microcontroller, actuator, and display on Blynk.

3.1 Prototype Setup

Each of the component of the microcontroller, sensor, actuator, relay, and battery will be connected using breadboard with jumper wire. Figure 5 show the circuit that have been assemble with each of the component needed. Each actuator has its own relay that connected to battery to supply the power for the fan, led and water pump. The sensor will be connected to ESP 32 pin as shown on the circuit diagram on figure 3. Figure 6 show the prototype that have been built to display the plant that connected to the automated system.

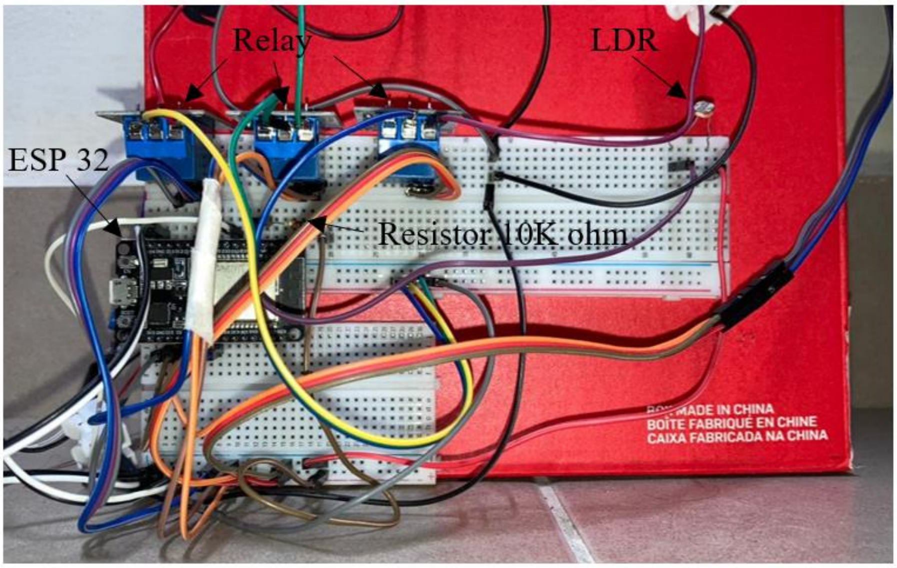

Figure 5: Circuit connection

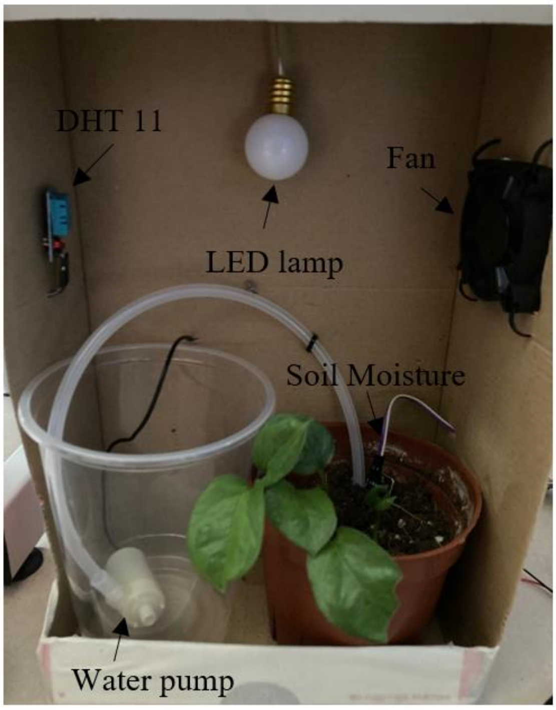

Figure 6: Prototype front layout

3.2 Blynk, sensor and actuator

Figure 7 shows the results displayed in the smartphone screen which shows the real temperature value in degree Celsius, humidity, LDR, light intensity value, soil moisture value, rain sensor value. The switch shows the fan, LED and water pump is off. All the sensors' connections are done by sensor basic knowledge. All the values are noted.

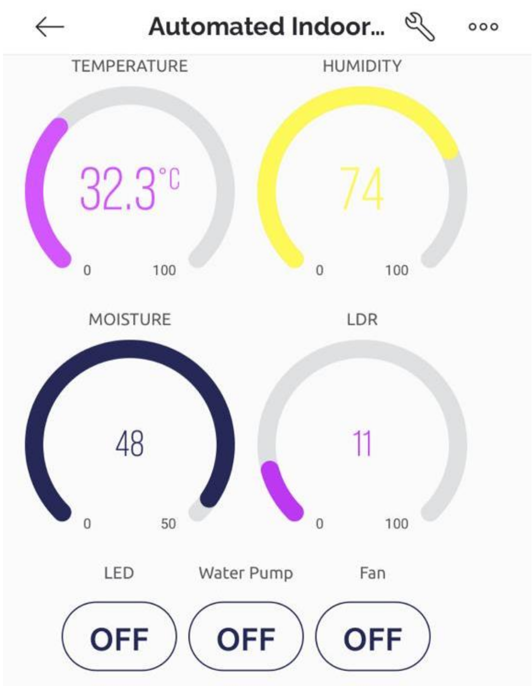

Figure 7: Result in smartphone screen

LDR and LED is synchronized to each other, when the LDR value is over 30%, the LED will turn on that act as the light for the plant when surrounding plant area is in dark. As the LDR value increasing, it means that the light density is low. When the LDR value is decreasing, the light density is high. Figure 8 show LED turn on when the LDR value is over 30%.

Figure 8: LED turn on

DHT11 have two features which can show temperature and humidity. In this project the value of temperature is taken to display the surrounding plant area temperature in the best condition, which when the temperature value is over 35 degrees Celsius, the Fan will turn on to blow out the hot air surrounding the plant. Figure 9 shows the fan is spinning when the switch on Blynk is pushed.

Figure 9: Fan turn on

As for the soil moisture, the value of the moisture is taken to make sure the soil moisture on the vase is moist enough for the plant. Figure 10 shows the water flow through the vase. When the switch on Blynk is pushed, the water will flow through the tube. If the moisture level drop below 25 %, water pump will turn on until it goes over 25 %.

Figure 10: Water flow through the vase

Table 2 shows the parameter on the Blynk application that use to turn on the fan, LED and water pump at certain value has been met.

Table 2: Result of parameter value

Item	Parameter Name	Value	Output
1	Temperature	35-degree Celsius and above	Fan On
2	Light	30% and above	LED On
3	Soil Moisture	25% and below	Water Pump On

4. Conclusion

This project aims to implement an IoT-based technology using the Blynk application for monitoring and controlling sensors and switches to regulate output actuators. The prototype developed demonstrates an automated system for efficient and healthy indoor plant growth. Despite challenges such as programming coding, sensor calibration, and relay configuration, the project successfully achieved its objectives. However, its current scope is limited to supporting the growth of indoor plants. Future work could involve upgrading the system to a programmable logic controller (PLC) that can accommodate multiple plants, thereby improving outcomes for greenhouses and boosting crop yield to increase farmers' income.

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