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Smart Plant System

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Abstract: Lately, the interest in urban gardening among people increased but they do not have much time to care for their plants due to busy schedule and daily responsibilities. This project was created to provide an easier way for the owners to water their plants, which is by clicking a button in Blynk application based on the signals sent by sensors to their smartphones via Blynk. The components used to build this smart plant system is a tomato plant, temperature sensor and moisture sensor, in this case will sense the specific parameter, jumper wires, relay, solenoid water pump and NodeMCU which send the signals from sensors to Blynk application via WiFi. Some practical and theoretical studies on tomato plants' parameters, steps to implements sensors to the system, ways to do circuit connection have been done to get more information and knowledge on this system. The project has been done and proved that this smart plant system is suitable and recommended to be used in daily life as it will ease people's job to take good care of their plants in a smarter way even though they are busy.

Keywords: **IoT, smart plant system, tomato plant, Blynk, NodeMCU**

1. Introduction

Nowadays people are more worried about their health and becoming cautious about the food they consume, the environment and their contribution towards the matter. Thus, the interest in urban gardening among people increased as per statistics [1] and as illustrated in **Figure 1** [2]. Growing their vegetables and plants at home provides a healthy meal without worrying about too many pesticides. However, most urbanites are busy with their daily routine and responsibilities. They do not have much time to take care of their plants and vegetables at home.

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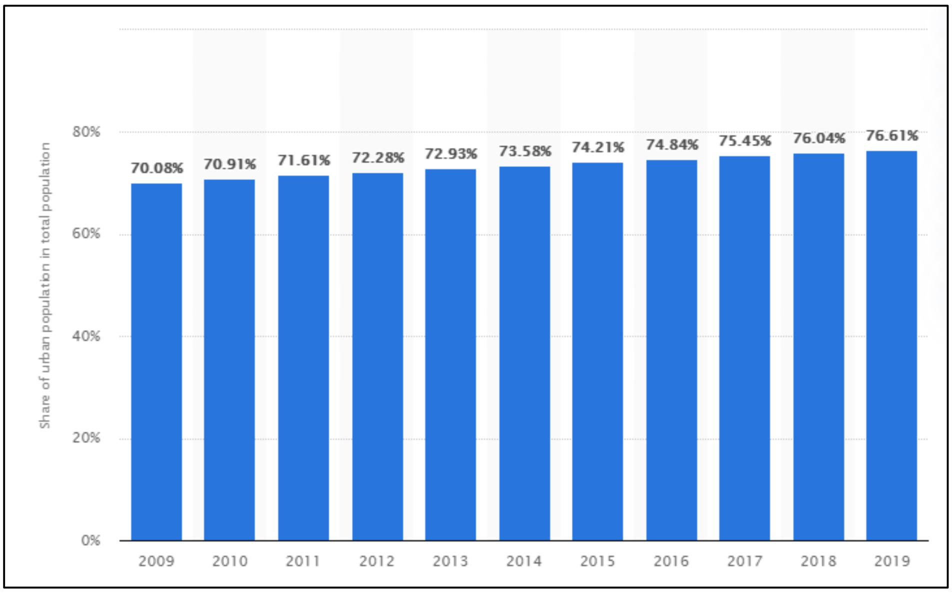


Figure 1: shows the share of urban population in total population in Malaysia [2]

Since humans cannot predict any plants' condition such as the soil moisture level and temperature around the plant by bare eyes, smart plant system was created to monitor the condition of plants by building circuits using electronic devices such as particular sensors, NodeMCU and so on. From using sensors, accurate reading on specific parameters can be obtained. Moreover, this system will notify the owners about their plants and reminding them to water the plants based on the parameters. This system also will lead to different smart ways to provide the plants' needs such as watering automatically or by pressing push buttons on the phone.

As tomato plant is one of the most planted plant by people in Malaysia [3], this research was focused on developing a smart plant system that will monitor the condition of a tomato plant. Specifications such as temperature level around the plant and the soil moisture level are focused in this system, as both of the parameters are considered as the important parameters for a general plant [4],[5]. Specifically, a tomato plant will be healthy when the temperature is between 23ºC - 33ºC and soil moisture level is between 70% - 80% [6].

Since the system is connected to the owner's phone by WiFi, the signals from the temperature sensor and soil moisture sensor will be sent to Blynk application in the phone via NodeMCU WiFi. The application gives notifications on the phone based on the plant's needs. For example, when the soil moisture sensor detects a low moisture level reading, it will give out a "water your plant" notification in Blynk. So that, it is easier for the owners to monitor and water their plants just by clicking a button in Blynk to energize the solenoid valve and allow water flow to the plant.

2. Materials and Methods

2.1 Concept of System

The proposed system incorporates the physical configuration of its electrical components with the Blynk application on the user's mobile phone and how the data is transferred between the system and the application. The implementation of this Smart Plant system mainly concentrates on the main units such as power supply, sensing unit, control unit, and output unit. The concept of Internet-of-Thing is applied in this project. The device uses two sensors that continuously send data to the microcontroller which are then transmitted wirelessly to a mobile application. This prototype's setup includes both hardware and software, as well as a communication medium in the form of a mobile application. The physical configuration of the system is depicted in **Figure 2**.

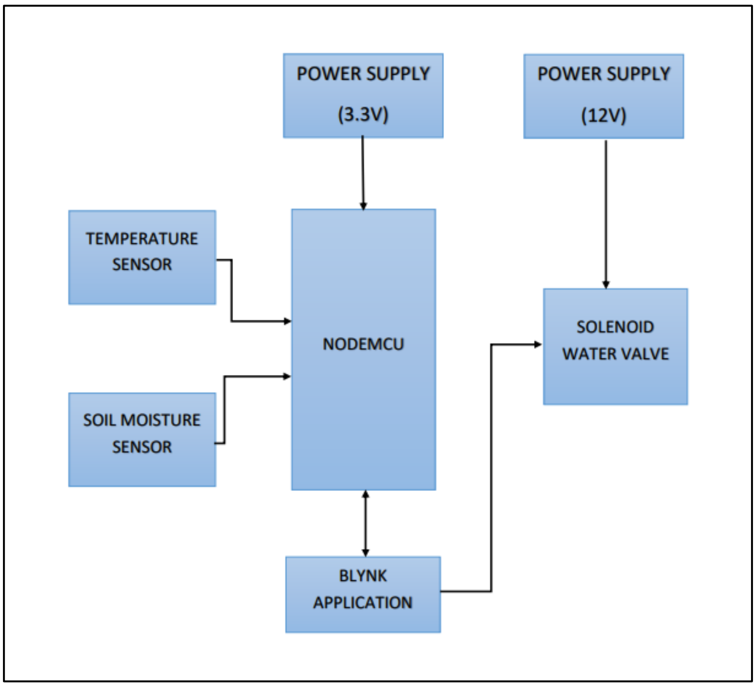


Figure 2: Block Diagram of Smart Plant System

NodeMCU is used as the controller to receive data from the temperature and soil moisture sensor. The data is then transmitted using WiFi to Blynk application on the smartphone. A virtual button in Blynk us used to control the output unit which is a solenoid valve.

A temperature sensor is used to monitor surrounding air temperature and humidity. The soil moisture sensor is connected to the NodeMCU for analog input, which aids in tracking the moisture level of the soil and comparing it to the threshold value of the soil moisture level before the final data is sent to users via the Blynk application. Initially, the soil moisture sensor injected into the soil send data to the NodeMCU microcontroller, which analyses the data before sending a signal to the solenoid valve and turning on the water pump based on the threshold values that are considered, similarly, the temperature sensor senses the levels and display them in the Blynk application. Throughout the process, the NodeMCU microcontroller operated in the range of 3.3V, while the solenoid valve operated in the range of 12V. The relay module used in this system has a 12V trigger voltage in which it is connected to the 12V DC power supply.

2.2 System Flowchart

The overall operation of the proposed system is depicted in **Figure 3**. Essentially, as the power supply of the system is always ON, this system will monitor the temperature of the surrounding air and displays the sensing value in the Blynk application. At the same time, it will also monitor and detects the moisture level of the soil from time to time and then compares it to the referred moisture. If the moisture level of the soil is less than 70% (716.8 according to the reading display in Blynk) the signal is sent to the NodeMCU, and then a notification will be sent to the Blynk application asking the user to water the plant. If only the user responds to the notification by pressing the pushbutton ON, the water pump will ON and start to water the plant.

When the moisture level is more than 70% (716.8 according to the reading display in Blynk), the sensing value will always be displayed in the Blynk application. No notification will be sent to the user. This process is carried out semi-automatically because it still needs human intervention to respond to the notification to water the plant and to stop watering. The proposed method periodically checks the temperature of the surrounding air and the moisture content of the soil.

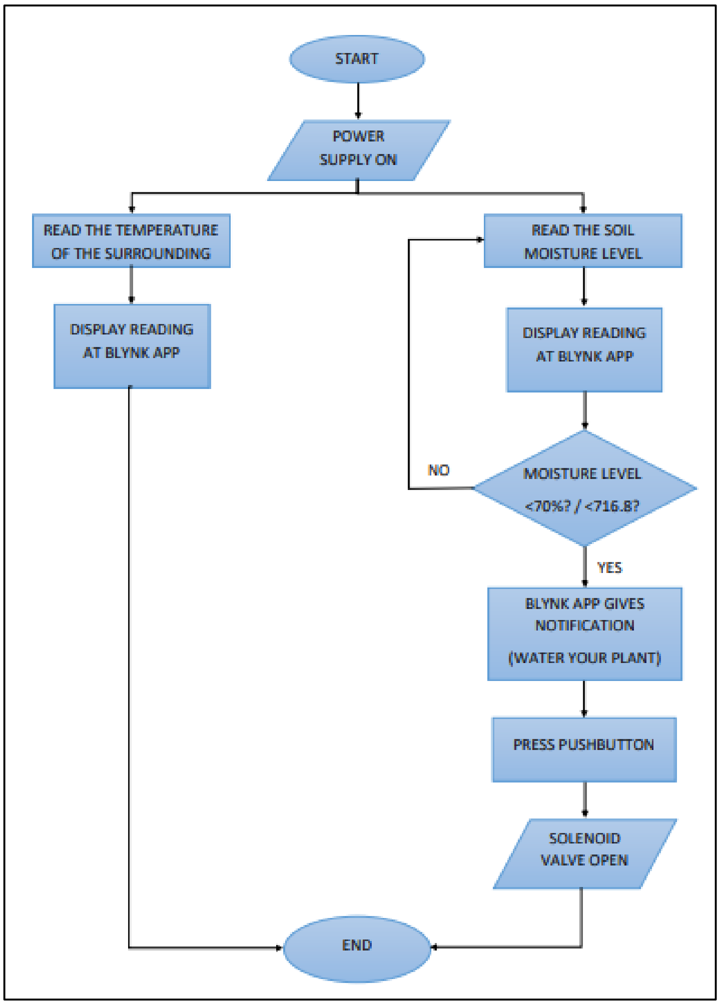


Figure 3: Operational Flow of Smart Plant System

2.3 Circuit Simulation

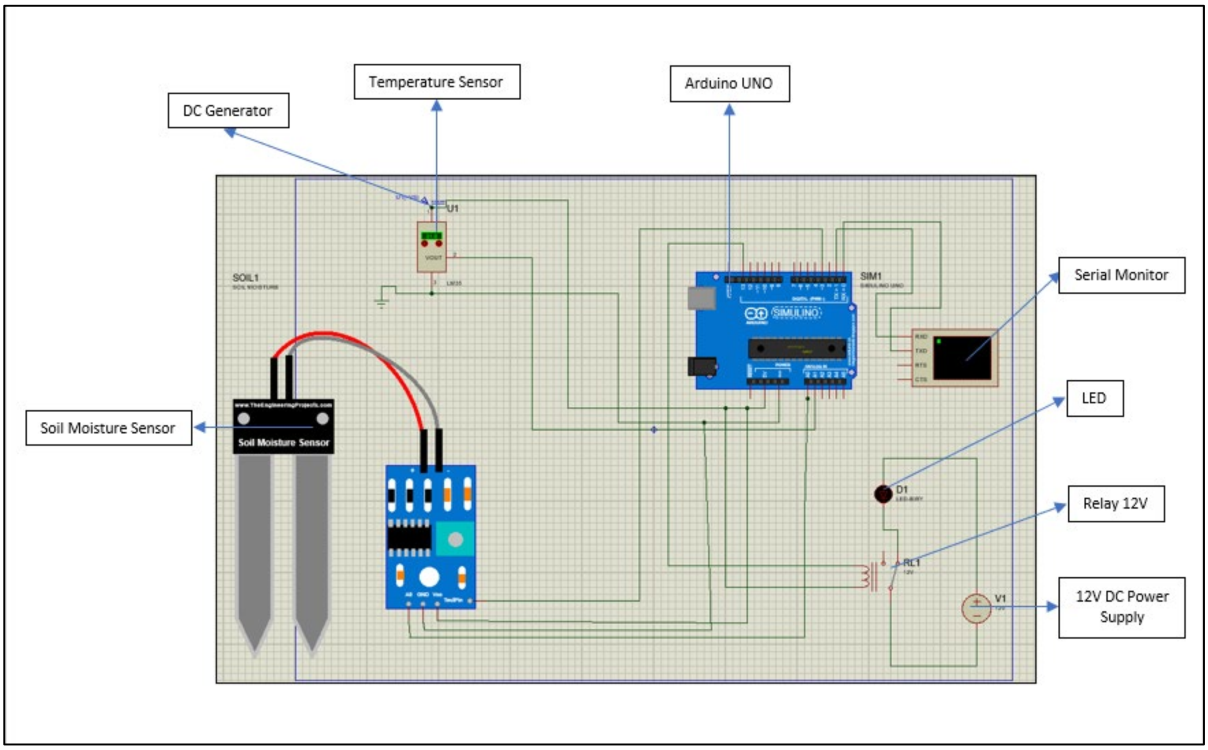


Figure 4: Electrical Circuit Schematic Diagram

Figure 4 shown the electrical circuit of Smart Plant system for simulation using the Proteus 8 Professional software. Supposed in this system, the microcontroller used is the NodeMCU ESP8266. But for the simulation, Arduino UNO is used as the microcontroller instead of the NodeMCU because the library for simulation of component NodeMCU in Proteus did not exist. As for the solenoid valve, LED is used to replace the component because also the library for solenoid valve did not exist. The main reason to perform this simulation in the beginning is to make sure that the sensors will display its values through serial monitor and the LED will turn ON or OFF based on simulation that will be performed. Hence through this process, if the sensors not displaying the reading or LED not turning ON and OFF the during the simulation, those errors can be fixed directly at that time so that it did not happen on the real prototype.

As the simulation start running, the serial monitor will display the temperature value and the soil moisture level value that is collected from the temperature sensor and soil moisture sensor on the virtual terminal. The reading of the temperature displayed on the virtual terminal are always in line with the temperature value that is sensed by the temperature sensor. The moment the LED is turned ON, it means that the soil moisture sensor is below than 70% (716.8 according to the reading display in Blynk) which results the relay to energize. When it is fully energized, it will cause the solenoid valve to open and allows water to flow to water the plants until the soil moisture level of the soil reaches the maximum referred value. For a 12V power supply, its connection is connected to the whole circuit.

2.4 Development of Prototype

2.4.1 Software

I. Proteus 8 Professionals
This software is used to build the schematic circuit diagram of the whole system before the actual prototype is built.

II. Arduino IDE
All the coding regarding the programming of the Smart Plant system is built in the Arduino IDE before it is connected to the schematic circuit diagram on Proteus software for simulation and the real prototype of the system.

III. Blynk app
The application is used as a user interface for the IoT function. This software can be installed on smartphone

2.4.2 Hardware

Table 1 lists down all the required component to develop the prototype as shown in **Figure 5** and **Figure 6**.

Table 1: List of hardware components

No.	Component
1	NodeMCU ESP8266
2	Temperature Sensor DHT11
3	Soil Moisture Sensor YL-69
4	Solenoid Water Valve
5	DC Relay Module 12V
6	12V Power Supply

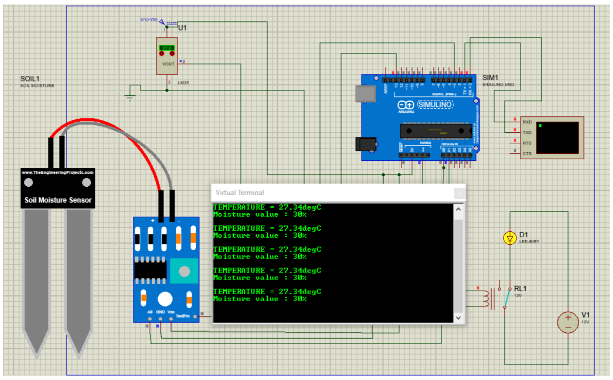
2.4.3 Prototype

Figure 5: Full prototype (Top View)

Figure 6: Full prototype (Frontal View)

Figure 5 and **Figure 6** shows the full prototype for this project. The system uses gravity to flow the water to the plant via a solenoid water valve that opens and close according to the program.

3.0 Result and Discussion



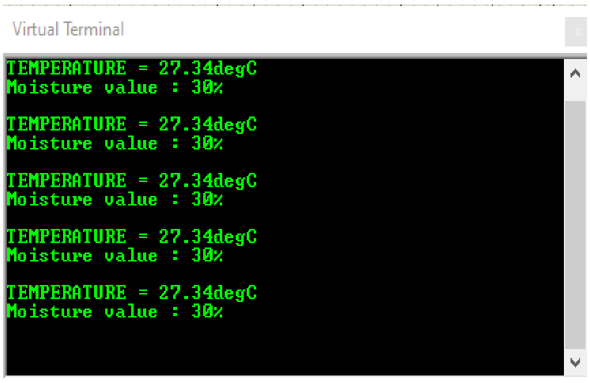


Figure 7: LED turned ON

Figure 8: Serial Monitor reading

Figure 7 shows that the LED is turned ON when the simulation is running after the coding is uploaded into the Arduino UNO board. The moisture level is set manually to be at 30% in the coding, which is below than the reference moisture level which is <70% (716.8 according to the reading display in Blynk). In the **Figure 7**, when the moisture level is at 30%, the LED is turned ON which means that the uploaded coding is correct.

It can be seen at **Figure 8**, the virtual terminal displayed moisture level value 30% and the temperature value is at 27.34 degree Celsius. The LED will continue to turn ON until when the value is set at greater than 70% (716.8 according to the reading display in Blynk), then it will be turned OFF. Based on the results shown, the simulation can be said to be successful because there are no errors occur during the simulation and the output shown is based on what has been declared in the coding. Therefore, from this simulation, the same method and coding can be applied into the real prototype to get the real output of this Smart Plant system.

3.1 Result of Prototype

Figure 9 is a complete circuit that display connection of components between Monitoring System and Watering System.

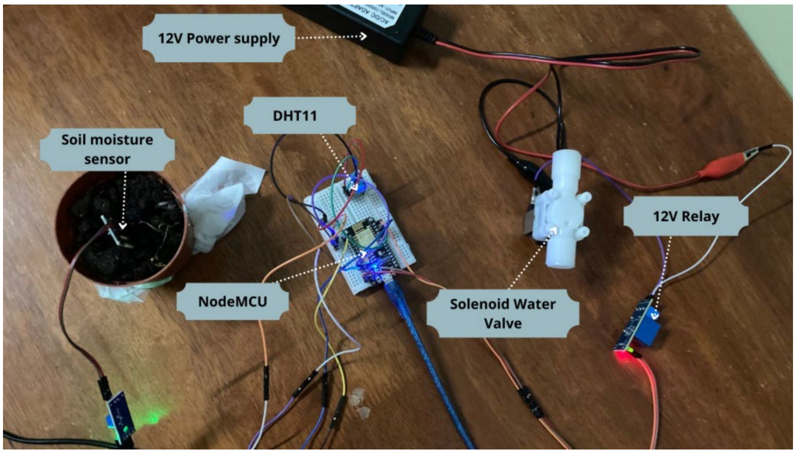


Figure 9: Monitoring System and Watering System

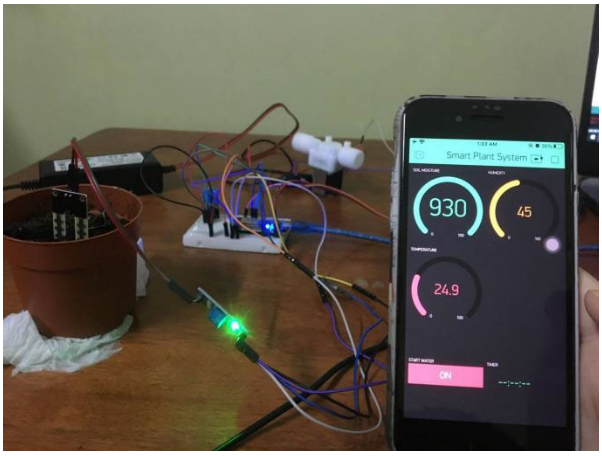


Figure 10: Circuit is connected to Blynk

Figure 11: The gauges display on Blynk

Figure 10 and **Figure 11** shows the monitoring system through the Blynk App. The data transmission from Arduino IDE to Blynk is successful, proving that the system is enabled to establish a connection to Blynk by using WiFi.

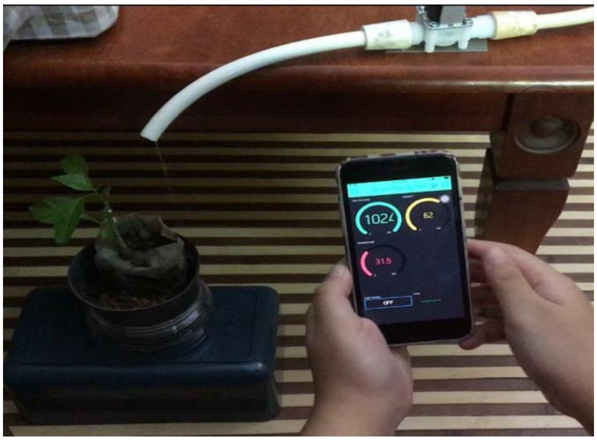


Figure 12: Solenoid valve is activated

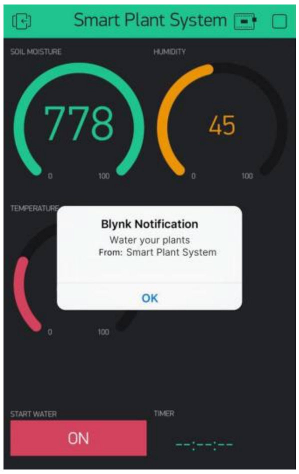


Figure 13: Blynk Notification

Figure 12 show the complete implementation of monitoring and watering system. By pressing the push button, relay will be energized and 12V power supply will be connected to the solenoid water valve. **Figure 13** display the Blynk Notification after data is received from NodeMCU.

3. Discussion

From **Table 2**, an observation is carried out in order to understand the correlation between parameters that prove how they are dependent variables. Three different time have been chosen to carry out the observation. Information from this observation help to understand the amount of water consumed by tomato plant daily.

Table 2: Reading of Parameters

Time	Parameter Reading		
	Temperature of surrounding©	Soil Moisture	Humidity of Air
9.00 a.m	25.2	785	46.2
2.00 p.m	30.0	544	37.2
9.00 p.m	24.8	679	45.0

The result of monitoring the parameters of plant indicate the amount of water supplied to the tomato plant. As the temperature of surrounding increased, it will reduce the soil moisture of the plant as more water within the soil have been evaporated to the surrounding. Besides, the low humidity of air due to the high surrounding temperature caused the soil to easily dry out. With this, water pump will start and the soil moisture of the plant can be restored. This implementation of this system is far more benefiting for the plant rather than setting up a timer for watering as it may cause over-watering [7], leading to stunted growth of plant.

Table 3: Average time for water to reach plant

Day	Time push button is pressed	Soil moisture	Time taken (minute)	Average time taken (minute)
Day 1	12.08 p.m	448	20.20	
Day 2	2.15 p.m	550	15.25	17.5
Day 3	3.45 p.m	524	17.15	

Table 3 shows the average time taken for the plant soil to regain its stable soil moisture range is 17.5 minutes. From this observation, it allows users to be more alert before the push button on Blynk is pressed OFF. Users are advised to set an individual timer to avoid from delaying the time to stop supplying water to the soil. Among the time of observation being conducted, it is decided that the most suitable time for users to water their plant is within 2.00 p.m to 4 p.m. Users can also set a timer within that range of time on the Blynk application. The solenoid valve is not turned on automatically as user needs to press the push button to activate it.

4.0 Conclusion

The project has been implemented successfully where; the system was able to sense the parameters such as temperature at the surrounding of the plants and the soil moisture level. The signals were then transferred to Blynk and able to give notification to water the plant when the soil moisture level is low, as explained in the results part. The system was then able to water the plant when the owner presses the button in Blynk.

In conclusion, this smart plan system will definitely help people all over the world to care for their plants and vegetables. This system is focused on those people who are being very busy in their everyday lives where they tend to forget or left their plants out of care. Hence, it will ease their job to water and monitor some parameters of the plant such as the temperature around the plant and the moisture level of the soil.

For the future project on smart plant system, it is recommended to carry out more studies on its hardware to make the system more effective for public use. For example, automatic watering system when the plants needed water, without the need of pressing the button in Blynk application to on the water pump. Other than that, it is highly recommended for the reference data of parameters will be displayed on the Blynk layout, as it will help users to be aware of the condition of their plant. In a nutshell, this system is suitable for real-life applications, yet some improvement can be done to make this system more beneficial.

Acknowledgment

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