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Development of Smart Weather Reporting System Based on Blynk Application for Agriculture

Siti NurFatin Muharam[1], Azlina Bahari[1]*, Mohd Hakimi Zohari[1]

[1]Department of Electrical Engineering Technology, Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia, 84600 Pagoh, Johor, MALAYSIA

*Corresponding Author Designation

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Abstract: The Smart Weather Reporting System for Agriculture is an Internet of Things-based project. IoT is one of the most frequently used terms in information technology [1]. Users can utilize the Blynk application to collect data on temperature, humidity, and rainfall to forecast specific global weather conditions despite what might be expected. However, Blynk is capable of storing and displaying data. Besides that, this Blynk can provide excellent storage for various commonly used devices, including Arduino, NodeMCU ESP8266, Raspberry Pi, and Spark Fun. Nowadays, simply watching weather news on television, reading weather reports on websites, or uploading weather apps to the Google Play Store can also assist users in staying informed about daily weather conditions. Furthermore, it uses meteorological satellites such as POES (Polar Operational Environmental Satellites) and GOES (Geostationary Operational Environmental Satellite) that have been in orbit for an extended period to determine all of these weather conditions. Some even develop their meteorological systems, incurring relatively high market costs. As a result, of the existence of this project, which was implemented at a low cost, it is capable of detecting changes in weather conditions in the surrounding environment. However, this project will connect several detectors to the NodeMCU ESP8266 module. One of the apparent benefits is that users have access to the weather in their immediate environment. Other than that, the project will assist users in sending data to the internet with specific weather parameters via the IoT concept, utilizing platforms such as Blynk, and will notify users when the weather is bright or dark or when the soil is moist or dry. Lastly, the Blynk app is used to send and receive data, which can be viewed directly on a mobile phone or by monitoring weather parameters. Thus, it enables users to gain faster and more efficient access to their data.

Keywords: Weather Reporting System, Agriculture, Blynk, IoT, NodeMCU ESP8266

Corresponding author: lina@uthm.edu.my

1. Introduction

The weather system might be the global movement of hot and cold air. These movements are referred to as low-pressure and high-pressure systems in web analysis. As earlier mentioned, weather consists of the following elements which are temperature, air pressure, wind, humidity, rainfall, and cloudiness. Thus, weather can play an important role in agricultural development, as agriculture requires a more precise understanding and forecasting of area weather. Especially in terms of how much technological improvement happens in the agriculture industry today, agriculture has always been climate-dependent. As a result, the environment is also the single most important element affecting crop growth. When predicting meteorological variables such as wind, temperature, humidity, and rainfall, crops can be strictly monitored. This project also has 3 major objectives the first is to be achieved project such as to develop an effective smart weather reporting system for agriculture that can monitor humidity, temperature, light, rainfall, soil moisture in a specific location where it can be monitored system effectively visualizes information charts and gives notifications to users when the weather is sunny or dark or moist soil or not. The second objective is to develop the most accurate and also user-friendly project smart weather reporting system for agriculture with Industrial Revolution 4.0 technology whereas this product will implement IoT technology using based on a suitable Platform (Blynk). The third is to analyze develop system performance through experiments and testing where it can test unpredictable weather conditions that can cause growth and expansion to be tested in several places during operation.

Next, this smart weather reporting system for agriculture will be a more innovative product with a simple prototype design, not too big and easy to carry. In addition, it also consists of multiple sensors used and linked to the NodeMCU ESP8266, with five weather parameters as light, temperature, humidity, rainfall, and soil moisture. Each of these sensors has unique features and benefits in determining more accurate readings. As a result, it can be distributed using the Internet through IoT techniques. While the data transmission process for this project can also be replicated with the use of Wi-Fi. These users will almost certainly check out the platform provided to check real-time weather using the Blynk app. The proposal uses a free platform to see the weather. Thus, users will have access to real-time weather updates by placing the device system at a location that users want to know. The system will also tell the user whether the weather is sunny or dark or tell the soil moisture level.

This project will significantly impact users to monitor weather conditions for their plants. The outcomes of this Smart Weather Reporting System for agriculture are extremely significant, as it can transmit forecasting data for specific global weather parameters such as light, temperature, rainfall, soil moisture, and humidity to the Blynk application, as well as it will be sent a notification if the weather is sunny or dark that day. Additionally, due to the general IoT technology employed in this smart weather reporting system, users may check the weather immediately and receive hourly weather data for the day. Moreover, the system utilizes various sensors connected to the NodeMCU ESP8266 to obtain precise readings of light, temperature, rainfall, and humidity, with the data being displayed on platforms such as Blynk.

2. Materials and Methods

This system project requires an internet connection in order to obtain data for all required parameters. Regarding this project, it consists of two separate prototypes, one of which is used to detect three parameters, namely humidity, temperature, and rainfall. While the second prototype is used to determine the moisture content of the soil. To obtain data for all of these criteria, the application Blynk must be used, and users can view the weather using only their phones. Additionally, this Blynk application will provide users with readings of humidity, temperature, and rainfall data, as well as a live graph visualizer and notifications.

2.1 Block diagram

Based block diagram for two (2) prototypes in Figure 1 and Figure 2 this project consists of four (4) main sensors to control the system, such as the DHT11, the Interfacing Rain Drop Sensor, the LDR Sensor Module, and the Soil Moisture Sensor. The most important sensor for controlling all of these sensors is the NodeMCU ESP8266 as the main Microcontroller. With this project, users are able to monitor weather conditions for their plants. The results of this Smart Weather Reporting System for Agriculture are significant, as it can send forecast data for specific global weather parameters such as light, temperature, rainfall, and soil moisture to the Blynk app, as well as notify the user the weather is bright or dark that day, or whether the soil is moist or dry.

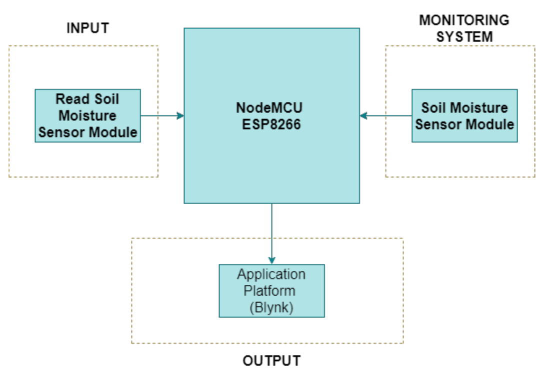

Figure 1 (a): System of Block Diagram to measure Soil Moisture

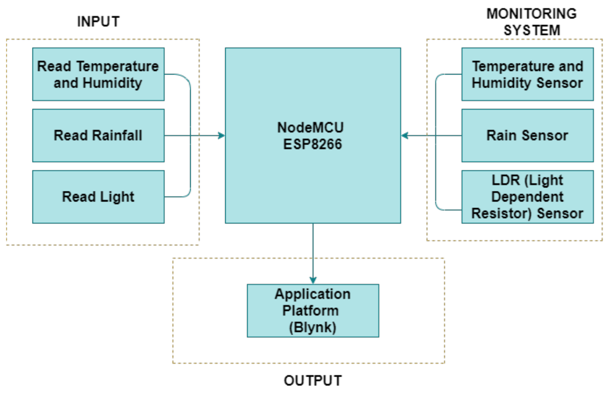

Figure 1 (b): System of Block Diagram to measure Humidity, Temperature and Light

2.2 Flowchart

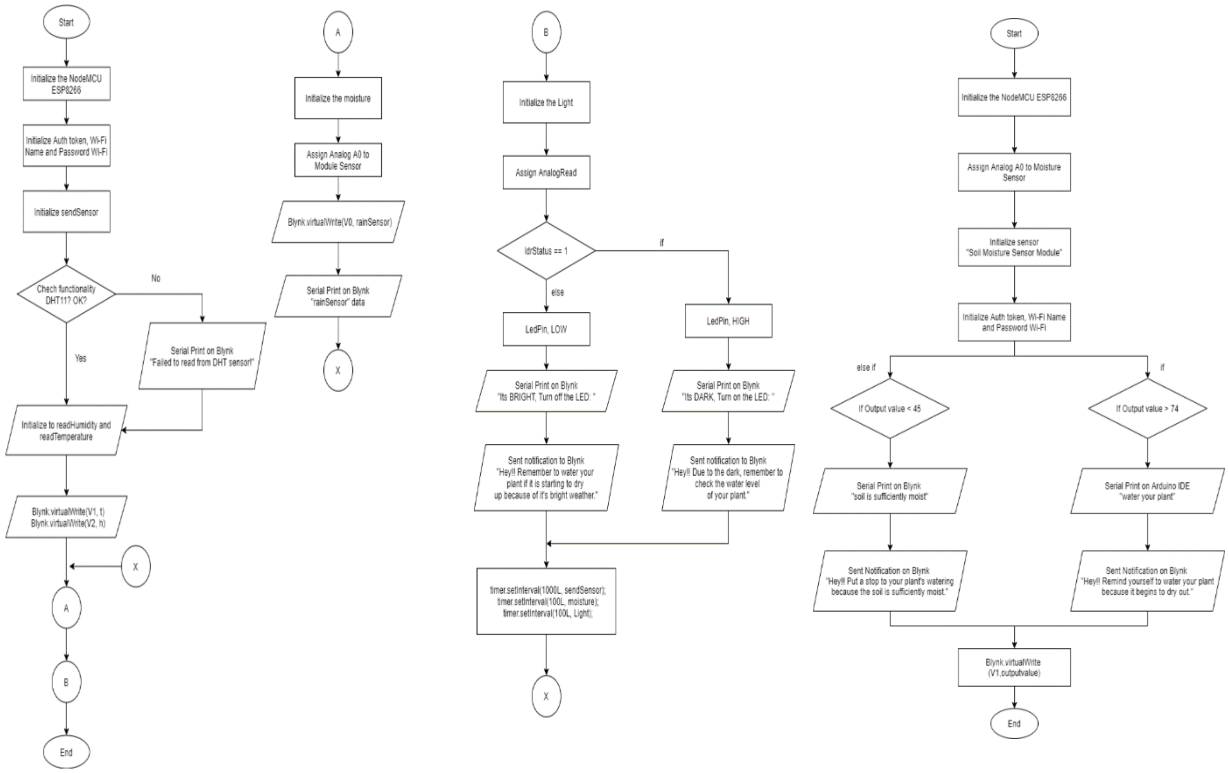

Figure 2: System Flowchart Smart Weather Reporting System

Flowcharts are used to show how a system works. According to Figure 3, it will require a 5V power supply or a power bank to interact with the ESP8266 NodeMCU component. Before starting, the system will verify the DHT11 sensor's functionality. When something goes wrong, the message "Failed to read from DHT sensor" will appear on the serial monitor in the Arduino IDE application. If there is no error, it will proceed to the following stages, which is the initialization process for Humidity and Temperature readings.

Based on Figure 2, based on connector A, will focus on rain sensor data collection. The concept is similar to that of monitoring humidity and temperature. While connector B is mostly used to obtain data about the Light parameter. The process is the same, except that AnalogRead is also assigned. And if variable == 1 indicates that the ldrStatus LEDPin is HIGH, it will continue to function even if the surroundings are dark, requiring the LED to be switched on and a notification transmitted to the Blynk application. In the other case, when the LEDPin is LOW, it will remain in the Bright condition, requiring the LED to be turned off and a notification sent to the Blynk application.

Based on Figure 4, focuses on the method by which soil moisture sensors run the system. Following that, assign analog A0 to the moisture sensor, as the analog reading of the soil moisture is taken. And it has two states in which if the output value hits 45, the notify will pop up to the user via the Blynk program vice versa when the output value is greater than 74, then notify will pop up also to the user via Blynk.

2.3 Hardware Development

2.3.1 NodeMCU ESP8266

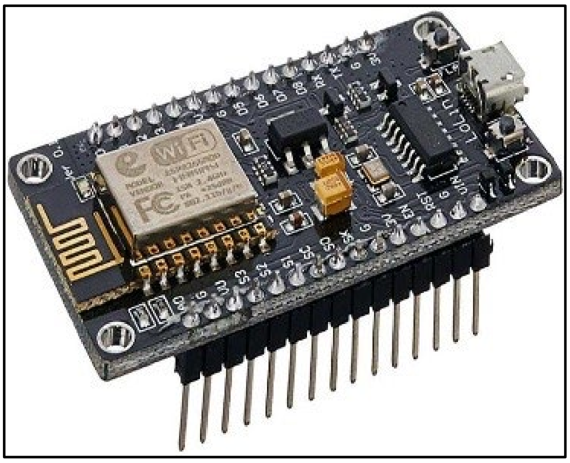

Figure 3: NodeMCU ESP8266

NodeMCU ESP8266 in this project is used to communicate projects to the internet. It is a highly user-friendly and low-cost device. The NodeMCU ESP8266 can perform as both an access point (it can produce hotspots) and a station (it can connect to Wi-Fi). As a result, it can easily collect and transmit data to the internet, allowing the Internet of Things. With NodeMCU ESP8266 has been employed in various applications [1], whether in the experimental or production phase, such as remote heart rate monitoring [2], peatland monitoring [3], flooding detection system [4], intelligent farming [5], and passenger authentication and payment in transportation [6].

2.3.2 DHT11

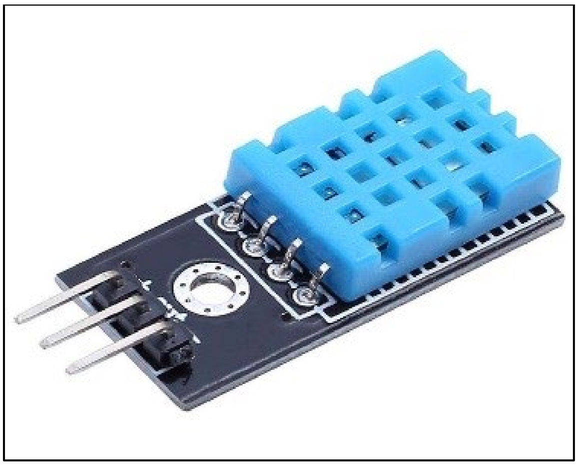

Figure 4: DHT11

The DHT11 is a low-cost digital temperature and humidity sensor. Also, this sensor may be connected to a microcontroller such as an Arduino, Raspberry Pi, or another to simultaneously detect humidity and temperature. As a sensor module, the DHT11 humidity and temperature sensor are provided. This sensor does not include a pull-up resistor or a power-on LED. The sensor of relative humidity Its DHT11 combines a thermistor and a capacitive humidity sensor in this sensor. The temperature range of the DHT11 is 0.0 to 50.0 °C with a precision of 2 °. The humidity range is between 20.00 % and 95.00 % with a 5.00 % accuracy. With DHT11 has been employed in various applications such as Weather Monitoring System Based on Real-Time System [7] and Real-Time weather prediction System and Machine Learning [8]

2.3.3 Interfacing Rain Drop Sensor

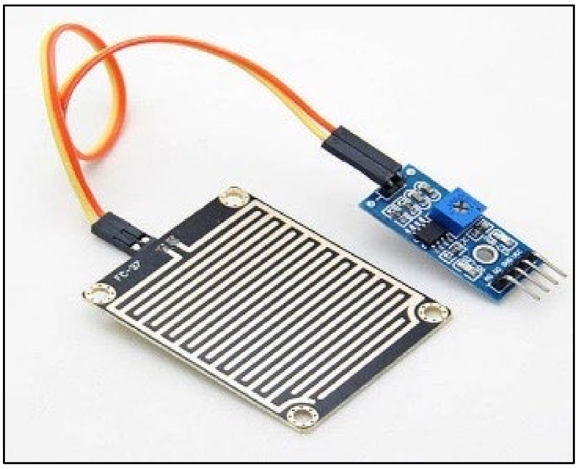

Figure 5: Interfacing Rain Drop Sensor

This raindrop sensor module is used to detect rain. The sensor also consists of two components. The first component is the Sensing Pad or PCB, printed with a network of copper wires. This copper path will allow raindrops to touch and lower the amount of resistance. With this Interfacing Rain Drop Sensor, it can also be used for various applications such as Arduino -based Rainfall Detector Design [9].

2.3.4 Light Dependent Resistor Sensor Module

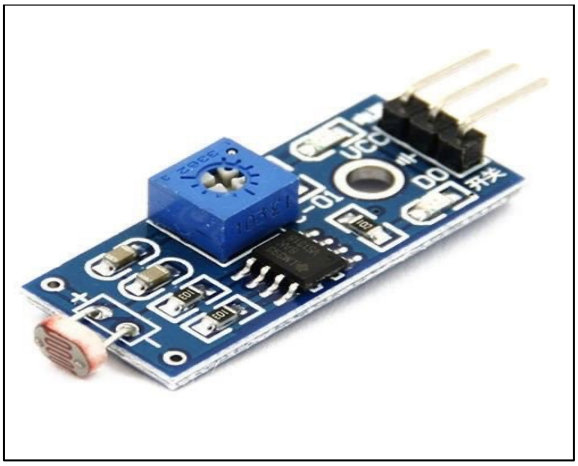

Figure 6: Light Dependent Resistor Sensor Module

This light sensor module called LDR (Light-dependent resistor) is used to determine the light intensity. And the main objective of this sensor is light control. And it, too, will be associated with both analog and digital output pins labeled AO and DO. At the same time, the resistance of LDR will decrease according to the light intensity. With this LDR Sensor Module, various applications can be used, such as IoT -based PID Controller for Light Control System [10] and IoT -based Smart Garden with Weather Station System [11].

2.3.5 Soil Moisture Sensor Module

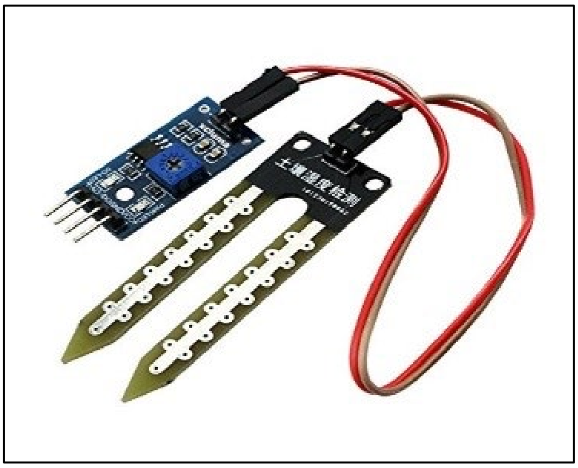

Figure 7: Soil Moisture Sensor Module

This Soil Moisture Sensor Module can measure the resistance between two metal probes inserted into the soil to be monitored. This sensor can be used in connection with the plant watering system automatically or to trigger some form of warning when the plant needs watering. With this Soil Moisture Sensor Module, various applications can be used, such as Monitoring soil moisture [12] and Efficient Water Management for Greenland using Soil Moisture Sensor [13].

2.4 Software Development

Table 1: Software List

Software Development	Description
Arduino IDE	To program the NodeMCU ESP8266 using the ESP8266 library. And another sensor also.

Google Sketchup	SketchUp is a 3D computer simulation software for architectural, interior, landscape, civil, mechanical, animation, and video game creation.
Fritzing	To develop amateur or hobby CAD software for the design of electronics hardware, to support designers and artists ready to move from experimenting with a prototype to building a more permanent circuit.
Blynk Application	To allow users to quickly build interfaces for controlling and monitoring their hardware projects from their iOS and Android device. With the Blynk app, users can create a project dashboard and arrange buttons, sliders, graphs, and other widgets onto the screen.

2.5 Lists of Equipment for Hardware

Table 2: Lists of Equipment

Hardware	Quantity	Price
NodeMCU ESP8266	2	RM35.80
Interfacing Rain Drop Sensor	1	RM6.50
DHT11	1	RM4.90
LDR Sensor Module	1	RM4.90
Soil Moisture Module	1	RM4.90
Breadboard (Small)	4	RM15.60
Jumper Wires (Female to Male)	1 Set	RM2.00
Jumper Wires (Male to Male)	1 Set	RM4.50
Led Blue	1	RM0.20
Resistor 10k Ohm	1	RM0.30
Cardboard Plastic	1	RM1.80

2.6 Circuit Diagram

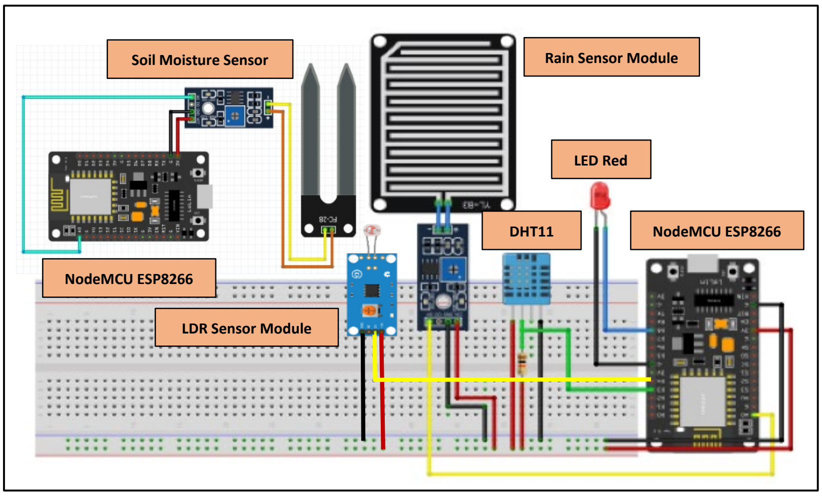

Figure 8: The illustration circuit of the project

This illustration circuit it has 2 prototypes that has been created for the project. For the first prototype seen in Figure 4 and 5, with these 2 protoype it used NodeMCU ESP8266 as a main MCU microcontroller, along with a DHT11, a rain sensor, and an LDR sensor. While Figure 9 represents the second prototype, which likewise makes use of the NodeMCU ESP8266 microcontroller as the main MCU and is connected to a soil moisture sensor. In this system also it uses Blynk application to get real-time data for these two prototypes which has 4 parameters for the first prototype and 1 parameter for the second prototype namely temperature, humidity, rain, light and soil moisture.

Following that, this circuit requires four sensors to monitor the smart weather reporting system for agriculture. This system can monitor humidity (range 20.00 % - 90.00 %) and temperature (0.0 ° C to 50.0 °C) with an accuracy of around ±1 °C and ±1.00 % using the DHT11 sensor.

Then rain sensors were included in the system to detect rain and act appropriately. Thus, the purpose of this rain sensor system is to determine whether or not it is raining in the tested area on that particular day by sending an airdrop reading to the Blynk app.

Besides, by using LDR sensors to detect the presence of light or to determine the intensity of light. The module's output increases in the presence of light and decreases in the absence of light. A potentiometer can be used to adjust the sensitivity of the signal detection. As a result, this system's LDR sensor determines whether or not there is sunshine. If there is sunlight, it will notify the user that the weather is Bright, while Dark is otherwise.

For the Soil Moisture Sensor, the quantity of soil moisture will be determined by measuring the resistance between two metal probes put into the soil to be monitored. It is used in this project to indicate whether or not certain species of plants require watering.

In a nutshell, once the process is complete, the Blynk application will receive sensor value data. This way, users can benefit from the capacity to precisely monitor the weather at the places where agricultural operations are tested.

2.7 Hardware Circuit Development

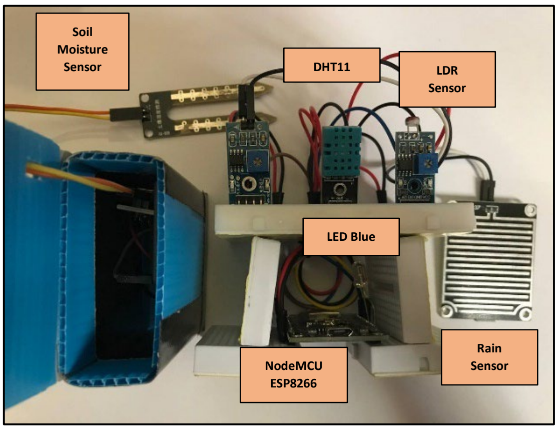

Figure 9 (a): Hardware Design without Full cover casing

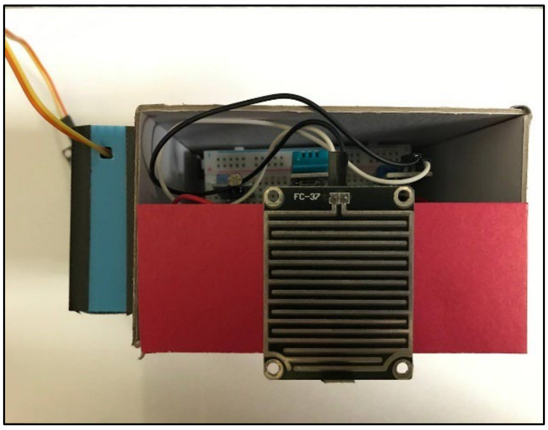

Figure 9 (b): Upper side view of the project

2.8 Software Interface Development

Figure 10 (a): Parameters readings during no rain; (b) Environmental readings when there is rain

The Blynk widget will also provide data in real-time, as the configuration is set to be updated. Figure 10 (a) displays the environment's reading when it isn't raining. While Figure 10 (b) depicts the environment while it is raining at the same location, in comparison. It displayed data from three separate sensors, namely the LDR sensor module, the DHT11 sensor module, and the rain sensor module, and it also collected total values over a specified time period using the chart widget. In another software, the chart's output can be used to plot a graph for data analysis. For this prototype, the Push Notifications Widget is used to allow users to send push notifications from hardware to their device so that users can learn more about the health of their plant in either a bright or dark environment.

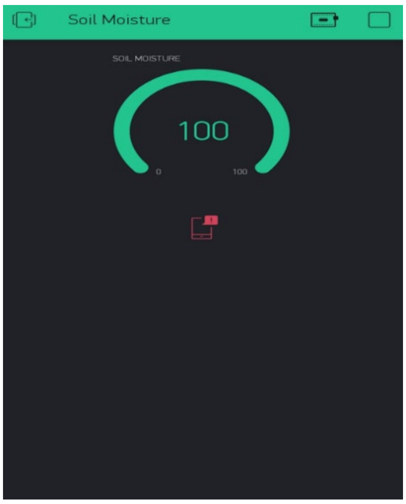

Figure 11 (a): Soil moisture readings while the soil is dry

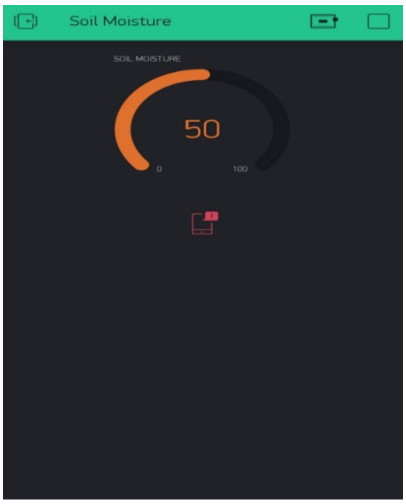

Figure 11 (a): Soil moisture readings when the soil is moist

Figure 11 (a) Soil moisture readings when the soil is dry. While Figure 11 (b) shows soil moisture readings when the soil is moist. The gauge widget displays data from a single sensor, which is a soil moisture sensor. Widget Push Notifications are also used in this prototype to allow users to send push notifications from hardware to their device, notifying them about the condition of their plant, such as whether the soil is moist and does not require watering or whether the soil is dry and requires watering.

3. Results and Discussion

3.1 The comparison weather condition with three (3) different state situations

The data collected may be classified as indoor, outdoor, or website. This data will also be connected to these four sensors through analog signals: DHT11, Rain Sensor Module, LDR Sensor Module, and Soil Moisture Module. The collected data will be exchanged with the ADC, which will then transfer it over the internet, save it on the Blynk server, and display it on the Blynk interface. According to the datasheets collected, it was first in terms of indoor conditions and during various hours, namely morning, afternoon, evening, and night. Temperature, humidity, rainfall, light, and soil moisture readings can be collected using the four sensors. This collection of data was created on the same day, at the same time, and in several locations.

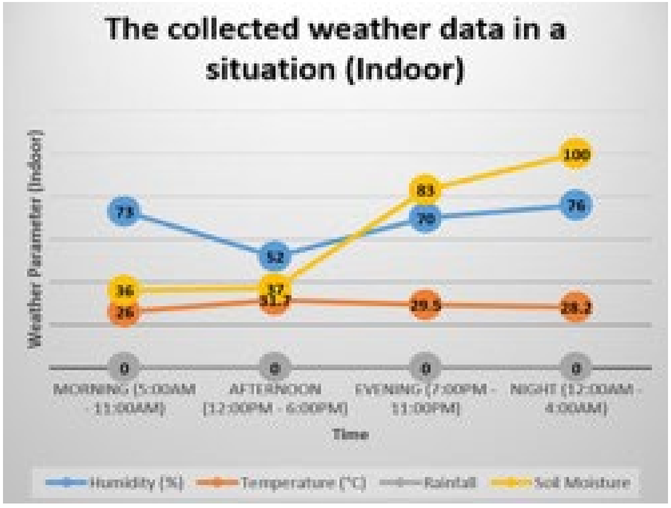

Figure 12: The collected weather data in a situation (Indoor)

As shown in Figure 12, three (3) sensors can produce variable data unless the rainfall data is unchanged on that day. Since the tested location is in an indoor area, the parameters for rainfall distribution cannot be taken, and the exact distribution of rainfall is zero, as there is no rainfall.

For data readings recorded for humidity in indoor conditions. In the morning between 5:00 am to 11:00 am, as much as 73.00 % of data can be recorded then, with a range it is very suitable for greenhouses, which can be used to grow various types of crops, whether tropical or otherwise. And the afternoon, the humidity data recorded dropped to 52.00 %, so, with a range, it is very suitable for the growth stage for the plant. And in the evening, it starts to increase by 70.00 %, and at night by 76.00 %. From these recorded data, it is very suitable for crop growth.

Next for the temperature data reading is also the temperature in the morning between 5:00 am to 11:00 am. It shows 26.0 °C is a relatively good temperature for plant foliage crops. And the temperature in the afternoon is between 12:00 pm to 6:00 pm. It also shows an increased value of 5.7 °C to get a value of 31.7 °C. Then, with a temperature like this, it is very high and can cause the pressure on the plant to dry out due to relatively hot weather conditions. Next, at night between the hours of 7:00 pm to 11:00 pm, the temperature data that can be recorded decreased by 2.2 °C and reached a value of 29.5 ° C. With a temperature like this, it can show that the temperature is perfect for plants. While at night, the temperature decreases by 1.3 °C to reach a value of 28.2 °C, it is also a good temperature range for plants.

In addition, for the reading of soil moisture data in the morning, the value data was recorded 36 values data that have been recorded, so in a range like this, it shows that the soil is still wet. Next, in the evening, the recorded value increased slightly to 37, which shows that the soil is still moist. This is due to consumers watering their crops in the morning and evening. While in the afternoon, the data recorded an increase of 83 shows that the soil is slightly dry and the soil drainage is in good condition. Next, at night the recorded data value goes up by 100, indicating the soil has started to dry out, and the user needs to add water to the crop.

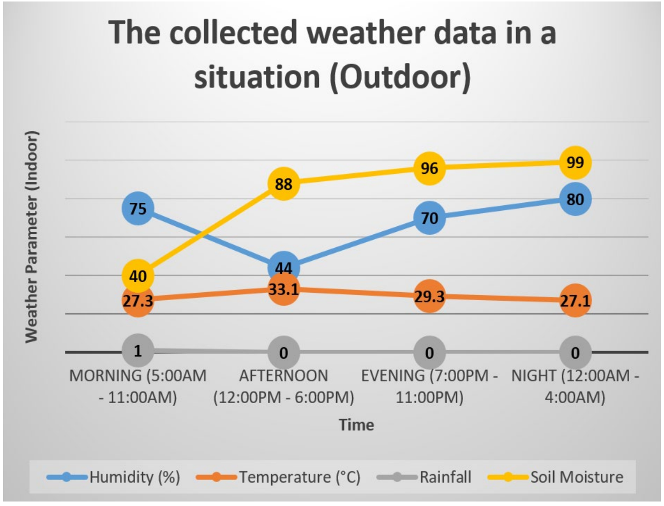

Figure 13: The collected weather data in a situation (Outdoor)

With the study conducted outdoors, it can be observed that the soil outdoors dries very quickly compared to the trees inside. So, both conditions must be monitored regardless of whether the user is indoor or outdoor.

As shown in Figure 13, four (4) sensors were able to produce variable data that day compared to the data recorded while inside. Since the tested location is in an open area, all four parameters are likely to change and differ. Referring, in the morning, the humidity parameter value can be recorded by 75.00 %. In contrast, in the afternoon, the recorded value decreased by 44.00 %, and the humidity value increased again in the evening by 70.00 %, and at night the humidity value increased again to 80%. Based on the humidity value recorded at 44.00 % this afternoon, it is very suitable for the growing stage of plants.

Next, for the reading of temperature data in the morning, the value that can be recorded is 27.3 °C. While in the afternoon, the value that can be recorded is 33.1 °C, so with a temperature like this, it is very high and can cause plant pressure to dry due to weather conditions. Quite hot. The temperature value drops to 29.3 °C in the evening, so this temperature range is quite suitable for plants. Furthermore, the temperature value decreased to 27.1 °C at night, probably because of the night factor, the temperature value became slightly lower than during the day.

In addition, the rainfall reading recorded in the morning is one (1), which means that there is rain in the morning. And in the afternoon, the rain stopped, and there was no rain until nightfall. Rainfall can also affect other parameters such as soil moisture, temperature, and even humidity.

Finally, the reading recorded on the soil moisture sensor in the morning is 40. It shows that the soil is too moist due to rain. In the afternoon, the value recorded was 88, indicating that the soil was relatively dry and needed to be well-drained. While in the evening, the data recorded has increased to 96, this means that the weather in the afternoon affects the soil to be dry and requires monitoring so that the soil does not become too dry. And at night, a total of 99 data were recorded for soil moisture parameters, so with a value like this, the user has to add water to the tree in a moist state.

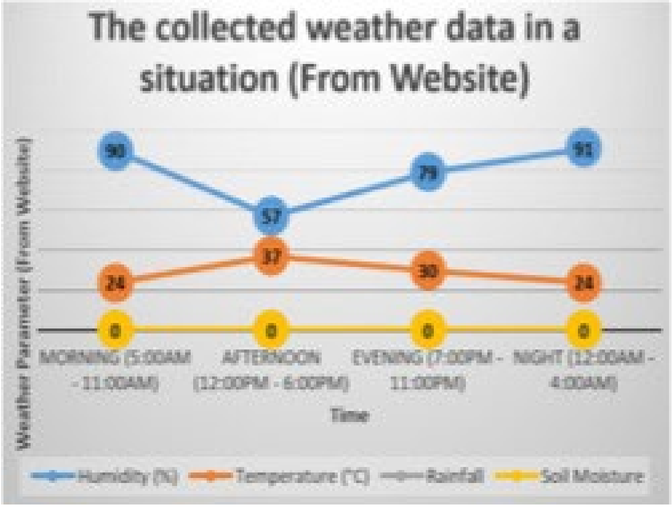

Figure 14: The forecast data weather (From Website)

Referring to Figure 14, the data taken is from website sources, so data for soil moisture parameters cannot be collected because soil moisture varies according to the crops cultivated by users. This data is not available on internet sources. And soil moisture should be measured by user in the area that the user wants. And rainfall data also could not be taken because the website source showed that there was no rain that day.

The humidity reading recorded in the morning is 90.00 %, so it is very suitable for seed germination and growth of some seedlings with a humidity range like this. While in the afternoon the value decreased to 57.00 % with a range like this it shows very suitable for the stage of plant growth. Next, the humidity value rises again to 79.00 % in the evening. Further, it rises to 91.00 %, so this range is very suitable for the germination of plant seeds and can also plant a variety of crops, either tropical or vice versa.

Finally, no data can be recorded for the reading of rainfall and soil moisture data because soil moisture cannot be measured and predicted via the internet. After all, it requires a tool that can measure soil moisture directly. At the same time, the data value for rainfall cannot be taken because it has not gone for a long time.

Figures 15 until Figure 18 show the comparison of collected data in four (4) parameters with three different situations, namely Indoor, Outdoor, and Website. Throughout this research, the data for the five parameters collected will also follow the morning, afternoon, evening, and night to ensure accurate readings within the specified time range. In addition, the collected data will use three different situational situations. That is, the first method is to collect data indoors. While the second method is to contain data outdoor the home, and the third method is to take data from existing online sources.

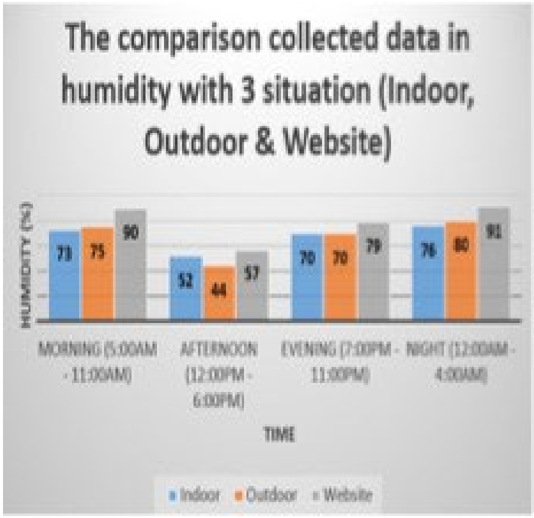

Figure 15: The comparison collected data in humidity with 3 situations (Indoor, Outdoor & Website)

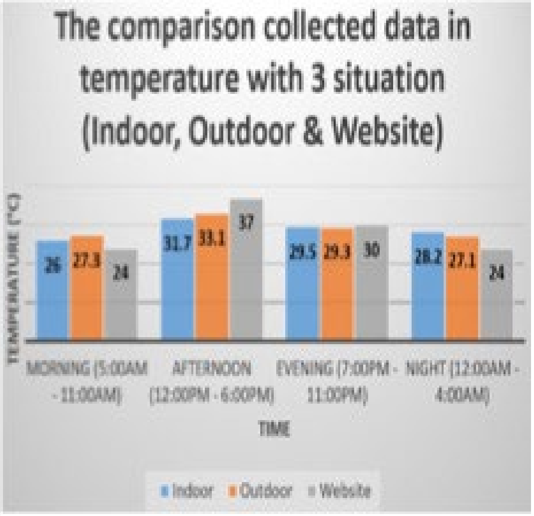

Figure 16: The comparison collected data in temperature with 3 situations (Indoor, Outdoor & Website)

As described in Figure 15, the comparison of humidity values for the three conditions is quite different. What matters is the data that has been collected over the internet. Only some humidity values are almost the same for indoor and outdoor readings. According to the study, a seven-day forecast can predict the weather accurately around 80.00 % of the time, while a five-day forecast can predict the weather with certainty about 90.00 % of the time. On the other hand, forecasts of ten days or so are only about 50.00 % correct, which causes the humidity conditions outside and inside to be different because the weather inside the house can be much different than outside when it comes to relative humidity. This is because the temperature inside the house can be much different than the temperature outside. This is because of the important relationship between temperature and how much maximum humidity there can be in the air.

Similarly, in Figure 16, the temperature data collected differed significantly from the data collected on the site. The statistics collected in indoor and outdoor terms are not much different. This may be because the items used are the same, and the readings taken are also the same.

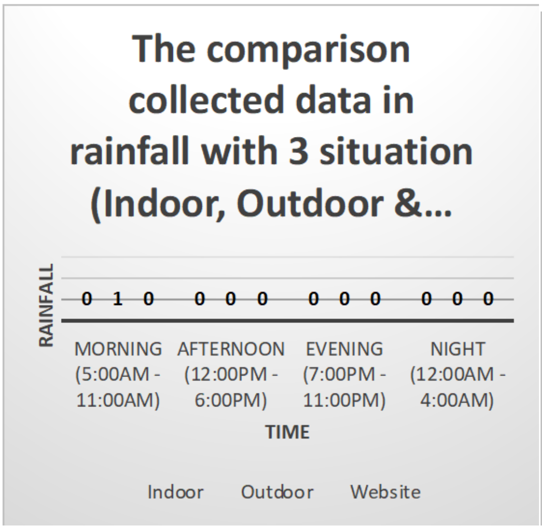

Figure 17: The comparison collected data in rainfall with 3 situations (Indoor, Outdoor & Website

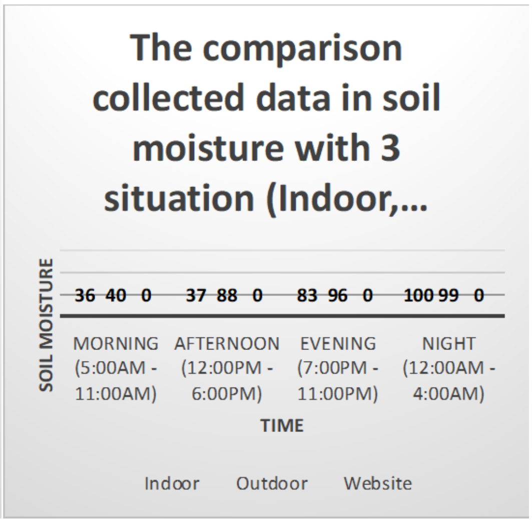

Figure 18: The comparison collected data in soil moisture with 3 situations (Indoor, Outdoor & Website

In Figure 17, the changes in the data collected for Rain show that Rain has fallen in outdoor locations. And data previously collected on the internet showed that the day tested was not rainy, but in reality, it rained at 8:00 a.m.

In a nutshell, in Figure 18, it can be seen that the data collected via the internet for soil moisture cannot be taken because the internet does not provide soil moisture data for the specific area that users want. So, in this project, this system can only test the difference data in soil moisture conditions indoor and outdoor using the soil moisture module. It can also be seen in outdoor conditions, and the soil dries faster because the sunlight is strong enough to dry the soil. In contrast to the situation indoors, it takes a bit longer for the soil to dry.

4. Conclusion

In a conclusion, the implementation of this smart weather reporting system for agriculture is successful to be implemented to monitor the accuracy of agricultural weather monitoring in the tested areas in terms of temperature, humidity, rainfall, light, and soil moisture. With this project, users can monitor the weather in their crop areas more accurately. Furthermore, the system is easy to implement due to its simple and user-friendly design and its ability to offer more accurate weather observations. Next, the system also uses apps like Blynk to display readings in full real-time via mobile phone. So, a project like this can give benefit users who use it, especially those who need a weather monitoring system for their crops to get more accurate weather data readings that can control their crops or vice versa. With a project like this, the crops can be monitored with more observation, and of course, with this monitoring, the garden will be more fertile and healthier. And also, it can help farmers in making the necessary preparations for their crops.

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