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A Monitoring System of Soil Moisture for Fertigation System using IOT Application

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Abstract: The advancement of agricultural technologies is gaining momentum, with the majority of these advancements assisting farmers in the facilitation of their plantation. Smart devices and the Internet of Things (IoT) are being used to help reduce the cost and time spent on labor. In order to meet the demands of the population, it is also necessary to improve the quality and quantity of agricultural production. The Internet of Things has been instrumental in monitoring the condition of a plantation in Malaysia, where the climate is unpredictable and it is impossible to predict when the rain will fall. As a result, a monitoring system based on Internet of Things application for agriculture was developed to assist farmers. This system enables farmers to monitor soil moisture levels that could otherwise result in undesirable consequences. It is possible for this system, which uses the Blynk application installed on smartphones, to check the soil condition at the plantation in order to determine whether the soil is dry or saturated with water. The prototype has been tested in both indoor and outdoor conditions at different times. The results of the experiment are obtained, and the goal is achieved. The user can monitor the condition of the soil over time using the Blynk application. There is a difference between indoor and outdoor plants because outdoor plants receive more sunlight and are exposed to it more directly than indoor plants but the results are not significantly different.

Keywords: Monitoring System, Fertigation System, IOT Application

1. Introduction

The concept of the monitoring system is to allow users to collect, process and analyses information in an efficient method. The monitoring system enables us to calculate different measures based on the data obtained. The monitoring system involved in every area such as security, healthcare, industrial, forecast and also agriculture, that it is already become part of our daily lives activities. Water supply is very important to plants because it is one of the ways to get a nutrient for growth, due to climate change, every farmer is very worried about the climate damage done to the plantation. The farmer cannot foresee

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the rainfall. So, if the irrigation system is on when rainfall, the plants may receive excess water. Due to excess water, plants may be affected and production efficiency may be reduced [1].

The internet of things (IoT) can be thought as a network of physical objects or "things" that have been embedded with electronics, software, sensors, and connectivity to enable these objects to collect and exchange data [2]. Nowadays, the usage of IoT devices is increasing rapidly. In every sector IoT are widely used such as residential, industrial and also institution. In this project, the system will be using Arduino as primary programming to monitor the water nutrient level. This is because it is flexible, easy to use hardware and software. The code itself is much easier to comprehend, and there are many examples to work with. With a combination of the esp32 module, it can send data to the farmer directly [2].

Many of the previous research that related into fertigation system and IoT has been developed in research paper such as:

O. M. E. Ahmed, A. A. Osman and S. D. Awadalkarim [3] proposed a design of an automated fertigation system using IoT to measure the value of soil moisture, pH, Ec, and control the valve. The main component of this project is by using Arduino Uno, Ethernet Shield and XBee. Ethernet Shield used Arduino Ethernet feature to support four simultaneous socket connections with long wire-wrap headers. Then by using XBee to control parameters from each sensor.

S. A. H. Z. Abidin and S. Noorjannah Ibrahim [4] proposed a design of automated fertigation system by using Arduino Uno and pcDuino, a mini-PC platform that run Pc like OS. This system uses an open-source webserver to design and optimized for high-performance environments, suitable for Graphic User Interface (GUI).

P.Vdvwud [5] proposed of the same system, by using Global System for Mobile (GSM) as a communication unit. Instead of Internet Network, this system uses SIMCARD and Radio Waves that are suitable in an urban area where the Wi-Fi coverage is limited. This system using NetBeans IDE 8.1 to design GUI.

2. Materials and Methods

This study will be conducted by using both software and hardware to complete the project.

2.1 Methods

Figure 1 shows the flowchart of methodology. The methods and the flow process about the project focus on the step to designing the software and hardware for the prototype of monitoring water level. This part also will explain the component and software that will be used in this project. This project is mainly focus on collecting the information from the plantation. The system is a monitoring water level for fertigation system using IoT technology.

To complete the project, the flowchart is used to guide the process to develop a prototype of monitoring water level. The flowchart is divided into 2 phases:

Phase 1: Project Planning and Simulation Development

(i) Design 3D model of the system using SketchUp software
(ii) Design the circuit and coding by using Proteus 8 and Arduino IDE platform
(iii) Simulation of the circuit with using Blynk application

Phase 2: Hardware Development and Testing

(i) Development and simulation of hardware
(ii) Result and analysis

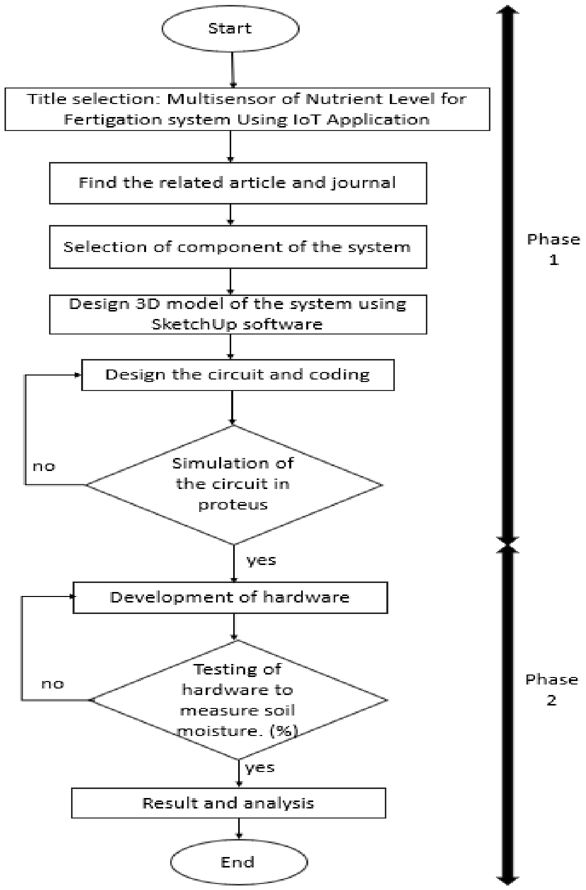

Figure 1: Flowchart of methodology

2.2 Materials

For this project, the hardware components used to complete the project will be mentioned below:

a. ESP32 Board

Figure 2 shows the ESP32 Board. ESP32 is a series of low cost and design on a chip microcontroller with integrated Wi-Fi and dual-core Bluetooth, making it an all-rounded chip for the development of IoT project and embedded systems in general. It is an improvement of the ESP8266 that is widely used in IoT projects. The advantages of ESP32 are that it can be programmed directly without needed extra Arduino board like ESP8266. ESP32 also has Ethernet MAC Interface, Touch Sensor, Temperature Sensor, and even Hall effect sensor. Unlike Arduino, ESP32 using 12-bit ADC instead of 10-bit ADC [6].

Figure 2: ESP32 Board

b. FC – 28 Soil Moisture Sensor

The soil Moisture sensor is one of the sensors used to measure water's volumetric content within the soil. This makes it ideal in experimenting such as agricultural, environmental, botany and biology. This sensor has 4-pins that is VCC pin is used for power, A0 pin is an analog output, D0 pin is a digital output, and GND pin is ground [7].

c. LCD display

The electronic display module is an LCD (Liquid Crystal display) screen. Usually, a 16x2 LCD is a fundamental component and is very commonly used in different devices and circuits. The reasons for this are that LCDs are an economical and the programming is easy. Therefore, there is no limit to displaying unique or custom characters and animations as well. A 16x2 LCD means that per line it can show 16 characters and there are two lines. There are two registers on this LCD, which are command and data. The LCD is used to display the output voltage and current for this project [8].

3. Results and Discussion

The results can be divided into 2 phases. Phase 1 can be categorized as simulation from software and Phase 2 categorized as simulation from hardware.

3.1 Results Phase 1

First, the circuit will be drawn in Proteus 8 where the component is consisting of Arduino Uno, moisture sensor, COMPIM, and 16x2 LCD. The main component for coding, ESP32 is replaced with Arduino Uno to run the simulation as shown in Figure 3. Even though it is replaced, the coding for the system is still the same. The variable resistor is acted as a sensor to give a reading to Arduino. COMPIM is used as a connection between Proteus simulation and Blynk application. 16x2 LCD used to display the value from sensor. When value sensor 1 and 2 change, can see the result both at LCD and Blynk are same. The results from Blynk is shown in Figure 4.

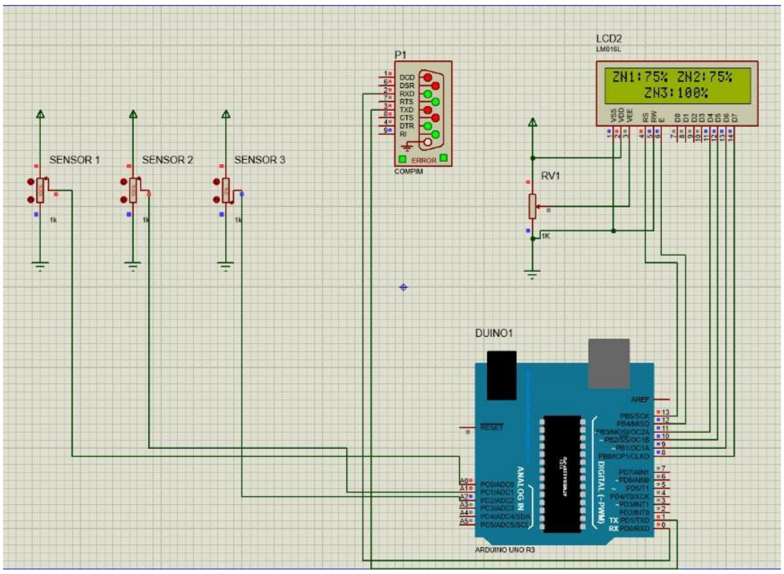

Figure 3: Circuit Design

Figure 4: Results from Blynk

3.2 Result Phase 2

Figure 5 shows the prototype that has been developed to detect the level of soil moisture in an indoor and outdoor location. The soil in the vase that serve as the testing object serves as the primary material for this prototype. There are three soil moisture sensors, each of which is placed into a vase separately. The Blynk output will be able to display the results of all of the sensors' readings.

(a) The Indoor Testing (b) The Outdoor Testing

Figure 5: Prototype of the system

3.3 Data Collection Indoor and Outdoor

The results of the hardware prototype for the monitoring system are discussed in this section. The information gathered in both indoor and outdoor conditions include the date, the time it was taken, and the percentage of soil moisture sensor results. The graphs in this section are taken from the Blynk display.

3.3.1 Results of Indoor Condition

The data analysis of the day 1 soil moisture taken indoor for 3 hours is shown in Table 1 and Figure 6. In the graph the condition of the soil was analyzed. The figure shows a 3-hour decrease in soil humidity from 10.04 PM until 12.55 AM, which for sensor 1, is 8.74%, for sensor 2, 19.77% and for sensor 3 13.97%. The losses in soil moisture for 3 sensors in 3-hour is between 8.84% - 19.77%.

Table 1: Day 1 data at indoor

Time	Time taken (min)	Sensor 1 (%)	Sensor 2 (%)	Sensor 3 (%)
10.04 PM	1	51.80	53.73	52.96
10.33 PM	30	48.02	44.82	41.12
11.03 PM	60	47.27	40.27	42.11
11.33 PM	90	46.36	37.52	41.38
12.03 AM	120	44.98	36.28	39.88
12.33 AM	150	43.89	34.89	39.02
12.55 AM	172	42.96	33.96	38.99

Figure 6: Result Day 1 at indoor from Blynk display

Table 2 and Figure 7 show the data analysis for the day 2 soil moisture taken indoors for 3 hours. The testing take place from 2.03 PM to 4.57 PM. The graph shows a decrease over time interval increases during this time. Sensor 3 has the highest reading of 51%, followed by Sensor 1 at 36.08%, and Sensor 2 has the lowest reading of 7.99%.

Table 2: Day 2 data at indoor

Time	Time taken (min)	Sensor 1 (%)	Sensor 2 (%)	Sensor 3 (%)
2.03 PM	1	45.32	40.79	50.01
2.32 PM	30	44.00	25.45	47.00
3.02 PM	60	40.00	19.04	47.00
3.32 PM	90	37.99	15.15	47.99
4.02 PM	120	35.02	11.99	50.00
4.32 PM	150	35.97	10.00	51.00
4.57 PM	175	36.08	7.99	51.00

Figure 7: Result Day 2 at indoor from Blynk display

The data analysis for day 3 soil moisture taken at indoor for 3 hours is shown in Table 3 and Figure 8. The testing take place between 5.02 PM and 7.55 PM. The graph also indicates a decrease in intervals over time during this timeframe. Sensor 1 has the highest reading of 52.72%, followed by Sensor 3 with 50% reading, and Sensor 2 with a 24.95% reading. For three sensors, the difference is between 4.34% - 20.74% to decrease the reading over a 3-hour period.

Table 3: Day 3 data at indoor

Time	Time taken (min)	Sensor 1 (%)	Sensor 2 (%)	Sensor 3 (%)
5.02 PM	1	62.50	45.69	54.34
5.31 PM	30	56.00	35.87	49.00
6.01 PM	60	53.92	30.54	48.61
6.31 PM	90	52.00	27.00	48.00
7.01 PM	120	52.00	25.99	48.99
7.31 PM	150	52.00	24.99	49.99
7.55 PM	175	52.72	24.95	50.00

Figure 8: Result Day 3 at indoor from Blynk display

3.3.2 Results of Outdoor Condition

Table 4 and Figure 9 shows the data and graph analysis of reading the soil moisture for outdoor condition at day 1. From 1.10 PM to 3.39 PM, the result shows that Sensor 1 with a value of 43.99% drops by 11.65%, Sensor 2 with a value of 40% drops by 9.56% and Sensor 3 with the value of 53%, increasing 3.55%.

Table 4: Day 1 data at outdoor

Time	Time taken (min)	Sensor 1 (%)	Sensor 2 (%)	Sensor 3 (%)
1.10 PM	1	55.64	49.56	49.45
1.39 PM	30	52.02	43.03	47.96
2.09 PM	60	50.01	41.02	51.01
2.39 PM	90	47.64	40.99	52.99
3.09 PM	120	45.01	40.00	53.00
3.39 PM	150	42.99	38.37	52.98
4.04 PM	175	42.00	38.01	53.06

Figure 9: Result Day 1 at outdoor from Blynk display

Table 5 and Figure 10 show the outdoor condition data and graph analysis for Day 2 at 4.21 PM until 6.50 PM. Sensor 2 has the highest reading, 49.01 %, with a slight decrease of 0.31 %, followed by Sensor 1 with a reading of 41.01 % and a decrease of 7.03 %, and Sensor 3 with the lowest reading of 14.54 % and a significant decrease of 29.57 %.

Table 5: Day 2 data at outdoor

Time	Time taken (min)	Sensor 1 (%)	Sensor 2 (%)	Sensor 3 (%)
4.21 PM	1	48.04	44.11	49.32
4.50 PM	30	46.49	35.00	45.98
5.20 PM	60	45.00	29.95	47.98
5.50 PM	90	43.91	25.96	47.95
6.20 PM	120	42.99	22.70	49.03
6.50 PM	150	42.00	18.43	50.00
7.15 PM	175	41.01	14.54	49.01

Figure 10: Result Day 2 at outdoor from Blynk display

The data analysis for day 3 soil moisture taken at outdoor for 3 hours is shown in Table 6 and Figure 11. The testing take place between 8.58 AM and 11.52 AM. Sensor 3 has the highest reading of 51 %, followed by Sensor 2 with 48.96 % reading, and Sensor 2 with a 20 % reading.

Table 6: Day 3 data at outdoor

Time	Time taken (min)	Sensor 1 (%)	Sensor 2 (%)	Sensor 3 (%)
8.58 AM	1	57.00	44.35	48.05
9.27 AM	30	45.99	35.00	49.00
9.57 AM	60	53.13	30.99	50.00
10.27 AM	90	52.00	27.34	51.00
10.57 AM	120	51.00	25.00	51.00
11.27 AM	150	49.94	21.95	50.94
11.52 AM	175	48.96	20.00	51.00

Figure 11: Result Day 3 at outdoor from Blynk display

4. Conclusion

This project's goal is to design a monitoring system to monitor water in plants using ESP32. The soil moisture sensor assists in plantation monitoring by reading soil moisture in the plantation using the Blynk application as a display. Furthermore, the system's performance has been evaluated and proven to be successful in the project.

The user can identify the reading at each zone put with soil moisture sensor from this monitoring system using the Blynk application installed on smartphones. It can also help the user save time and labor by monitoring each location on the plantation.

The user can use the Arduino IDE software to change any function based on the user's software programming criteria. The Arduino IDE is the leading programming software that iswidely used around the world, and there are numerous examples available on the internet. It is simple to compile and upload to the ESP32.

Finally, the ability and cost of integrating software and hardware into a project is dependent on their ability and cost to integrate with one another in an efficient manner. Each component is vital for the system to function properly.

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