Progress in Engineering Application and Technology Vol. 4 No. 2 (2023) 121-132

PEAT

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/peat
e-ISSN : 2773-5303

Solar IoT Smart Garden

Muhammad Fawwaz Hashim[1], Mardzulliana Zulkifli. [1]*, Zurina ABD Wahab [1]

[1]Faculty of Electrical Engineering Technology,
Universiti Tun Hussein OnnMalaysia, 84600, Pagoh, Johor, MALAYSIA.

*Corresponding Author Designation

DOI: https://doi.org/10.30880/peat.2023.04.02.012
Received 15 January 2023; Accepted 12 February 2023; Available online 12 February 2023

Abstract: Solar IoT Smart Garden improves sustainable farming over typical watering systems. The project is powered by a 50-watt solar panel and solar charger controller. Gardening without fossil fuels is greener with solar energy. The ESP8266 microcontroller allows internet connection and smartphone remote control. The DHT11 sensor for temperature and humidity, soil moisture sensor, ambient light sensor, and water level sensor collect garden environmental data. These sensors allow the system to continuously gather data and adjust watering to meet plant needs. This is much better than traditional irrigation methods, which often use a predetermined timetable regardless of plant needs. This project's Blynk mobile app user interface is notable. Users may remotely activate the irrigation system, check water levels, soil moisture, temperature, humidity, and sunlight with the Blynk app. This simplifies gardening. The Solar IoT Smart Garden project uses cutting-edge technology to improve plant growth and reduce environmental impact.

Keywords: Renewable Energy, ESP8266 Microcontroller, Irrigation Optimization, Blynk Application, Sustainable Gardening, Technology Optimization.

1. Introduction

Solar IoT smart garden systems have been the focus of several studies and research projects, which have explored different aspects of these systems, such as the technologies and devices used, the benefits, and challenges of implementing such procedures, and the impact on plant growth and sustainability. One problem that a solar IoT smart garden system could address is the need for efficient and effective garden management. Traditional gardening methods can be labor-intensive and require frequent manual monitoring and intervention to ensure optimal growing conditions [1].

Corresponding author: zulliana@uthm.edu.my

A solar IoT smart garden system could automate many of these tasks and allow gardeners to remotely monitor and control the garden environment, saving time and effort while improving the health and productivity of their plants [2]. Another problem that a solar IoT smart garden system could solve is the need for a reliable and renewable energy source for garden management. Traditional garden systems often rely on electricity from the grid, which can be expensive and may need to be more environmentally sustainable [7]. Solar panels to power the garden allows for a renewable and cost-effective energy source, reducing the environmental impact of garden management and saving money on energy costs. The objective of the project is to develop an efficient system for plant monitoring, integrate solar technology to support supply power and improvise the current monitoring system by applying IoT [8]. The scope of the project is to research on the different technologies and devices that can be used in a solar IoT smart garden system, such as solar panels, sensors, actuators, and communication systems, as well as to save the generated energy.

2. Materials and Methods

A block diagram is used to depict the operation or screen navigation of the entire system of automatic deodorization and toilet cleaning. Figure 1 depicts a simple block diagram of the solar(power supply), input sensor, wemos (microcontroller),output (pump control) and Blynk(user).

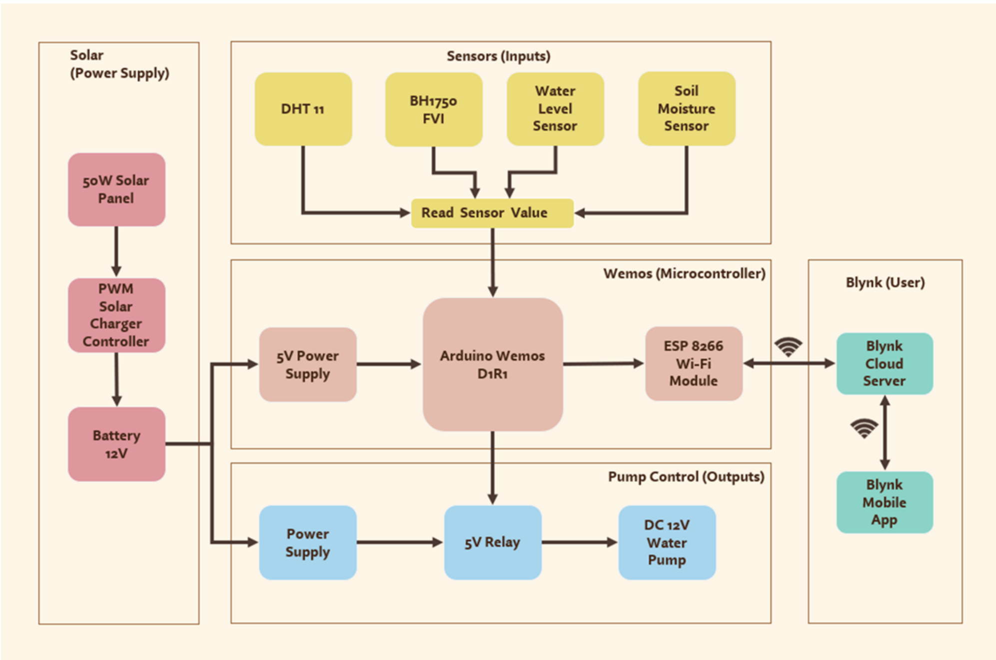


Figure 1: Simple system block diagram

Throughout the project and development of the automatic cleaning, the project flowchart as shown in figure 2 and figure 3 is used to represent the overall workflow of the development process.

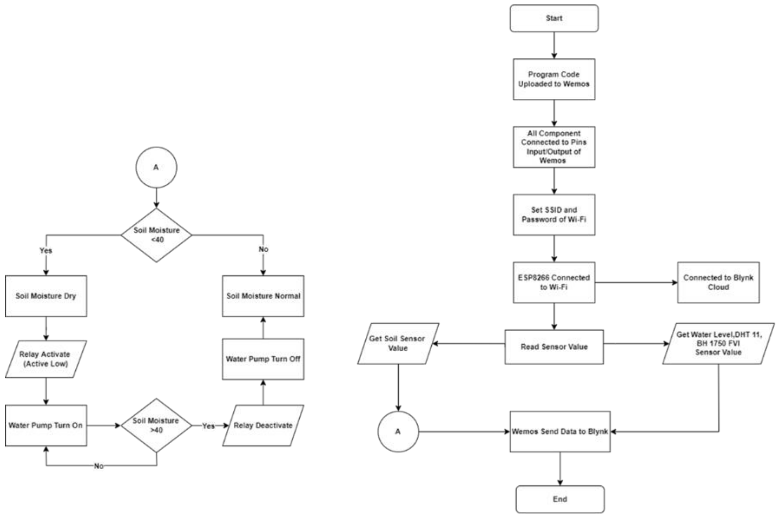


Figure 2: Flowchart of Arduino WeMo's

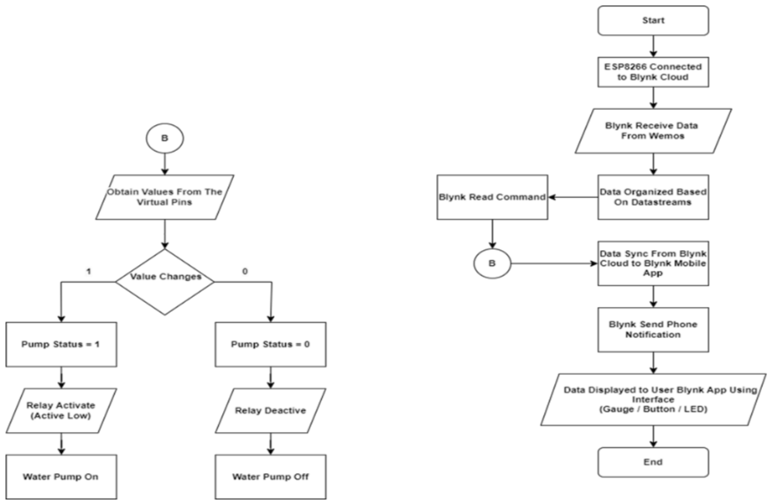


Figure 3: Flowchart of Blynk

Solar power controller flowchart in figure 1. First, Start: A 50-watt solar panel powers the system. The 20-amp solar charger controller manages the voltage and current from the 50-watt solar panel to properly charge the battery. Battery-DC motor pump: The 12V battery powers a DC motor pump. Battery-solar charger controller: The solar charger controller monitors the battery's charge and controls charging to the appropriate level. Solar charger controller to Arduino: The Arduino microcontroller controls the DC motor pump and monitors system performance. End: When idle, the system is powered down. Based on pictures 2 and 3, this flowchart for the Solar IoT Smart Garden project using an Arduino WeMo microcontroller may include these steps: Start: A 12 V battery powers the system through a rocker switch. Soil moisture sensor: Measures soil moisture. Soil moisture level check: A relay powers a DC motor pump if the soil moisture level drops below 40. DC motor pump: It waters plants. DHT11 sensor: Measures Garden temperature and humidity. Statistics: The Blynk smartphone app receives real-time DHT11 sensor data. Ambient light sensor: Measures Garden light. Data collection: The Blynk mobile app receives ambient light sensor data for real-time monitoring. Water level sensor: Monitors reservoir water level. Water level check: Blynk receives a message if the water level drops below a threshold. Remote control: Blynk can remotely turn on or off the DC motor pump. End: When idle, the system is powered down.

3. Results and Discussion

The performance of the Solar IoT Smart Garden was examined and deliberated upon by comparing experimental data. For ease of viewing, the results are summarized in anumber of tables, graphs, and charts. There four part observed. Firstly, Power Sources are Generated from Sunlight Sources (Solar Energy). Secondly, Supplying Energy to Load Control by IoT, Thirdly Watering System through The IoT Control System and for last is, Sensor Output Reading Control. The results are presented in various types of charts to make it easier for the readers to understand.

3.1 Power Sources are Generated from Sunlight Sources (Solar Energy)

According to the findings for the power gathered by solar energy for three consecutive days, the maximum capacity successfully recorded on the first day was 6.75 watts. Data was successfully acquired at two o'clock in the afternoon. Then, the voltage was 13.5 V, and the current was 0.50 A. The maximum wattage reading that could be achieved successfully on the second day was 7.42 watts, according to Table 4.2. The wattage figure peaked at two o'clock in the afternoon when the solar panel was exposed to the most sunlight. The increased current equals 0.55 A, whereas the gained voltage equals 13.5 V. Researchers resumed their efforts to assess the power worth of solar energy on the third day of the examination. At one o'clock in the afternoon, the wattage value was 6.55 W,

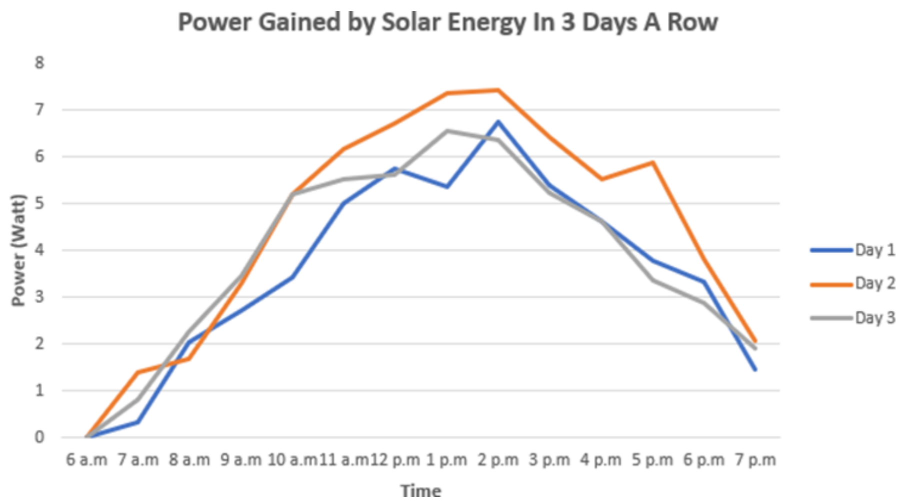


Figure 4: Line Graph of Power Gained by Solar Energy in 3 Days a Row

According to the findings for the power gathered by solar energy for three consecutive days, the maximum capacity successfully recorded on the first day was 6.75 watts. Data was successfully acquired at two o'clock in the afternoon. Then, the voltage was 13.5 V, and the current was 0.50 A. The maximum wattage reading that could be achieved successfully on the second day was 7.42 watts, according to Table 4.2. The wattage figure peaked at two o'clock in the afternoon when the solar panel was exposed to the most sunlight. The increased current equals 0.55 A, whereas the gained voltage equals 13.5 V. Researchers resumed their efforts to assess the power worth of solar energy on the third day of the examination. At one o'clock in the afternoon, the wattage value was 6.55 W,

The sky was clear and bright that day, and the solar panels had successfully absorbed all the sun's rays and energy. The voltage and current required to produce one watt of electricity are 13.1 volts and 0.50 amperes. With a voltage value of 4.1 volts and a current reading of 0.2 amperes, the lowest wattage figure that could be reliably measured is 0.82 W. Because the sun rises toward the east, the light from the sun is not yet at its peak intensity at seven a.m. As a result, this type of occurrence is possible. A comparison can be made by looking at Figure 4., which reveals that Day 2 has the highest power value, measuring 7.42W. Looking at the graph demonstrates this. On that specific day, the sun's position, which produces light, is such that it is aimed directly at the solar panel, and the cloud's location does not obstruct the path that the sunlight follows.

3.1.1 Time Taken to Charge Battery by Using Solar

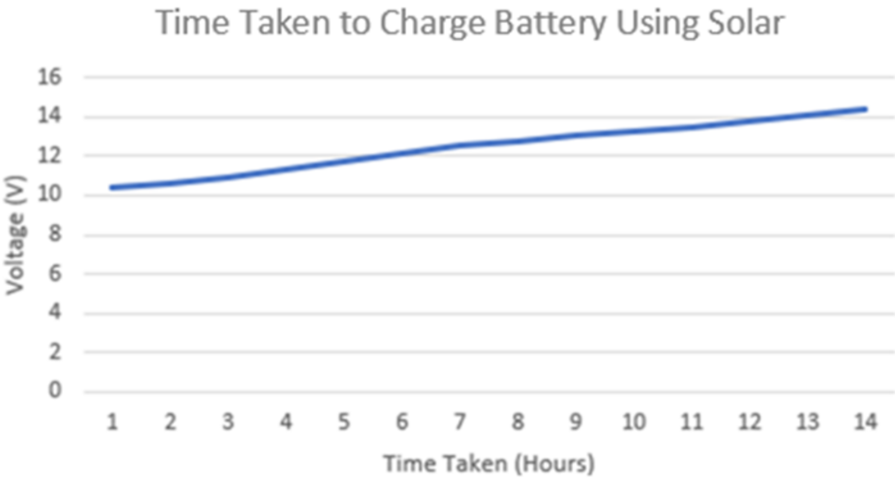


Figure 5: Line Graph of Time Taken to Charge Battery

The battery will charge to 14.4 V from 10.4 V. This project uses a 12V 7Ah Battery Matrix Rechargeable Sealed Lead Acid. From 9 to 6, the battery charges. Table 4.13 shows the first-day-charged battery had 13.3 V. The storm charged the next day. Solar charge controllers charge batteries. Solar charge controllers limit generator turbine voltage to the battery to prevent overcharging. 14.4 V prevents overcharging in this project. Thus, the solar charge controller will block voltage when the storm has fully charged. Solar panels charge batteries at noon. Solar panels provide the most storm-storable power.

3.2 Supplying Energy to Load Control by IoT

Arduino is a microcontroller with built-in WIFI that can connect with other devices through the internet. The WeMo's D1 Wi-Fi Uno R3 ESP8266 IoT connects to the internet through a smartphone in this experiment. Distance tests their communication. The table below shows results from the experiment where the WeMo's D1 Wi-Fi Uno R3 ESP8266 IoT and smartphone were split by 10, 50, 100, and 1000 meters. The experiment develops an embedded IoT-controlled remote-control system. Load off in Figure 6. This project utilizes a 6W DC Motor Pump and Arduino. 12V powers Arduino and DC Motor Pump. DC Motor Pump, Figure 7. The Blynk app's smartphone ON button activates it. The user saves time by not moving to turn on the irrigation system. The overall concept. Background research and comparative studies related to the issue were discovered,analyzed, and critically evaluated by the organization.

Figure 6: Load Activation OFF using Blynk

Figure 7 Load Activation ON using Blynk

In this project, Arduino drives the WeMo D1 Wi-Fi Uno R3 ESP8266. WeMo's D1 Wi-Fi Uno R3 ESP8266 starts at 5V. According to the data, the WeMo D1 Wi-Fi Uno R3 ESP8266 WiFi's maximum smartphone-to-internet distance is 100 meters. Microcontrollers must be at least 100 metres from smartphones. 10 distance-based tests tested smartphone-controlled load activation. Blynk manages settings. Arduino IDE programmes the WeMo D1 Wi-Fi, Uno R3, ESP8266, and relay. Remotely operate household appliances via IoT. IoT may speed up home appliance startup. Building construction and smartphone (WeMo D1 Wi-Fi Uno R3 ESP8266) signal strength complicate this experiment. Without a constant signal, the WeMo D1 Wi-Fi Uno R3 ESP8266 cannot switch the relay. According to the data, the smartphone, WeMo D1 Wi-Fi, and Uno R3 ESP8266 Wi-Fi all triggered the load within 10 meters. WeMo's D1 Wi-Fi Uno R3 ESP8266 is 10-meter-rated. One-meter load activation worked. Short. The WeMo D1 Wi-Fi and the Uno R3 ESP8266 Wi-Fi could not turn on the lights from 1000 meters away. Remote users activate lights at 10–100 meters. This study omitted 1,000 meters. recommendations

3.3 Watering System through The IoT Control System

This section has three watering modes: automatic, manual, and timer.

3.3.1 Condition A :Automatic Mode

The soil moisture sensor's signal allows the Solar IoT Smart Garden project system to run in autonomous mode. Because the soil is damp, the 5V relay module will not switch on the DC Motor Pump when the soil moisture measurement reaches 40. DC Motor Pump is off.

Figure 8: System in Automatic Mode

Because the soil is dry, the 5V relay module will switch on the DC Motor Pump to irrigate the trees when the Arduino soil moisture sensor sends a value below 40. Blynk will also notify the user when the ground is dry and the DC Motor Pump is ON.

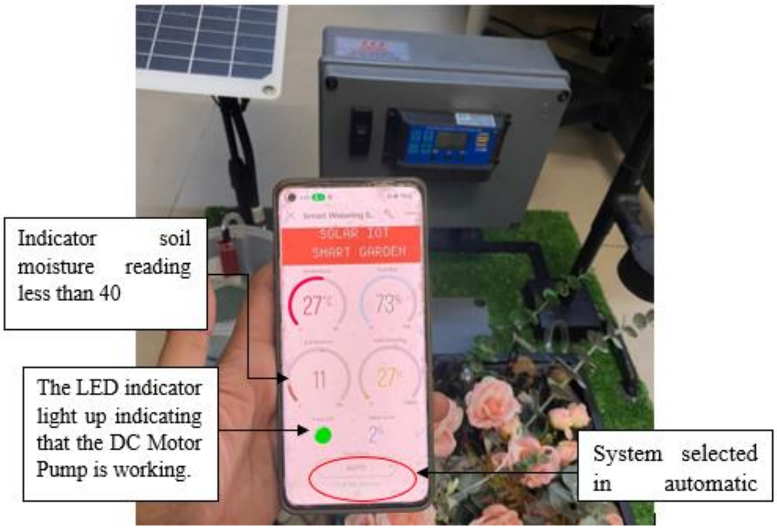


Figure 9: System Working when Soil Moisture Sensor Detect Soil is Dry

The DC Motor Pump will turn OFF when the soil moisture sensor reading exceeds 40, indicating that the soil is already moist. The Led Indicator is also extinguished, and once again, the user will receive a notification that the ground is in good condition and the pump motor is OFF. This mode is produced based on the source code that has been created 1. For more understanding of this automatic mode, refer to Table 1 below.

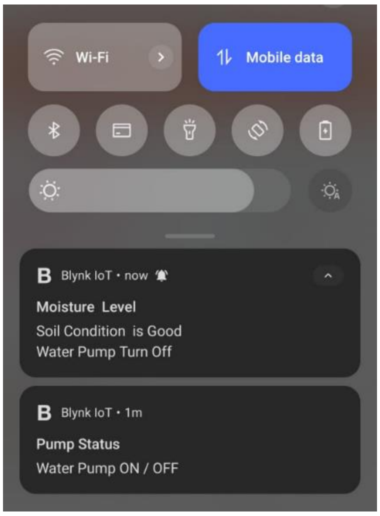


Figure 10: System Stop Working After User Receive Notification

Table 1: Automatic Mode Working

No.	Soil Condition	Moisture Sensor	DC Motor Pump
1.	Dry	0<40	ON
2.	Wet	0>40	OFF

3.3.2 Condition B: Manual Mode

The Dc Motor Pump can be controlled in this manual mode through the Blynk application. There is a manual or Auto button on the Blynk interface. The button on the interface is a switch to Dc Motor Pump. When the button is pressed to go from Auto to manual mode, the Dc Motor Pump will work, and the Led indicator will light up. When the manual mode is stuffed into auto mode, the Dc Motor Pump will stop, and the Led indicator will go out. With this mode, users can water their plants at any time.

This mode is produced based on the source code that has been created 1. For more understanding of this manual mode, refer to Table 2 below.

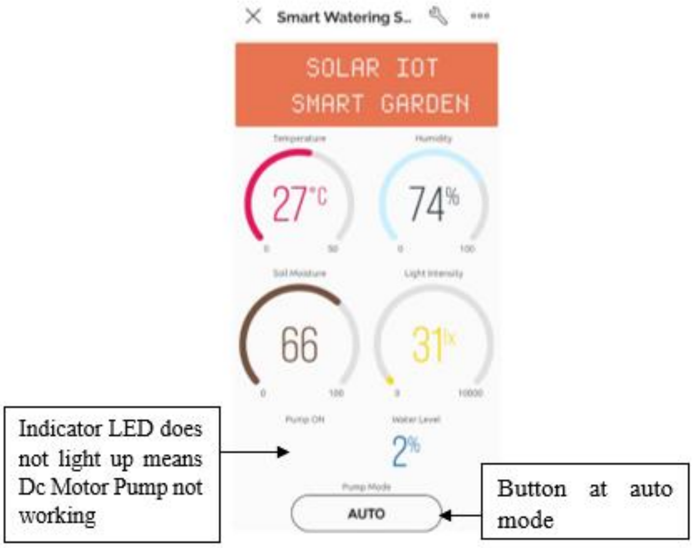


Figure 11: Dc Motor Pump Not Working when Button at Interface Blynk Application is at Auto Mode

Table 2: Manual Mode Working

Button at Interface Blynk	Dc Motor Pump
Auto	OFF
Manual	ON

3.3.3 Condition C: Timer Mode

In this timer mode, the system works when the time has been set on the Blynk application. When it is time for the system to work, the user will be notified that it is running where the DC Motor Pump is working.

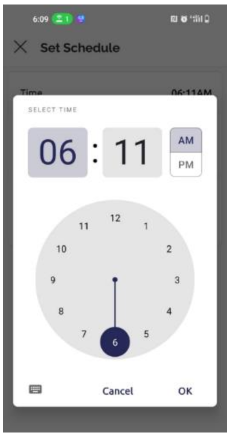


Figure 12: The User Needs to Set a Time for The Watering Process

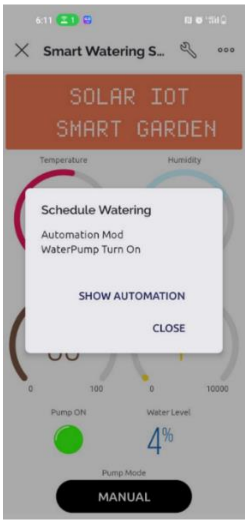


Figure 13 : When the Time that has been Set for Watering arrives, The User receives a Notification that Watering is Taking Place. DC Motor Pump will Turn ON

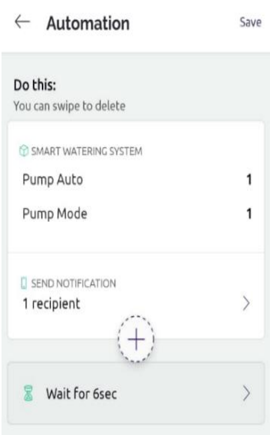


Figure 14: The DC Motor Pump will Work for 6 Seconds and will Automatically Stop Working for Watering

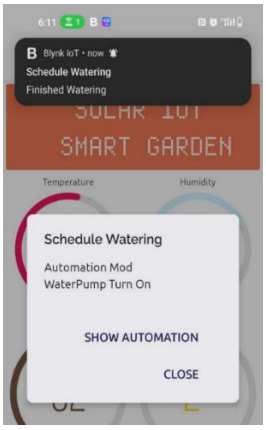
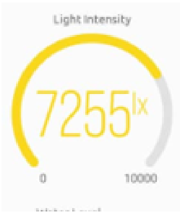
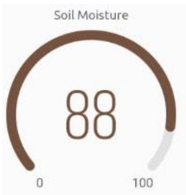
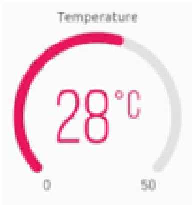
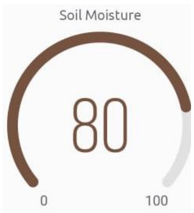
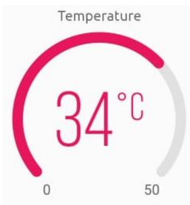
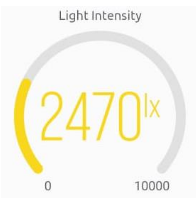
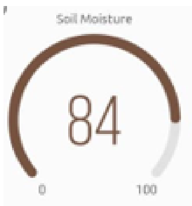
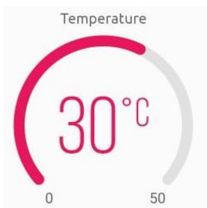
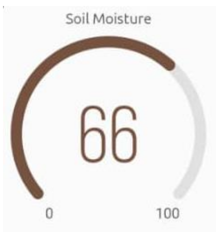


Figure 15: After 6 Seconds the User will get a Notification that Watering is Finished, and The DC Motor Pump will Stop Watering

3.4 Sensor Output Reading Control

This experiment included four sensor types. BH 1750 FVI Ambient Light Sensor, Soil Moisture Sensor, DHT 11 Temperature and Humidity Sensor. Each Blynk-displayed Water Level Sensor has been tested for accuracy. Testing these sensors' accuracy helps users monitor their plants' environmental conditions. Except for Water Level Sensor, this sensor was tested for accuracy in one day. This experiment occurs at 10 am, 1 pm, 7 pm, and 10 pm. Table 3 shows test results.

Table 3: Data Test of The Accuracy of this Sensor Reading through Blynk Application

Time	Ambient Light Sensor	Soil Moisture Sensor	DHT 11	
			Temperature	*Humidity*
10.00 a.m.				
1.00 p.m.				
7.00 p.m.				
10.00 p.m.				

As a result of the tests that were carried out on the sensor at 10 pm, the ambient light sensor detects the presence of the lowest sunlight, which is 31lx. This happened because, at that time, no sun rays could be seen except for the effects of lamp light which allowed the reading to be 31lx. While at 1.00 pm, the ambient light sensor detects the presence of the highest sunlight, 9410 lx. This happens because currently the sun shines and the earth are getting full sunlight. It was also found that the soil moisture sensor has detected that the water moisture on the soil is decreasing starting from 10.00 am until 10.00 pm. The test on DHT 11 on the temperature side also showed that at 1.00 pm, the temperature reading was the highest, which was 34 degrees Celsius. In addition, research on DHT 11 in the humidity section also showed that at 1.00 pm, it was the lowest at 43 per cent. Based on the data obtained above shows that all three sensors are working correctly because of the source code in Appendix 1 that has been programmed.

4. Conclusion.

The "Solar IoT Smart Garden" project developed an efficient plant monitoring system, integrated solar technology to support power supply, and improved the current monitoring system using IoT technology. The study collected plant environment data using water level, humidity, light intensity, and soil moisture sensors. Blynk and the ESP8266 microcontroller sent this data to an IoT platform. This project attained its goals through implementation. The system monitored plant-health-related environmental parameters. Solar power was sustainable and efficient. IoT technology allowed the plan to send real-time data to users so they could change their plants' surroundings. Real-time monitoring and automated watering reduce plant dependence. The "Solar IoT Smart Garden" project showed IoT's potential to increase plant monitoring systems' efficiency and sustainability. The technology is stable, cost-effective, and easily copied and scaled for commercial use. This effort can inform solar IoT-based smart gardening research.

5. Acknowledgement

This research was made possible by funding from the Universiti Tun Hussein Onn Malaysia. The authors would also like to thank the Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia for its support

References

[1] R. L.R. Lokesh Babu, D. Rambabu, A. Rajesh Naidu, R. D. Prasad, and P. Gopi Krishna, “Solar Power Monitoring System using IOT,” J. Eng. Technol., vol. 7, no. 3.12, p. 526, 2018, doi: 10.14419/ijet.v7i3.12.16172

[2] F. Balo and L. Şağbanşua, “The Selection of the Best Solar Panel for the Photovoltaic System Design by Using AHP,” Energy Procedia, vol. 100, no. September, pp. 50–53, 2016, doi: 10.1016/j.egypro.2016.10.151.

[3] A. Elamim, B. Hartiti, A. Haibaoui, A. Lfakir, and P. Thevenin, “Analysis and comparison of different PV technologies for determining the optimal PV panels- A case study in Mohammedia, Morocco.,” IOSR J. Electr. Electron. Eng., vol. 12, no. 01, pp. 37–45, 2017, doi: 10.9790/1676-1201013745.Pujara, M. M. (2021). Solar Powered Smart Irrigation System. International Journal of Advances in Agricultural Science and Technology, 8(3), 48–56. https://doi.org/10.47856/ijaast.2021.v08i3.0

[4] A. B. Sproul *et al.*, “Characterization and analysis of multilayer solar cells,” *Conf. Rec. IEEE Photovolt. Spec. Conf.*, vol. 2, pp. 1410–1412, 1994, doi: 10.1109/wcpec.1994.520212

[5] M. Ghebrebrhan, P. Bermel, Y. Avniel, J. D. Joannopoulos, and S. G. Johnson, “Global

optimization of silicon photovoltaic cell front coatings," Opt. Express, vol. 17, no. 9, p. 7505, 2009, doi: 10.1364/oe.17.007505

[6] W. Thounaojam, V. Ebenezer and A. Balekundri, "Design and Development of Microcontroller Based Solar Charge Controller", International Journal of Emerging Technology and Advanced Engineering, Vol. 4, Issue No. 5, May 2014, pp. 510-513.

Simple Autonomous cleaner Robot. Journal of Computer Assisted Learning, 4(5), 1231–1236

[7] T. Majaw, R. Deka, S. Roy, and B. Goswami, "Solar Charge Controllers using MPPT and PWM: A Review," ADBU J. Electr. Electron. Eng., vol. 2, no. 1, pp. 1–4, 2018. 1–7.

[8] V. Mantri, N. Mohite, P. Aishwarya, and N. Prof. Yadaf, "Automatic Drip Irrigation System using PLC," vol. 05, no. 03, pp. 38–41, 2018.

[9] A. Sharma, V. Vaidya, and K. Jamuna, "Design of an automatic solar tracking controller: Solar tracking controller," Int. Conf. Power Embed. Drive Control. ICPEDC 2017, pp. 505–510, 2017, doi: 10.1109/ICPEDC.2017.8081141.

[10] B. Naresh and K. R. K. Prasad, "Analysis of Dc Solar Water Pump and Generalized Photovoltaic Model Using Matlab / Simulink," vol. 2, no. March 2012, pp. 978–981, 2012, doi: 10.3850/978-981-07-1847-3.

[11] D., Drishti; Patil, Pallavi; Punjabi, Sunil K. (2016). [IEEE 2016 International Conference on Computation of Power, Energy Information and Communication (ICCPEIC) - Melmaruvathur, Chennai, India (2016.4.20-2016.4.21)] 2016 International Conference on Computation of Power, Energy Information and Communication (ICCPEIC) - Automated plant Watering system., (), 180–182. doi:10.1109/ICCPEIC.2016.755724

[12] Tatu, N. I., & Alexandru, C. (2012). Designing the tracking system for a string of photovoltaic modules. Advanced Materials Research, 463–464(February 2012), 1589–1592. https://doi.org/10.4028/www.scientific.net/AMR.463-464.1589

[13] Mane, Aruna D Arif, Sirkazi Mohd Sehzad, Shaikh Sohail, S. A. S. (2013). Solar Panel Tracking System for GSM Base. International Journal of Engineering and Advanced Technology (IJEAT), 2, 56

[14] Pujara, M. M. (2021). Solar Powered Smart Irrigation System. International Journal of Advances in Agricultural Science and Technology, 8(3), 48–56. https://doi.org/10.47856/ijaast.2021.v08i3.005

[15] Kumar, M., Hanumanthappa, M., & Campus, J. B. (2014). I Ntrusion D Etection S Ystem Using D Ynamic a Gent. 2017 IEEE International Conference on Power, Control, Signals, and Instrumentation Engineering (ICPCSI), 7(3), 1044–1052.