Progress in Engineering Application and Technology Vol. 1 No. 1 (2020) 274-283
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PEAT

Homepage: https://publisher.uthm.edu.my/periodicals/index.php/peat
e-ISSN : 0000-0000

IoT: Based Solar Powered Water Pump System

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DOI: https://doi.org/10.30880/peat.2020.01.01.030
Received 20 September 2020; Accepted 09 November 2020; Available online 02 December 2020

Abstract: IoT Based Solar Powered Water Pump System is project development of an automatic watering plant system that replaces the conventional watering plant. This project was focus on controlling the system by using is a mobile application called Blynk. The idea of the project is to help small farmers and users remotely controll and monitor their farm and remote workspace within a limited distance. Besides; remote monitoring, this project also provide automatic plant watering in order to reduce time-consuming activities at farm. This system used a solar panel as the main source which is connected to the solar charge controller in order to ensure the battery will not go overcharge and will act as the protection to the battery. IoT Based Solar Powered Water Pump System is created to improve the conventional system that is readily available by utilizing the different approach of an access system with the application of a Wi-Fi phone and solar system. In conclusion, : IoT based solar powered water pump system was successfully created and tested. This project provie proof of small scale concept which will help small farmers to replace the conventional ways of watering plant watering. Solar power offers sufficient amount of electricity to power up the system as well as the battery to ensure that the system is also operating during nigt hour without solar radiation energy for future work.

Keywords: Solar power, Soil sensor, Dht11 sensor, Water pump, Blynk

1. Introduction

Photovoltaic is being employed around the whole world in the most recent years. It is widely used in many applications in remote areas. The photovoltaic (PV) system is based on semiconductor technology that converts sunlight into electricity [1]. Using photovoltaic as the power source for water pumping is considered as one of the most promising areas of PV application. PV water pumping systems generally consist of PV array, controller unit, motor, pump and water storage tank. Furthermore, these solar pumping systems are environmentally friendly and require low maintenance with no fuel cost. PV water pumping is gaining importance in recent years due to non-availability of electricity and increase in diesel prices [2].

Photovoltaic (PV) power for irrigation is cost-competitive in comparison to traditional energy sources for small-scale water pumping requirements. With the continuous increase in fossil fuel cost

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and reduction in peak watt cost of solar cells due to mass production, the photovoltaic power is to become further economical in the future [3]. PV powered water pumping systems have become attractive for livestock and agriculture applications in remote locations with limited access to conventional electricity [4].

This system consists of a Solar panel, which is the main source of energy and is given to the charge controller for extracting regulated power from a solar panel at different irradiation and also to maintain correct charging voltage and current in order to charge the battery storage that capability via NodeMCU and increase its life. Furthermore, an automatic irrigation system was designed for ensuring the proper level of water for growing up the plants all through the season that using solar power and battery as only the source of power to drives water pumps to pump water from the tank and the outlet valve purpose.

In this project, water can be pumped during the day and night by using source form battery power. Hence, the wireless transceiver module is used to serves as a data transmitter and receiver in which transmitted data collected by soil and DHT11 sensor will wirelessly transmit to the Blynk application which is the receiver unit. The sensors will continuously monitor the moisture content of the soil whether the soil is wet or dry and also collect the data about the water level of plants and update on the Blynk application of the user. The user can switch ON and OFF the motor based on the water level even from distant places by using a cell phone.

2. Operating Principles &Methodology of the System

This section outline the methodology used in this work. These include in details of working principle, the flow of the overall development and techniques for the entire project as well as detailed methodology of hardware, software including project cost. NodeMCU act as a processing unit that connected to the Soil Moisture and DHT11 sensors that used to detect or measure the moisture content that present in the soil and to display humidity and temperature. Thus, after NodeMCU received data from Soil and DHT11 sensors, it will transmit data to mobile phones via the Blynk system.

Referring to Figure 1 below, in the input section, NodeMCU will act as the main control of the system which will receive input from two different things. First was the soil sensor that is used to detect the content of water in the soil. Then the DHT11 sensor is used to measure humidity and temperature. The program code that is the source code used by the overall activity exists in this project and lastly, the Blynk app that is used to receive specific commands from the owner.

In the output section, the actuator which is the solenoid valves pump and water pump will receive input from the control center to ON/OFF the pump throughout the button in Blynk. And then the soil and DHT11 sensors will send the current status to the owner through the Blynk application and the Blynk application will display the result of the command entered by the owner.

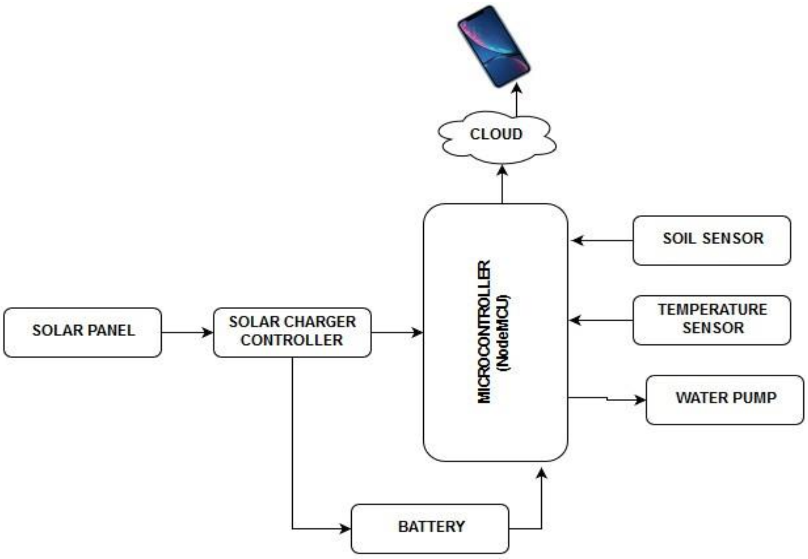

Figure 1: Block Diagram of IoT Based Solar Powered Water Pump System

This system consists of a solar panel, which is the main source of energy and is given to the charge controller for extracting regulated power from a solar panel at different irradiation and also to maintain correct charging voltage and current in order to charge the battery and increase its life

2.1 System Design

The system design is generally divided into two main pars. The first part is the development of hardware design while the second part was focusing on programming coding and software development. The hardware design involves the integration of the processing unit, a communication unit, and a sensor unit while software development focused on the programming implementation of the project.. Figure 2 shows the general flow diagram of the designing and development of hardware and softwareLists using items marked with a,b,c, or i, ii, iii, and so on can also be considered. Items in the list should be indented similar to paragraph indentation.

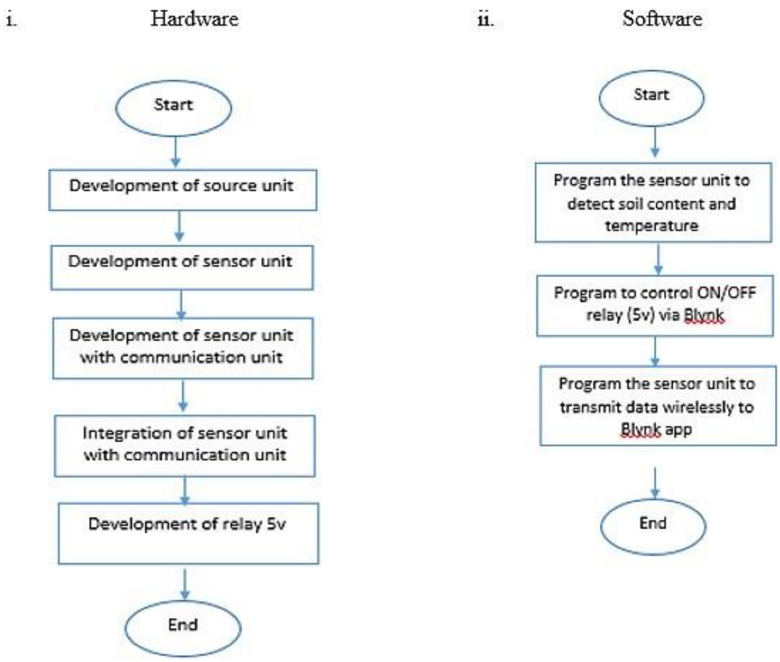

Figure 2: Flow diagram of designing hardware and software

2.2 Flowchart

The methodology of this study can be summarised in the flowchart below as shown im Figure 3.

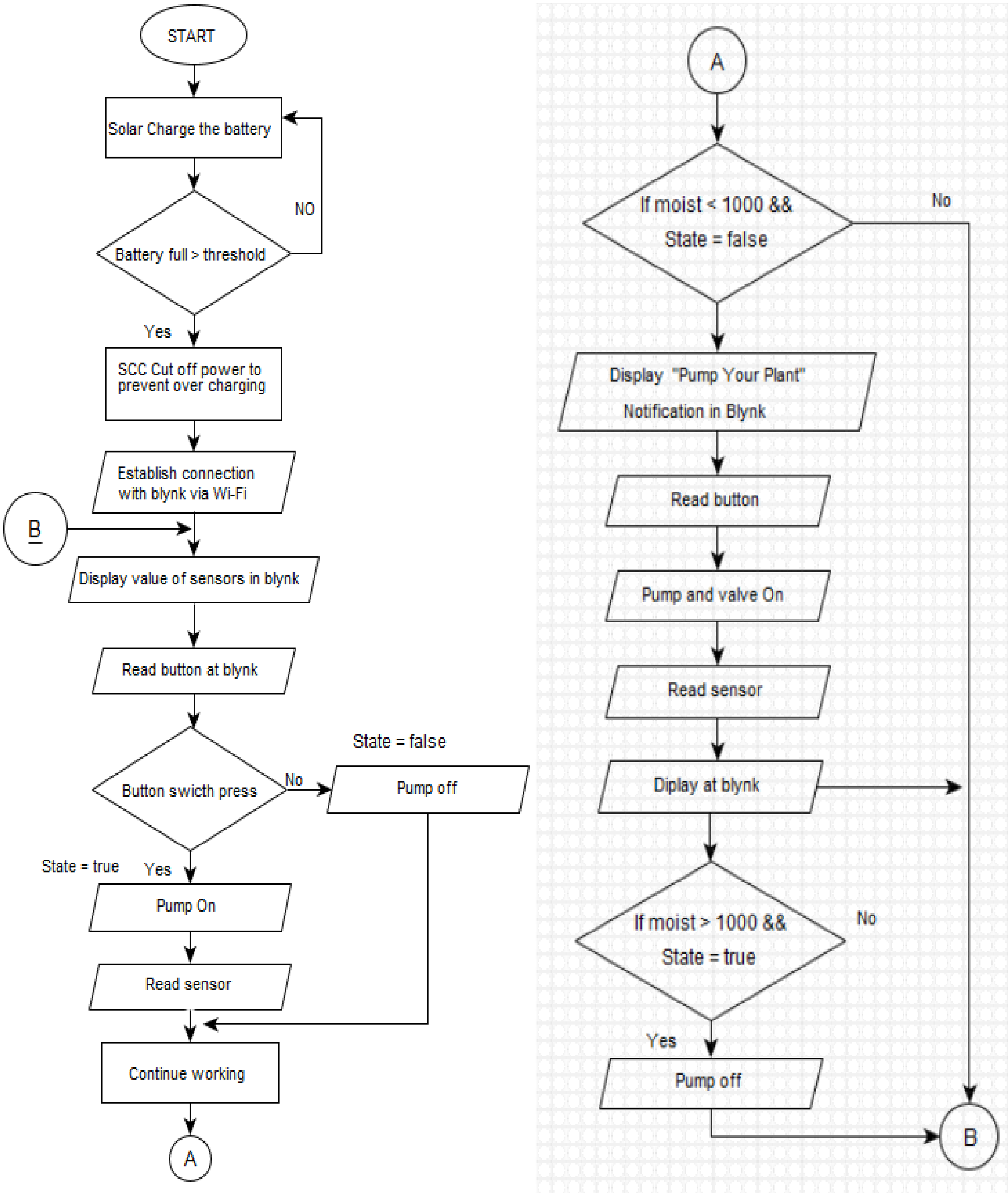

Figure 3: Flowchart of the project

2.2.1 Development of solar charger controller

Development of SCC is the important part, since in this project we only use the solar power as the main source and also to charger the battery. The understanding on development of SCC can be summarised in the flowchart below as shown im Figure 4.

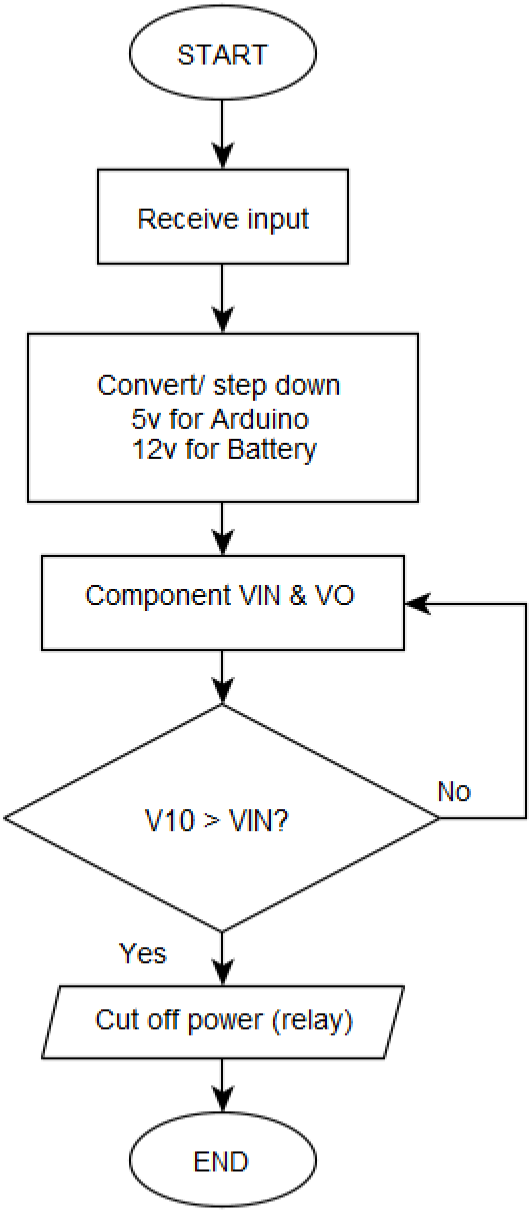

Figure 4: Flow chart of the SCC process system

2.3 Hardware Development

Figure 5 shows the design and development of solar-powered water pump systems would be take place in more detail. The development of the transmitter unit employed NodeMCU which connected with the soil moisture and DHT11 sensor. The NodeMCU act as the processing unit and the soil moisture and DHT11 sensor function to measure the moisture content present in the soil and temperature. On the other hand, the solar charger controller connected between the solar panel, battery, solenoid valve, and motor pump. Figure 5 shows the circuit diagram of the transmitter unit.

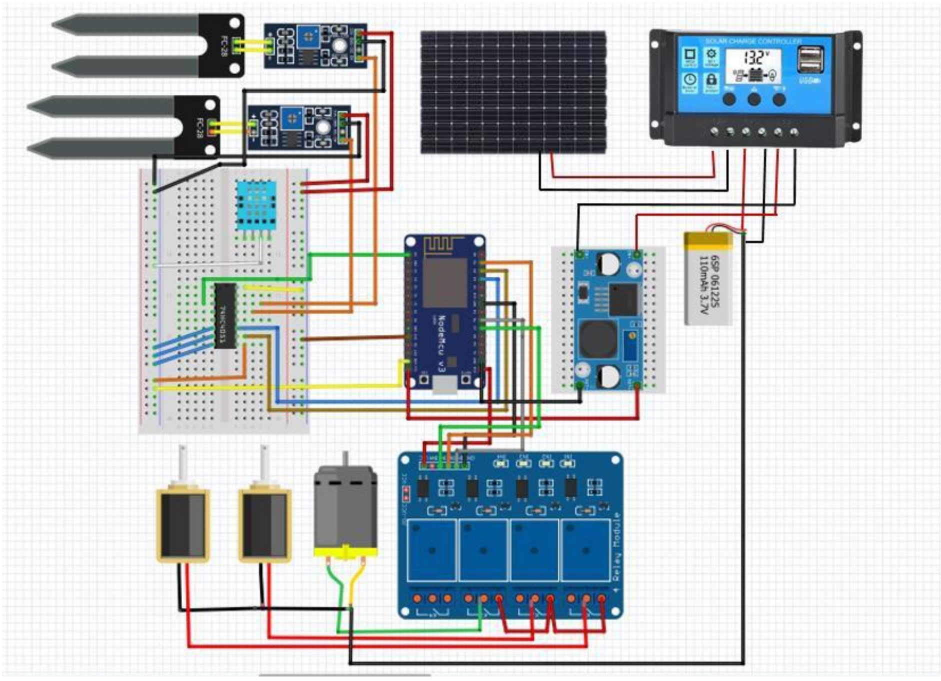

Figure 5: A complete connection diagram for this project

2.4 List of Hardware & Financial Cost

Below is the list of hardware and component cost of the project. Table 1 shows the hardware used for this project.

Table 1: List of Hardware

No.	Item	Quantity	Total
1	USB Micro B Cable	1	RM 4.00
2	Water Pump	1	RM 20.00
3	12V Battery	1	RM 37.00
4	Breadboard	1	RM 2.70
5	Jumper	2	RM 5.40
6	Soil moisture sensor	2	RM 7.00
7	Node MCU	1	RM 30.00
8	Solar Panel	1	RM 56.80
9	DHT11	1	RM 5.00
10	Solar Charger Controller	1	RM 27.00
11	Solenoid Valves	2	RM 26.00
		RM	RM 220.90

3. Results and Discussion

The developed prototype IoT Based Solar Powered Water Pump System is for the best method of watering and monitoring plant in this area that is completed and their functionality has been fully tested which strive to achieve the main aims of the work.

Figure 6 shows the complete circuit of The IoT Based Powered Water Pump System, where all the hardware part is combined. The NodeMCU will receive the data from the sensors and also receive the command given to turn ONN/OFF the pump from the Blynk app. The functionality test of the developed prototype work has been carried out on real scenarios and the overall system work well.

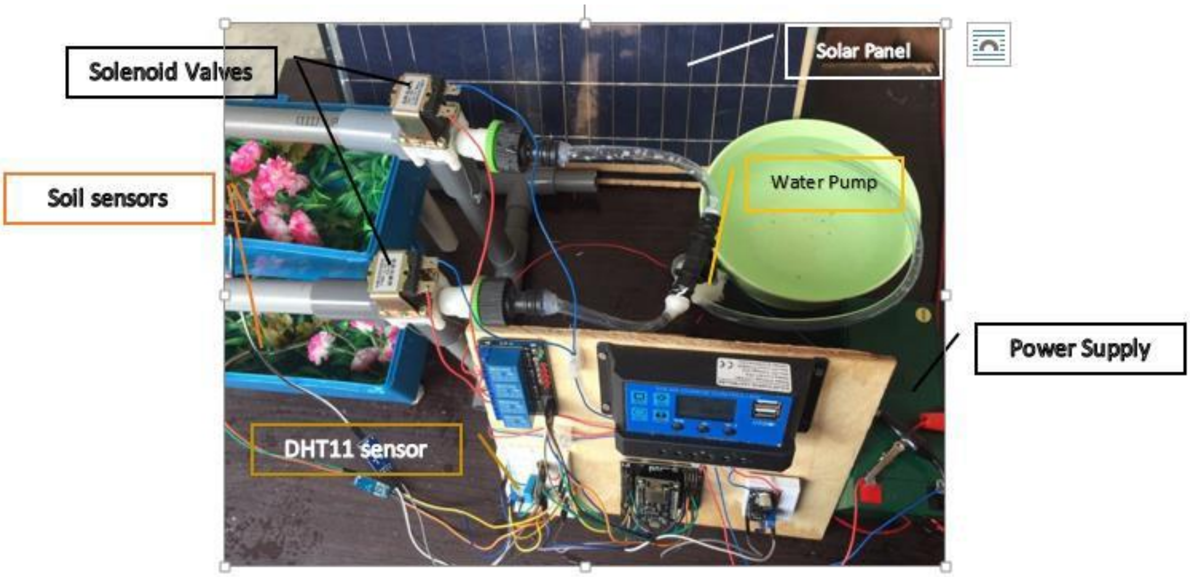

Figure 6: The circuit of the overall hardware

3.1 Solar Panel Charging Batteries

The test was conducted to determine the output voltage of the solar panel and the time taken to charge 12V batteries. The test was conduct on 23rd June 2020 and the data output produce from solar panel was recorded from 10:45 a.m. until 2:45 p.m. The hardware for the solar charger was assembled at Duyong, Malacca and the data was taken every thirty fives minutes continuously. Table 2 subsequently shows the reading of voltage reading during charging of the battery by solar panel.

Table 2: Voltage during charging of battery by solar panel

TIME	VOLTAGE
10.45 am	12.15
11.15 am	12.76
11.45 pm	13.34
12.15 pm	13.45
12.45 pm	13.49
1.15 pm	13.58
1.45 pm	13.63
2.15 pm	13.58
2.45 pm	13.60

Figure 7 shows the data collected from the solar panel to charge batteries. The results was shown as in every minutes, the voltage reading is increasing. From this test, it can be concluded that the highest output voltage solar panel can be obtained during peak hours between 11:45 a.m. to 2:45 p.m. because the changing value of voltage is high compared to the rest. This is because, during this hour, the sunlight produces the highest irradiance than other hours.

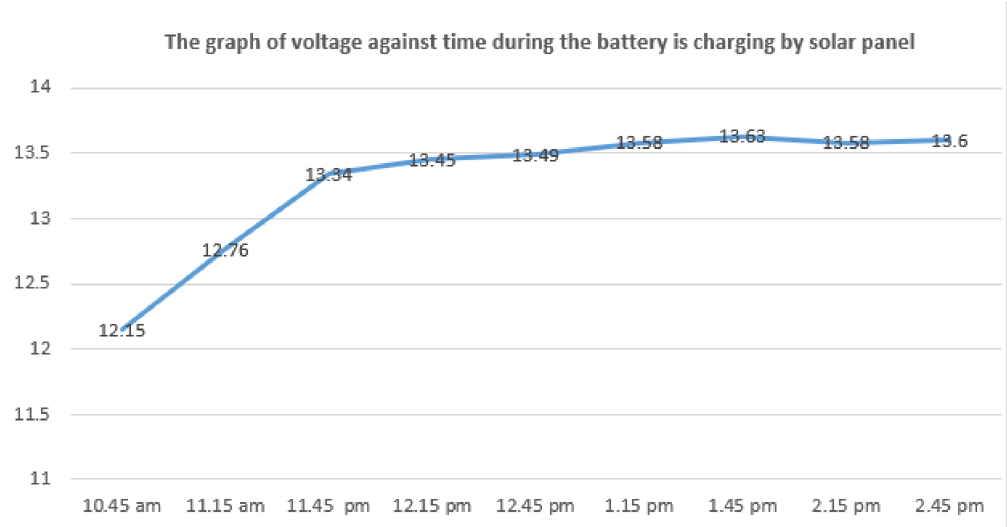

Figure 7: Charging voltage against time of the day

3.2 Testing and Result Analysis with Blynk application

Figure 8 (left pane) shows the notification that appears in the mobile phone when the soil sensor was in dry condition, so that the user or farmer will be more alert with their plants and gardens conditions. If the sensor value is is up to 66.0 % or higher, the notification will keep sending to user until the user opens the Blynk app and run the system. Then, the water pump will start to operate when the users begin to push button in the Blynk app according to which soil sensor was in dry condition. On the other side of the figure 8 (right pane) shows the value of the sensor during dry soil.

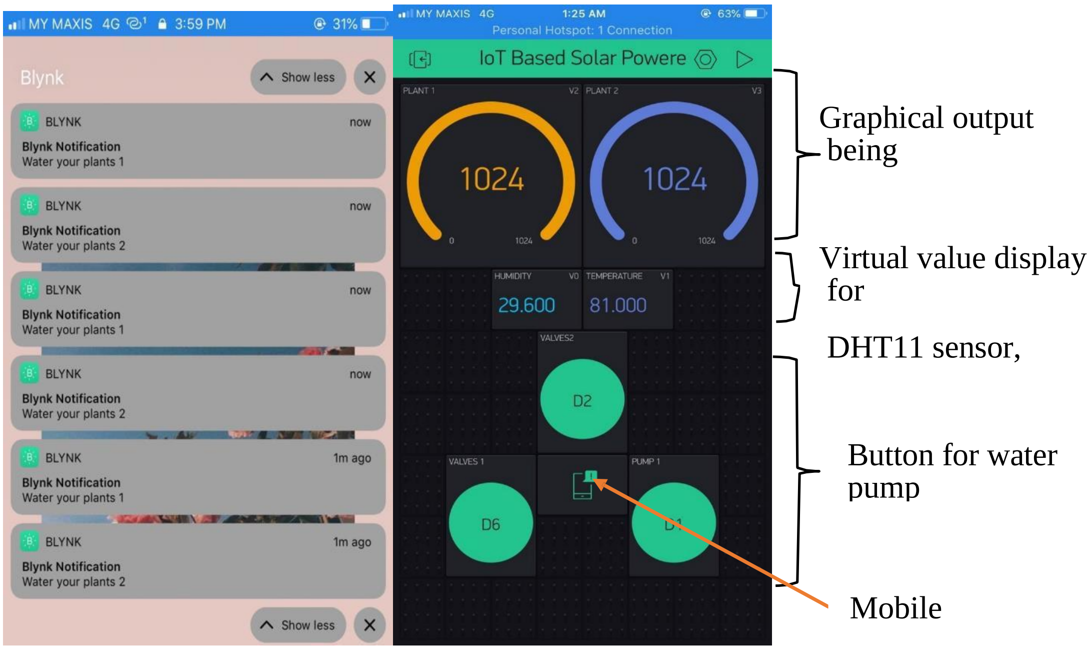

Figure 8 : (a) Notification on Blynk during dry soil and (b) Data displayed

3.3 Water Pump Operation

Figure 9 below shows the operation of the water pump in this project. In this system, the water pump only operate when the user turns ON/OFF the button of motor and valves through the Blynk application. For example, when the soil moisture sensor higher up to 66% the notification will send to user smartphone. And from that, the user will monitor the sensor first, on which soil moisture sensor has a higher of dry value. Then the user will run the motor and the solenoid valves according to which sensor. Figure 10 the operating condition on both plant.

Figure 9: Both solenoid valves open and pump water to plant 1 and plant 2

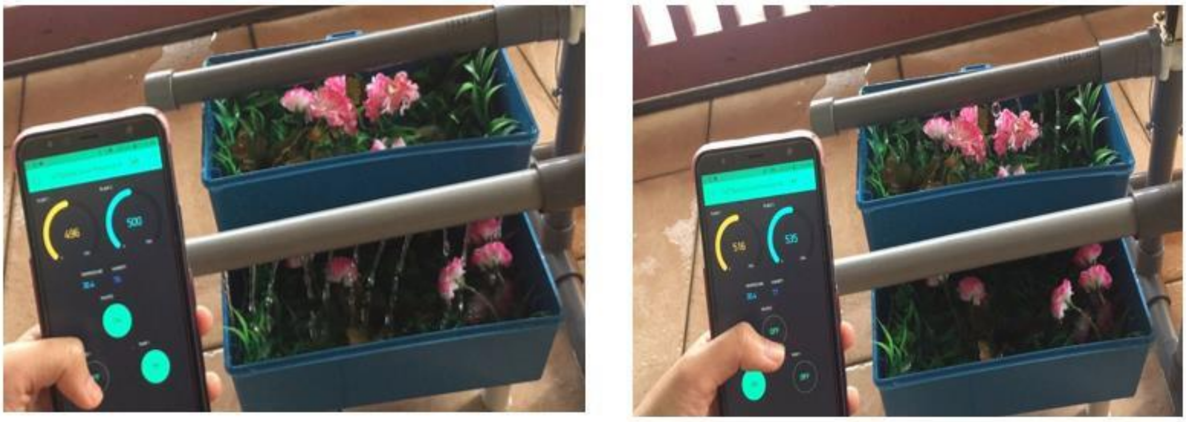

Figure 10: (a) Pump plant 1 ON, Pump plant 2 OFF and (b) Pump at plant 1 OFF, Pump plant 2 ONN

4. Conclusion

The prototype of IoT Based Solar Powered Water Pump Systems has been successfully developed and validated. Solar power provides a sufficient amount of electricity to power up the system as well as the battery to ensure that the system will can be operate at night. This project can be helpful in solving water wastage problem because this project can control the amount of water used with the used of sensors and also help plant grow in a health way. The results shows that iot based solar powered water pump systems can really help small farmers in reducing their workload as it can help reducing the time constraint, reducing the usage of water and also reduce the amount of money spends.

4.2 Recommendation

For the future extension of the prototype, there are several improvements that can be made to improve various features as follows:

i. The project can be extended by adding a camera such embedded at the around of the garden.

ii. Use a solar tracker to track the UV light from the sunlight

iii. A more powerful solar panel as well as a big battery capacity can make the project become more sustainable.

Acknowledgement

The authors would also like to thank the Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia for its support.

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