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A Smart Monitoring of Hybrid Mini Wind - Solar System Using IoT Application

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Abstract: Nowadays renewable energy systems becoming the most reliable way to generate electricity to exchange with non-renewable energy such as coal and gases. The objective of the paper is to develop a monitoring system for a hybrid mini-wind-solar system. Thus, the project has addressed the development of a prototype using NodeMcu ESP8266 as the main microcontroller. For the project development, the voltage sensor and current sensor function to monitor the mini hybrid wind-solar system's performance. The NodeMcu ESP8266 board is also through used to transfer data between system devices to the Blynk platform. A Blynk is a Platform used to achieve the Internet of Things (IoT) for this project. A mini hybrid wind-solar system data collection was conducted to evaluate hybrid system performance by directly automatic reading the data from the Blynk Application. The project was tested at Parit Sulong, Batu Pahat, Johor from 18th until 24th June 2021. Based on the result, the hybrid system was charging a 12V battery and turning on a 9V 3W bulb and a DC motor as a load of the system. The minimum and maximum power generated is 0.65W and 2.77W with the minimum and maximum wind speeds of 0.3m/s, and 2.4m/s, respectively.

Keywords: Mini Wind-Solar, NodeMcu ESP8266, Blynk Application

1. Introduction

Today, renewable energy systems are becoming the best way to generate electricity. Energy crises throughout the world are a serious issue. The non-renewable energy sources are rapidly depleting along with the increase in environmental pollution [1]. Solar energy and wind energy are the types of the most attractive sources of renewable energy used for electrification. In the Industrial Revolution 4.0 (IR 4.0), a comprehensive layout has been made for the new energy industry, as the representative of nuclear energy, wind, solar, and so on in the future.

The technology for the generation of electricity could support daily activities, especially for the people in rural areas [2]. Nowadays the most current and immediate concern affecting the power generation in Malaysia is the insecure gas supply, which leads to more dependence on coal and imported gas, and in the future time to time it will less and less run out.

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The research of a hybrid system at MingDao University at Taiwan Country using the vertical axis wind turbine design as an electrical power generation system [3]. The system uses Arduino and related electronic sensor modules to collect data. Next, the development of solar and wind turbine systems for power generation that supply to the domestic household in the remote area [4]. The microgrid system has been supplied from the 12 VDC solar and wind systems. The system gave the output of 220 to 240 VAC to the small house. The basic requirement of an electric minimum load is determined in 2 kWh for the small house which is including the essential load demand such as lighting and household appliances such as air conditioner, ceiling fan, water pump and socket outlet. The research are discuss switching between both generating systems to maintain constant energy production and keep longer battery life [5]. This research used the Visual Studio interface as the one in charge of the other part where the decision, to switch from one system to other, takes place. As a result, charging and battery voltage were around 11.8 volts, it was asked to deliver energy when the load got connected, and the current increased up to 600 mA so the control system switched to a W. T. battery, which had 12.02 volts and supported the 48 watt-load demand in that instant.

This project is using the Internet of Things (IoT) to perform monitoring output values such as voltage, current, and power. Thus, the project discusses the development of Smart Monitoring of Mini Hybrid Wind-Solar System Using IoT developers using Arduino Uno for testing and using NodeMcu ESP8266 as the main controller of the system. For the development of the project, voltage sensor, current sensor, and waterproof temperature sensor to monitor the performance of a solar panel system [6]. Using IoT increases knowledge of the operating parameters and also makes it easy to monitor the value from time to time. These reforms can make it easier to monitor the value of a long distance

2. Materials and Methods

This part discusses the main components and methods of this project.

2.1 Materials

The main components of the project are a mini wind turbine, a charger controller, a PV Solar panel, an Arduino UNO board [7], NodeMcu ESP8266 [8], a 12V battery and others.

i. NodeMcu Esp8266
   - To process all data input from the sensors and send output to the Blynk application for monitoring [9].

ii. Horizontal Axis wind Turbine (HAWT)
   - For this project, a mini horizontal wind turbine is used to monitor the output power generated from the wind turbine [10]

iii. Wind Turbine Charger Controller
   - A charge controller is essential for any wind turbine used to charge a battery [11]

iv. PV Solar Panel
   - PV Solar panel monocrystalline is used to generate energy from sunlight [12].

v. Solar Charger Controller
   - A charger controller is essentially a solar battery charger that connects from a PV solar panel to a battery [13]

vi. 12V Battery
   - Use a 12V battery to store electrical energy and to supply the load [14].

2.2 Methods

Focusing on the development of the hardware after the circuit development is successful. Numerous monitoring mini hybrid wind-solar system using IoT energy project has been developing in Malaysia. Nevertheless, for this project, both generators used are limited to 12V. Wind turbine takes two processes to generate electricity while solar energy is only one process to generate electricity. The first process is to convert the kinetic energy of the wind into mechanical energy using the rotor of the wind turbine. The second process is to convert the mechanical energy from the first process to electrical energy through a generator [7].

For solar energy, it only processes for solar panel are to convert solar energy into electrical energy from Photovoltaic panels [6]. The project used the IoT to monitor the value of voltage and current of the Hybrid Wind-Solar System. Thus, the project discusses smart monitoring of Mini Hybrid Wind-Solar Systems using IoT developers using NodeMcu Esp8266 as the main controller of the system. For the development of the project, the voltage sensor and current sensor to monitor the performance of the hybrid mini wind-solar system as shown in Figure 1.

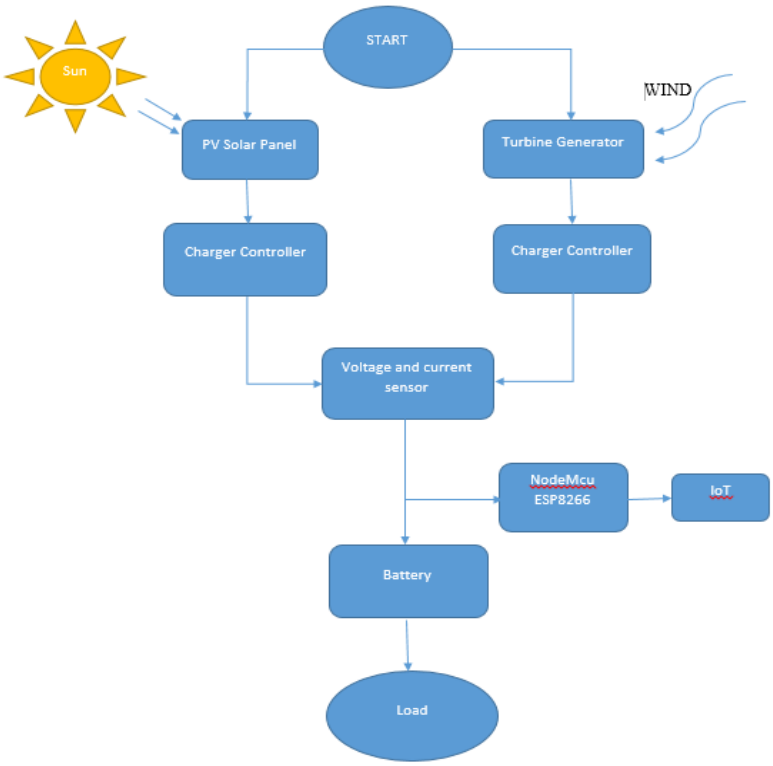


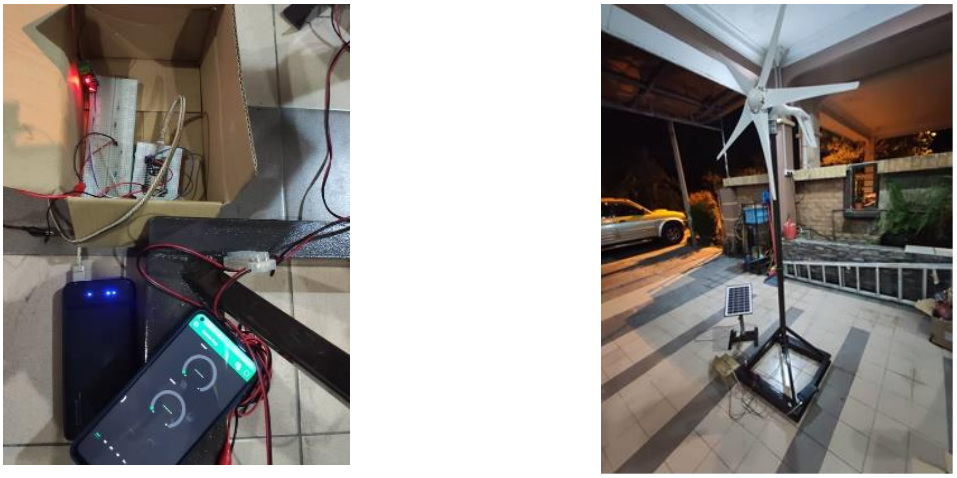
Figure 1: Flowchart of Project

3. Results and Discussion

The result is theoretically based on the simulation result and data collection for the mini wind turbine system by manual reading and Blynk platform based on charging a 12V battery and turning on the direct current load which is a 9V 3W bulb and 12V motor. The circuit's connection and coding program in this project are simulated using Proteus 8 Professional and Arduino IDE software.

Figure 2(a) and (b) show the prototype of the monitoring system attached to the Mini Wind-Solar System. The Mini Hybrid Wind Solar System is directly connected to the battery and connected to the monitoring system. For hardware development, several essential components were used to develop the hardware of this project. Firstly, the NodeMcu Esp8266 is the main component of this system. It is operated for the first when trial. All of the codings are processed in the NodeMcu Esp8266. Secondly, the part of the sensor consists of a current sensor and voltage sensor that are used to measure current and voltage. The sensors are connected to an analog pin in NodeMcu Esp8266 in testing. Lastly, for the

end user the NodeMcu ESP8266 replaces Arduino Uno and fully controls my NodeMcu ESP8266 for a monitoring system that continues updating the data to the Blynk platform.



(a) (b)

Figure 2: (a) The hardware of the monitoring system; (b) The prototype of the project

Smart monitoring of mini hybrid wind-solar system using IoT application comparison between the manual record and Blynk Application at Parit Sulong, Batu Pahat, Johor on 19th June 2021. The result is recorded every 1 hour, starting from 9.00 am until 5.00 pm. The data are recorded based on wind speed, voltage and current that also related solar system in Table 1. From the observation of the result at 1.00 pm on 19th June 2021, the higher percentage error is 1.28% based on the current result. Based on the voltage result the percentage error is 0% and for the power is 1.28%.

Table 1: Comparison of Reading Data manually and Blynk Application on 19th June 2021

Time	Reading Data Manually				Blynk Application			
	Wind Speed (m/s)	Voltage (V)	Current (A)	Power (W)	Wind Speed (m/s)	Voltage (V)	Current (A)	Power (W)
9.00am	2.2	10.40	0.074	0.77	2.2	10.30	0.08	0.82
10.00am	0.7	10.57	0.082	0.87	0.7	10.40	0.09	0.93
11.00am	0.5	11.80	0.088	1.04	0.5	11.60	0.09	1.04
12.00pm	0.7	12.23	0.098	1.20	0.7	12.30	0.1	1.23
1.00pm	1.2	12.78	0.156	1.99	1.2	12.75	0.15	1.91
2.00pm	1.7	13.30	0.208	2.77	1.7	13.40	0.21	2.80
3.00pm	1.6	13.28	0.197	2.62	1.6	13.45	0.20	2.69
4.00pm	1.8	12.67	0.167	2.12	1.8	12.50	0.17	2.13
5.00pm	1.9	11.82	0.091	1.08	1.9	11.75	0.09	1.06

Figure 4 and 5 shows the graph of voltage and current on 19th June 2021, respectively. Based on the graphs shows there are slightly different between reading data manually and the Blynk application. It is because of the different accuracy when the system read and the human read. The data error is because of the delay in transferring the data to the Blynk application from the system. It also the error may be from the potentiality of human error and instrument error when humans take a reading inaccurately.

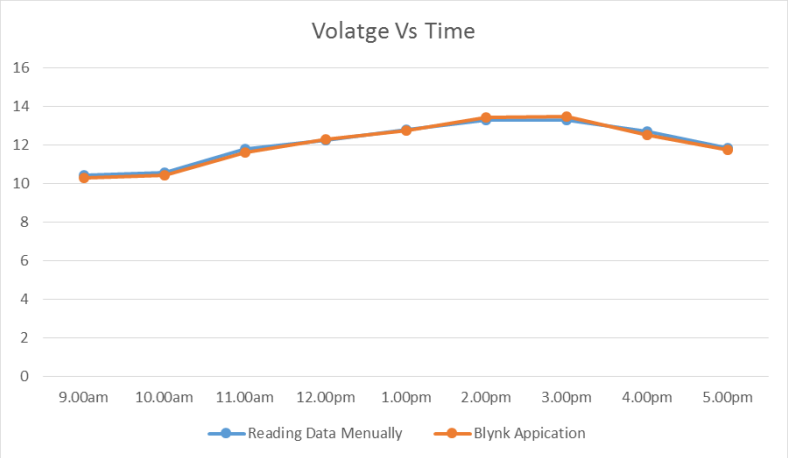


Figure 4: Graph of Voltage Vs Time on 19th June 2021

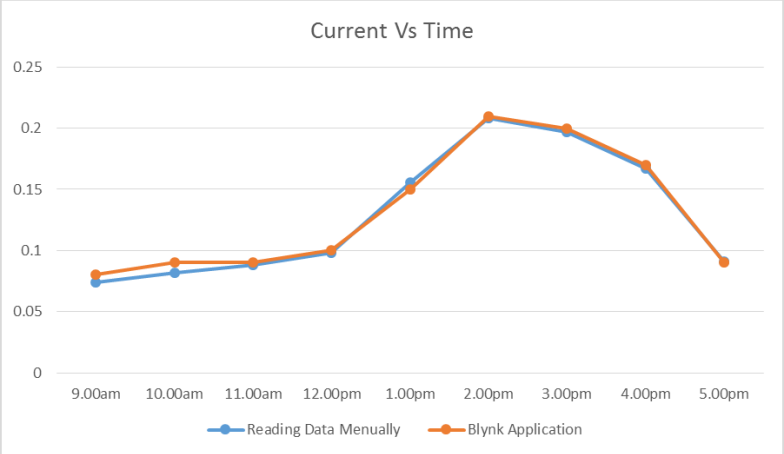


Figure 5: Graph of Current Vs Time on 19th June 2021

4. Conclusion

In conclusion, the development of the prototype for the mini hybrid wind-solar system with smart monitoring system using IoT succeeded through the Blynk application. Test output is generated on a mini hybrid wind-solar System in residential around Parit Sulong, Batu Pahat. The design of a hybrid mini wind-solar energy system is successfully done using Sketchup Software. Smart monitoring of the generation system using IoT using NodeMcu Esp8266 was also well developed as the monitoring system worked successfully. The data collection is difficult for measuring the cause of the mini wind turbine's output as the wind in a residential area of Parit Sulong is uncertain and the wind is not high speed to cycle the blade of the wind turbine even though the testing is in good weather. For the charging current, the current can generate an average of around 0.124A with an average wind speed of around 1.1 m/s from 18th June 2021 until 20th June 2021. For the direct current load test, the average power with a 9V 3W bulb load is 0.38W with an average wind speed of 0.8 m/s on 22nd June 2021 and the average power generated with a 12V dc motor load is 0.38W with an average wind speed of 1.3 m/s on 24th June 2021.

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