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Design of System Monitoring for Floating Solar Pane Energy Based on IoT: Blynk

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ABSTRACT

Floating Solar Power Plant is one of the energy plants that does not damage nature because solar panels are new renewable energy or EBT and are very effective in supporting world conservation and can be applied in remote areas in Indonesia. This research aims to design and create an IoT-based Floating Solar Power Plant monitoring system. The research methodology used is the experimental method by designing hardware and software monitoring systems, the hardware consists of temperature sensors, voltage sensors, and current sensors connected to a microcontroller. The result of this research is a monitoring system on floating solar panels using esp8266, DHT11, and ACS712. Tests conducted on the monitoring system have an average error value of 1.08% for temperature measurements, these results are based on comparing data on the system and manual measurements with calibrated measuring instruments. Current and voltage measurements have an error value of 4.65% and 2.20%. Based on the test results, it can be said that the monitoring system can work well, because the error value obtained is relatively small in the measurement of temperature, current, and voltage compared to the manual monitoring, from a fairly small error value can be concluded that the monitoring of the floating solar power plant made has worked well.

INTRODUCTION

In recent years the amount of fossil fuels has been depleted, which can lead to the need for new and renewable energy sources (Bilgen, 2004) (Shafiee & Topal, 2009) (Gunoto et al., 2022). Renewable energy is a source of energy produced from the utilization of natural resources that are environmentally friendly (Ng & Kingdom, 2013) (Yudhistira Nugraha et al., 2023) (Ellabban et al., 2014). Solar cells are one of the devices that can convert sunlight energy into electrical energy, this event is referred to as the Photovoltaic effect (Makki et al., 2015), which is the phenomenon of the relationship of each semiconductor in a photovoltaic (Bahers et al., 2014) (Lopez-Varo et al., 2016) (Mahmudah, 2021). Solar power plants (PLTS) in Indonesia began to be developed significantly in the 2010s (Rachmawati, 2024), Floating solar power plants were first introduced in Indonesia in 2014 (Andini et al., 2022).

The first floating solar power plant pilot project was built on a lake in Cianjur Regency, West Java (Sitompul et al., 2022) (Luckyardi et al., 2021). The project was developed by the State Electricity Company (PLN) in collaboration with the Indonesian Institute of Sciences (LIPI) (Kadang, 2022). Today, there are many solar energy systems available such as PV/Trombe walls, Floating Solar Power Plants (A. Jasim et al., 2023), Rooftop Solar Power Plants, and solar energy systems (Yadav & Bajpai, 2018). A floating Solar *P*ower *P*lant is a PLTS model that is placed floating on water such as lakes (Suh et al., 2020) (Cazzaniga et al., 2018) (Haas et al., 2020), reservoirs, and the like, including the sea, the advantage of floating *S*olar Power Plant does not require land which is generally expensive and reduces water evaporation inhibits the growth of weeds or water hyacinth, floating Solar Power Plant has a higher efficiency than conventional and can the temperature on floating *s*olar power plant is lower than *s*olar *p*ower *p*lant on land (Sahu et al., 2016) (Esmaeili Shayan & Hojati, 2021) (Bošnjakovic & Tadijanovic, 2019).

The use of IoT can monitor remotely and will regulate the battery charging and discharging mechanism in the *s*olar *p*ower *p*lant configuration so that the continuity of inverter operation can be maintained in supplying the load (Wu et al., 2017) (M. Sadeeq & Zeebaree, 2021) (Eghtedarpour & Farjah, 2014). From this description, a monitoring and control system that is fast and precise and can be accessed from anywhere and anytime by utilising the development of the internet network is needed. (Botta et al., 2015) (Hassanalieragh et al., 2015) (Haryudo et al., 2023).

Research related to the Solar Panel Monitoring System was carried out by Bagus Suryanto and Asnil in 2021 using esp8266 based on a website that holds the data in the MySQL database (Suryanto, 2021). Solar panels themselves produce the Photovoltaic effect, which is a condition in which an electrical voltage is created due to the intersection or contact of two connected electrodes when they receive light energy (Sigalingging & Ananda, 2021). The electric current generated in the solar cell is a DC current (Nurosyid et al., 2019).

METHODS

This research adopts a quantitative experimental method, where this approach is applied to system design and data analysis (Cahyo & Y, 2024) (Ananda et al., 2024).

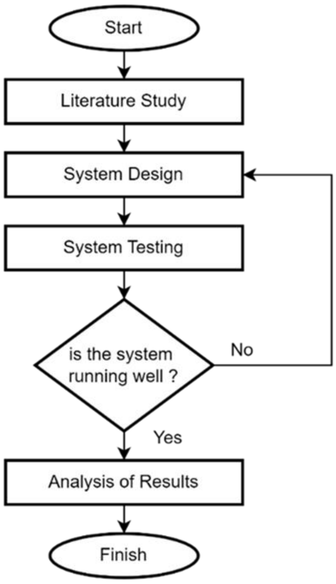

Figure 1 Research Stages

Literature studies are carried out by collecting and analyzing various theories obtained from various sources and further design and design of tools to design a solar power plant so that it can float and must be able to monitor, this monitoring uses an esp8266 microcontroller and DHT11 ACS712 sensor which is programmed using the Arduino IDE application to check temperature and voltage, current. Tool testing or PLTS testing so that it can float and monitor, if there is an error the tool does not work properly, it must be analyzed against the tool or program again esp8266 which has been assembled with sensors if it is deemed correct then testing the tool will be carried out Returning the tool runs well, retrieving data to analyze the results and finish.

Plan the design of the floating solar panel monitoring system, including the components to be used (DHT11 sensor, ESP8266, ACS 712 sensor, Microcontroller, Solar Panel), as well as the mechanical design to float the solar panel, the floating solar panel testing is carried out at 09.00 to 15.00 if the tool runs well the author will continue to the next stage, namely the analysis of the results.

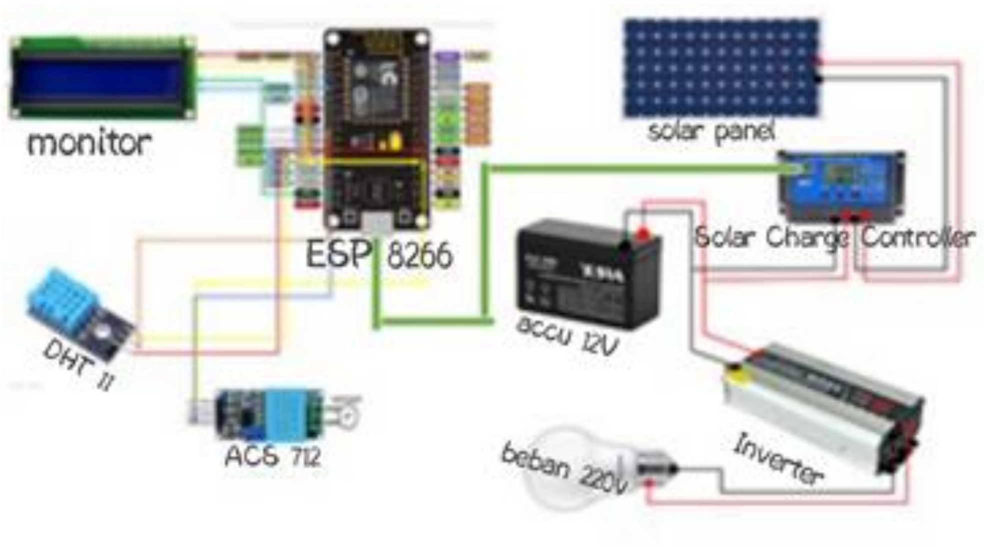

Figure 2. Schematic circuit

Based on Figure 2, the solar panel is connected to the SCC which functions to regulate battery charging, while the inverter functions to convert DC electricity to AC, the USB inverter output is used to power the esp8266, DHT11 sensor, and ACS 712 sensor then the value on the DHT 11 sensor and ACS 712 will be displayed on Blynk Monitoring to find out the value read by the sensor, the power value of the solar panel is calculated by multiplying the voltage by the current.

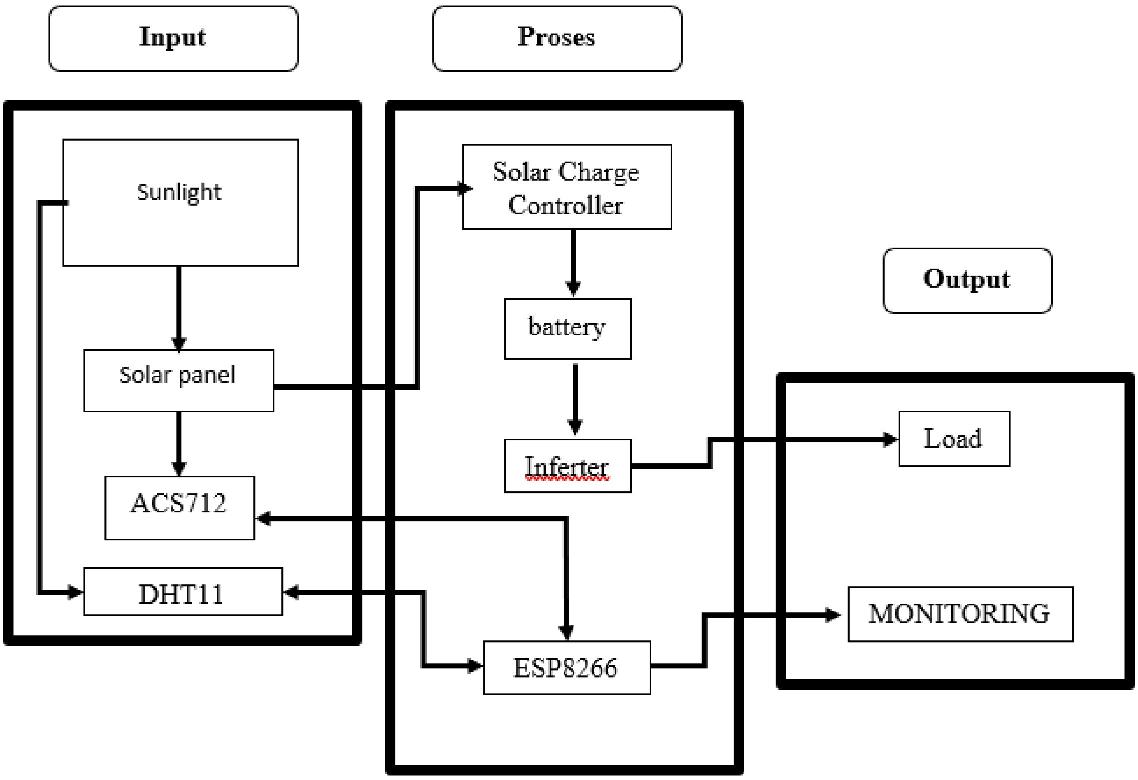

Figure 3. Component diagram

The work program of the solar panel monitoring system begins with turning on the ESP8266 to activate the sensor. Furthermore, the DHT11 sensor will read the temperature value on the solar panel and send data to the monitor used, the ACS712 sensor to read the voltage flowing through the sensor, and the results of the 2 sensor readings are sent to the ESP8266 then the data will be displayed on the monitoring.

Table 1. Solar panel specifications

Specifications	Value
Materials	Polycrystalline
Maximum voltage value	18 Volt
Maximum current value	1,11 A
Maximum power output	20 Watt
Size	450 x 350 x 15 mm

Table 1 explains the specifications of the solar panel material used, namely polycrystalline solar panels polycrystalline material is widely found in Indonesia (Asrori & Susilo, 2020). because the price is cheaper than monocrystalline and the maximum voltage entering the solar panel is 18 volts and a maximum current of 1.11 ampare and the power output on the solar panel is 20 watts. System description. The solar panel used is 20 WP with a maximum power capacity of 20 watts, more details can be seen in Table 1. In Figure 2 the system uses the ESP8266 as the microcontroller and the DHT11 sensor as the temperature detector and ACS712 as a solar panel current meter.

Monitoring research on the IoT-based Floating Solar Power Plant was carried out in the *Setu Patok* reservoir area located at (-6.7836400, 108 5717181) Situnggak Block, Setupatok, Mundu district, Cirebon, West Java. Testing was carried out on 07 June 2024 at 09.00 WIB until 15.30 WIB with clear weather conditions. Solar panels are in a static position with an angle of 15° facing north. Tests were carried out to compare the value of voltage, current, and surface temperature of solar panels based on the results of manual measurements and monitoring. Here are the conditions when testing or measuring solar panels.

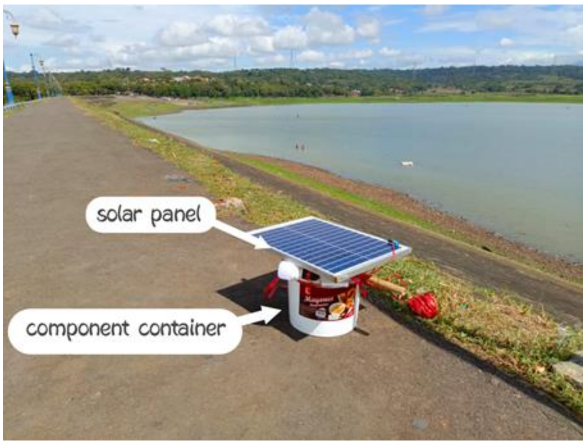

Figure 4. Condition of finished solar panels

Figure 4 above is a picture of the finished solar panel but has not been given a buoy or tyre for floatation.

Results and Discussion

Floating solar panel design and testing have been carried out. From the test results, the values of voltage, current, and surface temperature of the solar panel were obtained. The output of the floating solar panel in the form of voltage and current is measured using 2 methods, namely monitoring using sensors and manually using an Avometer. The temperature of the solar panel is measured using a thermogun.

Figure 5. Floating Solar Panel

Figure 5 shows the measurement of floating solar panels carried out from 09:00 to 15:00 and also performs manual and monitoring measurements. IoT-based monitoring system with Blynk application can be seen in Figure 6.

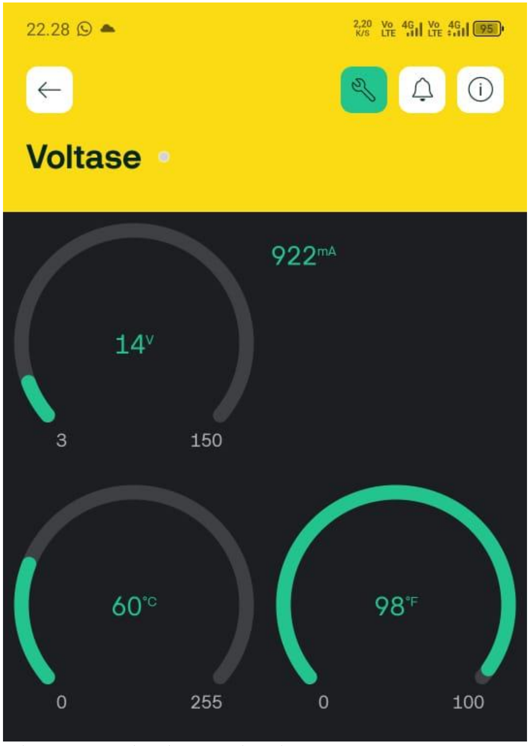

Figure 6. Blynk Monitoring

Table 2. Solar panel surface temperature test results

Time	Temperature Manual	Temperature Monitoring	Error (%)
09.00	33,00	34,00	-2,94
10.00	41,00	41,00	0,00
11.00	41,00	42,00	-2,38
12.00	45,00	45,00	0,00
13.00	44,00	45,00	-2,22
14.00	43,00	43,00	0,00
15.00	41,00	41,00	0,00
Average	41,14	41,57	1,08

Based on Table 2, the average temperature for manual measurements is 41.14°C while the average temperature for monitoring measurements is 41.57°C. The average error value is 1.08%.

Table 3 Solar Panel Output Voltage Test Results

Time	Voltage Manual (V)	Monitoring Voltage (V)	Error (%)
09.00	14,00	13,00	7,69
10.00	14,00	13,00	7,69
11.00	14,00	14,00	0,00
12.00	14,00	14,00	0,00
13.00	13,00	13,00	0,00
14.00	13,00	13,00	0,00
15.00	13,00	13,00	0,00
Average	13,57	13,29	2,20

Based on Table 3, the average voltage for manual measurement is 13.57 V while the average voltage for monitoring measurement is 13.29 V. The average error value is 2.20%. Based on Table 4, the average current for manual measurements is 0.87 V while the average current for monitoring measurements is 0.84A. The average error value is 4.65%. Based on Table 4, the average current for manual measurements is 0.87 V while the average current for monitoring measurements is 0.84A. The average error value is 4.65%.

Table 4 Solar Panel Output Current Testing Results

Time	Current Manual (A)	Current Monitoring (A)	Error (%)
09.00	0,93	0,85	9,41
10.30	0,91	0,86	5,81
11.30	0,95	0,88	7,95
12.30	0,92	0,95	3,16
13.30	0,91	0,88	3,41
14.30	0,83	0,84	1,19
15.30	0,62	0,63	1,59
Average	0,87	0,84	4,65

Based on the voltage and current values obtained, the value of the power generated can be calculated by multiplying the voltage and current values based on the data in Table 3 and Table 4. So the power value obtained can be seen in Table 5.

Table 5. Solar Panel Output Power Calculation Results

Hour	Measurement Power Manual (W)	Monitoring Measurement Power (W)
09.00	13,02	11,05
10.30	12,74	11,18
11.30	13,30	12,32
12.30	12,88	13,30
13.30	11,83	11,44
14.30	10,79	10,92
15.30	8,06	8,19
Total	82,62	78,40

Based on Table 5, the total power obtained for manual measurement is 82.62 W while the total power for monitoring measurement is 78.40 W. Research related to Solar Panel Monitoring Systems was conducted by Ida Ayu Nyoman Iswari Wikapti et al in 2023 with the discussion of solar power plants need to be monitored in real-time to get optimal performance. Real-time monitoring can provide information about system operating conditions and operating status (Ayu et al., 2023). next conducted by Saiful Bahroni et al in 2020 which discusses Solar Cell Monitoring using esp8266 and Android applications used for monitoring current and voltage parameters are made using MIT APP Inventor. The solar system is equipped with batteries and inverters to convert direct energy (DC) into alternating energy (AC) (Mayangsari & Yuhendri, 2023). Solar power plants can still generate electricity in cloudy weather as long as there is still light (Setiawan et al., 2014).

CONCLUSION

Floating solar power plant monitoring design and testing have been carried out. Based on the test results obtained the value of voltage, current, power, and surface temperature of the solar panel, the average manual temperature is 41.14 while the average monitoring temperature is 41.57 the error value is 1.08%. The average manual voltage is 13.57 (V) and the average monitoring voltage is 13.29 (V) the error value is 2.20%. The average manual current is 0.87 (A) and the average monitoring current is 0.84 (A) the error value is 4.65%. From the voltage and current data, the power value is obtained, the manual power is 82.62 and the monitoring power is 78.40.

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