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Design of Prototype Hybrid Solar and Wind Power Electric Boat

Reza Juliangga[1)]
1)Prodi Teknik Elektro, Fakultas Sains dan Teknologi, Universitas Pembangunan Panca Budi, Indonesia

*Coresponding Email: rezajuliangga@dosen.pancabudi.ac.id

ABSTRACT

Design of hybrid Solar and Wind Power Electric Boat powered by a 12V DC motor prototype. In the initial stage of the project, technical drawings of the Electric boat were drawn using Sketch Up software. In the technical drawings, the positions of all important components such as solar panels, wind turbines, and batteries on the boat are shown. In the next stage, the design of a battery charging system will follow. ATMega 8535 microcontroller is used as a 'brain' to select the higher DC input voltage from either solar or wind energy. After the design of the battery charging system has been completed, the hardware will be installed on a small-scale Electric Boat similarly as in the technical drawing, with previously calculated specifications 1 5Watt 12V photovoltaic and 12V 1.2aH battery. In the final stage, the prototype will be tested to assess the efficiency of the battery charging system using ATMega 8535 microcontroller, with delay reads 1 second and an accuracy of 98% reading. Condition of the battery is also stable enough to provide a load on the motor with an average of 9.8 V. The boat can also move steadily even though the movement Slow speed.

Keyword: Prototype, Electrik Boat, Hybrid, Solar and Wind Power, Sketch Up.

INTRODUCTION

With the high prices of fuel oil, the impact on the fishermen's economy and the fish seekers is increasingly depressed. Their condition is increasingly apprehensive when the supply of fuel oil that becomes an alternative to fuel goes out to sea is difficult to obtain. Once out to sea, these 10 horse power boating fishermen spent twenty-five litters of diesel for one day (Dewi Rianti Mandasari, et al.2024). The use of fuel oil also causes severe environmental pollution, there is often a leakage of fuel storage tanks, this is what causes environmental pollution due to fuel oil spilled into the sea.

To help the fisherman's economy or the provider of marine transportation services and reduce the environmental pollution that occurs in the sea, the use of electrical energy is more helpful in terms of cost and ease of use and the amount of renewable energy available such as wind and solar power which is a kind of renewable energy with zero level pollution, and its unlimited availability. Solar power can be converted directly into electrical energy using photovoltaic, whereas to convert wind energy into electricity by utilizing the wind blow used to rotate the blades on the wind turbine (Dewi Rianti Mandasari, et al.2024). Electrical energy generated by solar cells and wind turbines is stored in batteries and used to operate a DC motor as a booster driver. Where all these systems can we control with a monitoring system.

The monitoring system is one form of control over something the equipment may only consist of several parts of the machine and components that work together, which is used to perform a particular operation. This system is widely used in its application to the industrial sector. This is done to determine the performance of a plant. At this time, there is much software that can be used to perform monitoring system.

Here the author will make a boat monitoring design using ATmega 8535. Which will be monitored on a boat is a control circuit of the boat consisting of DC motor rotation as a boot drive, battery voltage on the boat to know the capacity of the battery, and the temperature of the plate that is cooling IGBT (Insulated Gate Bipolar Transistor). The results of monitoring motor rotation, battery voltage and temperature will be displayed on the LCD display.

RESEARCH METHODS

To Optimum Sizing of the Electric Boat, a simulation using the Pspece software based on solar energy, temperature, and wind speed data is then adjusted to the equipment and components that will be used as hardware, it aims to calculate the number of components, and equipment used late, then the design of hybrid solar and wind energy will be implemented on boat prototype using 3-12V DC motor.

The generator that will be used as a wind turbine is a DC motor, the voltage generated by Photovoltaic and wind turbine is DC, which then the voltage will both be received by elimination system because the maximum capacity of the battery to be used is small, the elimination system will work to avoid overcharging, where the system will choose one of the larger input voltages to charge the battery, the battery will supply voltage to DC motor through the DC motor control system this is aimed to adjust the speed and polarity of DC motor to rotate propeller. In addition, the microcontroller will work when it gets a voltage supply from the battery then the microcontroller ATmega 8535 can receive and display voltage conditions on the battery, input, and output (Henry Toruan. 2021). As shown in Fig 1.

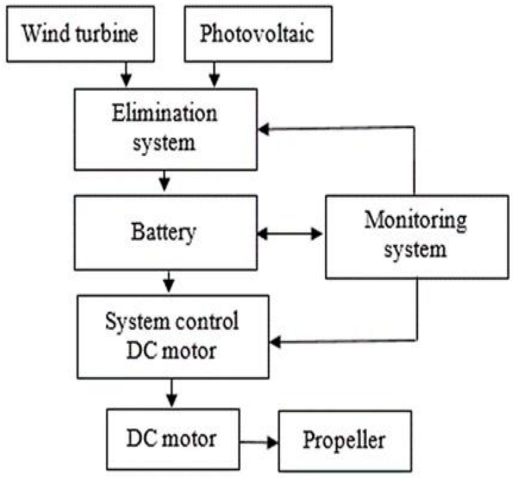

Fig 1. Block Diagram

A. Number of Photovoltaic module and Wind power generation

The number of Photovoltaic module and wind power generation is create using equation (1)

$$\Delta W = W_g - W_d \quad (1)$$

Where ΔW is difference between the generated energy and demanded energy. Number of PV module and wind power generation is optimum if the system is balance. In order for the hybrid system and load to stability over a given period of time, the curve of ΔW versus time must have an average of zero over the same period. A positive value of ΔW indicates the accessibility of generation and negative ΔW indicates generation deficiency. The sizing of charger controller and number battery can be calculated following the equation (2) and (3).

$$controller = 1.25 \times short\ circuit\ current \quad (2)$$

$$Battery\ (Ah) = \frac{Demanded\ energy\ of\ DC\ motor\ per\ day\ (Wh)}{12\ V} \quad (3)$$

B. Design prototype and Equipment specification

The boat prototype is designed using the Skechup software; the design is raining to know the shape, location of the equipment used, and the size of the boat that will be made (A Jaelani at, al., 2019). The design of the boat is shown by Fig 2.

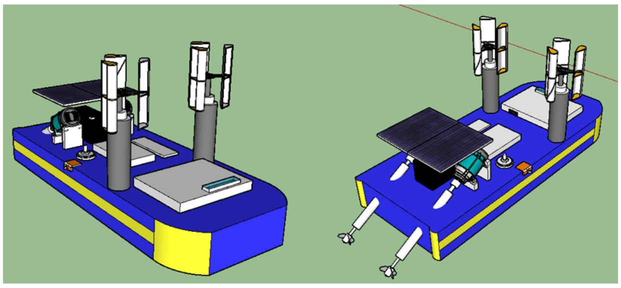

Fig 2. 3D Design using Sketch Up software

Table 1. Boat size specifications

No	Section boat	size (cm)
1	length Boat	45
2	width Boat	29
3	High boat	7
4	overall height	31

Selection of equipment specifications it is very important to know the compatibility of the equipment with each other than specifications of this equipment will be used to calculate optimize which will then get the number of equipment that is suitable for use in making prototypes, as shown in Table 2.

Table 2. Equipment specifications

No	Equipment	Specification
1	Wind turbine	DC motor 12-24v Motor diameter: approx. 24.5mm Motor height: approx. 34.2mm Motor shaft diameter: approx. 2mm Motor shaft length: approx. 13.5mm Rated speed: 100 - 6000 rev/min Diameter blade 11.5cm
2	Photovoltaic	Maximum power: 5.2W Material quality: polycrystalline silicon Working current:0-0.43(A) Working voltage: 12V Open circuit voltage:13 (V) Short circuit current:0.5(A) Size :210x165mm
3	Motor DC	Working voltage = 3-12 V DC Size = 2.5x 3 cm Trunk length = 8mm Diameter rods as = 2mm Current output = 0.06 - 0.16 A Power 5 watt Rotation speed = 4000 - 16000 rpm
4	ATmega 8535	ATMEGA8535-16JU MCU 8-bit ATmega AVR RISC 8KB Flash 5V 44-Pin PLCC
5	LDC display	16 x 2 cm
6	Battery	type 12V 1.2Ah

7	propeller	shaft length 15cm aperture / hole diameter 4 mm weight 5g diameter blade 2.5cm

C. ATMega 8535 micro-controller Design and Simulation

The simulation will be carried out using Proteus software to test programs and systems that will be installed on the ATmega8535 microcontroller; this also aims to design a circuit that will be implemented on a PCB board as a form of hardware. Simulation can be seen in the Fig3.

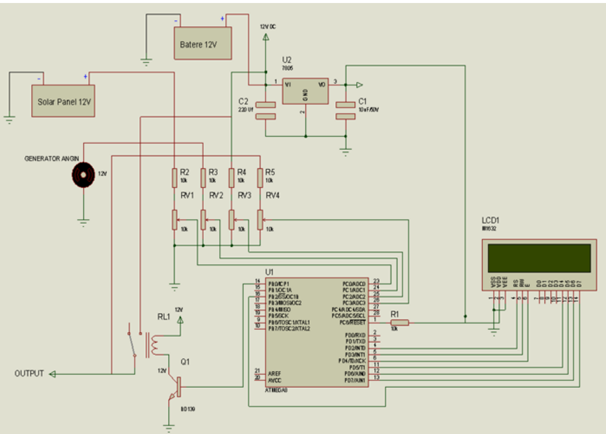

Fig 3. Simulation using proteus software

RESULTS AND DISCUSSION

A. Output Power of Photovoltaic module and Wind Power Generation

The PSpice software is used to simulate the curve of current versus voltage c (I-V curve) and the curve of power versus voltage (P-V curve) of 12 V, 3 W DIY polycrystalline silicon PV module. The simulation is based on the standard test condition (STC) on the solar irradiance of 100 W/m2 and temperature of 25°C (A.R. Amelia et al., 2016). The simulation results are compared to data sheet of 12 V, 3 W DIY polycrystalline silicon PV module using percentage error, e.

Fig 4 and Fig 5. show the I-V curve and P-V curve simulation results of 12 V, 3 W DIY polycrystalline silicon PV module, respectively. The comparisons of open circuit voltage, short circuit current and power of simulation results and data sheet of 12 V, 3 W DIY polycrystalline silicon PV module are shown in Table 3. They are validated using statistical analysis of percentage error, e in percent.

The percentage error of open circuit voltage, short circuit current and power are 2.27 %, 0% and 2.33%, respectively. They are indicated that the simulation results are acceptable and applicable because they are in the percentage error range of ±10% (Daut et al, 2011).

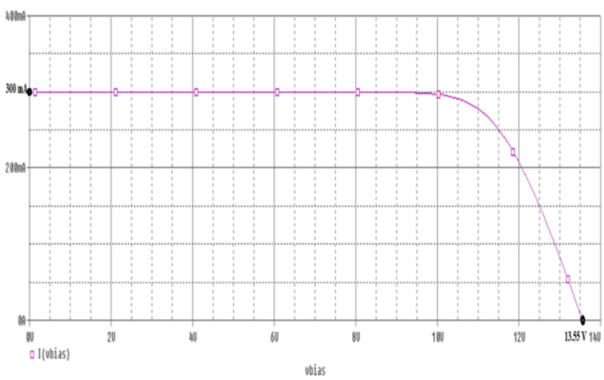

Fig 4. I-V Curve simulation of 12 V, 3 W DIY polycrystalline silicon PV module

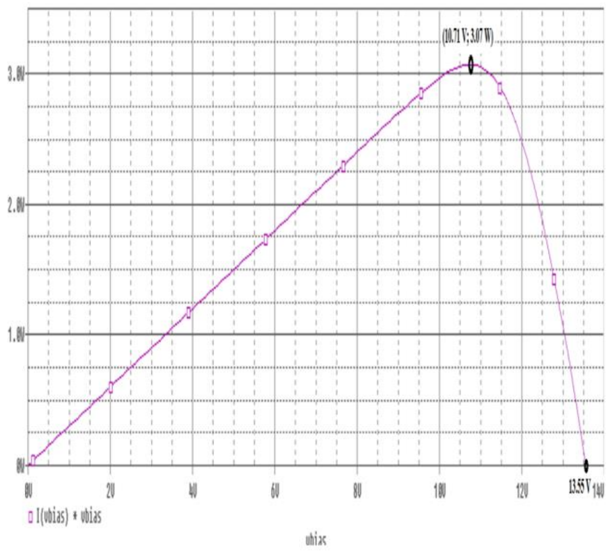

Fig 5. P-V Curve simulation of 12 V, 3 W DIY polycrystalline silicon PV module

Table 3. Comparison between simulation and data sheet of 12 V, 3 W DIY polycrystalline silicon PV module

Open circuit voltage (V)			Short circuit current (mW)			Power (W)		
Simulation	Data sheet	e (%)	Simulation	Data sheet	e (%)	Simulation	Data sheet	e (%)
13.5	13.2	2.27	300	300	0	3.07	3	2.33

The wind speed is a main parameter in the calculation of wind power generation when the diameter of turbine blade is constant. The power of wind power generation is proportional of wind speed and it is powered three. The higher wind speed produces the higher power of wind power generation. based on Web World Weather Information Service The minimum wind speed of 0.43 m/s occurs on 22th September 2023. The maximum wind speed of 2.08 m/s occurs on 7th December 2023. The average wind speed is 1.05 m/s, it is classified in a very poor wind speed (Irwanto et al, 2014). It indicates that Bandar Setia has not good potential of wind power generation

B. Optimum Sizing of PV/Wind Hybrid Powered Electric Board

The design of optimum sizing of PV/wind hybrid powered Electric boar are very important to obtain its good performance related to main energy sources (solar irradiance and temperature for PV module and wind speed for wind power generation). The optimum sizing is based on the number of PV module, wind power generation. Two DC motors are as DC loads of PV/wind hybrid powered motor board system. One DC motor has a rated power of 5 W, thus the total demanded power is 10 W(A.R. Amelia et al., 2016). In the design, they are operated in 24 hours per day, thus total demanded energy is 240 Wh. It is summation of energy of one PV module which operate in 12 hours per day and energy of one wind power generation which operate in 24 hours per day, the total daily energy generation is fluctuation following the weather condition of solar irradiance, temperature and wind speed.

This total energy generated by the PV/wind hybrid generation is as main energy generation to operate the DC motors. It is due to the energy generated by wind power generation is very poor, thus only one wind power generation is decided in the design of PV/wind hybrid powered motor board. A calculation should be done to obtain the optimum number of PV module following the equation (2) (Irwanto et al, 2014). The number of PV module is optimum if the generated energy by PV/wind hybrid generation is equal to the demanded energy of DC motors. The other hands can be said that number of PV module is optimum if the energy difference between the generated energy by PV/wind hybrid generation and the demanded energy of DC motors is zero. This condition can be achieved for the number of PV module is 17 modules. The PV/wind hybrid powered motor board system has optimum number of PV module of 17 module. On PV module has short circuit current of 0.3 A, thus the total short circuit current for 17 PV modules connected together in parallel are 17 x 0.3 = 5.1 A. The optimum sizing of charger controller of PV/wind hybrid powered motor board system can be calculated following the equation (2).

$$\text{Optimum sizing of charging controller} = 1.25 \times \text{short circuit current} = 1.25 \times 5.1 = 6.38\ A$$

A 12 V, 1.2 Ah battery is applied in the PV/wind hybrid powered motor board system. The optimum number of battery can be calculated following the equation (3).

$$Battery\,(Ah) = \frac{Demanded\ energy\ of\ DC\ motor\ per\ day\ (Wh)}{12\ V} = \frac{240\ Wh}{12\ V} = 20\ Ah$$

$$Number\ of\ battery = \frac{Batery\ (Ah)}{1.2\ Ah} = \frac{20\ Ah}{1.2\ Ah} = 16.7 = 17$$

Table 4. Optimum sizing of PV/wind hybrid powered motor board system

Number of wind power generation	Number of PV module	Sizing of charger controller	Number of battery
1	17	6.38 A	17

C. Prototype hybrid powered motor board

prototype made with a small size so that it has a small space as well so it is not possible to install the amount of PV and a battery of 17 pieces on the prototype, prototypes are based on designs that have the same size and use of the same components Prototype hybrid powered motor board shown in Fig. 6.

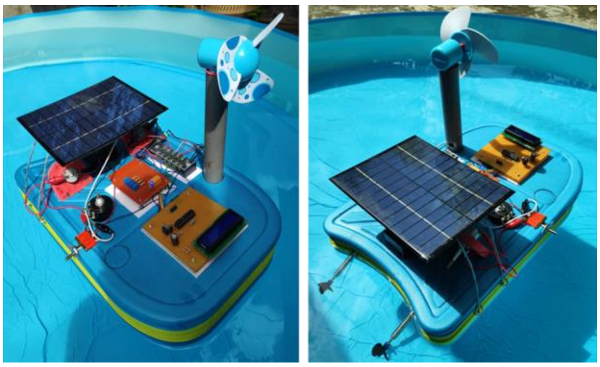

Fig 6. Prototype hybrid powered motor board

The system running on the circuit printed on the PCB board uses the 12V system and short circuit 0.6A, andmonitoring section, there is a port downloader, this port is used to install programs on the ATMega8535 microcontroller where program previously simulated using Proteus software will be transferred to the CodeVisionAVR (CVAVR) software to do the Burning process using a USB ISP or cable downloader (Henry Toruan. 2021).

CONCLUSION

Because prototype was made with a small size where the prototype was made using only 1 5Watt 12V photovoltaic and 12V 1.2aH battery and the experiment was successfully carried out even though the results or results were not optimum but only using 1 12V photovoltaic 12v supply the main battery and the condition of the battery is also stable enough to provide a load on the motor with an average of 9.8 V. The boat can also move steadily even though the movement speed is slow, for the monitoring system that uses the ATMega 8535 microcontroller also runs well with delay reads 1 second with an accuracy of 98% reading. This is a successful experiment.

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REFERENCE

A.R. Amelia, Y.M. Irwan, W.Z. Leow, M Irwanto, I. Safwati, M. Zhafarina. (2016, October). Investigation of the Effect Temperature on Photovoltaic (PV) Panel Output Performance. International Journal on Advanced Science Engineering and Information Technology · October 2016 DOI: 10.18517/ijaseit.6.5.938.

A Jaelani, Y S Kusumah and Turmudi. (2019). The design of sketchup software-aided generative learning for learning geometry in senior high school. IOP Conf. Series: Journal of Physics: Conf. Series 1320 (2019)

Dewi Rianti Mandasari, Budi Sudiarto, Lia Amelia, Cuk Supriyadi Ali Nandar. (2024, May). Electric Boat Propulsion with IPM BLDC Motors: Performance and Efficiency Analysis. Jurnal Nasional Teknik Elektro dan Teknologi Informasi.Volume 13Number 2 May 2024

Henry Toruan. (2021). PERANCANGAN DAN PEMBUATAN MODUL ADC BERBASIS MIKROKONTROLER ATMEGA8535 Jurnal Borneo Informatika & Teknik Komputer (JBIT) P-ISSN: 2808-8190 Vol. 1, No. 1, 2021. Hlm 01-07

I. Daut, M. Irwanto, Suwarno, Y.M. Irwan, N. Gomesh, N. S. Ahmad. (2011, December). Potential of Wind Speed for Wind Power Generation In Perlis, Northern Malaysia. TELKOMNIKA, Vol.9, No.3, December 2011, pp. 575~582 ISSN: 1693-6930.

M. Irwanto, N. Gomesh, M.R. Mamat and Y.M. Yusoff "Assessment of wind power generation potential in Perlis, Malaysia," Renewable and Sustainable Energy Reviews, Vol. 38, pp. 296-308, 2014