PHOTOVOLTAIC DESIGN ON ROBOTIC MOBILE SURVEILLANCE SYSTEM IN IMPROVING SECURITY

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ABSTRACT

The development of the current era of globalization has an impact on the increasing demand for electrical energy consumption. Very needed alternative renewable energy sources to meet the electricity needs at this time one of them uses photovoltaic. Photovoltaic functions to convert solar energy into electrical energy. The robot is a piece of technology that cannot be separated from consumption of electric energy; electric energy is the primary power source of the robot. Limitations of battery resources in robots can be assisted by the alternative energy to meet the electrical power needs of the robot battery.

Keywords: battery, photovoltaic, robot, surveillance, security, solar cell

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1. INTRODUCTION

The development of life and technology needs cannot be separated [1]–[3]. One indication that the development of the world is increasing along with the development of technology and the rapid development of automation and measurement has changed the working processes in life [4]–[8]. Much emerging communication tools can be connected wired or wirelessly [9]–[11]. By utilizing the development of existing mobile technology, it is expected that the control of the tools used can be more efficient because there is no limit to the distance between controllers with tools to be controlled. It can make it easier for users to monitor or operates the device automatically. Robot technology is a tool that can be used as human aids and has several advantages [12]. Robots can perform many useful tasks, such as exploration, rescue, entertainment, or floor cleaning. One of the benefits of robots is that it can be used in places that are not possible or harmful to humans. For example, chemical research laboratories that sometimes do not let humans be in place because of the danger of poisonous gas or radioactive. Mobile robots are grouped into two distinct groups of robots controlled by humans and autonomous robots. Autonomous mobile robots can move in dynamic environments and are known without human control. The current era of globalization has an impact on the need for increased electrical energy consumption requires that robots can perform their duties while maintaining sufficient energy while operating. So it is in need of renewable alternative energy sources to meet current electricity needs one of them using solar energy (photovoltaic) [13].

2. THEORIES

2.1. Robotic Technology

A robot is a set of electronic and mechanical devices that can replace human tasks, both with human supervision and control, or using programs that have been implanted in the robot [14]–[16]. A robot is usually used for tasks that are light, heavy, dangerous, repetitive work continuously — for example, a car maker robot. This robot belongs to the category of industrial robots. It is used in the field of production. The use of other robots includes cleaning of toxic waste, underwater and space exploration, mining, work and for mining searches. This technology has entered the consumer market in the field of entertainment, and housemaids, such as vacuum cleaners, and lawn mowers [17].

2.2. Photovoltaic

Photovoltaic is the direct conversion of light into electricity at the atomic level [18]–[20]. An electric current can be used as electricity when free electrons are collected [21]. Photovoltaic panels are a source of electricity in solar power generation systems, semiconductor materials that directly convert sunlight energy into electrical energy. The electricity produced by PV is DC power. The term "photovoltaic" has been used in English since 1849. This section discusses energy conversion, type, and development of photovoltaic panels. Most PV panels use Poly Crystalline Silicon as a photocell semiconductor material. The principle is the same

as the principle of the diode p-n junction. The following figure illustrates the working principle of PV panels [22].

Figure 1 p- n junction principal on PV panel

3. METHODOLOGY

The research method used in this thesis is the study of the experimental method. This study is a research experiment is an experiment that is applying and plans to prove the truth of these experiments, in which the experimental activities carried out during the making of the unit that has been proposed, then testing after completion of the unit is made.

Figure 2 Flowchart of the robot

Figure 2 describes the process flow of the robot. First, the robot is started then the robot will reset and initialize the port after that the program will read the command from the user who came from the smartphone and received by the repeater to proceed to the serial port to verify the user command. Data command that has been checked by the program is then used to run the motor drive, if the code received in the form of code F, B, R, L, U, and D the actor will move by the command of the user. To distinguish between two commands used ASCII code. If a user command has been processed, the program will return to read the next user command.

3.1. Calculation of Photovoltaic System

To know the voltage of each cell in a module can be determined by the following formula:

$$V_{\text{cell}} = V_{\text{max}} / N_{\text{cell}} \quad (1)$$

$$V_{\text{cell}} = (17.4) / 36$$

$$V_{\text{cell}} = 0.483 \text{ Volt / cell}$$

The maximum current in a photovoltaic module of 0.58 Ampere with the number of 36 cells, then each cell for:

$$I_{\text{cell}} = I_{\text{max}} / N_{\text{cell}} \quad (2)$$

$$I_{\text{cell}} = 0.58 / 36$$

$$I_{\text{cell}} = 0.0161 \text{ A / cell}$$

The output of the photovoltaic is a voltage and current is determined by the load connected to the photovoltaic. If $V = V_{\text{out}} = 0$, $I = I_{\text{out}} = I_{\text{sc}}$, but if load is open then $I = 0$, the open voltage (V_{oc}).

The photovoltaic output power can be determined by the following equation:

$$P_{\text{out}} = V_{\text{m}} \times I_{\text{m}} \quad (3)$$

$$P_{\text{out}} = 17.4 \times 0.58$$

$$P_{\text{out}} = 10,092 \text{ watts}$$

From the above technical specifications can be seen that the maximum current of 6 volts 4.5Ah batteries and robots using two batteries in series, so the voltage of batteries 6 volts + 6 volts = 12 volts while the battery power remains 4.5 then the power on the batteries are:

$$\text{Bat. Power} = \text{Battery voltage} \times \text{Battery current} \quad (4)$$

$$\text{Bat. Power} = 12 \text{ volts} \times 4.5 \text{ Ah}$$

$$\text{Bat. Power} = 54 \text{ Wh}$$

To calculate the long battery charging time, then the total power stored by the battery, which is 54 watts in the share with battery voltage.

$$I = (54 \text{ Wh}) / (12 \text{ Volt})$$

$$I = 4.5 \text{ Ah}$$

From the data obtained in the know that the battery charging current of the control circuit is 4.5Ah then the charging time is:

$$T_{\text{c}} = (\text{Battery Capacity}) / I_{\text{cell}} \quad (5)$$

$$T_{\text{c}} = (4.5 \text{ Ah}) / (0.58 \text{ A})$$

$$T_{\text{c}} = 7.75 = 8 \text{ hours}$$

4. RESULT AND DISCUSSION

4.1. Photovoltaic Result

Testing with resistance 100 Ohm

Table 1 Test data with resistance 100 Ohm

Time (hours)	Output (volt)
9:00	10,7
10:00	12,2
11:00	17,2
12:00	17,1
13:00	15,9
14:00	14,2
15:00	13,9
16:00	12,7

From table 1 data can be calculated current and power generated:

Current: $I = V_{out} / R$: (6)

Example: 9:00 = $I = 10,7 / 100 \text{ ohm} = 0,107 \text{ A}$

10:00 = $I = 12,2 / 100 \text{ ohm} = 0,122 \text{ A}$

Power : $P = V_{out} \times I$: (7)

Example: 9:00 = $P = 10,7 \times 0,107 \text{ A} = 1,144 \text{ watt}$

10:00 = $P = 12,2 \times 0,122 \text{ A} = 1,488 \text{ watt}$

Table 2 Result test data with resistance 100 Ohm

Time (Hours)	Output (Volt)	Current(Ampere)	Power(Watt)
9:00	10,7	0,107	1,144
10:00	12,2	0,122	1,488
11:00	17,2	0,172	2,958
12:00	17,1	0,171	2,924
13:00	15,9	0,159	2,528
14:00	14,2	0,142	2,016
15:00	13,9	0,139	1,932
16:00	12,7	0,127	1,612

Figure 2 Chart result test data with resistance 100 Ohm

From the results Table calculation of photovoltaic power can be obtained from 100Ω load is as follows:

Power At resistance 100Ω

$$Wh = (P1 \times t) + (P2 \times t) + (P3 \times t) + (P8 \times t) \quad (8)$$

t=time, in this case 1 hour.

$$\begin{aligned} Wh &= (1,144 \times 1) + (1,488 \times 1) + (2,958 \times 1) + (2,924 \times 1) + \\ & (2,528 \times 1) + (2,016 \times 1) + (1,932 \times 1) + (1,612 \times 1) \\ &= 16,602 \text{ watts/hour} \end{aligned}$$

4.2. Testing Automatic Battery Charger

The test is done with the panel and the circuit charger that has been connected to the battery. When the battery voltage is below 12.5 V the circuit will activate the relay. After several hours in the drying in the sun, the battery voltage begins to rise and indicate voltages above 14 V. When the relay is on the off right by the controller. Here are the results of measurement.

Table 3. Testing Battery Charger

Time (minute)	V _{out} (V)	I _{out} (A)
30	12,2	1,11
60	12,6	1,19
90	12,7	1,28
120	12,9	1,25
150	13,1	0,95
180	13,2	0,72
210	13,8	0,94
240	14,1	0,81

From the above data can be calculated charging power and can be in search of energy into the battery with the following equation:

$$P = V \times I \quad (9)$$

Example:

$$P = 12,2 \times 1,11 = 13,542$$

$$P = 2,6 \times 1,19 = 14,542$$

Table 4 Result testing Battery Charger

Time (minute)	Volt	Ampere	Watt	Relay
30	12,2	1,11	13,542	On
60	12,6	1,19	14,542	On
90	12,7	1,28	16,256	On
120	12,9	1,25	16,125	On
150	13,1	0,95	12,445	On
180	13,2	0,72	9,504	On
210	13,8	0,94	12,972	On
240	14,1	0,81	11,421	Oof

Figure 3 Result testing Battery Charger

Power on the battery during charging

$$E = (P_1 \times t) + (P_2 \times t) + (P_3 \times t) + (P_8 \times t) \quad (10)$$

Where $t = 30$ minutes

$$\begin{aligned}
 E &= (13,542 \times 0,5) + (14,994 \times 0,5) + (16,256 \times 0,5) + (16,125 \times 0,5) + \\
 &+ (12,445 \times 0,5) + (9,504 \times 0,5) + (12,972 \times 0,5) + (11,421 \times 0,5) \\
 &= 53,628 \text{ watts / hour}
 \end{aligned}$$

5. CONCLUSION

This is a brief overview of the use of photovoltaics in robot surveillance can help the robot to have additional energy so that it can help the robot can work longer in conducting the surveillance area, to generate more power then we need a larger photovoltaic and larger batteries as well to store energy produced by photovoltaics.

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