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Optimization of Solar Panel Output Using Smart Relay

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Abstract**—** *Renewable energy can be used to overcome the limitations of electrical energy. Solar energy is an easy and cheap renewable energy. Solar energy can be converted into electrical energy using solar panels. The use of many solar panels is installed permanently and does not take into account the optimal point of sun exposure. This causes sunlight received by solar panels to be less than optimal. So that the electrical energy produced by solar panels is not optimal. Therefore we need a solar panel control system automatically and can follow the direction of the movement of sunlight. This method uses a potentiometer as an angle sensor. The result achieved in this method is the optimal solar panel output. potentiometer as an angle sensor can work properly.*

Keywords**—** *Renewable energy, optimization, solar panel, smart relay, electrical.*

I. INTRODUCTION

The use of renewable energy such as solar energy is widely used. This renewable energy does not cause air pollution [1], [2]. Solar energy is a renewable energy that has abundant availability.

One of the tools that utilize solar energy is solar panels. The efficiency of solar panels is low because the use of solar panels is mostly installed static. This causes the intensity of sunlight received by solar panels to be less than optimal. The electrical energy produced will be maximized if the solar panels are always perpendicular to the direction of the sunlight [3]. Therefore we need a system that can control solar panels automatically so that they remain perpendicular to the direction of the sun [4], [5].

This study uses a smart relay to regulate the rotation of the DC motor (Linear Actuator) which functions as a driving force for solar panels. This study discusses a solar panel tracker using smart relay-based astronomical methods. This method uses a potentiometer as an angle sensor. The result achieved in this method is the optimal solar panel output.

II. METHODOLOGY

In this study, it is divided into the research scheme and the design of the tool.

A. Solar Panel

Solar panels are a component to convert sunlight energy into electrical energy using the photovoltaic effect principle. The electrical energy produced is usually used for electricity needs and some is stored first with a battery. The way this solar powered panel system works can still run even in the afternoon, at night or even in rain because it uses the help of a battery. In terms of use, solar electric energy is very suitable because it does not use conventional fuel. The main energy is the sun which can be obtained for free. If this is applied in various agencies, industries, to households, it can save expenses and the funds saved can be allocated for other purposes.

B. Linier Actuator

Linear actuator is a motion that moves linearly or in a straight line by utilizing the difference in air pressure. The actuator moves forward if the air pressure exerted on the forward side of the actuator is greater than the air pressure on the reverse side of the actuator. Conversely, when the actuator moves backwards if the air pressure exerted on the reverse side of the actuator is greater than the air pressure on the forward side. The difference in air pressure on the actuator affects the movement speed of the actuator.

C. Motor Power Window

The drive motor that rotates clockwise or the opposite direction. This drive motor can move the window regulator into an up and down motion. DC motors are widely used for power window motors. Motor operation depends on the interaction of two magnetic fields. In simple terms it is said that an electric motor works on the principle that two magnetic fields can be made to interact to produce motion. The purpose of working motor is to produce torque.

D. Smart Relay

Zelio Smart Relay is a small programmable logic controller (PLC). Zelio is a logic-based automatic controller that is relatively small in size as a substitute for conventional control systems such as relays and ordinary contactors. Zelio is a mini PLC with Input / Outputs ranging from 10 I / O to 40 I / O. It is called Smart Relay because it is relatively small in size but has high controllability. The advantage of using zelio smart relays is the availability of a MODBUS communication module so that Zelio can become a PLC slave in a PLC network. There is a Fast Counter facility (up to 1KHz). Can be programmed using the Ladder and FBD. There are 16 timers (11 kinds), 16 counters, 8 clock function blocks, each function block has 4 channels), automatic summer / winter time switching, 16 analog comparators. 1 additional I / O module can be added.

E. System Diagram

In order to easily design a research scheme, it is necessary to first determine the specifications of the tools used. Some of the tools used are the zelio SR3B261BD smart relay, solar panels, angle sensors, DC relays, 0.75mm NYAF cables, actuator motors and power window motors.

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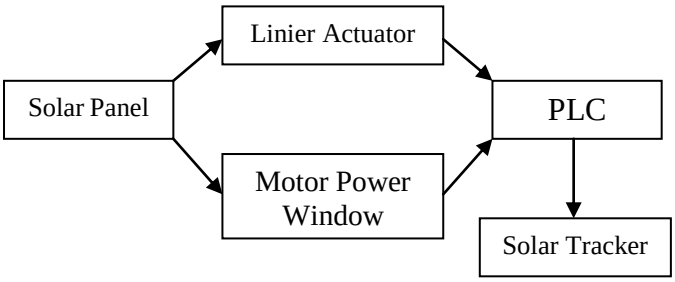

Fig. 1. Solar Tracker Sistem

The function of the circuit based on the circuit scheme is as follows:

1. Zelio Smart Relay in the circuit, the main control is the input and output commands.
2. The potentiometer angle sensor is used as an analog input on the Zelio Smart Relay. The rotary encoder angle sensor is used as a digital input for the Zelio Smart Relay.
3. The DC 12V relay is used to control the actuator motor and power window motors.
4. Actuator motors and power window motors are used to drive the solar panels.

F. Design System

Fig. 2. Schematic of solar tracker

Schematic of models with geometry and manufacturing of construction dual axis solar tracker show in Figure 2.

III. RESULTS

This research uses Zelio Soft 2 software. Smart relay used refers to Zelio Soft 2 software. The entire solar panel program on Zelio Soft 2 is as shown in Figure 3. This whole program is a combination of tracking programs, motor power window programs and actuator programs. The tracking program consists of the FBD sunrise and sunset. on a tracking program based on sun conditions in the Madiun City area. The tracking program inputs longitude, latitude and time zone values. The input used in the actuator program is a potentiometer sensor. this potentiometer sensor affects the actuator movement. The motor power window program uses input from the rotary encoder sensor.

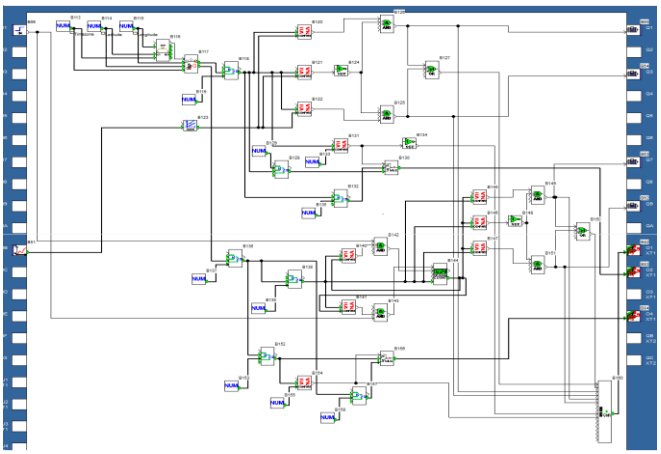

Fig. 3. Solar Panel Program.

TABLE I. Test Data System Solar Panel.

Time	Elevation		Azimuth	
	Value	Angle	Value	Angle
07.00	440	4,4	6850	68,5
08.00	1600	16,0	6120	61,2
09.00	3500	35,0	5610	56,1
10.00	4180	41,8	4460	44,6
11.00	5250	52,5	3020	30,2
12.00	5920	59,2	1190	11,9
13.00	5610	56,1	-1240	-12,4
14.00	4880	48,8	-3420	-34,2
15.00	3090	30,9	-4450	-44,5
16.00	2090	20,9	-5340	-53,4

The results of the tracking program are as shown in table 1. From table 1 it can be explained that tracking the position of the sun can be followed by solar panels. Changes in program hours result in changes in tracking data as well. the actuator program can follow the sunlight. This can be seen from the changes in the elevation data in table 1. The actuators on the solar panel have also been able to move. the motor power window program can follow the sunlight. This can be seen from the changes in the azimuth data in table 1. The motor power window on the solar panel device can also move.

The tilt angle on the sensor can be seen from the tilt of the solar panel. The tilt of the solar panel can be seen and measured using an arc. The tilt angle test of the condition of the solar panels when tracking is shown in Figure 4 and Figure 5. This test can also be measured using the arc application on the mobile phone. Because the application is now more sophisticated, so we will not be confused about measuring the tilt angle of the solar panel.

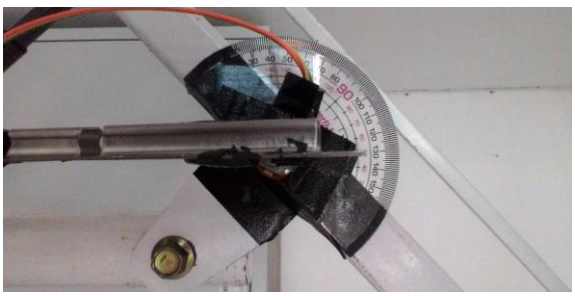

Fig. 4. Test the angle of inclination using a bow

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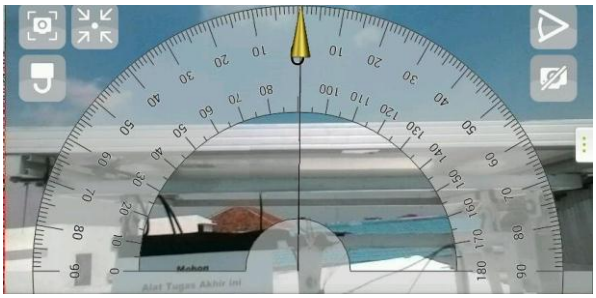

Fig. 5. Test the tilt angle using the mobile application

The tracking program is running well. Then the next program is the output from the solar panel. The output voltage of the solar panels was tested in two conditions, namely the stationary condition and the tracking condition. The output voltage in the tracking state is greater than the idle state. This is because the solar panels can follow the sun's conditions so as to produce the optimal output voltage. The results of the solar panel output voltage can be seen in Figure 6.

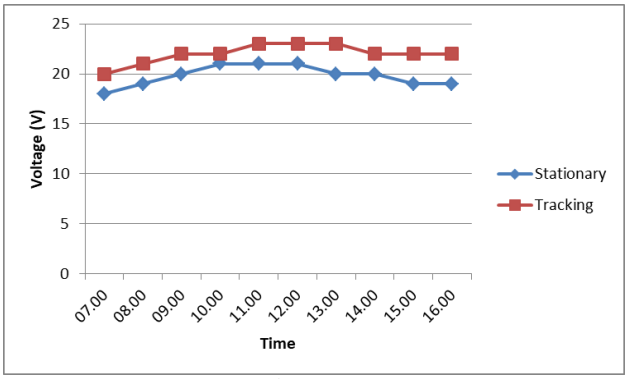

Fig. 6. The results of the solar panel output voltage

IV. Conclusion

The output from the solar panel can reach the optimal point because of the tracking system. The potentiometer as an angle sensor works well. The tracking program runs automatically according to the desired place. For further development, it can be applied to larger systems and good sensors.

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