Developing Portable Solar Cell Trainer Using Dynamic Rotation with Microcontroller-Based

Siti Sendari, Yuni Rahmawati, Adhi Bagus Pribadi, Tegar Wira Abdillah, Fauzy Satrio Wibowo
Electrical Engineering
Universitas Negeri Malang
Malang, Indonesia
siti.sendari.um@um.ac.id

***Abstract*— A method of Dynamic rotation is a proposed concept to be applied to a solar cell trainer. The Solar cell trainer has two DC motors controlled by a microcontroller. The result of this research is to get a solar cell trainer using dynamic rotation based on microcontroller system. This research used a development model proposed by Sugiono. The trainer is developed with four Light Dependent Resistor (LDR)sensors, which are covered with PVC pipe ¾ inch to make the sunlight focus on the sensors. The unit process of the trainer is the microcontroller ATMega 16 accomplised with two DC motors to rotate the solar cell plate of 360 °.The implementation of dynamic rotation to the solar cell trainer has a goal to increase the stabilization of voltage and electric current generated by the trainer.The voltage of solar cell trainer using dynamic rotation method is relatively stable at 19 volt while the trainer without using that method tends to be unstable. The result of this study indicates that the solar cell follows the light with predominant intensity, so, the Dynamic Rotation method can be applied to optimize the solar cell power plant in Indonesia.**

Keywords— Dynamic Rotation; Microcontroller; Solar Cell Trainer

I. INTRODUCTION

According to the projected demand for electricity from 2003 to 2020 made by the Office of Systems Planning PT PLN (Persero) and BPPT Energy Team, it shows that during this period the average electricity demand in Indonesia grew by 6.5% per year with electricity growth in The highest commercial sector, which is about 7.3% per year and followed by households demand growth of 6.9% per year.

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However, from the electricity sector, in 2011 the power plant in Indonesia is still dominated by the use of fossil fuels, especially coal amounted to 27 434. 163 tons. While the region is still experiencing power shortages such as Sulawesi, Kalimantan, and Nusa Tenggara, Papua and other power plants are still using diesel generators with fuel consumption amounted to 11,466,851 kiloliters, with the plant operating costs Rp 36.928630 million [1] ,

With the increasing demand for electrical energy thus we need other sources of electrical energy alternative beside PLN. Meanwhile, there have been many turning blackouts done in these areas. This happens because the energy supply of electricity often overload. The power plant was insufficient even when doing parallel work [2].

In order to find out an oil supply (BBM) that is dwindling, it takes an infinite source of energy such as solar energy. Solar energy (solar) as one of renewable energy and environmental friendly. Indonesia is a tropical area which has a very large potential for solar energy with daily insolation invitation average from 4.5 up to 4.8 kWh / / day [3].

The earth's surface only receives 69 percent of the total radiant energy of the sun. The supply of solar energy which is received by the Earth's surface is very enormous, it reaches 3 x 1 joule per year, the energy equivalent of 2 x 1 Watt. The amount of energy is equivalent to 10,000 times the energy consumption in the world today. Therefore, by covering only 0.1% of the earth's surface with solar cells have an efficiency of 10 percent has been able to cover the energy needs in the world today [4].

Solar cell is an equipment for converting the solar energy. The efficiency of solar cells is fairly low between 18-22% while getting the maximum energy from the sun, the one way to add efficiency value, we need a reflector devices [5]. While to keep the solar cells can receive the maximum light, we need sun tracking devices [6]. Yet the way to optimize the solar cells also depends on the intensity of solar radiation that hit the Earth's surface. The greater angle of

incidence of sunlight, the higher the solar energy that can be received [7].

The fact that the use of solar cells as a power remains low and can not be relied upon as an alternative energy source which able to replace electrical power. This due to several factors such as the ability of solar cell which is not optimal in generating electric power, the cost of cell manufacturing cell is high, especially if the cells are to be imported [8]. Therefore, the research team intends to develop a method of *dynamic rotation* and apply it to the media Trainer Solar Cell for renewable energy learning media at the college. *Dynamic rotation* is a concept that uses a DC motor to drive the acceleration of the solar cell plate follows the direction of the dominant solar radiation. This method is expected to produce maximum power on the condition that the value of the low efficiency of the solar cell can be resolved.

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II. RESEARCH METHODS

A. Types of research

This research uses a development research, the development model which uses are the steps proposed by Sugioyono which has been modified due to time, cost and energy [9] The researchers examine the system on solar cells and comparing the results of the optimization of the energy generated by the solar cell trainer that uses a method of dynamic rotation with trainer solar cells without using the method of dynamic rotation.

B. Potential Problems

According to the preliminary survey through interviews to the lecturer of the Power Plants course (PTT 451), the competency which is written in the catalog of Undergraduate Program of Education Electrical Engineering, State University of Malang has not been done completely due to unavailability media for lab Power Plant, therefore, we need solar cell trainer to support learning activity and competency effectively .The expected outcomes from the innovation of microcontroller-based solar cell trainer is to make students have better understanding upon the material of power plant.

C. Data collection

Data collection was conducted in order to collect data on the materials concerning about Solar Power, while the data collected include: (1) Reviewing some literature about the optimization of solar cells; (2) Examining the RPS to the lecturer of the course, on what kind of practical activity related to the materials; and (3) Collecting materials for designing the trainers and its modules.

D. Product Design

At this stage, the research team make a product design that are tailored to the subject matter of Power Plant materials. Trainer is made with a dynamic design based on the draft. In the process of making, the researchers use a stainless steel plate that has the knock down properties, thus the trainer can efficiently move the position to the desired spot. A weight of trainer that is designed is approximately 15 kg.

E. Design Validation

The next step is to validate the product, the validation is done by distributing questionnaires to the experts of media and its materials as a source. The validation process is performed in order to obtain quantitative and qualitative data.

F. Products Revised

After the validation process, the researchers use the obtained for improving the design and its materials.

G. Trial Use

Design products that have been validated and revised by the experts of media and its material is ready to be tested.The testing is conducted on a S1 Education Electrical Engineering, Faculty of Engineering, State University of Malang as a sample of research. The questionnaire will be used to examine the response of the students regarding the use of student trainer.

H. Repair Products

After the testing is complete and products are analyzed, it is necessary to repair the product trainer for the finishing stage of solar cells. Products are repaired in accordance with the standardization provided by materials experts, media experts and students as the object of the trial.

I. Test Repair Product

After repaired, the design is tested on students as learners as the object of the trial.

J. Location and Time

This research was conducted in place in accordance with the development process in the Department of Electrical Engineering, Faculty of Engineering, State University of Malang. Data collection, validation and application testing conducted on the learning process of the subject Power Plant in Undergradute Program Electrical Engineering Education.

III. DISCUSSION

A. Construction Trainer of Dynamic Rotation

This trainer has a stainless steel construction design which is removable. This level of flexibility of the trainer reaches 360˚ which make it possible to follow the solar position from every single directions. The researchers use Power Window DC motor trainer *and 4 pieces LDR light sensor*. The function of these sensors is to compare the intensity of the received sunlight by the sensor thus that the microcontroller will be able to decide in which direction the

solar cell will be moved in accordance with the intensity of the dominant sun's light.

B. *The Experiment Using Dynamic Rotation*

In this study, the researchers apply *Dynamic Rotation* to trainer solar cells to power solar panels based on the sun's most dominant**.** Table 1 shows the results of the test product.

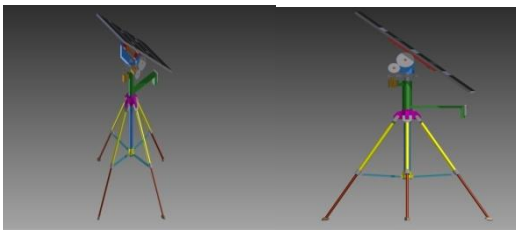

Fig. 1. Side view and top of Trainer Model

TABLE I. RESULTS OF THE TEST PRODUCT.

Time	Positioning of Solar Cell	Solar Cell Voltage	Charging-current (Amphere)	Battery Voltage (Volt)
08.00		19,4	1,07	11,21
09.00		19,5	1,02	11,3
10.00		19,47	0,99	11,89
11.00		19,53	0,23	11,91
12.00		19,6	0,058	12
13.00		19,53	0,034	12,1
14.00		19,6	0	12,4
15.00		19,53	0	12,5
16.00		19,45	0	12,5

C. *The Experiment without using Dynamic Rotation method*

In this second experiment, the researchers do not use Dynamic Rotation method and the result is not linear as Well as using Dynamic Rotation method. Table 2 shows the result of solar cell without using Dynamic Rotation method.

D. *Graphical Result*

The result of implementing solar cell without dynamic rotation, the highest peak voltage is at the point of 19.57 volts. While the lowest voltage at 14.5 volts.

On the other hand, the highest voltage of implementing solar cell trainer using dynamic rotation has a stable voltage with the range approximately above 19 and it does not drop all day long.

TABLE II. RESULTS WITHOUT USING DYNAMIC ROTATION METHOD

NO	Hours	Solar Cell Voltage	Charging-current	Battery Voltage
1	08.00	14,5	0,23	11,21
2	09.00	15,3	0,412	11,3
3	10.00	17,6	1,03	11,4
4	11.00	17,5	1,07	11,5
5	12.00	19,53	1,07	11,6
6	13.00	19,57	1,03	11,67
7	14.00	16,52	0,23	11,8
8	15.00	15,2	0,036	12
9	16.00	14	0,0347	12

IV. CONCLUSION

Based on the experimental results of the research, the researchers conclude that Experimental Method Using Dynamic Rotation shows that solar cell has a stable voltage with the range approximately above 19 and it does not drop. The voltage drop in the order of 0.1 volts. Therefore, the charging of voltage is far more stable and faster.

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