Vol. 5, No. 1, 2024, pp. 1-6
DOI: https://doi.org/10.29210/810444800

Contents lists available at Journal IICET

Southeast Asian Journal of technology and Science
ISSN: 2723-1151(Print) ISSN 2723-116X (Electronic)

Journal homepage: https://jurnal.iicet.org/index.php/sajts

Low-cost solar tracking with LDR-based sensing: optimizing energy harvest for domestic applications

Nur Syamilaini Binti Mohd Hasni, Zubaidah Binti Abdul Rahman*), Mohd Hafizuddin Bin Ibrahim
Departement of Electrical and Electronic, Politeknik Kuala Terengganu, Terengganu, Malaysia

Article Info

Article history:

Received Jun 10th, 2024
Revised Jun 24th, 2024
Accepted Jul 14th, 2024

Keyword:

Solar panel

ABSTRACT

Solar panels have been widely used in recent years in converting solar energy to electrical energy. To maximize the conversion of solar energy to electrical energy, the solar panel should always be in a position perpendicular to the sun. The main goal of this project is to design a solar tracking system that can detect the position of the sun in turn converting and storing solar energy to electrical energy to the maximum. In this project, the solar tracker moves 60 degrees from east to west and vice versa. The project involves the development of hardware and software for simulation testing. The system consists of Arduino Uno, servo motor, Light Dependent Resistor (LDR) as sensor and solar panel. Ihe impact of this project can reduce operating costs for the production of electricity using fuel.

Corresponding Author:

Zubaidah Binti Abdul Rahman,
Politeknik Kuala Terengganu
Email: zubaidah@pkt.edu.my

Introduction

A solar tracker is a device that follows the sun as it moves. When solar trackers are combined with solar panels, the panels can follow the sun's path and produce more renewable energy to use. The most common applications for solar trackers are positioning photovoltaic (PV) panels (solar panels) so that they remain perpendicular to the sun's rays, so that they can determine the Sun's direction. Solar energy conversion is one of the most addressed topics in the field of renewable energy. Solar radiation is usually converted into two forms of energy: thermal and electrical energy. The solar electricity has applications in many systems such as rural electricity, water pumping and satellite communications. The efficiency of the photovoltaic (PV) system depends on the climate conditions of solar radiation, ambient temperature and wind speed, matching of the system with the load and appropriate placement of the solar panels. A majority of solar panels in use today are stationary and therefore do not consistently output the maximum amount of power that they can actually produce. A solar tracker will track the sun throughout the day and adjust the angle of the solar panel to make the sun normal to the solar panels at all times. The orientation of the solar panels may increase the efficiency of the conversion system from 20% up to 50%. The sun tracking solar power system is a mechatronic system that integrates electrical and mechanical systems, and computer hardware and software.

Renewable energy is a trend in today's technology whereby solar energy or photovoltaic energy is the hottest topic among scientists and engineers to become an extremely popular alternative power. Commonly, utilization of solar energy is to produce and provide electricity for the usage of industrial or residential.

Indirectly, solar energy may affect the alternative payment charges of electricity due to high demand of fossil fuel or gas which has higher value. Therefore, plenty of the researches had been carried out in order to develop alternative sources of energy that able to replace the fossil fuel or gas. Therefore, another alternative which can provide energy is photovoltaic energy that is one of the type of solar energy. As a result, of the solar panel is made up from the solar cells that enable to convert heat energy to electrical energy by absorbing the sunrays. The tilt angle of solar panel facing the sunlight may affect its performance in order to produce electricity. The most efficient method is to direct the solar panel to perpendicular sunray. However, the solar panel that is available in the market is in fixed position that cannot be adjusted. In the other hand, to extend the efficiency of the solar panel while generate electricity, the intervals time should be moveable. Thus, 2 the goal of proposing this project is to develop a simple solar tracker system to enhance its efficiency. There have several parts in this project which consists of software and hardware implementation. Each of the parts are designed by considering the performance, cost, capability and maintainability.

There are three problems that led to the idea to make this project.

1. Though solar energy can be utilized to maximum extent this may create problem in rainy season.
2. The only solar panels used are in one direction and the power that can be generated is low.
3. Expensive electricity bill payments because of the high electricity consumption.

The objective of this project is to design solar tracking that can save energy that has been absorbed from sunlight and can be reused during the rainy season. To create a solar tracking system that can detect a 120-degree of rotation. So, the solar panel that can be generated here is very high helps in maximizing the absorption of sun rays. This project also can reduce electricity consumption.

First of all, trackers increase the amount of solar energy which is received by the solar energy collector and improves the energy output of the heat or electricity which is generated. Then, the solar panel tracker is a single axis tracker, means it tracks in both X and Y (east–west direction). This solar energy can be utilized when required or can be used as a direct alternative to the grid supply. Solar Trackers are used to keep solar panels oriented directly towards the sunray as it moves through the sky every day. Using Solar Trackers increases the amount of solar energy which is received by the solar energy collector and improves the energy output of the heat and electricity which is generated.

Based on figure 1 it shows, the overall diagram of the Single Axis Solar Tracker, this system has one degree of freedom; they continue follow the sun either vertical or horizontal. The horizontal type solar tracker is used in tropical regions where the sun gets very high at noon but the day is short whereas vertical type solar tracker is used at high latitudes where the sun does not get very high but the summer days can be very long. These are the classification of single axis solar tracker which include HSAT (horizontal single axis trackers), VSAT (vertical single axis trackers), TSAT (tilted single axis trackers) and PSAT (polar aligned single axis trackers). The name was based on these tracker is how tracker rotate in reference to the surface, like HSAT motion is horizontal to ground. VSAT motion is vertical to the ground and is aligned to the east to west direction. TSAT axis is projected at angle from the horizontal or vertical. And PSAT aligned to the polar star which has also a tilted axis. In the case of concentrated solar energy processes, single-axis trackers are used with flat surface solar module. Single axis solar tracker is less complex and cheaper but less efficient than dual axis solar tracker.

Figure 1 <Single Axis Solar Tracker (TSAT, HSAT, VSAT)>

The different between another project with mine is the design of solar tracker, I create a single axis solar tracker with fixed solar PV system. Single axis solar tracker is designed in which sun tracking is done by two LDR (light dependent resistor). A motor servo is use to control and monitor the automatic movement of PV panel and collect sunrays. In our project the hardware of solar tracking solar panel design and the

implementation of the design has been proposed. Our result shows that the solar tracking system increases the efficiency of the solar panel. Solar tracking solar panel is completely automatic and it ensures the minimum low cost. So, it is a single axis system which maximizes the efficiency and can be obtained over a period of time. Normally a solar panel converts only 30 to 40 per cent of the incident solar radiation in to electrical energy. An automated system is required to get a constant output, which should be capable to constantly rotate the solar panel. The sun tracking system was made as a prototype to solve the problem. It will be automatic and keeps the panel in forward facing of sun until that is visible.

Method

In this chapter, will be explained the planning steps and the manufacture of sun tracking solar panel. The first step before the project implemented is to review the project scope and research area. In this case, the field of tracking the sun light radiation is reviewed thoroughly in order to establish based on sun tracking solar panel to perform the specified task. Then, the next task is to design the mechanical structure which is to be built. At the same time, studies on programming Arduino Uno to the hardware is also been done. Then, if all the design has been finalized, the implementation of the hardware and the circuitry takes place.

Reaching the peak of the project, the programming segment takes place especially for the sensor input by light dependent resistor (LDR), tracking process and output to the servo motors. Last but not least, certain modification on the circuitry and software took place in order to make the solar panel perform in finer movements. Thus, troubleshooting process also took place o correct certain faulty processes while the solar panel is performing its task.

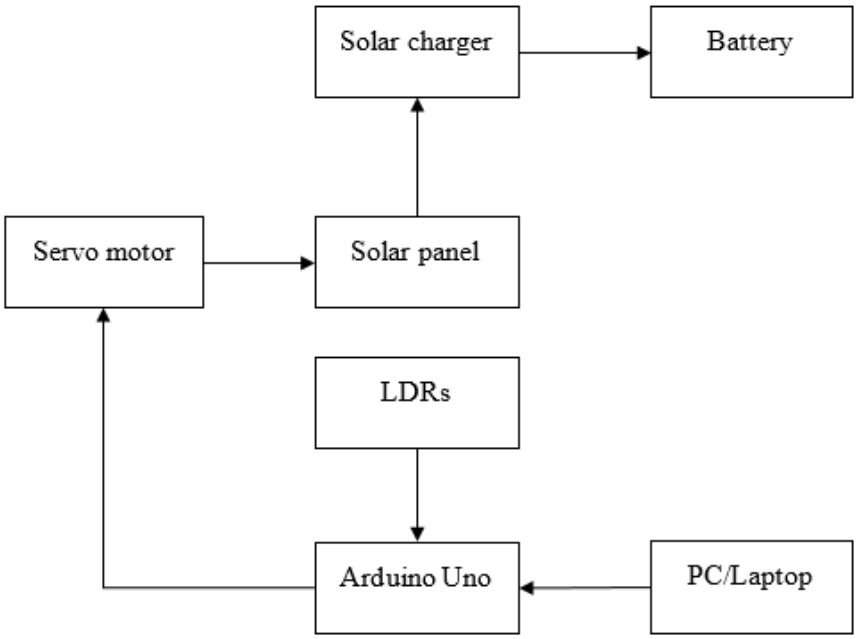

Figure 2 <Block Diagram>

Based on the Figure 3 the main components in the solar tracking system are standard photovoltaic solar panels (PV), a deep cycle rechargeable battery, solar charger, servo motor, light dependant resistor (LDR) and Arduino Uno. The block diagram of the system is shown in Figure 1. The main solar panel is rated at the voltage of 9V and current of A. The main solar panel provides all the power for the system and charges the battery. The LDR1 and LDR2 work as light detectors. The LDRs will detect the intensity of the sunray then the servo motor will move the solar panel to the exact angle in which the solar panel must face to gain maximum power output. When the sun is perfectly normal, the voltages on both LDRs are equal, and solar panel stays in its position. However, if one of those LDR detect the different intensity of the sunray, the solar panel angles will be change. The Arduino Uno gives an output to the servo motor based on the difference of voltages to rotate the solar panel to be perpendicular to the sun. The stand of the solar panel is made of perspex and the components including the solar panels and charge controller, the rechargeable battery, Arduino Uno, servo motor and LDR will be explained. A solar tracker has single axis. The solar tracker follows the sun throughout the day, facing east in the morning and west in the afternoon.

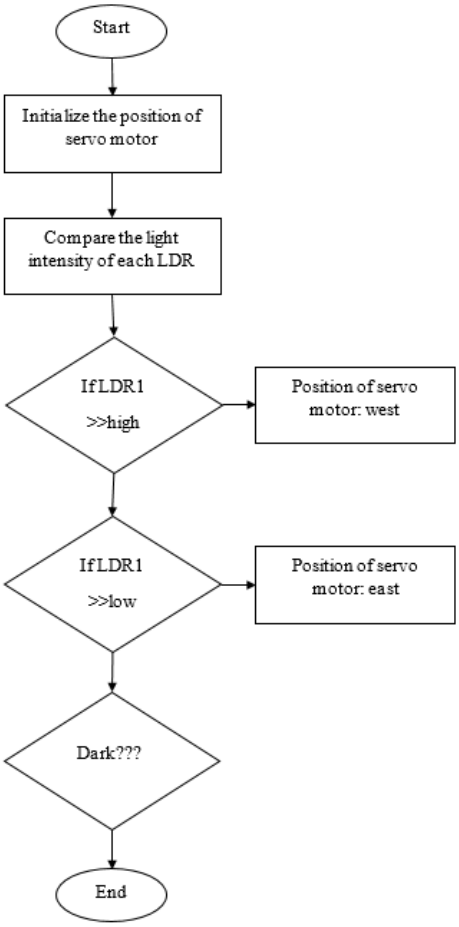

Figure 3 <Flowchart>

Results and Discussion

This chapter discusses on the result, analysis and problems that are encountered throughout the completion of design and development of Sun Tracking Solar Panel. After the development and completion of the project, it will then be evaluated in order to measure the effectiveness and to ensure whether it had met the outlined objectives successfully.

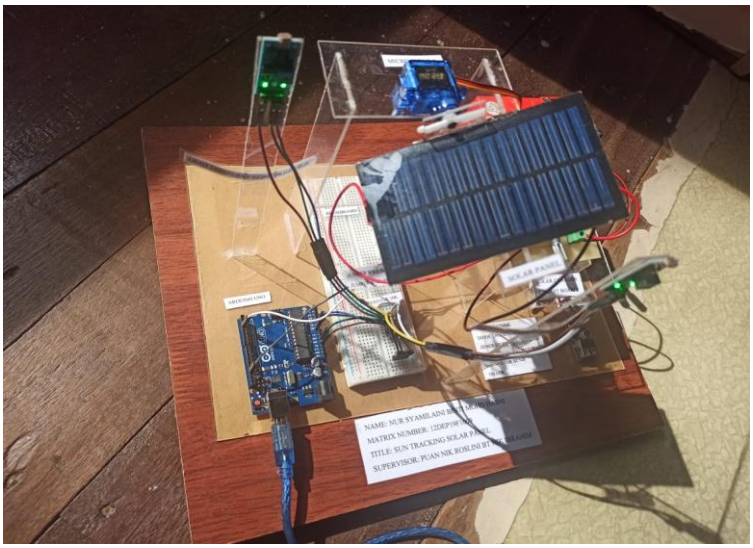

Figure 4 <Sun Tracking Solar Panel>

The table given below shows the efficiency and performance of the solar panel with tracking.

Table 1 <Solar Panel with Tracking>

Time (Hrs)	Voltage (V)	Current(A)	Power (W)
9 am	5.5	0.11	0.605
10 am	9	0.19	1.71
11 am	10.5	0.2	2.1
12 pm	12.5	0.28	3.5
1 pm	14	0.32	4.49
2pm	13.5	0.3	4.05
3pm	11	0.26	2.86
4 pm	8	0.16	1.28
5pm	6	0.12	0.72

In order to collect data from our project solar tracking solar panel we need to calculate and evaluate all the important parameters. To asses our systems performance need to require. For this purpose, we took the help of our lab technician for the data collection with multimeter. The multimeter is used in our project to find the voltage being produced by the solar panels at many different stages, when solar panel was incident by sunlight. First the voltage checked when sunlight was perpendicular to the solar panel. Second time voltage checked when solar panel was tracking the sunlight. We repeated this process throughout the day time.

Conclusions

Thus the Sun Tracking Solar Panel has been designed and tested successfully. It has been developed by integrated features of all the hardware components used. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. The system has been tested to function as was planned. The panel change their orientation in relation to solar radiation to increase the efficiency and results in maximum production of energy and helps in getting full benefit of optimal angle between solar panels and solar radiations. The execution of solar tracking system was made clear because of our sufficient research and preplanning of our goals and objectives. The main agenda of this project was to make simple machinery on low cost basis. Trial and error method help us in achieving our goal. This project was successful in developing and designing low cost solar tracking system. Because the issue of global warming must be controlled by making use of alternatives that are environmental friendly.

For the future works the very embodiment through which the futuristic conundrum be set aside, is the project called "Sun Tracking Solar Panel". A trailblazer by its spirit, this system works in its utmost efficiency, whether that be in terms of its pecuniary ability or in terms of its accessibility. In the smoke of the darkness where pollution engulfing every sphere of advancement as an outcome of producibility, this device in its very efficiency work towards only advancement and development by flushing out the pollution at large. The goals of this project were outlined keeping in mind the timeline and resources that were attainable. However, this initial design can be subjected to many improvements. Initially this design represents a miniature scale model which can be modified into a much larger scale. Easy to bend cables can be used which do not apply any force on the motor when it is rotating the solar panel. To get a better tracking precision, a photo transistor with and amplification circuit can be used. Furthermore, accuracy can also be increased by utilizing dual axis design versus single axis design. Future projects can make use of microcontroller. This microcontroller can serve as standalone unit in the fabricated circuit.

References

Bauer W. et.al.. 2015. Project report on Competence-based education and training in the field of solar energy and energy efficiency. Unpublished. https://www.na-bibb.de/fileadmin/ user_upload/na-bibb.de/Dokumente/06_Metanavigation/01_ Ueber_uns/05_Deutsch-Israelisches_Programm/2015_09_ PTK_SE_final_report_web.pdf (Accessed 31 January 2017.)

Scott J Hamilton, "Sun-Tracking Solar Cell Array System," University of Queensland, Department of Electrical Engineering, 1999

Mayank Kumar Lokhande, "Automatic Solar Tracking System," International Journel of Core Engineering & Management, October, 2014

Oloka Reagan Otieno, "SOLAR TRACKER FOR SOLAR PANEL", University of Nairobi, Dept. of Electrical and Electronic Engineering, 24th August 2015

Kamrul Islam Chowdhury, Md.Iftekhar-ul-Alam, Promit Shams Bakshi, "Performance Comparison Between Fixed Panel, Single-axis and Dual-axis Sun Tracking Solar Panel System," BRAC University, Department of Electrical and Electronic Engineering, 2017.

Chetan Singh Solanki (2015). "Solar Photovoltaics- Fundamentals, Technologies and Applications". Department of Energy Science and Engineering, IIT,Bombay.

Asmarashid Ponniran, Ammar Hashim, Handy Ali Munir (2011). "A Design of Single Axis Sun Tracking System". Faculty of Electrical and Electronic Engineering, University Tun Hussein Onn Malaysia, School of Mechanical Engineering, University Malaysia Perlis.

Imam Abadi, Adi Soeprijanto, Ali Musyafa (2015). "Design of Single Axis Tracking System at Photovoltaic Panel Using Fuzzy Logic Controller", Department of Engineering Physics and Electrical Engineering, Sepuluh Nopember Institute of Technology, Surabaya.

Gajadharane, M. R., Gijare, N.A., & Joshi, M. H. (June, 2016). Design and development of mechanical Solar Tracking System. Retrieved on October 7, 2019 from https://www.academia.edu/26526209/Design_and_Development_of_Mechanical_Sol