DESIGN AND CONSTRUCTION OF AN EFFICIENT LDR AUTOMATIC SOLAR TRACKER

Ismail I[1]., Femi-Jemilohun O.J[2] and Fasina E.T[3]

1 (Department of Electrical and Electronic Engineering, Ekiti State University, Ado Ekiti, Nigeria.
Email: isiaka.ismail@eksu.edu.ng)

2(Department of Electrical and Electronic Engineering, Ekiti State University, Ado Ekiti, Nigeria.

Email: oladunni.femi-jemilohun@eksu.edu.ng)

3 (Department of Electrical and Electronic Engineering, Ekiti State University, Ado Ekiti, Nigeria.
Email:emmanueltaiwo.fasina@eksu.edu.ng)

Abstract:

Renewable source of energy generation has come to rescue the consumers on the shortage of electricity generation by the power sector of the country. One of these promising renewable sources is the solar power generation. There is a limitation to what this source can generate per time due to the Earth rotation around the Sun, this tends to cast shadow on the radiance of the sun at a particular time of the Earth movement and therefore hinder the solar panels from proper alignment to the ray of the sun. It becomes imperative that a device that monitors the angle of the highest intensity of the sun radiance must be put in place. A solar tracking device using semiconductor technology is constructed in this work to enhance the performance of the sun ray collection by the solar panels at different angles of sun radiation. The device can be used in every walk of life where clean, reliable noiseless electricity supply from solar energy system is preferred.

Keywords: Renewable, Solar Tracker, Light Dependent Resistors, Sun Radiation, Light intensity, semi-conductor Technology

I. INTRODUCTION

The increase in the population and consequent increase in demand for energy together with shortage in fossil fuels supply to cater for the needs of the populous citizenry of Nigeria, has necessitated a push in research arena for means of more energy generation alternatives [1]. Also to make the planet conducive for continual existence, reduction of the carbon emission to the eco system through decarbonization of the energy sector is a most goal for all the stakeholders. A report released by the International Energy Agency (IEA) finds that in 2018 global energy demand grew by 2.3%, the fastest pace in a decade, leading to1.7% of growth in energy-related CO2 emissions (IEA, 2019). Rising concerns about climate change, the health effects of air pollution, energy security along with the volatile oil prices in recent decades, have led to the need to produce and use alternative, low-carbon technology options such as renewables. One of the technical solutions to achieve this goal is the adoption of low carbon technology for energy supply. One major source of a clean, sustainable and renewable energy is solar power generation through the photovoltaic modules [2,3]. Solar Energy contributes in no small measure to the expansion of the renewable energy power generation capacities [4]. Thanks to nature for the free and abundance provision of this element. The low cost, reliability, maintainability attributes of solar energy position it as one of the most preferred source of renewable energy [5]. Nevertheless, a challenge arises in proper harnessing this free gift by the consumers. Sun as a dynamic element of nature, rises in the East and set in the West the Latitude and Longitude regions during day and night respectively, requires a proper knowledge of its position per time for optimal harnessing of solar energy and maximum efficiency of the solar system performance [5]. Again, the shape of the Earth does not encourage the perpetual alignment of the panels and the sun radiation, as the sun revolves around the earth the intensity of sun radiation decreases with time of the day and hence reduced solar energy is harvested at such times. because the intensity of sun goes down by the revolution of the Earth. Researchers rising to this occasion, came to this technology of solar energy tracking system. Solar tracking system will circumvent this limitation [4]. For appreciable energy quantity harnessing, the position of the panels arrays. The orientation of the solar panels must be in proper alignment with the sun rays motion as the day goes [5]. A solar tracking system for improved efficiency of energy concentration for the period the solar panels are exposed to sun radiation is carried out in this work. Some authors have worked on similar field in some countries, since research is environment specific, this work will be beneficial to my immediate locality as part of contribution to knowledge . Some of the similar work in this field are briefly summarised below:

II. RELATED WORK

The author in [6] worked on a solar tracking system utilising an embedded LPC1768 microcontroller which controls the movement of two stepper motors for the rotation of the solar panels in two coordinates. A quantitative record of the output power performance of the designed tracking system was also conducted while a photo sensors were used for information retrieval when the determination of the panel rotation is done by the microcontroller. While in [1], a one coordinate solar tracker using PIC was conducted where the position of the sunbeams is constantly tracked in alignment with the solar PV cells for efficient energy extraction from sun radiation. The light intensity is sensed by the 2 LDR sensors which generate input signals to the microcontroller, while a perpendicular arrangement of the PV to the sunbeams is ensured for maximum energy catching. The work was carried out in Malaysia. Four coordinates array of LDR sensors, potentiometer, servo motor and microcontroller were used in [5] for the construction the solar tracking system in Kumasi, Ghana. The system through appropriate orientation of the solar panel harness the sun radiation for energy provision in the targeted area. Testing of the design reveals an efficiency of 2 degrees change in sun radiation that triggers a corresponding respond in the tracking system. A report by [2] examined and summarised the role of PV power in the global energy transformation based on the IRENA's climate Resilient. A projection was made for the next three decades need of the PV power deployment in Paris climatic region. It was pointed out that the need for the Solar PV industry to rise up to this challenge for the time in speculations noting that a solar PV generating capacity of 270GW per year and 372GW per year will be needed in 2030 and 2050 respectively in comparison with 94GW realized in 2018. The author in [7] proposed proteus software device using a microcontroller solar tracking system for the control of the solar panel cells in response to change of sun direction. Real time application of the device was also included.

III. MATERIALS AND METHODS

The design and construction of a single axis solar tracking device using Four (4) LDRs to detect the actual position of the sun was carried out in this work . Signals from a microcontroller triggers the servomotor by the Micro-controller to tilt the solar panel modules towards the highest sun's intensity. The Solar tracker is designed to rotate within 180° swing to track the sun radiation and a Battery indicator to indicate if the Solar Panel is charging the battery.

Figure 1 and table 1 show the block diagram and the components respectively used form the proposed device

TABLE I
Electronic Components Used in the Project

Item No	components	Name and Specifications
1	LDRs	GL5528
2	Servo Motor	Micro Servo 9g (SG90)
3	Microcontroller	ATM Mega 328
4	Battery	3.7V 2Amps
5	Board	PCB Board
6	Resistor	10K
7	DC-DC Boost Converter	MT3608

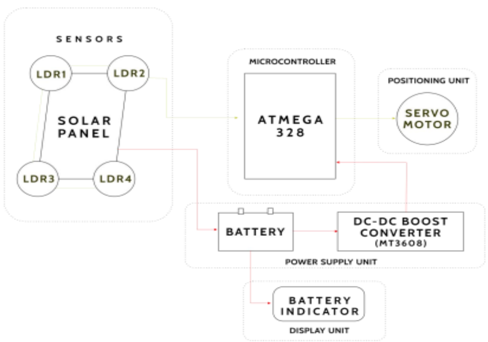

Fig 1: Block Diagram of Solar Beam Tracker Device

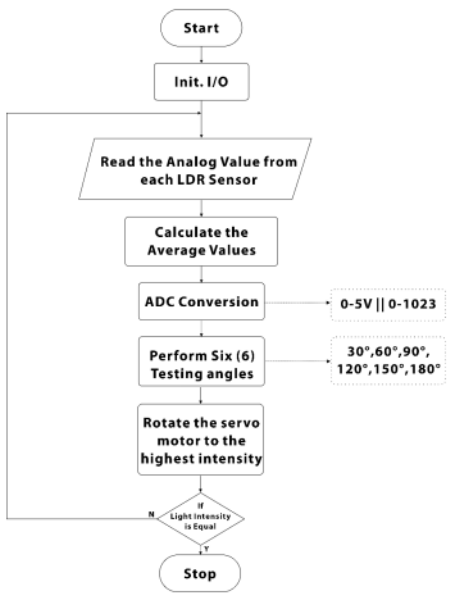

Fig 2: Flowchart of the Solar Tracker Operation

The flowchart of the solar tracking system is as shown in Fig 2. The program code was debugged and tested with a CAD electrical software. From Fig 2, the signal from the LDRs is converted to digital form by the ATMega328. The Servo motor rotates the LDRs to six (6) different angle position at 30°, 60°, 90°, 120°,
150° and 180° to get the highest light intensity. Then it rotates the panel to the highest
sun's intensity.

IV. RESULTS AND DISCUSSION

TABLE II

Relationship between the resistance, light intensity and the voltage generated

Light Intensity (Lux)	LDR (kΩ)	Resistance (kΩ)	Voltage (V)
10	10	10	2.5
10	11	10	2.38
10	12	10	2.27
10	13	10	2.17
10	14	10	2.08
10	15	10	2
10	16	10	1.92
10	17	10	1.85
10	18	10	1.79
10	19	10	1.72
10	20	10	1.69

In Table II, the relationship between the light intensity and corresponding supplied voltages at different variations in the LDR are shown. It is revealed in the table that a slight increase in the value of the light dependent resistance produces a corresponding decrease change in the value of supplied voltage, the light intensity and the resistance of the system are unchanging.

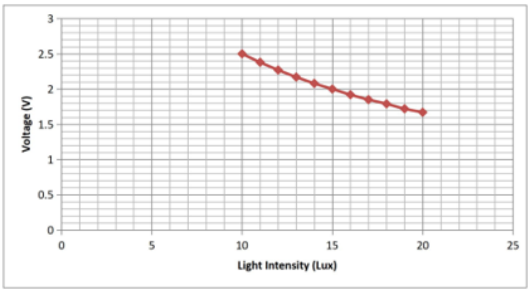

Fig 3: Voltage Generated at various Light Intensity

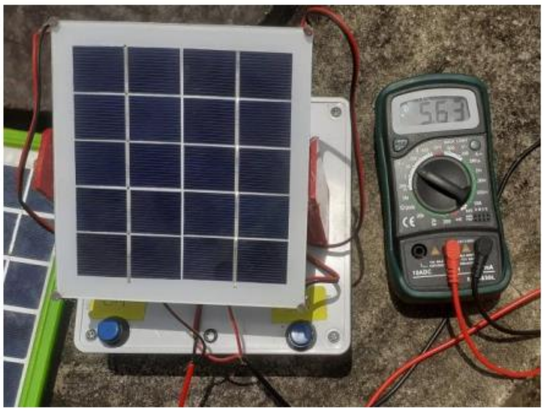

Fig 4: Angle: 30° Voltage: 5.63V 1:21PM

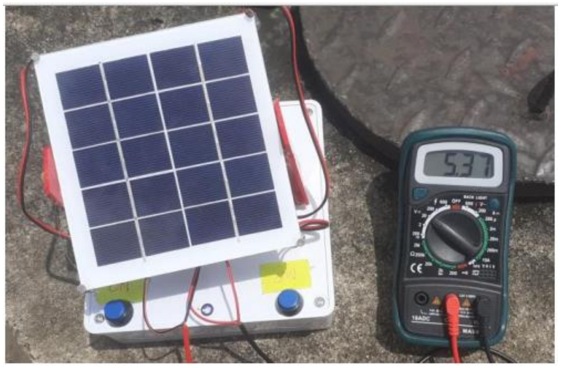

Fig 5:Angle: 60° Voltage 5.37V 1:33PM

Fig 6: Angle: 90° Voltage: 5.29V 1:34PM

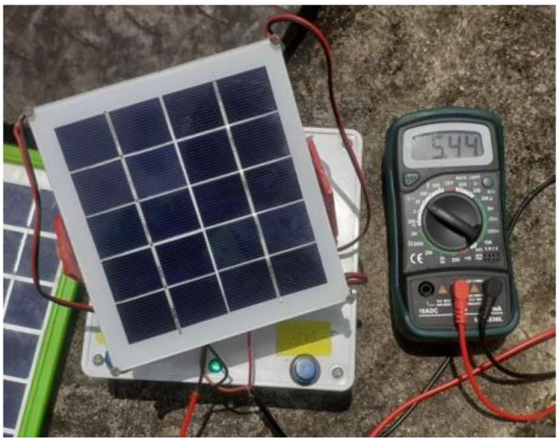

Fig7: Angle: 120° Voltage: 5.44V 1:34PM

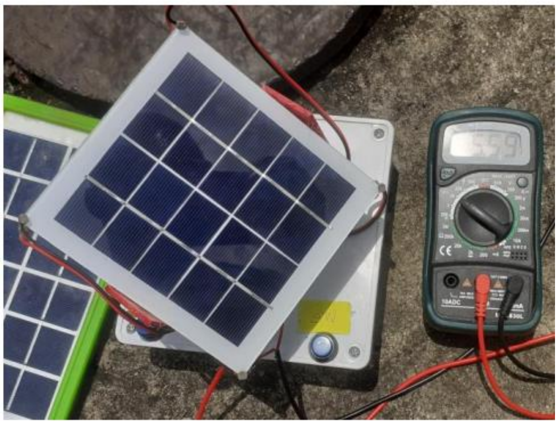

Fig 8: Angle: 150° Voltage: 5.59V 1:21PM

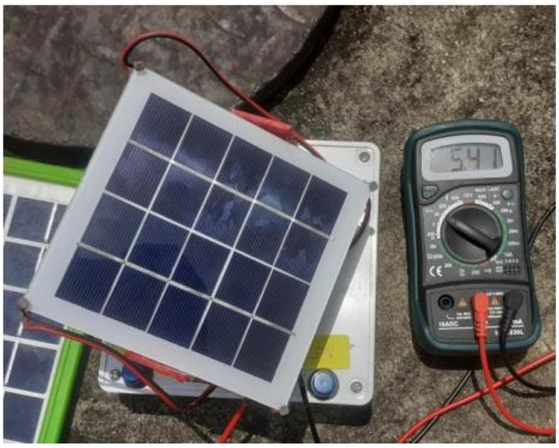

Fig 9: Angle: 180° Voltage: 5.41V 1:33PM

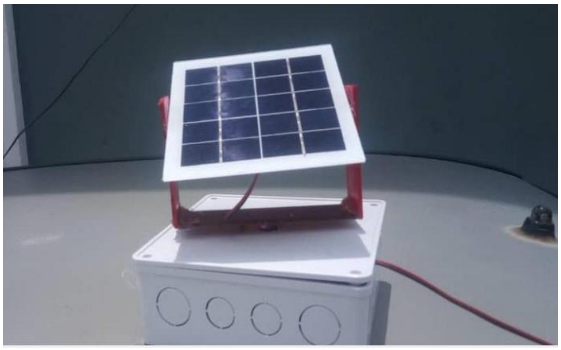

Fig 10: The Complete Design and Implementation of Solar Tracker

TABLE III

Results from the Solar Tracker System at various Angle Positioning

Time	Light Intensity at Different Angle of Rotation						Tracked Voltage(V)
	30	60	90	120	150	180	
11:22am	5.50	5.61	5.57	5.38	5.44	5.47	5.57
11:23am	5.58	5.54	5.44	5.33	5.32	5.29	5.58
11:26am	5.45	5.50	5.63	5.64	5.59	5.60	5.64
11:35am	5.36	5.54	5.65	5.64	5.67	5.52	5.67
11:41am	5.52	5.54	5.65	5.64	5.67	5.62	5.67
11:55am	5.72	5.74	5.71	5.61	5.53	5.58	5.74
12:03pm	5.62	5.64	5.65	5.63	5.61	5.57	5.65
12:17pm	5.57	5.53	5.52	5.55	5.56	5.53	5.57
12:30pm	5.50	5.55	5.61	5.65	5.58	5.60	5.65
12:50pm	5.67	5,71	5.70	5.68	5.67	5.60	5.71
12:59pm	5.58	5.49	5.56	5.47	5.59	5.53	5.59
1:07pm	5.65	5.44	5.49	5.60	5.58	5.55	5.65
1:09pm	5.34	5.32	5.43	5.22	5.13	5.52	5.52
1:20pm	5.67	5.52	5.48	5.46	5.58	5.52	5.67
1:21pm	5.63	5.44	5.41	5.58	5.59	5.40	5.63
1:33pm	5.52	5.37	5.32	5.39	5.50	5.41	5.50
1:34pm	5.49	5.29	5.29	5.44	5.29	5.27	5.49
1:35pm	5.26	5.35	5.33	5.35	5.50	5.39	5.50
1:41pm	5.09	4.98	4.89	5.02	4.99	5.03	5.09
1:43pm	5.20	5.35	5.24	5.41	5.27	5.19	5.41
1:57pm	5.26	4.96	4.98	4.82	4.81	4.71	5.26
1:58pm	4.91	4.98	4.66	4.93	4.92	5.26	5.26
Total	59.02	58	57.72	58.12	58.16	58.24	59.98
11:22am	5.50	5.61	5.57	5.38	5.44	5.47	5.57

V. CONCLUSION

The efficient generation of energy from the sun is essential, especially due to the call for reduction of the use of fossil fuel in energy generation across the world and the evolving renewable, zero waste energy source. Efficiency in this case refers to the maximum collection of sun rays on solar panels, such that energy is stored at the maximum capacity available as supplied by the sun each day. In order to achieve this aim, this project was designed, constructed and implemented to meet this need, employing the use of an efficient LDR solar tracker in precise prediction of the sun movement for efficient energy generation and storage. The circuitry was kept simple, while ensuring that efficiency is not affected. Dual axis trackers are more efficient in tracking the sun, but the additional circuitry and complexity was not required in this case. This is because Nigeria is situated between 4°N and 14°N of the equator and between 3°E and 15°E of the Greenwich meridian to east longitude and therefore there is a little significant change in the apparent position of the sun during the various seasons.

The state of electricity in Nigeria is well known and is characterised by blackouts, unstable voltage supply, and damages due to extreme weather. Similarly, the popular alternative source of energy, which is the use of generating plants which makes use of expensive fossil fuels has resulted into noise pollution, environmental pollution amidst other related adverse effects. This work recommends the use of renewable energy source, specifically the solar energy power system. For maximum efficiency of this source of energy, a solar tracking system to monitor the movement of the sun for maximum collection of rays concentration is provided in this work. With this device in place for solar tracking, sufficient sun energy will be gathered at every point in time during the day time. It is therefore recommended for use in buildings and facilities of academic environments which includes Ekiti State University, Ado-Ekiti, Nigeria for the enhancement performance of a regular, safe, renewable, noiseless and self-reliant energy generation source.

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REFERENCES

[1] Cindy Tay Yin Xi et al Development of Microcontroller-Based Solar Tracking System Using LDR Sensor, Journal of Telecommunication, Electronic and Computer Engineering, Vol. 9 No. 2-7, 2017 pg 71-75

[2] IRENA (2019), Future of Solar Photovoltaic: Deployment, investment, technology, grid integration and socioeconomic aspects (A Global Energy Transformation: paper), International Renewable Energy Agency, Abu Dhabi. ISBN 978-92-9260-156-0

[3] IEA Global Energy and CO2 Status Report 2018, International Energy Agency, 2019 pp. 3

[4] Mayank Kumar Lokhande Automatic Solar Tracking System International Journal of Core Engineering and Management Vol 1, Issue 7 2014 pp. 122-133

[5] Nwanyanwu C.J, Dioha M.O. and Sholanke O.S Design, Construction and Test of a Solar Tracking System Using Photo Sensor International Journal of Engineering Research & Technology (IJERT Vol. 6 Issue 03, 2017 pp169-175

[6] Nam Nguyen Solar Tracking System Helsinki Metropolia University of Applied Sciences Bachelor of Engineering Degree Programme of Electronics Thesis 2016

[7] Parameswari A, Kavithamani.V and Vedha vinodha.D Energy Saving from Sunlight with Microcontroller Using Proteus Software Design International Journal of Trend in Research and Development 2016 pp. 26-31