DUAL-AXIS SOLAR TRACKING OVER FIXED SOLAR SYSTEMS

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ABSTRACT

This paper presents the comparison of dual axis solar tracking system with the fixed solar system. Dual-axis solar tracking system to ensure maximum extraction of energy from the sun, an automatic dual-axis solar tracking system developed using arduino controller based on sun-earth geometrical relationships and two motors (dc motor_linear) with gearbox arrangement on a mechanical structure to move the solar panel so that sun's beam is able to remain aligned with the solar panel. And four sensors, which are mounted on the sides of the photo module by these sensors the solar tracking system becomes more sensitive and it allows to determining a more accurate location of the sun. The results showed that the dual-axis solar tracking system is highly efficient in terms of electrical energy output when compared with fixed solar system.

KEYWORDS: *Dual-Axis, Solar Tracking, dc motor, linear motor, optical sensors and Arduino.*

I. INTRODUCTION

Due to the depletion of fossil fuels, renewable energy sources such as solar and wind energies are of wide interest. Most solar cells are based on polycrystalline silicon and have a relatively high cost price determined by the costs of the starting material and the expensive manufacturing process. In the last years, the development of solar cells based on organic molecules [1–3] and conjugated polymers [4–5] have progressed rapidly which are a good alternative for the silicon-based solar cells due to their potentially low manufacturing costs and their light weight. The conversion of solar light into electrical energy represents one of the most promising and challenging energetic technologies, in continuous development, being clean, silent and reliable, with very low maintenance costs and minimal ecological impact. Solar energy is free, practically inexhaustible, and involves no polluting residues or greenhouse gases emissions. The conversion principle of solar light into electricity, called Photo-Voltaic or PV conversion, is not very new, but the efficiency improvement of the PV conversion equipment is still one of top priorities for many academic and/or industrial research groups all over the world [6]. Solar tracking systems are of several types and can be classified according to several criteria. A first classification can be made depending on the number of rotation axes. Thus we can distinguish solar tracking systems with a rotation axis, respectively with two rotation axes. Since solar tracking implies moving parts and control systems that tend to be expensive, single-axis tracking systems seem to be the best solution for small PV power plants. Single axis trackers will usually have a manual elevation (axis tilt) adjustment on the second axis which is adjusted at regular intervals throughout the year [6].

Among the proposed solutions for improving the efficiency of PV conversion, we can mention solar tracking [7], the optimization of solar cell configuration and geometry [8], new materials and technologies [9], etc. The solar tracking system is the most common method of increasing the efficiency of solar photo module. This study presents the efficiencies of energy conversion of photo module with solar tracking system and fixed photo module. The proposed sun tracking system uses 4 photo resistors, which are mounted on the sides of the photo module [10]. Many of sun tracking studies carried out to test the performance of the solar tracking system with several types of tracking strategies including open and closed loop method. For open loop system, the motion of the sun is

tracked via geometric formulas that relate the position of the sun with respect to earth; or via forecasting of the sun paths [11]. The solar cells are made up of silicon (sand). They are then connected to complete a photovoltaic (solar) panel. When the sun rays are incident on the solar cell, due to the photovoltaic effect, light energy from the sun is used to convert it to electrical energy [12]. Solar tracking approaches can be implemented by using single-axis schemes, and dual-axis structures for higher accuracy systems. In general, the single-axis tracker with one degree of freedom follows the Sun's movement from the east to west during a day while a dual-axis tracker also follows the elevation angle of the Sun [13].

The aim of this paper is to present a solar energy collection technology by a photovoltaic cell. To present this efficient solar distributed generation system, a dual-axis solar tracker is designed. The tracker actively tracks the sun and changes its position accordingly to maximize the power output. The designed tracking system consists of sensors, arduino controller to control circuits to drive two motors used to move the solar panel so that sun's beam is able to remain aligned with the solar panel, so this paper has resorted to the method of tracking the sun for maximum ability of solar energy through the use of motors to control and move the solar panels to track down the sun.

II. MECHANISM OF CONSTRUCTION

This section discusses the way it is fabricated building tracking solar system has fragmented this system into two parts so in order to be a division process more easily first practical step in the system is to read several values through optical sensors and compare these values are then give orders to the two motors (dc motor _ linear) shall move to the system by the great values readable by sensors and which corresponds to the direction of solar radiation and thus the maximum point of the sun and the rest of the sections of the system involved a study of the selection used programs best suited to implement the system considerations. Figure 1 shows the practical design of mechanism of dual-axis solar tracking system.

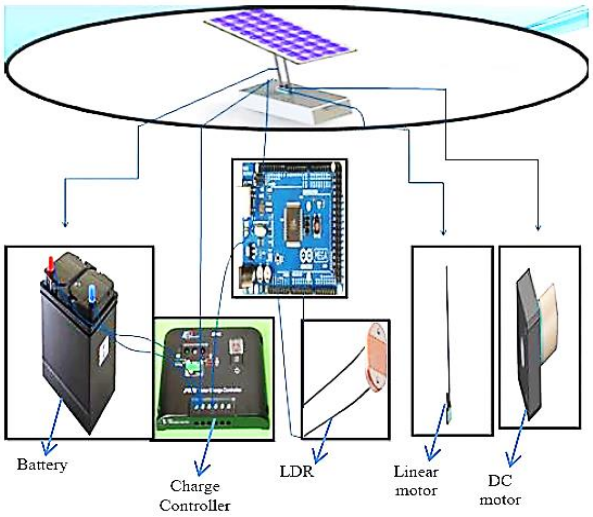

Figure 1 show the Mechanism of Construction

Also, table 1 shows the components that are used in practical design to implement the dual-axis solar tracking system.

Table 1 shows the components that used in practical design

Item	Size or part no.
ARDUINO	ATmega2560
Regulator	7805
Resistor	10k
Resistor	1k
Two Transistor(NPN)	BC 547
Two relay	10 Ampere ,12 Volt
Photo cell 100 watt ±10	Cadmium
(linear , DC) motor	5V

As a results the sun rotational movement relative to the earth also spacing distance between the sun and the earth during the day as the position of the sun relative to the earth varies from time to time during the day so it was necessary to prosecute the system of the sun to take advantage of the maximum amount of sunlight to generate electricity through the programming to control of motors movement of rotation and movement of the top and bottom of the system. Figure 2 shows the circuit to control the movement of the motors.

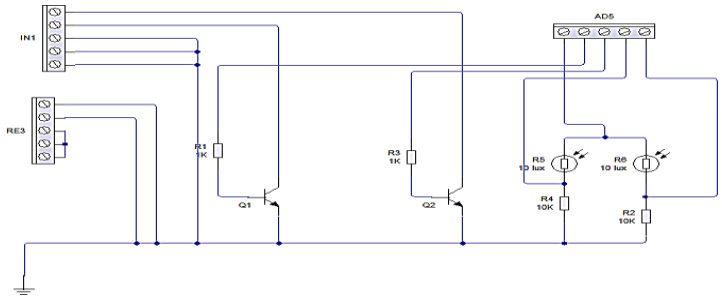

Figure 2, control circuit in motors.

Figure 3 describes the full circuit design

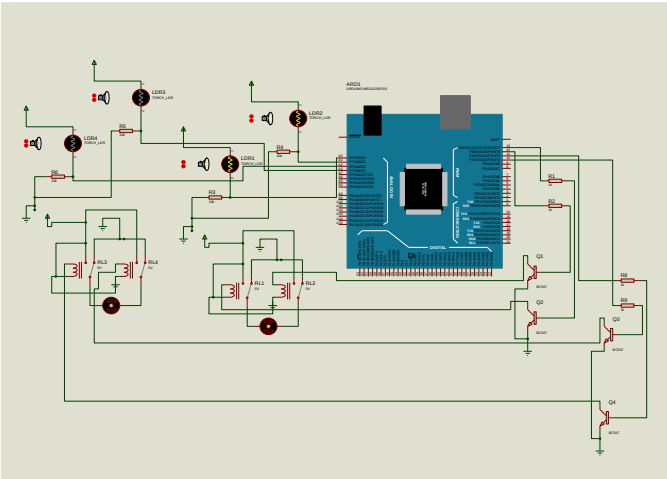

Figure 3, shows the full circuit design.

III. DESIGN PROCEDURES

In this section the work is divided into four main parts.

A. Starting Point:

Before feeding system, the photovoltaic cells must be directed manually to the starting point which is the brightness of the sun point and then to bring the system to this point, the sensors will move towards the direction of the sun by sending an order to the motors in the direction of the sun hand clockwise until the radiation photosynthesis value becomes larger of the calibrated value of the system in advance. Value calibrated by the system corresponds to a reference tension 4.60 volts where this value was chosen in order to conform to the PV cell tension in the state were covered and directed toward the sun. This value ensures that the solar tracking system will haunt super solar radiation value.

B. Optical Sensors:

This part is the core of the program after it is primitive position calibration system for prosecution by a high intensity light source (the sun) is ready then to adjust itself more carefully and follow the light. Observers measured at the beginning the intensity of light at where it is and then moves counter-clockwise and then measures the radiation value and then moves with the clock and takes a reading

last program and comparing two values the system will return to the previous point, which began then and repeat the measurement process again after going four minutes before the measurement again and this time is taken from the fact that the sun moves by degrees every four minutes.

C. Sensitivity to Weak Light:

It is similar to the process described previously part where if the light intensity is less than the minimum light threshold supplements will continue to be compared in the position where it moves even up to a measure equal to light the threshold of this world and this value in the program is assigned to meet the tension of 3.75 volts and this value is commensurate with the value measured by the shaded photocell on a cloudy day, a suit the conditions of radiation on cloudy days.

D. Follow-up System that repeats itself at the end of the Day:

After all movement is one guardian motor or decreases depending on the variables in order to know the exact location of which is increasingly reached her system at any time. After the tracker to rotate 180 degrees is verified light intensity if the value of the light intensity corresponding to the value of tension less than the tension threshold which is 3.75 volts as we mentioned earlier will return the tracker to primitive status and enter into snooze mode and if the value higher than the minimum threshold value will continue to be tracked compared until you reach the measured value is less than the minimum threshold. In the time that enters the system state dozing faithful can be brought back to the primitive through the manual key.

IV. RESULTS AND EXPERIMENTAL EVALUATION

Results taken in month of May were taken results in two cases:

A. In the Case of Fixed Solar Panel:

In this case the results were taken from twelve and a half hours noon until six pm and it even intervals every 15 minutes were recorded value of each of the electric current, voltage and also power that generated from solar panel in accordance with the following schedule table 2.

Table 2, results in the case of fixed solar panel

P (watt)	V (volt)	I (ampere)	T (hour)
80	20	4	12:30
86.8	20	4.34	12:45
89.847	20.1	4.47	1:00
90.698	20.2	4.49	1:15
90	20	4.50	1:30
87.435	20.1	4.35	1:45
85.172	19.9	4.28	2:00
81.6	20	4.08	2:15
78.6	20	3.93	2:30
73.829	19.9	3.71	2:45
69.451	19.9	3.49	3:00
63.8	20	3.19	3:15
59.302	19.9	2.98	3:30
54.471	20.1	2.71	3:45
49.2	20	2.46	4:00
41.989	19.9	2.11	4:15
35.621	19.9	1.79	4:30
30.248	19.9	1.52	4:45
24.304	19.6	1.24	5:00
16.965	19.5	0.87	5:15
11.966	19.3	0.62	5:30
7.938	18.9	0.42	5:45
4.836	18.6	0.26	6:00

Note from the table that the solar panel records maximum capability of electric power in the period from 1:15 pm to 1:30 pm and also recorded the lowest value in the sixth hour of the night, which is in the case of the solar unseen as explained from the results recorded in the previous table 2.

B. In the Case of Tracking Solar Panel:

In this case the results were taken from nine and twenty minutes in the morning until five o'clock and forty minutes pm and it even intervals every 10 minutes were recorded value of each of the electric current, voltage and also power generated from solar panel in accordance with the following schedule table 3.

Table 3, results in the case of fixed solar panel

P (watt)	V (volt)	I (ampere)	T (hour)
105.524	5.13	20.57	9:20
103.935	5.07	20.5	9:30
102.0566	5.02	20.33	9:40
102.461	5.03	20.37	9:50
102.008	5.03	20.28	10:00
102.413	5.04	20.32	10:10
101.803	5.01	30.32	10:20
102.616	5.05	20.32	10:30
101.453	5.01	20.25	10:40
101.755	5.02	20.27	10:50
101.5527	5.01	20.27	11:00
101.7052	5.02	20.26	11:10
101.253	5.02	20.17	11:20
101.4048	5.03	20.16	11:30
101.7072	5.04	20.18	11:40
102.515	5.05	20.3	11:50
102.971	5.06	20.35	12:00
100.349	4.99	20.11	12:10
101.254	5.03	20.13	12:20
101.606	5.05	20.12	12:30
100.551	5.01	20.07	12:40
100.35	5.01	20.03	12:50
102.9192	5.09	20.22	1:00
99.75	5	19.95	1:10
101.052	5.04	20.05	1:20
100.551	5.02	20.03	1:30

Follow of table 3, results in the case of fixed solar panel

P (watt)	V (volt)	I (ampere)	T (hour)
101.505	5.05	20.1	1:40
100.651	5.02	20.05	1:50
98.456	4.97	19.81	2:00
99.6	4.99	19.96	2:10
97.804	4.9	19.96	2:20
100.149	5.02	19.95	2:30
99.9495	5.01	19.95	2:40
101.053	5.03	20.09	2:50
99.75	5	19.95	3:00
100.35	5.01	20.03	3:10
99.152	4.97	19.95	3:20
99.6	4.98	20	3:30
90.374	4.53	19.95	3:40
98.8	4.94	20	3:50
98.6	4.93	20	4:00
86.6	4.33	20	4:10
100.55	5	20.11	4:20
97.702	4.89	19.98	4:30
96.703	4.84	19.98	4;40
99.245	4.94	20.09	4:50
97.346	4.86	20.03	5:00
89.284	4.42	20.2	5:10
86.37	4.28	20.18	5:20
83.224	4.12	20.2	5:30
72.576	3.6	20.16	5:40

Note from the table that the solar panel records maximum capability of the electrical power of about 100.524 watts and also recorded the lowest value at five and forty minutes pm, in the case of the solar unseen as explained from the results recorded in the previous table 3, also shows that the electrical power value increased markedly worth in the case of tracking in the case of fixed.

V. CONCLUSIONS

In this research, we offered the importance of the work of the tracking with the sun to generate electrical power than in the case of use of fixed solar panels also explained the results that took and recorded while taking readings and work the system to the electrical power generated value as a result of the work of the tracking of the solar panel to the sun is higher than in the case of fixed panels as he explained previously of readings recorded during the making of the system. After studied this work we have got solar tracking system is highly efficient in terms of electrical energy output when compared with fixed solar system. Hence the efficiency of solar tracking system is higher than the fixed solar system. Also we can increase the electric power by using solar cells can be connected together to use in many applications.

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