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SOLAR TRACKING SYSTEM FOR SOLAR POWERED GARDEN LAMPS

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ABSTRACT

With the growing human population and advancement of technology, requirement for clean renewable energy goes high. Solar energy is the most abundant clean renewable energy resource and it can be used either direct (solar radiation) or indirect form. About 60% of the total energy emitted by the sun reaches the Earth's surface. By using energy efficient photovoltaic (PV) modules, solar energy can be efficiently converted in to electricity. This fundamental concept is used in a wide range of applications and efficiency of all these applications depend on the success of the solar radiation collecting process by PV modules. This research discusses how dual axis solar tracking system can be used in solar powered garden lamp units to increase solar radiation harvesting process. Solar tracking system includes a solar panel (20 W, 18 V), PWM charge controller, four light dependent resistors (LDR), Ardunio UNO R3 development board with built in ATmega 328P-PU microcontroller and high torque DC gear motors 60 rpm and 80 rpm. With fitted solar tracking system solar powered garden lamps can harvest solar energy efficiently regardless of sun's motion across sky, seasonal changes, geographical location and shading.

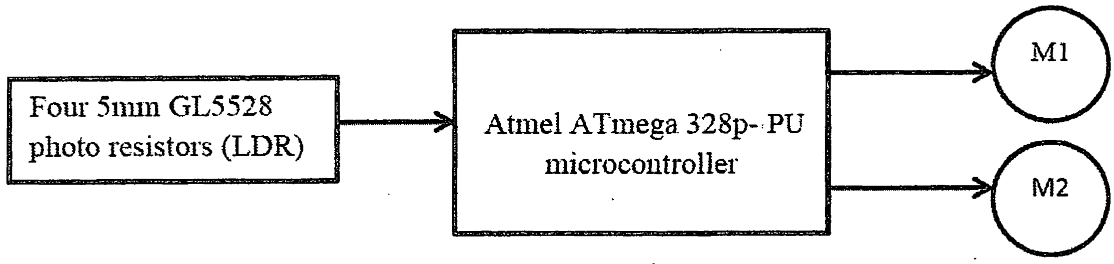
Keywords: Solar radiation, Solar tracking, LDR

1. INTRODUCTION

To improve the efficiency of devices that produce solar energy, it is an essential to pick up solar radiation much as possible. For that it is needed to improve materials and methods used to harvest solar radiation. There are several factors that govern the harvesting process such as solar cell efficiency, intensity of radiation and in addition energy storage techniques[1]. From three factors mentioned above, improvements in the solar energy collection process can lead to increase the mean solar radiation intensity received from the Sun. Solar radiation intensity on a PV module (solar panel) depends on movement of the sun from east to west, seasonal changes, geographical location and shading[2]. Solar energy collection of a PV module can be made efficient with help of a solar tracking system. Sun tracker is a mechanical tracking system use to collect the highest possible radiation and thereby to maximize the energy output from solar panels. It follows the motion of Sun when moves from east to west every day. By tracking motion of the Sun, sun tracker aligns solar panels directly towards the sun bringing solar panel in to its optimal position.

2. EXPERIMENTAL

2.1 Methodology:



M1-12V DC, 60rpm high torque gear motor

M2-12V DC, 80rpm high torque gear motor

Figure 1: Block diagram of solar tracking system

When the sun is rising early in the morning, solar tracker is in its default position which is 10° incline to horizontal plane. Solar radiation is sensed by four LDR (Model: GL 5528) and all 4 LDRs are connected to analog input pins in the Ardunio UNO R3 board using point "A" (Figure 2). Voltage values at "A" are analog inputs to the Ardunio UNO R3 (inputs to the micro controller ATmega 328P-PU). As there is a 10-bit analog to digital converter in Ardunio UNO board[3], it will map input voltages between 0 and 5 V into integer values between 0 and 1023. When it is dark, LDR has very high resistance. When solar radiation is sensed, resistance values of the LDR go to a low value changing the voltage value at point "A". Sun's motion across the sky or a shade of an object on the solar panel changes the radiation intensity which changes resistance value of each LDR. Solar radiation intensity variation generates changing voltage inputs for all four analog inputs that will be converted in to values between 0 and 1023. After sensing 4 analog inputs from 4 LDRs, program written on the microcontroller decides logically what output signal should be given to motors in the solar tracking system to direct the solar panel to its optimal position to collect optimum yield of solar radiation.

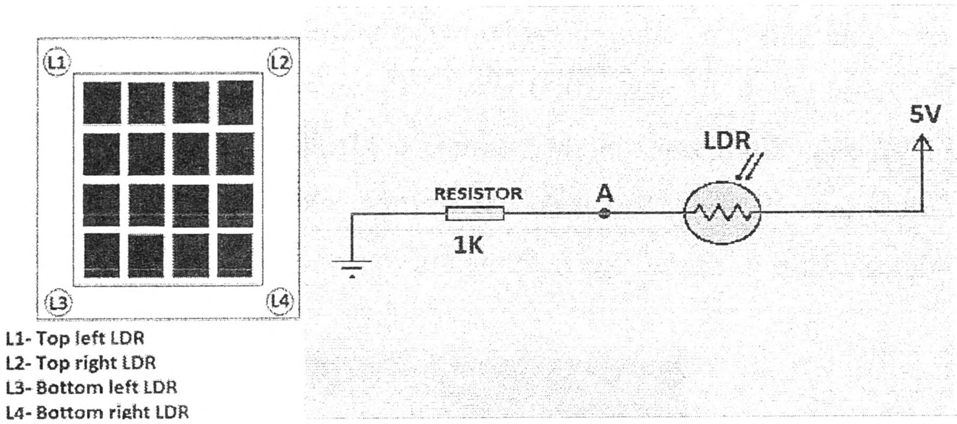


Figure 2: LDR configuration

2.2 Ardunio program logic flow chart:

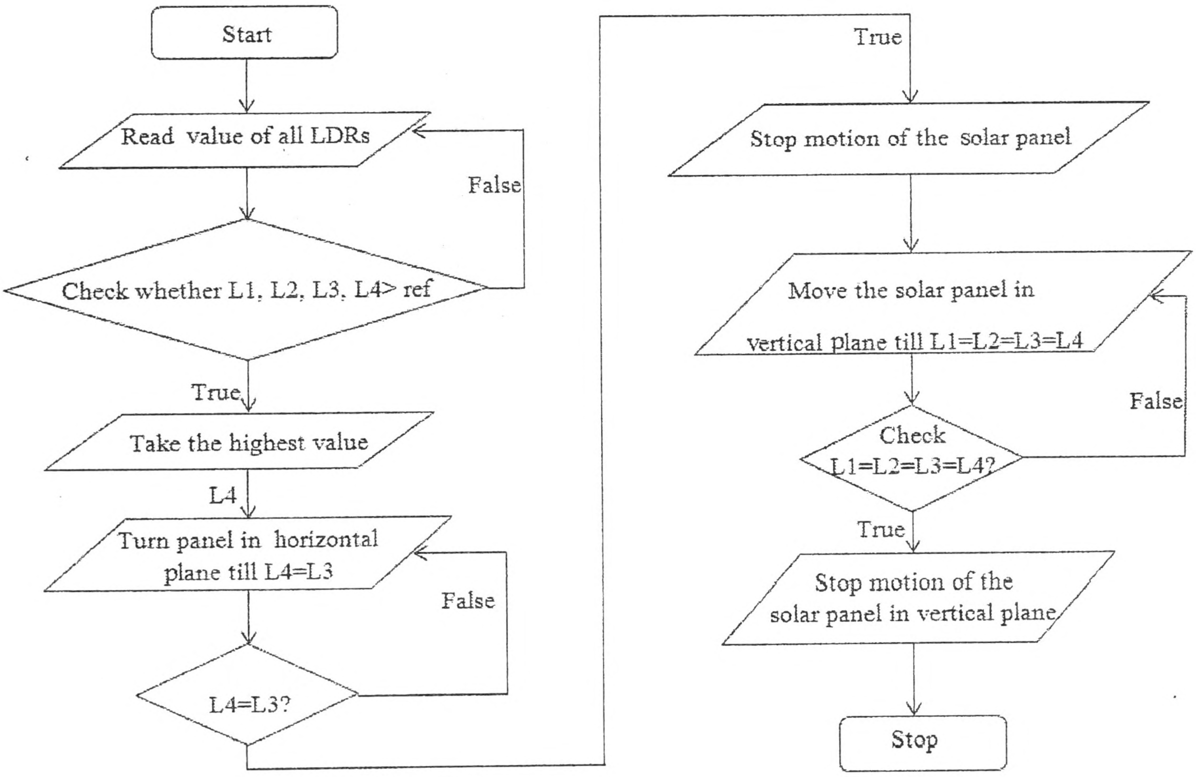


Figure 3: Program flow chart

"ref" is the reference value which starts the operation of the solar tracker and assume L4 receives the highest radiation intensity when the Ardunio program starts the execution.

2.3 Hardware structure:

Hardware structure consists of several types of materials. Low cost, light weight and hard materials that can bear the weight of the whole structure were chosen. Structure which holds the solar panel and can rotate in horizontal plane using 2 ball bearings (number 4, Figure 4) was fabricated using 40 mm, 1000 kpa PVC. Steel structure (number 1, 2 and 3) holds the whole PVC structure. Horizontal motion is controlled by motor M1 which is a 12 V, 60 rpm high torque gear motor. Movements in vertical plane is controlled by motor M2 (12 V, 80 rpm) with the help of thread bar mechanism (number 5, 6 and 7 in Figure 4).

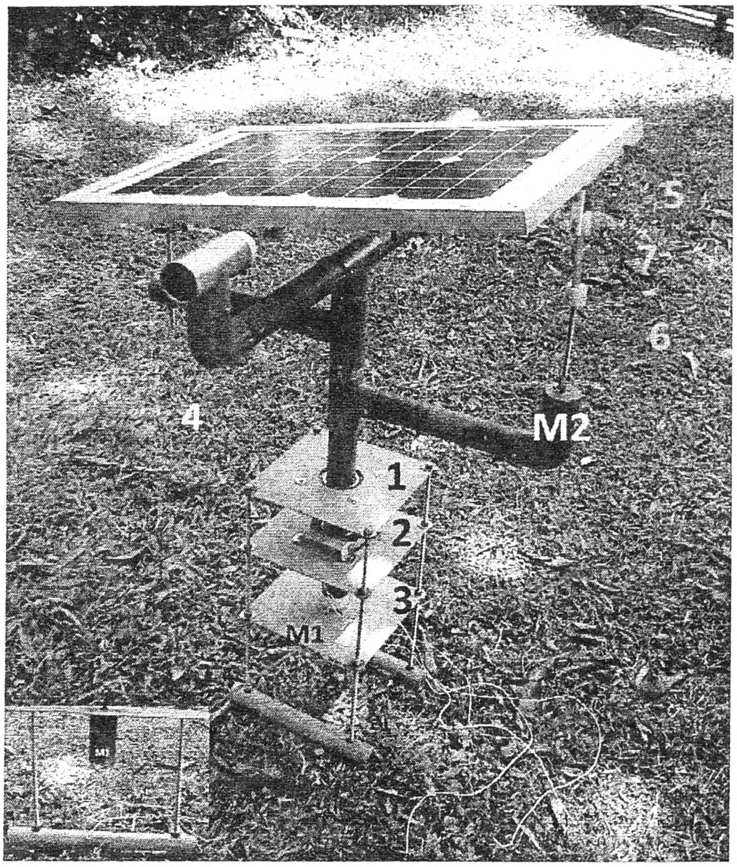


Figure 4: Hardware structure solar tracking system

3. RESULTS AND DISCUSSION

3.1 Results

Voltage output of solar panel of the garden lamp was measured before and after the solar tracking system was fitted. Output voltage values of the solar panel were measured hourly for a time period of 12 hours, starting from 6.30 a.m. in the morning till 6.30 p.m. in the evening. Observed voltage values were tabulated as shown in Table 1.

Table 1: Output voltages of the solar panel measured before and after the installation of solar tracking system.

Time	Output Voltage (V)of Solar Panel Test1		Out Voltage (V) of Solar Panel Test2	
	Before	After	Before	After
6.30 a.m.	9	11	9.3	9
7.30 a.m.	15	15.5	15	15
8.30 a.m.	15.3	17	15.7	15
9.30 a.m.	18	17	17	16
10.30 a.m.	18	17.5	18.1	18.8
11.30 a.m.	18	19	18	18
12.30 p.m.	19	19	19.3	20
1.30 p.m.	20	19	19	20
2.30 p.m.	19	20	20	20.4
3.30 p.m.	19	20	20	20
4.30 p.m.	17	17.1	16	15
5.30 p.m.	13	13	14.5	15
6.30 p.m.	11	8.7	8	9

3.2 Discussion:

With the results in Table 1, it shows some improvement in output voltage of the solar panel. But to obtain best performance and results, solar tracker must be tested in different lighting conditions (sunny days and days with cloudy skies) and different geographical locations. And to test its durability in all weather conditions, it needs to be further tested in high winds and rainy conditions.

4. CONCLUSION

This research discusses a method to increase the intensity of solar radiation incident on to a PV module. This prototype active solar tracking unit is capable of aligning the PV module automatically to an optimal position with the change of solar radiation intensity which will make the radiation collecting process efficient. Fitted with low cost solar tracking system, company can explore in to new market with this "Enhanced Solar Powered Garden Lamp". System can be improved further with light weight strong material for the structure.

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10.30 a.m.	18	17.5	18.1	18.8
11.30 a.m.	18	19	18	18
12.30 p.m.	19	19	19.3	20
1.30 p.m.	20	19	19	20
2.30 p.m.	19	20	20	20.4
3.30 p.m.	19	20	20	20
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