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Maxi dual axis solar tracker system

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Abstract

In this work, a maxi dual axis solar tracker is proposed. This tracker is used to track the sun path within a day and during a year. The tracking system is composed of two parts: mechanical and electrical parts. The mechanical part is composed of panel carrier, panel carrier rotator according to horizontal/vertical axis, two actuators. The electrical part is composed of light sensor, microcontroller, relays. The light sensor receives an artificial light and sends a potential difference as an analog signal to microcontroller. The microcontroller converts the analog signal into a digital signal using ADC and sends it to relays. The relays activate the two actuators to orient the maxi solar PV into the artificial light with the purpose to produce maximum energy.

Keywords: Maxi dual axis solar tracker, light sensor, microcontroller, relays, maxi solar PV.

1. Introduction

In this new era, the conventional energy source such as fossil fuels and coal are depleting so fast. The deficiency of these resources can be overcome by the use of renewable energy. The problems caused by the use of fossil fuels like global warming, and environmental pollution, laid more emphasis on using renewable energy such as solar energy. Solar energy is one of the most efficient sources of renewable energy. It exists abundantly in the environment, is inexhaustible, and is cleaner [1-2]. Solar panels or PV panels convert the solar rays into electrical energy. The efficiency of commercialized PV cells is between 10 to 20% [3]. The PV cell works similarly to the classical p-n junction diode. The semiconductor within the PV cell absorbs the photons from the sun and moves the electron from their atoms, enabling electrons to go through the semiconductor to generate electricity [4-5].

The efficiency of conversion from solar ray's into electrical energy is low because it's depending on the amount of sunlight. The static solar panels must be perpendicular to the solar radiation to produce maximum electrical energy [6]. It's well known that the sun changes its position within a day from East to West. In this case, a single axis tracker is sufficient to track the sun path. On the other hand, the sun changes its position within a year from winter to summer. For that reason, a dual-axis solar tracker is used to track the sun path.

The present work is divided as follows: in section 2, the literature review is described, in section 3, the methodology of our work is detailed, and in section 4, the result and discussion are mentioned. Finally, in section 5, the conclusion is drawned.

2. Literature review

The literature review of dual axis solar tracker systems is annotated in table 1.

Table 1. Literature review of tracker system.

Authors	**Tracking system**	**Sensor**	**Advantage**
Shashank et al. 20 [6]	Efficient dual axis solar tracking system	LDR's (Light Dependent Resistor)	-
S. Davies et al. 21 [7]	Development of an advanced solar tracking energy system	M16C/62P Microcontroller using PI controller	-
Cha et al. 21[8]	Dual solar tracker without microcontroller	Four reference panels	The tracker system is low cost
Kumar et al. 21[1]	Solar tracker which consist of removing dust and dirt from solar panels	LDR's (Light Dependent Resistor	Increase productivity

From the literature review, we conclude that many researchers realized and implemented a dual axis solar tracker using the LDR's as light sensors, Arduino Uno as microcontroller, and two servomotors in purpose to track the sun path within a day according to the horizontal direction and during a year according to the vertical direction. The main objective of the tracking system is to produce maximum energy from the sunlight. In these previous works, the majority of

authors realized a mini dual axis solar tracker working with mini solar panel. In our work, the maxi dual axis solar tracker is designed and implemented to track the sun path.

3. Methodology

Our tracker system is composed of two part: the mechanical part and the electrical part. The mechanical part is composed of a panel carrier, panel carrier rotator, and two actuators. The electrical part is composed of a light sensor, microncontroller (Arduino Uno), and relays.

3.1 The mechanical parts

The realization and assembly of different mechanical parts are done using: some piece of iron to develop a panel carrier and panel carrier rotator (horizontal/vertical axis). The latter are assembled by a circular rod, bolt, and screw thread (as shown in figure 1).

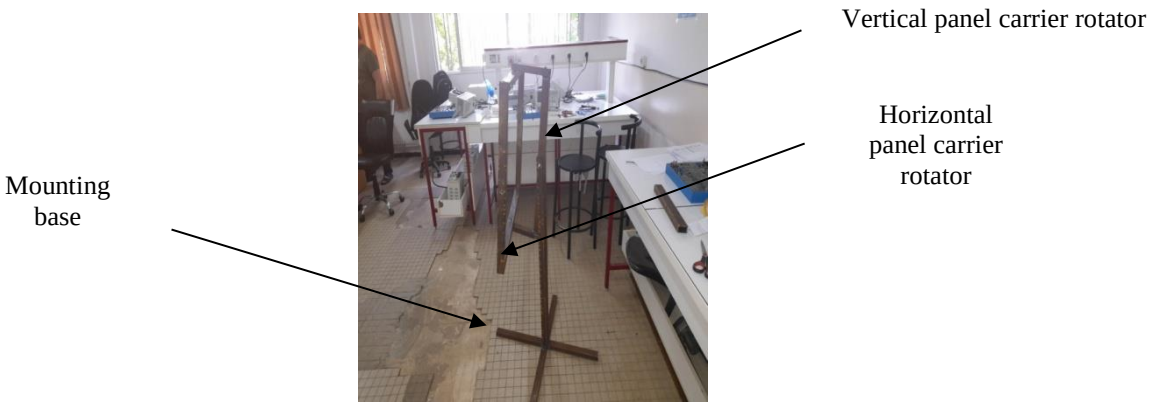

Fig. 1 The mechanical part.

Fig. 2 The first actuator

Fig. 3 The second actuator

3.2 The electrical part

The electrical part of our tracker system is composed of a light sensor, microcontroller, and relays.

3.2.1 Light sensor

The light sensor is composed of 4 LDR (Light Dependent Resistor) connected with 4 resistors forming a divider circuit as shown in figure 4. The light sensor receives sunlight and the output of the divider circuit provides a potential difference as an anolog signal to the microcontroller.

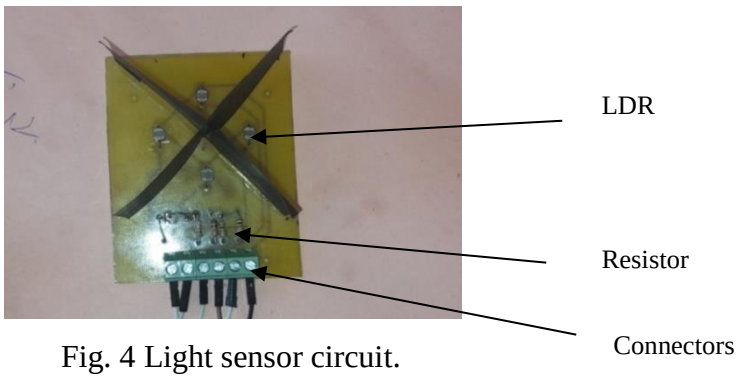

Fig. 4 Light sensor circuit.

3.2.2 Microcontroller

The microcontroller : Arduino Uno converts a potential difference as an analog signal from a light sensor to a digital signal by ADC (Analog Digital Converter) and sends it to relays in purpose to activate two actuators.

Figure 5 illustrates a flowchart of C programming code implemented in Arduino Uno Board.

L_LDR: Left_LDR

R_LDR: Right_LDR

T_LDRt: Top_LDR

B_LDRb: Bottom_LDR

L_LDRV: Left_LDR Voltage

R_LDRV: Right_LDR Voltage

T_LDRV: Top_LDR Voltage

B_LDRV: Bottom_LDR Voltage

R1: Relay which control first actuator

R2: Relay which control second actuator

R_R: Relay that activates actuator R1 to the right direction.

L_R: Relay that activates actuator R1 to the left direction.

T_R: Relay that activates actuator R2 to the top direction.

B_R: Relay that activates actuator R2 to the Bottom direction.

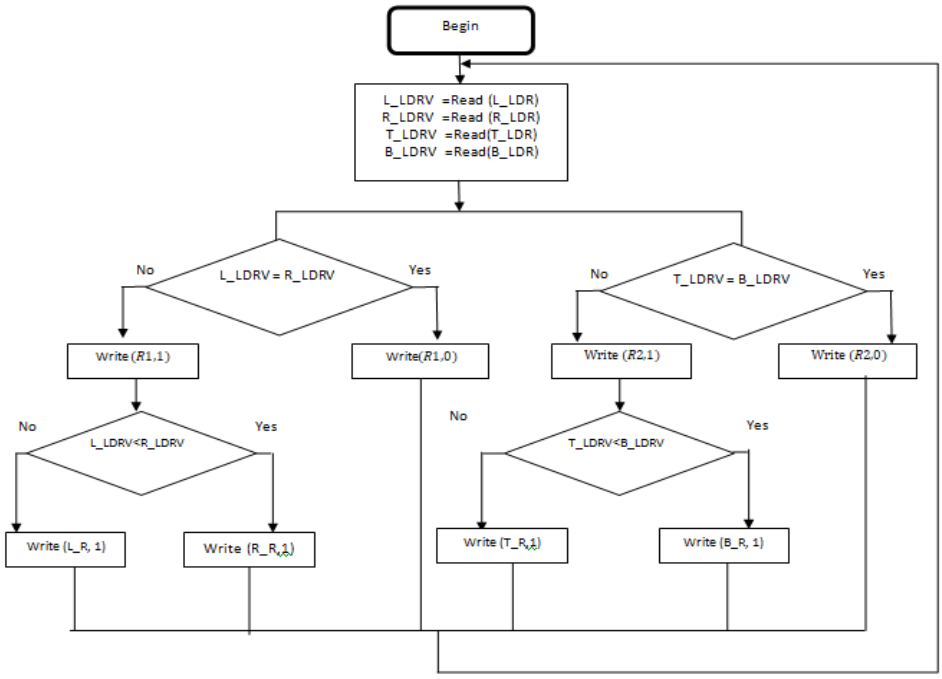

Fig. 5 Flowchart of C programming code implemented in Arduino Uno Board.

3.2.3 Relays

The relays are used to activate the two actuators. For this reason, we realized a relays circuit as shown in figure 6. The relays circuit is composed of the following:

- **Connectors:** the connectors are used as input for the 12 V power supply, connect the microcontroller (Arduino Uno) to the relay circuit (input relays), and connect relays to the first and second actuator.

- **Fuse:** The fuse is used to protect the circuit from overvoltage.

- **Resistor:** 6 resistors are used to limit the flowing current**.**

- **Transistor:** 6 transistors 2N2222 are connected with 6 relays.

- **Diode:** 12 diodes 1N4008 are utilized as flyback diodes relay.

- **R_1:** R_1 is composed of two relays (switches).The R_1 control: L_R and R_R.

- **L_R:** L_R is composed of two relays (switches). The L_R turn on the first actuator in the left direction.

- **R_R:** R_R is composed of two relays (switches). The R_R turn on the first actuator in the right direction.

- **R_2:** R_2 is composed of two relays (switches).The R_2 control: T_R and B_R.

- **T_R**: T_R is composed of two relays (switches). The T_R turn on the first actuator in the top direction.

- **B_R:** B_R is composed of two relays (switches). The B_R turn on the first actuator in the bottom direction.

Figure 6 denotes the relay circuit.

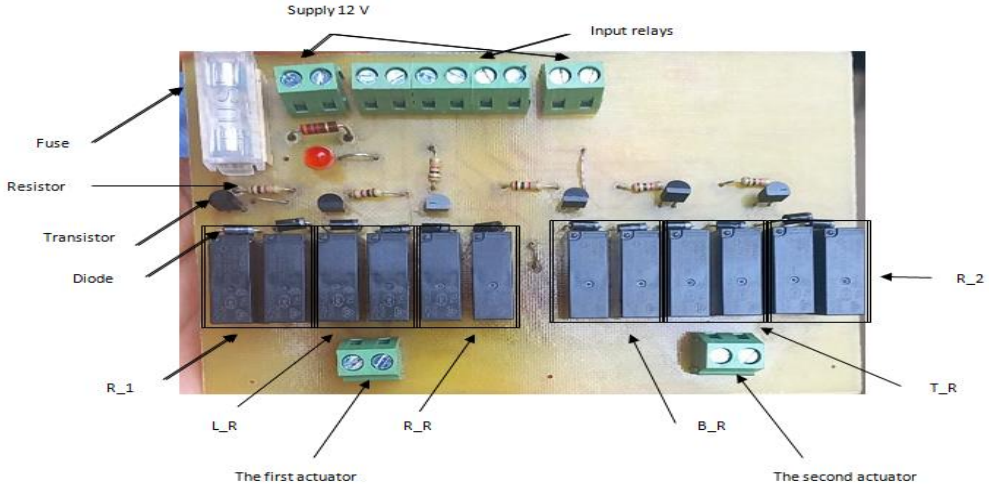

Fig. 6 Relays circuit.

4. Result and discussion

The objective is to make work our proposed tracking system: dual axis solar tracker. For that, a transformer 220V/12V is used for supplying the relay circuit. Then, the regulator is utilized to provide 5V from 12V and use for supplying power to light sensor and microcontroller. The two actuators work under 12 V and have the capacity to support solar PV. All different circuits are connected with wires as shown in figure 7.

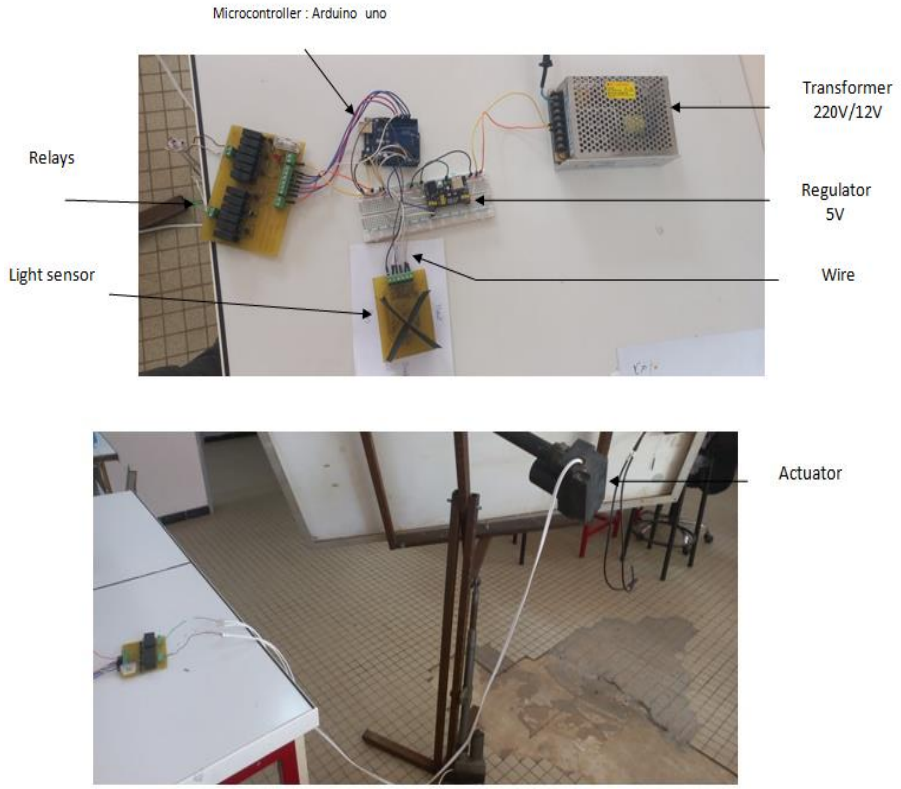

Fig. 7 Proposed dual axis solar tracker system.

In our experiment, artificial light is utilized rather than sunlight. The light sensor is placed as indicated in figure 7. We exposed the light with a cell phone on the 4 LDRs. We noticed that when the light is exposed on the right side LDR, the tracker will turn to the right and will stop when the voltage value of the right LDR is equal to that of the left LDR and if the light is exposed on the left side LDR, the tracker will turn to the left and will stop when the voltage value of the left LDR is equal to that of the right LDR. The same process is applied to the top side, the tracker will go up and will stop when the voltage value of the high LDR is equal to that of the low LDR. While for the bottom side, the tracker will go down and will stop when the voltage value of the low LDR is equal to that of the high LDR.

5. Conclusion and future work

The proposed tracker system is a maxi dual axis solar tracker. This tracking system orients the maxi solar PV to the sunlight with the purpose to produce maximum energy. In the experiment, we use artificial light rather than sunlight. The Experimental results showed that our tracker system worked efficiently using the light sensor. In future works, we will try to measure the power, the voltage, and the current from solar PV.

6. References

[1] Kumar M, Sharma R, Kushwaha M, Yadav AK, Ahmad MT, Ambikapathy A. Solar Tracker With Dust Removal System: A Review. In: Bhoi AK, Mallick PK, Balas VE, Mishra, B.S.P. (eds) Advances in Systems, Control and Automations. Lecture Notes in Electrical Engineering 2021;708.

[2] Aziz S, Hassan M. Dual Axis Solar Tracker for Solar Panel with Wireless Switching. In: Nath, V., Mandal, J. (eds) Proceeding of the Second International Conference on Microelectronics, Computing & Communication Systems. Lecture Notes in Electrical Engineering 2019;476.

[3] Zhan T, Lin W, Tsai M and Wang G. Design and Implementation of the Dual-Axis Solar Tracking System. 2013 IEEE 37th Annual Computer Software and Applications Conference, 2013, p. 276-277.

[4] Shen C, Wu Y, and Liu F. A double-linear approximation algorithm to achieve maximum-power-point tracking for PV arrays. 2009 International Conference on Power Electronics and Drive Systems (PEDS) 2009, p.758-763.

[5] Liu K. Dynamic characteristics and graphic monitoring design of photovoltaic energy conversion system. WSEAS Transactions on Systems 2011;10:239-248.

[6] Shashank, H N, Hithashree C. Efficient Dual Axis Solar Tracking System. In: Kumar, A., Mozar, S. (eds) ICCCE 2020. Lecture Notes in Electrical Engineering 2020; 698.

[7] Davies S, Sivanathan S, Constant E, Thanapalan K. Development of an Advanced Solar Tracking Energy System. In: Mporas I, Kourtessis P, Al-Habaibeh A, Asthana A, Vukovic V, Senior J. (eds) Energy and Sustainable Futures 2021.