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A Prototype solar tracking system design and implementation

*Abbas F. Nori   Faisel G. Mohammed

[1]University of Kufa, Faculty of Sciences, Physics Dep.
[2]University of Baghdad, College of Sciences, Remote Sensing & GIS Dep .

*Corresponding Author E-mail: abbasf.hussein@uokufa.edu.iq

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ABSTRACT

In this work comparison between the results of the first systems is a fixed solar and the second is the sun tracking in an attempt to increase the proportion of electricity production. Here a microcontroller (Arduino) and the light-dependent resistor (LDR) photo detector is used in this tracker. And then compare the results in different weather conditions and on different days to test the efficiency of the two systems. The efficiency of the tracking system is better than the fixed system by 12.3% on a sunny day and 4.9% on a partly cloudy day. However, it failed by 3.3% on a cloudy day. With a sunny day preference in the tracking system at 6.9% of partially cloudy days, and 12.1% with partially cloudy to a cloudy day. And verified from The efficiency of the work of the microcontroller (Arduino) system and the optical detector (LDR).

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تصميم و تنفيذ منظومة متتبع شمسي تجريبية

عباس فاضل نوري[1]   فيصل غازي محمد[2]

كلية العلوم جامعة الكوفة [1]
كلية العلوم جامعة بغداد[2]

الكلمات المفتاحية:

المتتبع الشمسي
الاشعاع الشمسي
استخدام كارت الاردوينو
الطاقة المتجددة
متحسس المقاومة الضوئية

الـــخُـــلاصـــة

في هذا العمل جرت المقارنة بين نتائج منظومتين للطاقة الشمسية الاولى ثابتة و الثانية تعمل على تتبع الشمس في محاولة لزيادة نسبة انتاج الطاقة الكهربائية. هنا يتم استخدام متحكم دقيق وكاشف ضوئي في جهاز التعقب الشمسي. و من ثم مقارنة النتائج في ظروف جوية مختلفة و في ايام مختلفة لاختبار مدى كفاءة المنظومتين. وقد ثبت أن كفاءة نظام التتبع أفضل من النظام الثابت بنسبة ١٢.٣٪ في اليوم المشمس و ٤.٩٪ في اليوم الغائم جزئيا. ومع ذلك ، فشلت بنسبة ٣.٣ ٪ في يوم غائم. مع تفضيل يوم مشمس في نظام التتبع بنسبة ٦.٩٪ من بعض الأيام الغائمة ، و ١٢.١٪ مع الغائم جزئيا إلى اليوم الغائم. و ايضا تم التحقق من كفاءة عمل

المنظومة التي تعمل بالمتحكم الدقيق و الكاشف الضوئي المعتمد على تغير المقاومة في عمله.

1. INTRODUCTION

While ‘energy’ is the prime factor for developing any country. where the huge amount of nonrenewable energy is extracted like oil and about 85% of energy production depends on fossil fuels. The resources of fossil fuels are limited and constitute a threat to a human being by the emission of gases. If we want to provide a sustainable power production, we have to use the energy from renewable sources like solar energy. Renewable energy sources are considered to be the best sources of friendly environment energy. Solar energy is a renewable resource which is clean, economical, and less polluted compared to other resources and energy [1].

Solar panel module is one of the efficient sources by which solar energy is converted to electricity. Various semiconductor materials are used to make a solar panel. Si is used to make a solar panel, to approximately 24.5% efficiency improvement [2]. The photovoltaic module is used with solar-tracker to obtain better performance [3]. The solar - tracker can increase the power output of the solar panel about 30% to 60% compared with the fixed solar panel system [4].

The solar tracker is not new, but the researchers are working to develop it. In 2010, (Ahmed Abu Hanieh) make a solar tracking system using two grope of (LDR) and two DC motors [5]. In southern Algeria in 2015, (Djilali Chogueur, Said Bentouba and , Amraoui Merouane) They studied a smart solar system with one degree of freedom to detect the sunlight using a photovoltaic cell. Driven by a smart algorithm [6]. While (Ming – Cheng Ho) and his team, design a prototype system to mobile sun tracking with using GPS system in 2017 [7]. In 2018 (Arbaj N.Aga, Sanket G.Govekar and Asif Ali S.Jamadar) made a project include sun tracking by a solar panel mounted to a time-programmed by using stepper motor and Arduino microcontroller [8]. Then in 2019 (Hachimenum Nyebuchi Amadi and Sebastián Gutiérrez) implemented and evaluated in Nigeria, the performance of a dual axis solar tracking system by using (LDR) and DC motor with microcontroller to get continuous electricity and made a comparison between single and dual axis solar tracking [9].

Then compare the fixed system and the two-axis tracker in different weather days. After that, the system of the tracker is the largest cost from the fixed system and the difficulty of the process of programming Arduino Uno, in addition to the problems of placing the system over buildings. Here the system was built in an easy and inexpensive way to enhance results for different weather types.

2. EXPERIMENTAL

This test was done in November because in this month the weather is changing wither (sunny day, partially cloudy day and cloudy day). By applying the operating circuit in figure (1), Which includes the microcontroller Arduino Uno figure (2), with four photosensors (LDR), there are also four electric resistors and two servo motors, to be a dual axis solar tracking, the real shape of device is in figure (3), this device with fixed solar photovoltaic system put above the building, where setting the fixed solar photovoltaic at an angle (30 °) with earth, to the south direction, to compare with sun tracking system.

The device takes the position to the east and tilts down. When the solar radiation reaches the sensors (LDR), it will alert the Arduino to move the motors to focus the sun on the photovoltaic. In this regards, Arduino will compare LDR readings Continuously to drive the motors to concentrate the solar Continuously on the photovoltaic. After the light rays disappears at sunset, the device will stop and the reason is that the LDR will give zero for each comparison, in the next day when the light rays returns at sunrise the LDR will sense and will alert the Arduino to compare between the LDR readings to move the motor to move the photovoltage to the east and tilts down again.

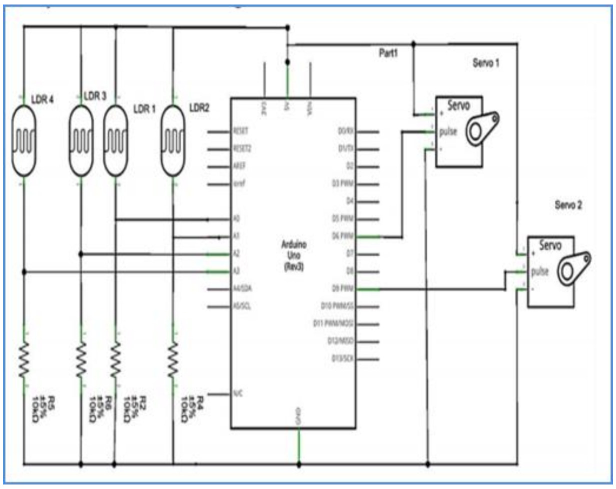

Figure (1): operating circuit

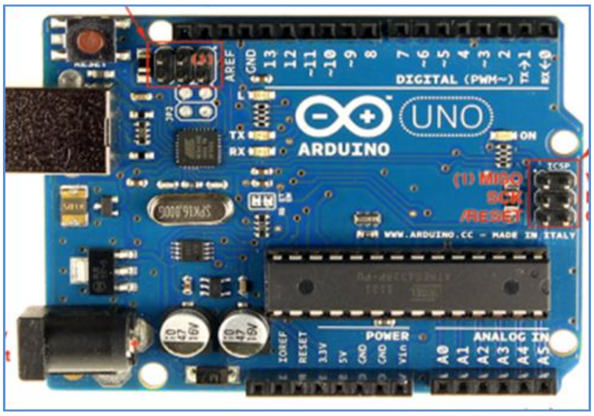

Figure (2): Arduino Uno[10]

Figure (3): real shape of device

3. RESULTS AND DISCUSSION

I. In the sunny day:

Compared between the different voltages with the time for the two systems (fixed and tracking system) in figure (4), we note the voltages in the tracking are clearly superior.

In figure (5) shows the diagram of the compared between the different currents between the two systems with the time, we note the current in the tracking are clearly superior.

And figure (6) represents the comparison of the power of the two systems with the time, we note is the power is greater in the tracking system than in the fixed system, Here the sky does haven't clouds.

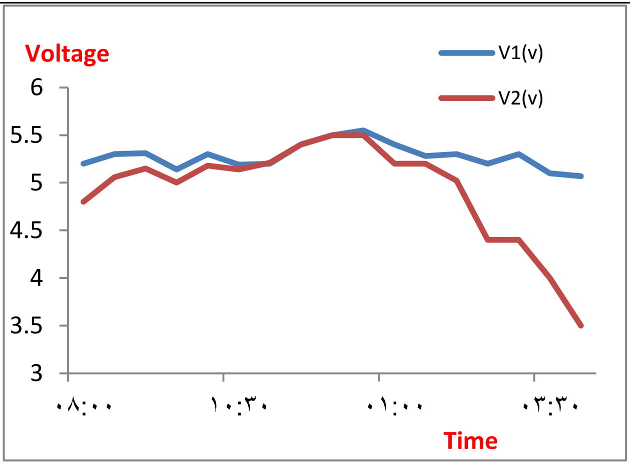

Figure 4: (v1) voltage for a tracking system, (v2) voltage for a fixed system. (for a sunny day)

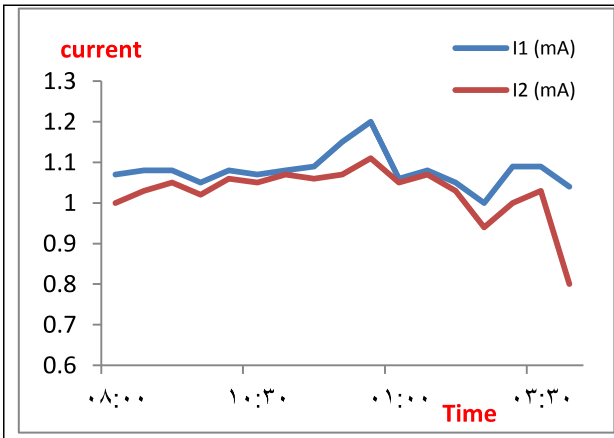

Figure 5: (I1) Current for a tracking system, (I2) Current for a fixed system. (for a sunny day)

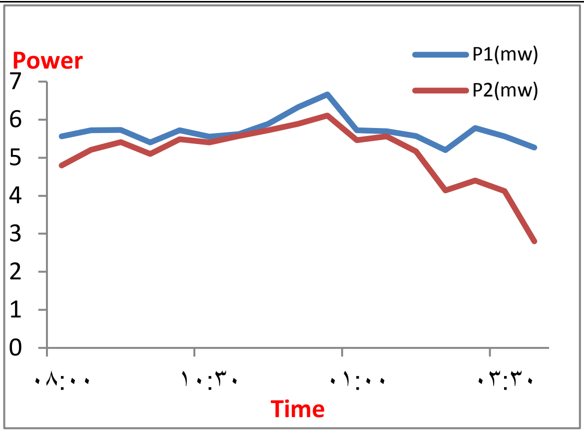

Figure 6: (P1) power for a tracking system, (P2) power for a fixed system. (for a sunny day)

I. In the partially cloudy day :

So if the sky has partially cloudy in sometimes, were compared the different voltages of the two systems (fixed and tracking systems), with the time as shown diagram in figure (7), we note the voltages in the tracking are clearly superior.

In figure (8) shows the diagram of the compared between the different currents between the two systems with the time, we note the current in the tracking are clearly superior. And figure (9) represents the comparison of the power of the two systems with the time, we note is the power is greater in the tracking system than in the fixed system.

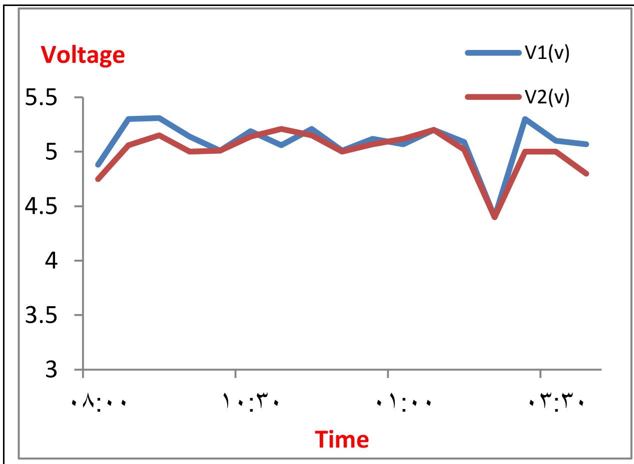

Figure 7: (v1) voltage for a tracking system, (v2) voltage for a fixed system. (for partially cloudy day)

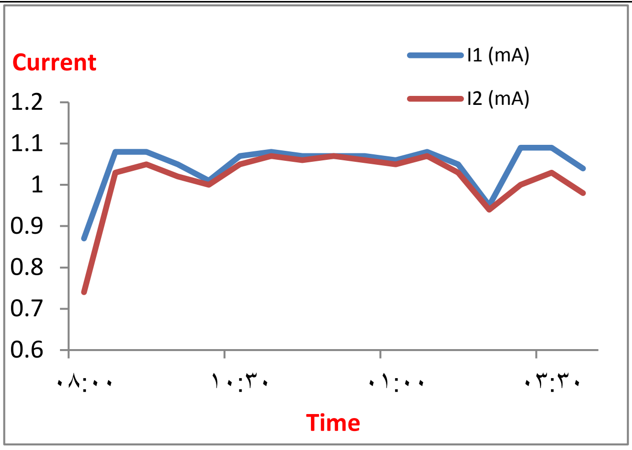

Figure 8: (I1) current for a tracking system, (I2) current for a fixed system. (for partially cloudy day)

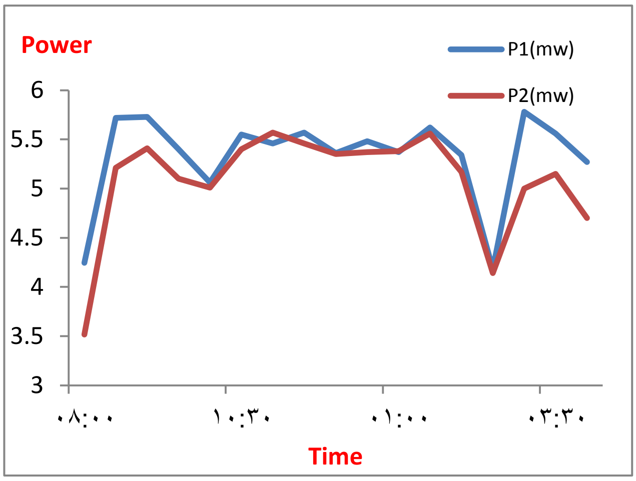

Figure 9: (P1) power for a tracking system, (P2) power for a fixed system. (for partially cloudy day)

II. Cloudy day:

After that, for a totally cloudy sky, the results gotten for this day were compared the different voltages of the two systems (fixed and tracking systems) with the time as shown diagram in figure (10), we note the voltages in the fixed are clearly superior. In figure (11) shows the diagram of the compared between the different currents between the two systems with the time, we note the current in the fixed are clearly superior. And figure (12) represents the comparison of the power of the two systems with the time, we note is the power is less in the tracking system than in the fixed system.

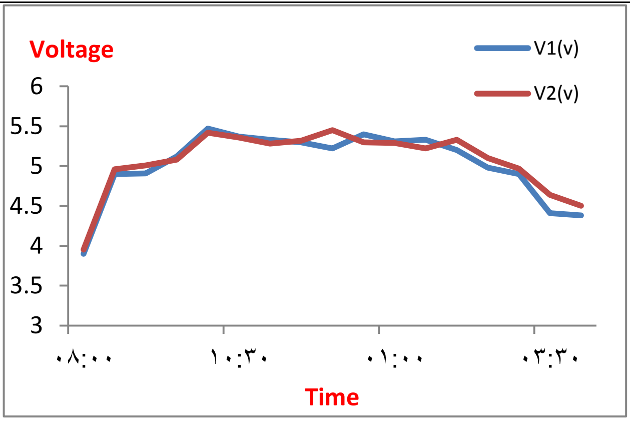

Figure 10: (v1) voltage for a tracking system, (v2) voltage for a fixed system. (for a cloudy day)

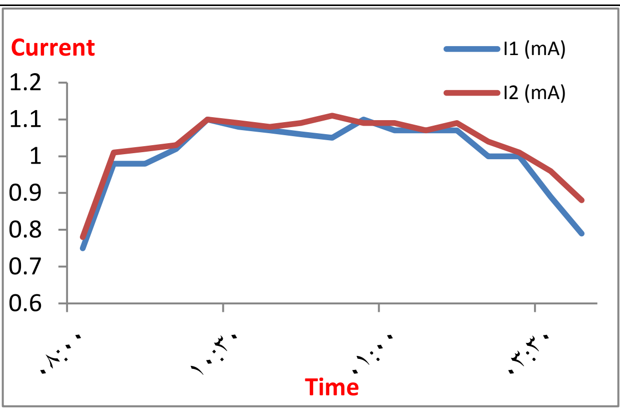

Figure 11: , (I1) current for a tracking system, (I2) current for a fixed system. (for a cloudy day)

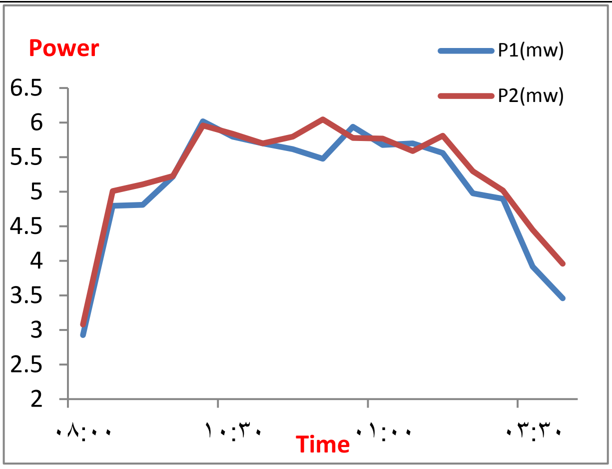

Figure 12: (P1) power for a tracking system, (P2) power for a fixed system,. (for a cloudy day)

Table 1: total power and the Ratio % between the energy gain for the fixed and the tracker system.

Ratio %	total power		
(|P2-P1|/P2)*100%	P1(mw) Fixed system	P2(mw) Tracker system	day
10.96 %	86.35	96.98	sunny
4.63 %	86.50	90.70	partially cloudy
-3.4 %	89.46	86.52	cloudy

4. Conclusion :

For the sunny day, the total power for cell in the tracking system is (10.96%) from a fixed system. In partially cloudy day, the total power for cell in the tracking system is (4.63%) from a fixed system. In a cloudy day, the total power for cell in the tracking system was (-3.4 %) from a fixed system. The total power for the cell in a tracking system on a sunny day is (6.48%) from partially cloudy day. The total power for the cell in a tracking system on a sunny day is (10.79%) from a cloudy day. The total power for the cell in a tracking system on partially cloudy day is (4.61 %) from a cloudy day. The total power for the cell in a fixed system to a sunny day is (-0.17%) from partially cloudy day. The total power for the cell in a fixed system to a sunny day is (-3.6 %) from a cloudy day. The total power for the cell in a fixed system to partially cloudy day is (-3.42 %) from a cloudy day.

Since the weather in Iraq is usually sunny, and in a few days it is completely cloudy, this device is ideal for work in Iraq.

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