

Improving the Efficiency of the Solar Cell Systems Panels by Arduino

تحسين كفاءة عمل منظومة الخلايا الشمسية باستخدام تقنية الاردوينو

Mohammed Abais Yousif, Assistant Lecture – Technical Institute in
Musaib.

Hamdiyah Sekeb Jasim ,Electrical Engineering ,Technical College in
Musaib.

Abstract

It is known that solar panels are fixed and one-way, but the fact that the solar panels are the most efficient value when the sun light is vertical or fixed if it means that the board does not work at full capacity so it must be moving with the change of location of the sun to get a vertical to The board. On the other hand, our country is witnessing a lot of dust storms, which leads to the accumulation of dust on the surface of the board, which affects the efficiency of work and requires cleaning after every dust storm and this cleaning over time reduces the efficiency of the board and increase in material cost . This project addresses the two problems together, where the board tracks the sun by using the light sensor, through which there is control in the movement of the board in the direction of changing the location of the sun. As for the accumulation of dust, the board moves downwards through a dust sensor, when it detects dust in the air, it will give instructions to the servo motor that controls the motion of the board to move 180 degrees. The board will be reflected downwards to prevent dust from accumulating on it. Which is that the efficiency of the board in this position is close to zero, so was put a mirror heading towards the top when the board goes down to reflect the light of sun to the board and then keep the board works during this period .

المستخلص :-

من المعروف ان الألواح الشمسية تكون ثابتة وذات اتجاه واحد ولكن بالحقيقة ان الألواح الشمسية تكون كفاءتها اعظم قيمة عندما تكون اشعة الشمس عمودية عليها اما اذا كانت ثابتة يعني ان اللوح لايعمل بكامل طاقته لذلك يجب ان يكون متحرك مع تغير موقع الشمس للحصول على اشعة شمس عمودية على اللوح . من جهة اخرى ان بلدنا يشهد كثرة العواصف الترابية مما يؤدي الى تراكم الغبار على سطح اللوح مما يؤثر على كفاءته في العمل ويتطلب تنظيفه بعد كل عاصفة ترابية وهذا التنظيف بمرور الزمن يقلل من كفاءة اللوح وزيادة في التكلفة المادية

ان هذا المشروع يعالج المشكلتين معا حيث يقوم اللوح بتتبع اشعة الشمس وذلك باستخدام متحسس الضوء ،الذي عن طريقه يكون هناك تحكم في حركة اللوح باتجاه تغير موقع اشعة الشمس . اما مشكلة تراكم الغبار فأن اللوح يتحرك الى الاسفل عن طريق متحسس للغبار ، فعندما يتحسس بوجود غبار بالجو سوف يعطي ايعاز الى المحرك الذي يسيطر على حركة اللوح كي يتحرك 180 درجة اي سوف ينعكس اتجاه اللوح الى الاسفل لمنع تراكم الغبار عليه ولكن سوف تكون هناك مشكلة اخرى وهي ان كفاءة اللوح في هذه الوضعية تكون قريبة من الصفر لذلك تم وضع مرآة تتجه نحو الاعلى عندما يتجه اللوح الى الاسفل ليعكس اشعة الشمس نحو اللوح ومن ثم يبقى اللوح يعمل خلال هذه الفترة

Introduction :-

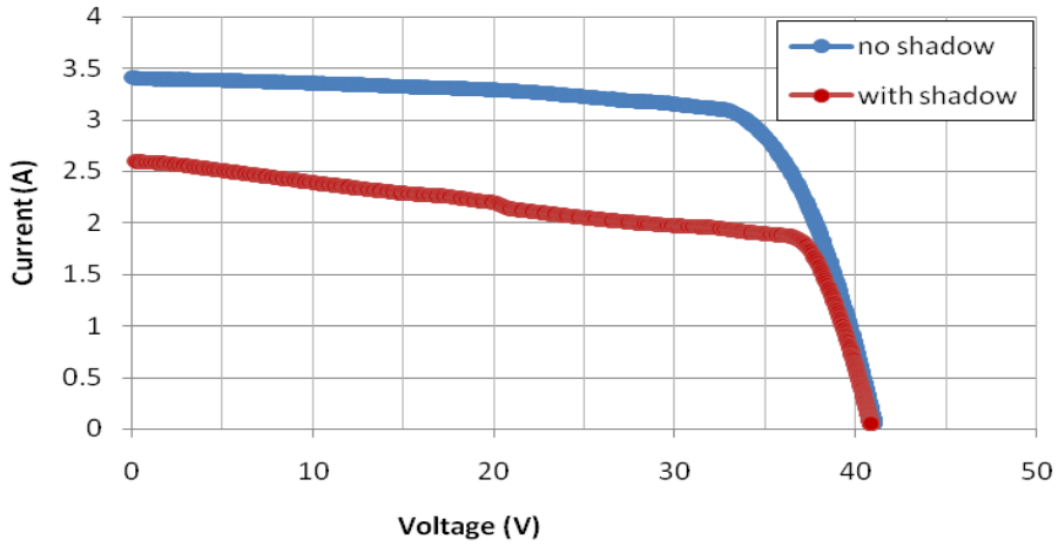
The renewable energy sources which are also called non-conventional energy resources are the sources which are continuously renewed by natural processes. They include solar energy, bio-energy, wind energy, ocean energy, tidal energy, hydropower, etc. A renewable energy system converts the energy found in sunlight, falling-water, wind, sea-waves, geothermal heat, or biomass into a usable form, in the form of heat energy or electrical energy. The majority of the renewable energy is derived directly or indirectly from the sun and wind. However, in the modern world, majority of the world's energy sources are from the conventional sources (non-renewable) - fossil fuels such as coal, natural gases and petroleum. Renewable energy resources exist over wide geographical areas, in contrast to other energy sources, which are concentrated in a limited number of countries. Rapid development of renewable energy, energy efficiency and technological diversification of energy sources, would result in significant energy security and economic benefit for the country[14] . Solar energy is clean and available in abundance. Solar technologies use the sun for provision of heat, light and electricity. These are for industrial and domestic applications, with the alarming rate depletion of major conventional energy sources like petroleum, coal and natural gas, coupled with environmental caused by the process of harnessing these energy sources, it has become an urgent necessity to invest in renewable energy sources that can power the future sufficiently. The energy potential of the sun is immense. Despite the unlimited resource however, harvesting it presents a challenge because of the limited efficiency of the array cells. [15]

The Earth's solar radiation in one hour is sufficient to provide it with energy for a whole year, but there are some problems that face this process and that whatever the sun is bright, the panels turned into electricity must of course continue upward, so they are always exposed to dirt and soil , Which greatly weakens its efficiency, Several ideas have arisen about how to continuously clean plates. For example, using robots to perform this task requires continuity, but the biggest ambition now is how to reduce the amount of dust accumulating on those plates. The study confirmed that the exposure of energy cells to dust for six months without any cleaning leads to a reduction in energy produced by 50%. There was also a 20% reduction in energy produced in all solar panels during a sandstorm period. Despite the rain, which in turn helps to clean the solar panels to restore the energy produced by the heavy dust, it is not supposed to rely on rain because the possibility of a few rains and especially in a weather similar to the weather in our country, the dust with low rain. Regular methods such as cleaning by brush or by water will cause over time to reduce the efficiency of these panels in addition to the cost of material. [9].

History of (Shadow & Dust) Studies with Solar Cells :-

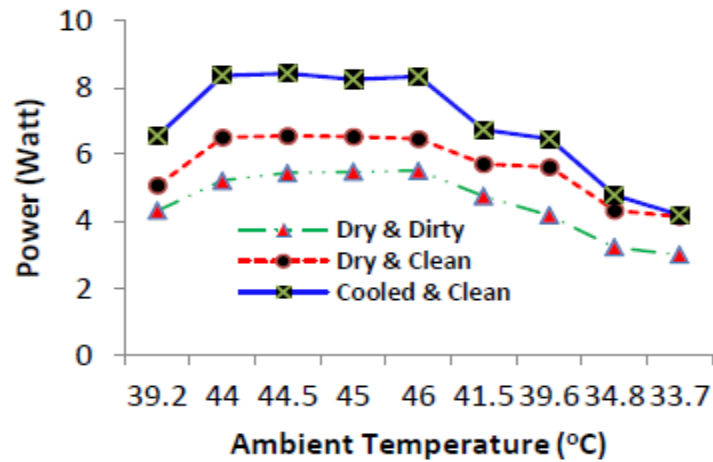
The effect of dust and shade on the solar cells is a topic that has attracted the interest of many researchers by the time researchers are trying to obtain the greatest possible energy from these cells .Many studies have investigated the effect of dust and shadow on cell efficiency of research by studying only the effects of dust and the other by studying shadow effect only and studying the effect of the two together .

1- E. Kaplani,2011: his papers analyses design and performance considerations and factors that affect the performance of the SAPV such as PV sizing, the effect of shadowing, temperature, and dust, and shows how these can lead to reduction in power output of the SAPV and cause a permanent progressive degradation of the PV cells and the entire PV generator.fig(1)[18].



Fig(1)effect the shadow

2- Hussein Akazem,2012: Studies The effects of dust on the performance of solar PV panels was the primary objective of this study, where six types of dust investigated from different areas of the North region of Oman (Al-Batinah region and Muscat). The study results show that the dust of Sohar and Saham has the biggest negative impact on PV performance because of their properties. The moisture content of saham is 52.21%, Sohar is 45% as the results showed. In the other hand, the dust from the other four locations was lighter and with lower moisture content. However, it is found that north region have less dust effect on PV performance comparing with other countries in the gulf region .fig(2) [6].

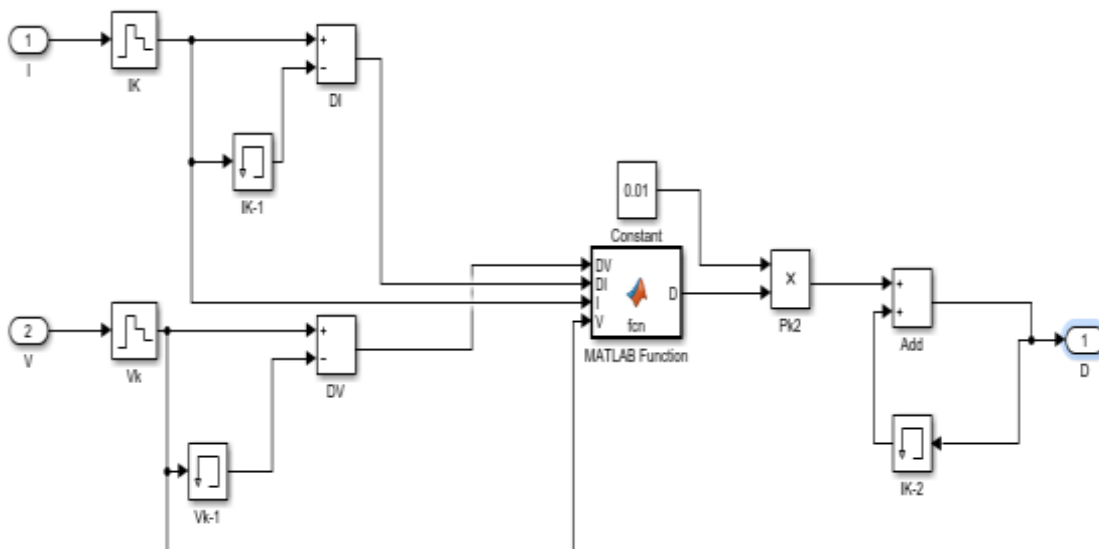


Fig(2)effect the dust

Ways to reduce the problem :

1-Simulink by using matlab.

There are many previous methods and most of them are mathematical is the attempt to make the solar panel traces the sun's rays and most of those methods are using simulation, but the problem of dust has not been addressed to solve the problem of self-solved only the problem of dust using mechanical methods and these methods repeated reduces the efficiency of the board. These methods are characterized by mathematical complexity and many mathematical equations [17], Use Matlab to simulate the tracking of the board for the sun's rays



Fig(3) tracking by using simulink

2- Smart Solar Panel.

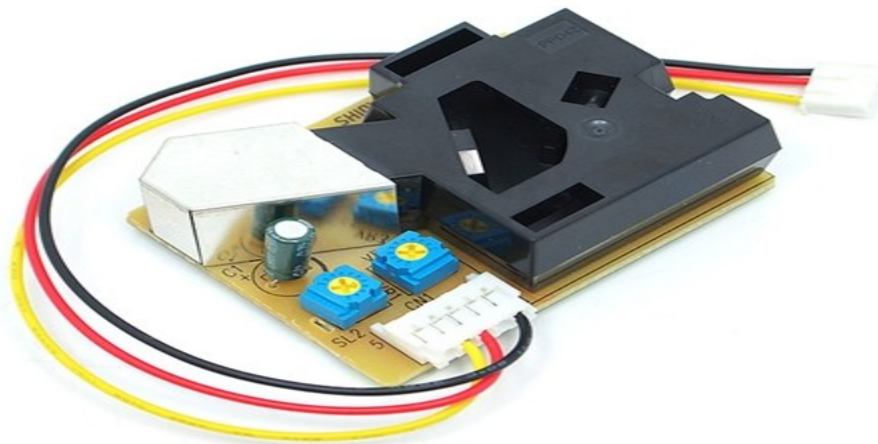
These panels are dust-sensing plates trying to change direction when the dust in the atmosphere until the weather improves and then return to its original state, but there may be a reduction of the efficiency of these panels at this time because it has been mentioned that the panels must be vertical with rays But it is possible to go beyond that problem, which is to place a panel from the mirror under the solar panel. This mirror is in the normal weather going down to keep it clean. In the case of cloudy weather, when the solar panel goes down, the mirror will move upwards to reverse the sun's rays towards The solar panel in order to continue its work naturally . As well as heading towards the top in the case of rain to clean it and all these operations controlled by an electronic board, the Arduino and be sensitive by the dust sensor and rain sensor and through the engine Servo Revolves at an angle 180 degrees .[3].

2-1.The Dust sensor:-

This sensor is characterized by low power consumption, consuming only a maximum of 20 mA and 11 mA in a stable operation and operating at a voltage of up to 7 V, making it an ideal device for portable pollution measurement devices and in different places where electricity is not available. This sensor produces the relative voltages and the number of suspended particles in the air, resulting in an equal voltage of half volts per 0.1 milligrams of particulate matter with air fig(4) . [19]

Specification :

Model	PPD42NS
Detectable particle size	approx. 1 μ m (minimum.)
Detectable range of concentration	0~28,000 pcs/liter (0~8,000pcs/0.01 CF=283ml)
Supply Voltage	DC5V +/- 10% (CN1:Pin1=GND, Pin3=+5V) Ripple Voltage within 30mV
Operating Temperature Range	0~45°C
Operating Humidity Range	95%rh or less (without dew condensation)
Power consumption	90mA
Storage temperature	-30~60°C
Time for stabilization	1 minute after power turned on
Dimensions	59(W) \times 45(H) \times 22(D) [mm]
Weight	24g(approx.)
Output Method	Negative Logic, Digital output, Hi : over 4.0V(Rev.2) Lo : under 0.7V (As Input impedance : 200k Ω) OP-Amp output, Pull-up resistor : 10k Ω



Fig(4)dust sensor

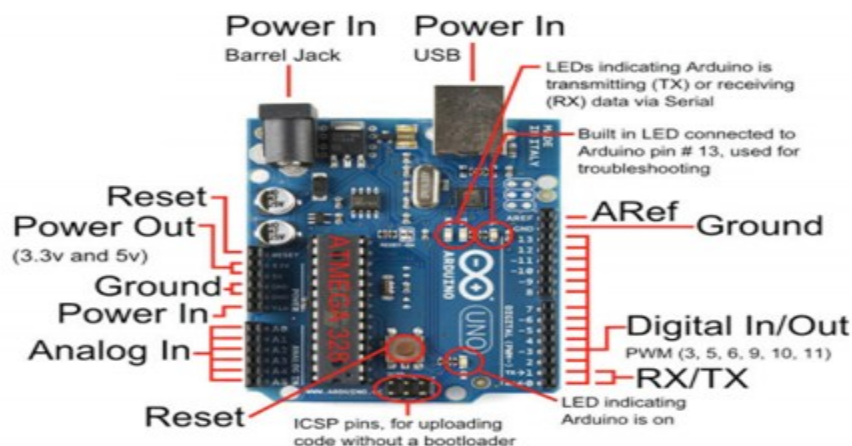
2-2.The Arduino .

An Arduino is a tiny computer that we can program to process inputs and outputs going to and from the chip. The Arduino his hardware and his software are both Open Source. Which means (code, schematics, design, etc) are all open for anyone to take freely and do as they like with it. Every Arduino board must have the same form as the standard Arduino. Power and ground pins on one eight or six pins header. and analog pins on a six-pin header next to that. Digital pins cover the other edge on the other side of the Arduino, an eight-pin header separated from a 10-pin by that weird 0.5 spacing. Some boards also require a connection to the Arduino’s ICSP header.

Arduino consists of a programmable circuit board (called the microcontroller), as well as a programmable part of an integrated development environment (IDE) that runs on the computer and is used to write and load code from the computer to the Arduino board fig (5). [16] .

Reset	3.3V	5v	Gnd	Vin	Analog In	RX/TX	Digital	PWM(~)	AREF
Resets Arduino sketch on board	3.3 volts in and out	5 volts in and out	Ground	Voltage in for sources over 7V (9V-12V)	Analog inputs, can also be used as Digital	Serial comm. Receive and Transmit	input or output, HIGH or LOW	Digital pins with output option of PWM	External reference voltage used for analog

Table(1) Arduino pins



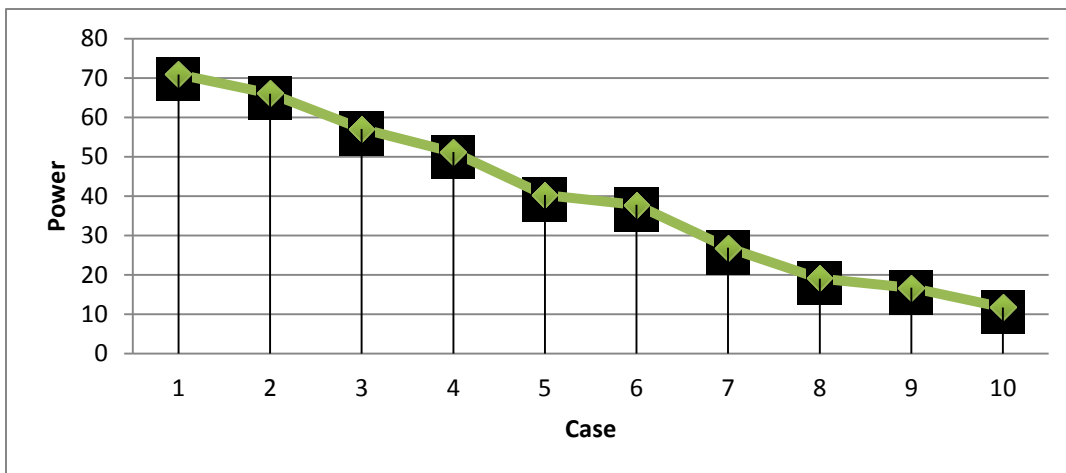
Fig(5) Arduino uno board

Experimental work :-

As for the study I have done the calculation of the ability produced by the solar panel in two cases the first case is the panel under the sun rays of variable cases of the proportion of dust and the second case is the solar panel under the shadow and variable conditions of the proportion of dust, the results were as follows : See table (2 & 3).

No	Case	Current(A)	Voltage(V)	Power(VA)
1	Clean	3.48	20.37	70.88
2	few dust	3.36	19.65	66.024
3	dust case1	3.33	17.14	57.07
4	dust case2	3.16	16.2	51.19
5	dust case3	2.99	13.47	40.27
6	dust case4	2.91	12.98	37.77
7	dust case5	2.648	10.15	26.87
8	dust case6	2.45	7.77	19.03
9	dust case7	2.368	7.06	16.71
10	cover	2.28	5.15	11.74

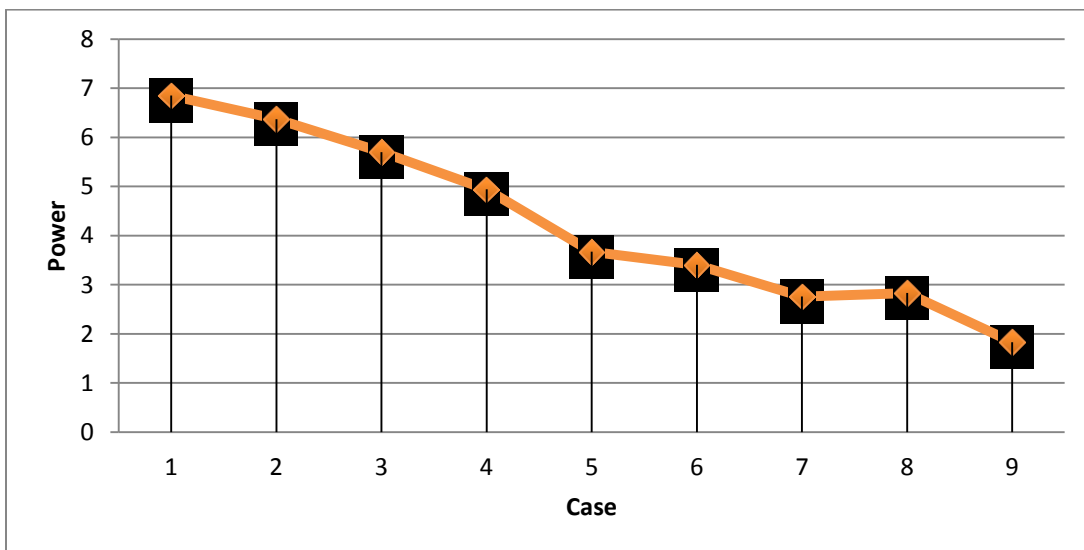
Table(2) : VA Results under sun rays with variable cases of dust



Fig(6): effect sun rays with variable cases of dust

No	Case	Current(A)	Voltage(V)	Power(VA)
1	Clean	2.02	3.39	6.8478
2	few dust	1.93	3.3	6.369
3	dust case1	1.9	3	5.7
4	dust case2	1.83	2.7	4.941
5	dust case3	1.83	2.01	3.67
6	dust case4	1.72	1.98	3.405
7	dust case5	1.56	1.77	2.76
8	dust case6	1.36	1.494	2.83
9	dust case7	1.24	1.47	1.832

Table(3): VA Results under shadow with variable cases of dust



Fig(7) : effect shadow with variable cases of dust

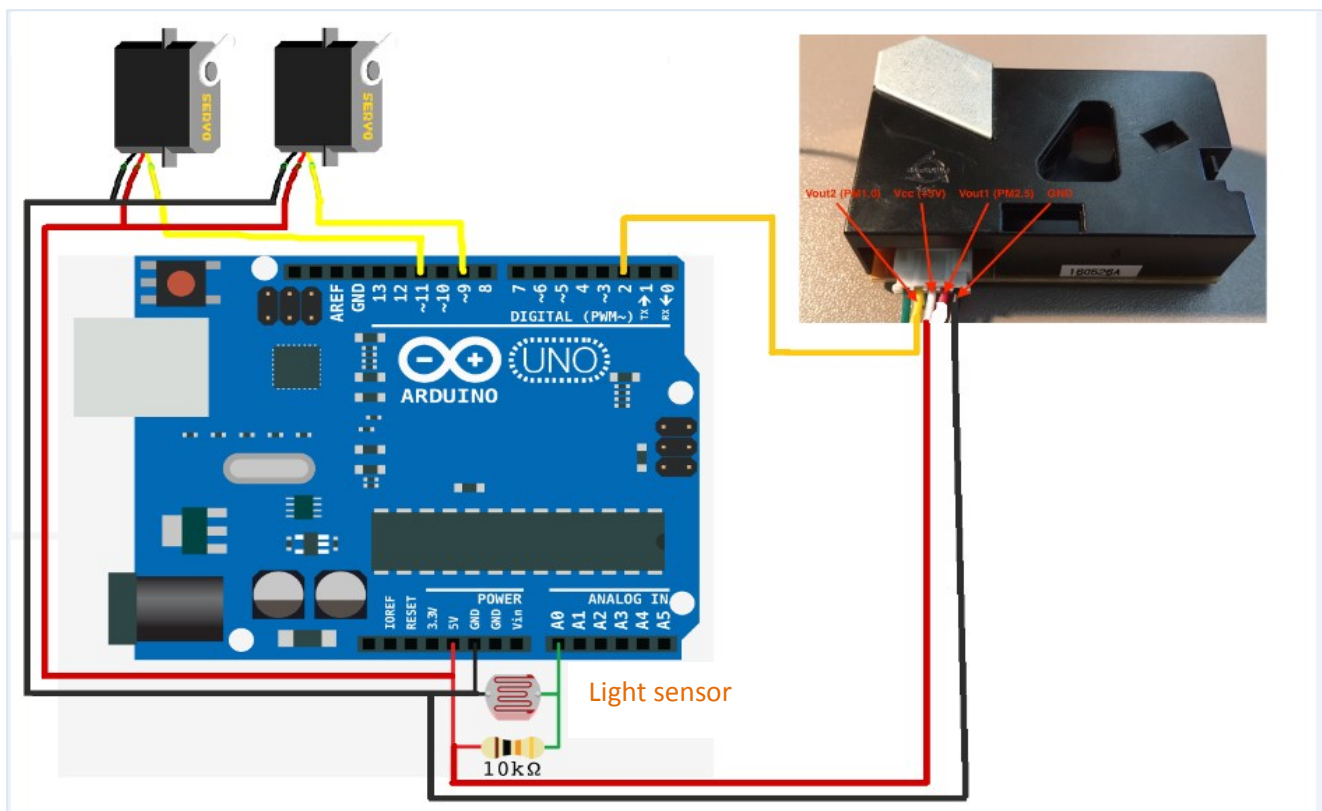
These results are the ones that must be addressed to benefit from the solar panel with maximum efficiency so we designed the electronic circuit using the Arduino board (Smart Solar Panel) to reduce the effect of dust and shadow problem .

The work of this circuit is to try running solar panels with the greatest energy. It is known that the solar panels are fixed trend, but it is known that the solar panels work with maximum energy when the sun's rays are vertical on the board and so remained the solar panel constant trend means that the board does not work at full capacity must be variable with the change of direction of sunlight and this Mutant Treat him in this circle. The other side is that it is known that our country has many dust storms. This means, through previous studies, that every dusty storm can lose the solar panel a lot of efficiency, which must be cleaned after every dusty storm, which means that this frequent cleaning loses the efficiency of the solar panel in addition to the material cost This circuit deals with this situation, i.e. when there is dust in the air, the dust sensor will feel this dust and then give the direction to the circuit against the

direction of the solar panel towards the bottom to avoid the accumulation of dust on the solar panel but there will be a problem is that at that time will be the board Solaris If the solar panel moves down, the mirror will move towards the top to reverse the sun's rays towards the board so that the board will work normally. This means that the board It works at full capacity, either in a dusty or net atmosphere and with the direction of the sun's rays. The mirror will go back down when the board returns to its normal position to get rid of the dust that accumulated during the dust period. See Fig (8) and Fig(9) .

Servo1(for solar) Servo2(for mirror)

Dust sensor



Fig(8) Block diagram of working circuit .

- 6- ‘ Experimental Invetigation of Dust type effect on photovoltaic systems in Norh Region Oman , Hussein Akazem , Abeen Arshid and Ali Alweeli , International Journal of Scientifice ,ISSN2229-5518, 2015 .
- 7- “ Shadowing Effect on the Performance in Solar PV – Cells “ , Masters thesis , Sustainable Enrgy systems . Hans Wigo , 2015 .
- 8- “ Solar tracking system “ , Deekshithithk and Bhaskar Reddy, International Journal of Scientifics & Engineering Research , Volume 6 Issue 9 ,2015.
- 9-Solar Energy ,Fundamentals, Technology, and Systems, book, *Specialists Conference (PVSC), 2012 38th IEEE (2012)* pp. René A.C.M.M. van Swaaij ,Miro Zeman , Klaus Jäger ,Olindo Isabella, University of Technology, 2014 .
- 10-The International Conference on Technologies and Materials for Renewable Energy, Environment and Sustainability, TMREES14 “Influence of Dirt Accumulation on Performance of PV Panels
- 11-Thomas, Isabel. *The Pros and Cons of Solar Power*. New York: Rosen, 2007.
- 12- U.S. Energy Information Administration EIA , Solar, natural gas, wind make up most of generation additions,2016
- 13- International Renewable Energy eAgency. Rnewable Energy Technologies: Cost Analysis Series – Volume 1: Power Sector – Solar Photovoltaics. (Online.) 2012.
- 14- “ The Affect of setting harmattan Dust on photovoltaic Module in Walewak , Northen Ghana “ , by Owusn- Brownbernard , College of Engineering Science , University of Science and technology ,2016 .
- 15- “Solar Tracker for Solar Panel”, Oloka Regau , university of Nairobi,Departement of electrical and Information Engineering , 2015 .
- 16- Allison M.okman 2013 , Arduino Programming Language , pdf ,
- 17- “ Modeling and Simulation of PV array in Matlab/Simulink for comparison of perturb and observe incremental conductance algorithims using buck converter “Sandeep Neupane ,Ajagkumar, Subhart university , India,IRJET, Volume 4 Issu7,2017.
- 18-“ Design and performance consideration in stand-alone PV powered telecommunication systems “,E kaplani ,Journal of Engineering Science and Technology Rrview,2012.
- 19- “ Test of Partical Sensor “ PPD42NS” and integration with Arduino boards , pdf , Jordi Fonollose , Institute for Beioengineering of Catalonia “ IBEC” , 2016 .