

Efficiency Enhancement of Solar System Using Sun Truck and Effective Cooling Systems

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Abstract:

This paper implements and tests on one type of renewable energy, which is solar energy. Raising and performance of the efficiency of these sources has become a vital importance over the past few years in order to be able to compete with traditional sources of fossil fuels by efficiency, quality of power produced, and cost matter of power production. This project explains in detail the methods used to raise the efficiency of solar energy.

The primary way to improve efficiency is the solar tracking system, which constantly directs and tracks the solar panels at the sun to get the most out of the main beam of sunlight that carries the most solar energy, with a focus on techniques for the daily sun shine and seasonal as well.

As the increment of the system's temperature reduces its efficiency, it has also deemed us to have the optimum

temperature for the photovoltaic performance of cells to get a max. Efficiency from the solar system, and improve its lifelong, thus by implementing a cooling system along with sun tracking system. The Photovoltaic (PV) cells are sensitive to temperature variations. When the ambient temperature and the intensity of solar irradiance falling on the PV cells increases, the operating temperature of the PV cells also increases linearly. This increase in operating temperature of the PV cells leads to reduction in open circuit voltage, fill factor and power output for mono and polycrystalline PV cells, which are used in most of the power applications. The net results lead to the loss of conversion efficiency and irreversible damage to the PV cells materials. Therefore, to overcome these effects and to maintain the operating temperature of the PV cells within the manufacturer specified value, it is necessary to remove heat from the PV cells by proper cooling methods. This review presents an overview on passive cooling (heat pipe based and by fins) to enhance the performance of the commercially available PV and concentrated photovoltaic (CPV) cells.

Using these methods mentioned above, the efficiency of the solar panel has improved in a tracking system of 15%, and after a cooling process, we have acquired an efficiency of about 85%.

Key words:

Solar cells, Solar rays, Sun tracking system, Cooling system, Photovoltaic.

1.Introduction

This study is about controlling the movement of solar cells during the day in order to make the most of solar rays in generating electrical energy. The amount of solar energy that the earth receives is very large compared to the world's energy needs. However, it is time for us to realize the fact that this energy falls on the surface of the earth, which consists of seas, mountains, valleys and different regions has to be used for generating electricity and other industrial demands of energy, using the photovoltaic techniques or others. This project used the methods of sun tracking and cooling system to raise the efficiency of solar energy in order to compete with traditional sources of fossil fuels efficiency.

2.problem statement

Energy is the basic and most comprehensive measure of all kinds of human and nature's work. Energy is an essential commodity in the process of economic, social and industrial development. As the traditional energy sources are exhausted day by day, using the alternative energy source is the only solution. The increasing demand for energy, the depletion of fossil fuel resources and the increasing environmental pollution, have prompted the world to think seriously about another alternative source of energy and to provide this energy as much as possible. Renewable energy in general, and solar energy in particular, receives attention at the global and local levels, as at

the local level, there is a large deficit in the supply of electrical energy as a result of the limited power stations and fuel supply to power stations, which leads to daily power cuts, especially in the summer. Everything has an advantage and a defect, the defect of the solar panel is placed in a fixed place, and this is a reason that reduces the efficiency of the solar panel due to the rotation and movement of the angle of solar radiation. Exposing the solar panel to solar radiation for a long time leads to an increase in temperature, and this reason leads to a decrease in the efficiency of the solar pane.

3.Methodology

In this research, I relied on the analytical and experimental approach, and we will present some points that show the effectiveness of the analytical and experimental study of the project on the ground.

3.1. Design a sun tracking system with double motions on the horizontal axis (left and right) and the vertical axis (up and down), in order to transmit the max. The energy out of the sun's rays on a daily and seasonal basis.

3.2. Designing an appropriate cooling system to obtain the optimum operating temperature for the photovoltaic cells to give a maximum. Electrical power output cells, which include a water radiator and cooling fans.

3.3. Designing and programming a control system using ORDINO system with suitable voltage sensor for trucking systems and temperature sensor for cooling system, that to have the max. efficiency out of our system. These three major components implemented were designed, manufactured, and tested for their results and compared with original results before our improvements which gave a notable improvement for system efficiency. This shall be briefly discussed in the next chapter four.

4.Motivation

The idea of a microcontroller that helps us in our daily functions, but this dream cannot become a reality without developing the design of the microcontroller-based system and taking new steps in this field of research. Control engineers study electronics, computer science, artificial intelligence, mechatronics system design, and microcontrollers. Almost all of these topics are covered and studied independently of each other in the Department of Control Engineering, making this research paper the center of our studies. With these ideas, we wrote the first words in this paper and hope it becomes the first step in our long journey into the world of microcontroller system design.

5.The objectives of this scientific paper

The scientific paper aims to achieve the following goals.

Studying the role of solar energy in achieving development, studying the risk of using traditional energy in power stations, studying the factors affecting solar energy, studying the role of solar energy in achieving sustainable development and environmental security, and studying how to raise the competencies of the solar pane.

6. Materials and Methods

6.1. Hardware used for trucking, cooling and control systems.

Materials	definitions
Light Sensors	A light sensor is a passive sensor that had used to indicate the intensity of the light by examining the radiant energy that exist in a certain range of frequencies. In the spectrum of electromagnetic waves, the ranges of frequencies that had used to detect using a sensor are between infrared to visible and up to ultraviolet.
Resistor.	The most important task of a resistor in an electrical circuit is to regulate the amount and amount of voltage (voltage) and current (ampere).
Servo Motors.	A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a actively sophisticated controller, often a dedicated module designed specifically, for use with servomotors.
Adriano mage2560	It is a Microcontroller board based on Atmega2560. It comes with more memory space and Input/output pins as compared to other boards available in the market. This board comes with USB cable port that is used to connect and transfer code from computer to the board.
light Emitting Diode	It is a semiconductor device that emits light when an electronic current is passed through it.
Power supply, AC-to-DC	DC power supplies use AC mains electricity as an energy source. Such power supplies will employ a transformer to convert the input voltage to a higher or lower AC voltage. A rectifier is used to convert the transformer output voltage to a varying DC voltage, which in turn is passed through an electronic filter to convert it to an unregulated DC voltage.
Battery.	A battery is a device consisting of one or more electrochemical cells with external connections [12] for powering electrical devices such as flashlights, mobile phones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode.
Temperature sensors LM35.	It is one of the most popular temperature sensors available out there, which is being used even today. LM35 is an Analog Temperature Sensor that is calibrated directly in Celsius. The output analog voltage is linearly proportional to temperature in Centigrade.
Fan Cooling	Axial flow fans have blades that force the air to move parallel to the shaft around which the blades rotate. This type of fan is used in a wide variety of applications, from small electronics cooling fans to giant fans used in wind tunnels. Axial flow fans are applied in air conditioning applications, industrial processes, and in solar energy systems.
Switch	It is an electrical component, which can make or break electrical circuit automatically or manually? Switch is mainly working with ON (open) and OFF (closed) mechanism. Numerous circuits hold switches that control how the circuit works or actuate different characteristics of the circuit. The classification of switches depends on the connection they make.
Bread board	It is a rectangular plastic with a bunch of tiny holes in it. These holes let you easily insert the electronic components and test them.
Connection Wires	Connection wires male to female or female to male is used to provide connection between sensor and Adriano
Potentiometer.	A potentiometer is a resistor that has a mechanical shaft or screw that can be turned to change its resistance.
Relay	A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal.
pump 12v DC	A mechanical machine used to transfer liquids from one place to another by increasing the pressure of the fluid and supplying it with energy to travel in the pipes to the required place and this energy must be sufficient to enable the liquid to overcome the effect of friction and gravity forces.
Voltage Regulator *7805	A regulated power supply is very much essential for several electronic devices due to the semiconductor material employed in them have a fixed rate of current as well as voltage. The device may be damaged if there is any deviation from the fixed rate. The AC power supply gets converted into constant DC by this circuit. The help of a voltage regulator DC will fix unregulated output fixed to a constant voltage.

6.2. Circuit Diagram

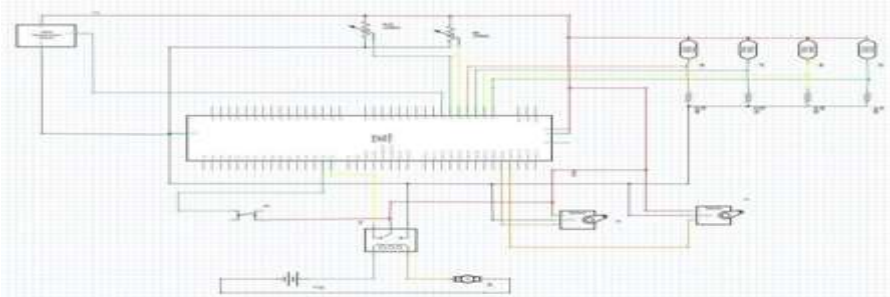


Fig. 6.1 Circuit Diagram Tracking and Cooling For Solar System

6.3. Software used for trucking, cooling and control systems

Software	definitions
Adriano IDE	It is mainly used for editing, compiling and uploading the code in the Adriano Device. It is easily available for operating systems like MAC, Windows, and Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment .The Adriano input port when is connected to the computer. It also contains the main space from which the program code is written and modified.
PLX-DAQ Excel Macro	The PLX-DAQ Excel Macro is used for data acquisition from the Adriano microcontroller to an Excel Spreadsheet. We only need to download it. After installation, a folder named "PLX-DAQ" will automatically be created on the PC in which a shortcut named "PLX-DAQ Spreadsheet" is inside. Then, to establish the communication between the board and Excel, we just need to open the Spreadsheet and defining the connections settings (Baud rate and port) in the PLX-DAQ window
Frizzing	Frizzing is an open-source initiative to develop amateur or hobby CAD software for the design of electronics hardware, to support designers and artists ready to move from experimenting with a prototype to building a more permanent circuit .

6.4. Practical Implementation of the Circuit

6.4.1 Instruments used for making the actual circuit:

We use prototyping board, a voltmeter, Soldering Iron, lead solder wire, solder sucker, shears, Stanley knife, electric Tester, plastic cable wire, plastic cable wire and sticky tape.

6.4.2 Working Principle:

- LDRs are used as the main light sensors. Two servomotors are fixed to the structure that holds the solar panel.
- LDRs sense the amount of sunlight falling on them. Four LDRs are divided into top, bottom, left and right.
- For east – west tracking, the analog values from two top LDRs and two bottom LDRs are compared and if the top set of LDRs receive more light, the vertical servo will move in that direction.
- If the bottom LDRs receive more light, the servo moves in that direction.
- For angular deflection of the solar panel, the analog values from two left LDRs and two right LDRs are compared. If the left set of LDRs receive more light than the right set, the horizontal servo will move in that direction.
- If the right set of LDRs receive more light, the servo moves in that direction
- The LM35 is used as a solar panel temperature sensor
- The LM35 senses the amount of heat emitted by the solar panel is compared with the reference value that was specified in the software code.
- A cooling process that is carried out by a fan and a water pump
- Reference value divided into 2 reaction values 1 (25C) Reaction values 2 (34)
- If the temperature is less than 25, the fan and pump do not work
- If the temperature is greater than 25, give me a fan order, but work

- If the temperature is greater than 34 we give an order to me a pump, it works
- This process is carried out by a temperature sensor that sends a signal to an Adriano controller, and after the comparison process, it gives commands to the relay to open or close



Fig.7.2 Solar panel cooling composition of solar tracker

7.4.3 The algorithm

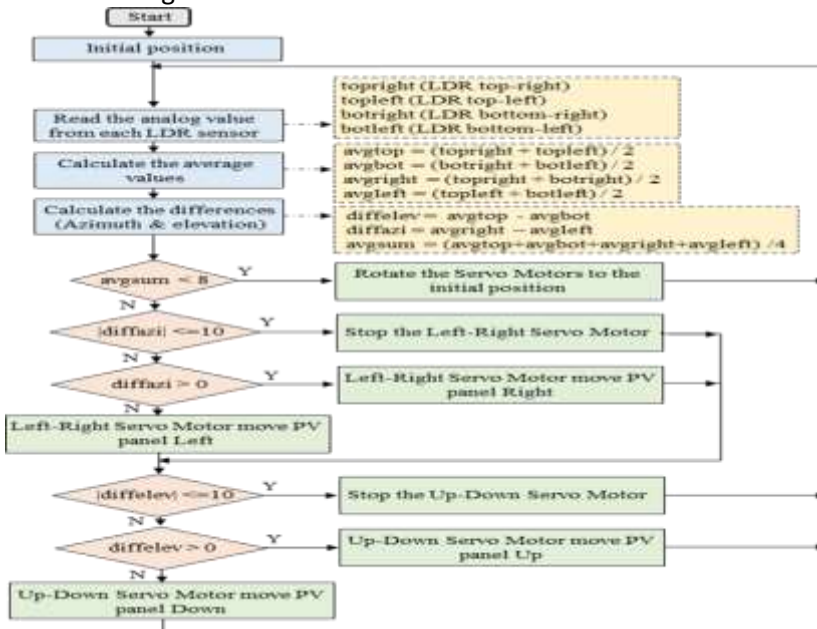


Fig. 7.3 The software algorithm

8. Results:

8.1. Tests made for both the circuit and code functionality:

Figure 8.4. And Table 8.2 shows the entire test bench, the solar tracker with virtual instruments, and an artificial lamp that can expose the light to the solar tracker test. The solar tracker and the computer are connected through a USB cable. Once the photoelectric voltage is obtained, the controller processes this information and uses it to calculate the photoelectric current and power. Then, all this data is sent to computer for presentation in MS Excel. The proposed test bench is clearly small, flexible and easy to use. It can enable students, researchers and engineers to apply their algorithms in a easy way before embarking on a large solar tracker. We have noticed in the results that there is a difference between a fixed solar panel system and a tracking system.

- The efficiency of the solar panel has improved in a tracking system of 15%, and after a cooling process, we have acquired an efficiency of about 85% the results were as follows.
- This was tested at the end of 2020, in November, they used a 20W GT solar panel, the panel specification was as follows: MWG-20 cell specification.

Maximum power of STC (Pmax):	20W
Optimum Operating Voltage (Vmp):	17.49 V
Optimum Operating Current (Imp):	1.14 A
Open circuit voltage (Voc):	21.67 V
Solar cell efficiency:	16.51%
Solar module efficiency:	11.21%
Operating temperature:	-10°C to 55°C
Maximum working voltage:	1000V DC
ISC temperature coefficient:	+0.036% / ° C
Temperature coefficient of VOC:	-0.346%/°C
Pmax temperature coefficient:	-0.47%/°C
Solar Cell:	Polycrystalline 156 x 33
Number of cells:	36 (2 x 18)
Nominal cell operating temperature (NOCT):	47°C +/- 2°C
Maximum fuse value:	15 A
Weight:	2.6 kg
Dimensions:	505 x 353 x 28 mm

Table8.1Date cheat solar panel

- ☐ The results of practical encasement of solar system using sun tracking system and cooling system with automatic control.
- ☐ In a table that shows the maximum value and the minimum value of the capacity produced by the solar panel.
- In the case of a fixed solar panel and without cooling means.
 - In the event of using cooling devices and manual and automatic solar tracking
- ☐ It was shown in Table 5.2 The efficiency ratio of how we were able to raise the efficiency of a solar panel, and the best of it was in the case of

cooling with air and water, and tracking automatically, and the value was efficient 85%.

Note:

- The maximum value is an expression of the maximum radiation we can get in an afternoon.
- The minimum value It is the lowest ray in the early morning and at sunset.

The Value Was Read On The Solar Panel With Capacity Of 20 Wat, And The Output Was The Following

	Fixed Without Cooling		Manual Control Tracking		Automatic Control Tracking		Tracking And Cooling					
							Air		Water		Air And Water	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
	3	5	3	7	6	10	8	11	9	13	10	17
	Wat	Wat	Wat	Wat	Wat	Wat	Wat	Wat	Wat	Wat	Wat	Wat
Efficiency $\eta = (P_{out}/P_{in}) * 100\%$	15%	25%	15%	35%	30%	50%	40%	55%	45%	65%	50%	85%

Table8.2. the entire test bench with virtual instrumentation

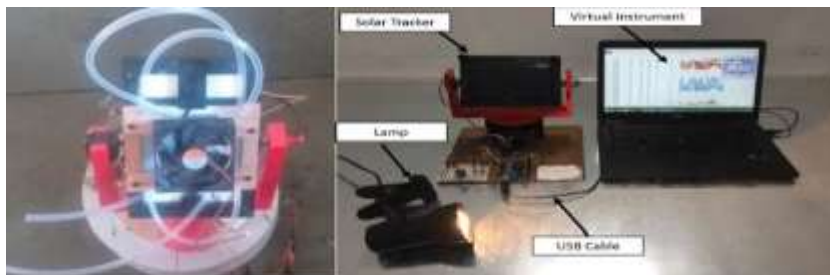


Fig 8.4. The entire test bench with virtual instrumentation

8.2 Correcting errors using guided tests

If none of the components, (actuator and sensor) are present:

1. Ensure that the components of the regulated power supply circuit are operational correctly using avometer.

- Measure the 12 volts coming from the battery.
- Measure the 5Vs coming out of the circuit.

2. Make sure the Adriano is working properly.

- Use the LEDs, LM35, and buttons to test on a separate hub.

3. Make sure the circuit components connected to the LDR pin are Working properly.

Note: Previous tests were conducted to verify other major components

- The components depend on them to work. The rest of the components are independent
- Their faults can be easily found by energizing the circuit.
- The rest of the errors can be traced back to the origin of the problem using avometer

1. If the sensor doesn't work, then

- Check the sensors if they are working properly
- Check the rest of the ingredients

2. If PV does not work, then authorization

- Check if the temperature is ideal and if it is high, and confirm that the fan is working
- Check if the pump is working
- Check if the Adriano gave the signal
- Check if the transistor is on.
- Check if the relay is working properly.

9. Advantages of solar energy

One of the most important features of energy

- ☐ Clean and safe energy.
- ☐ permanent and continuous energy.
- ☐ Easy to use and uncomplicated.
- ☐ Countries depend on local sources without relying on other countries.

10. Disadvantages of solar energy

One of its main drawbacks

- ☐ Need large areas of land.
- ☐ The frequency of weather factors emerging from temperature and dust is volatile.
- ☐ Needs regular cleaning.
- ☐ Quick response in terms of losing loads due to clouds and shadows.

11. Conclusions

- In this model, the Adriano is the controller of a single panel, however, on real solar farms, a single powerful server will implement control logic over thousands of panels, knowing that all panels use the same program logic that tracks the direction of the highest amount of sunlight regardless of where the panel is placed, it is automatic, meaning that no human is required to control or direct it, but solar farms still need human assistance in cleaning, maintenance and monitoring. It is not enough to develop the solar cell architecture to get more energy, thus solar energy tracking systems are used. Solar Tracking Systems is a simple and effective technology for solving low- efficiency problems of solar energy systems.

- The work of photovoltaic panels requires exposure to solar radiation and that exposure to this radiation for a long time leads to an increase in the temperature of the solar cell, and this is the reason for the decrease in the value of the energy produced from the solar panel energy as a result of the decrease in the voltage of the cell. We put a fan under the solar panel and pipes under the solar panel. We pump water in pipes for me in the cooling process here. We solved the problem of high temperatures and benefited from hot water in the pipes and we were fortified with hot water.

12. Benefit from renewable energy

- ☐ Rehabilitation of remote agricultural lands
- ☐ Stability of the public electricity network
- ☐ Exporting electrical energy abroad

☐ Creating new job opportunities and reducing the unemployment rate

13. Recommendations

One of the most important recommendations

☐ Issuing or establishing legislative decisions in the field of renewable energy.

☐ Establishing a training and research center in the field of renewable energy.

☐ Supporting those continuing in the field of renewable energy in all political, security and economic aspects.

☐ Formation of a unified solar energy institution to facilitate the expenses procedures for projects and to play the oversight role in addition to attracting external support for projects.

14. .Future Work

There is always room for improvement. In the future, we will have more new technologies that we can implement. For now, the things we can think of for improvement in the future are.

1. Upgrade the circuit to be able to connect to a wireless network.
2. Software development is necessary to use the micro-console as an interface, to control the circuit from a control panel over the network.
3. Development of the project to include a multi-mode solar control panel.

4. From solar panels that track sunlight, we can trap sunlight and convert it into electrical energy that Can be conserved and used for other implementations.
5. Development of the project to be able to work with artificial intelligence.
6. Solve the problems of dust and dirt that reduce the energy efficiency of solarpanels.
7. Finding other means for the cooling process of the solar panel from hightemperature.
8. We have the intention of using the results of this project in a real manufacturing work for the photovoltaic systems market, meanwhile looking for funding the fundamental push-start.

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