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SOLAR PANNEL EFFICIENCY IMPROVEMENT BY TEMPERATURE AND DIRECTION CONTROL

Pandit Vitthal Rathod[1], Akshay Balaso Jadhav [1],

Akshay Patlu Patil [1], Akshay Anantrao Dhanure [1]

B. Tech EE Dept., D.Y. Patil Technical Campus, Talsande,
Tal. Hatkanangale, Dist. Kolhapur Maharashtra 416112.

Project Guide: Asst. Prof. Trupti Shivanand Shirdhone[2]

Wathar Warna Nagar Road, Talsande, Tal. Hatkanangale,

Dist. Kolhapur Maharashtra 416112, India.

ABSTRACT

Solar energy is playing a very important role in the present global energy production scenario. In this project, an experimental setup is designed in which water spray is fitted to the solar panel to reduce its temperature and bring the temperature to a normal operating point. Before this, both air-cooling model and water-cooling model conditions are investigated under normal operating conditions. After getting the result for the various model we compared our water cooling spray results with the ordinary solar panel. The other method is the tracking of the sun in real-time. By combining these two methods we can increase solar panel efficiency by a great amount.

I. INTRODUCTION

Sun tracking and Cooling of solar PV modules are important because they have a non-linear voltage-current characteristic with a unique point where the power produced is maximum. The maximum power point depends on module temperature and irradiance conditions. Both these conditions change during the day and are different for different places depending on the season of the year. Moreover, irradiation can alter rapidly due to varying atmospheric conditions such as clouds and the sky. It is important to track the maximum power point accurately under all possible conditions so that the maximum available power is always obtained. The temperature of the solar PV module is decreased by providing water spray using mini DC water pumps. In this project, an experimental setup is designed in which a spray of water tube is fitted to the back of the solar panel to reduce its temperature and bring the temperature to a normal operating point. Before this, both air-cooling model and water-cooling model conditions are investigated under normal operating conditions. After getting the result for the various model we compared our backwater cooling tube array results with the ordinary solar panel. The efficiency of a PV plant is affected mainly by the factors like the efficiency of the PV panel (in commercial PV panels it is between 8-15%), the efficiency of the inverter (95-98 %), and the efficiency of generation due to increase in module temperature. The efficiency of photovoltaic solar panels decreases with an increase in operating temperature. This is because the photo voltaic modules take only the visible light intensity for converting it to electrical energy and the rest of the spectrum of light is converted to heat leading to the increase in operating temperature. Reflection from the top surface is another reason for an increase in operating temperature.

I. BLOCK DIAGRAM

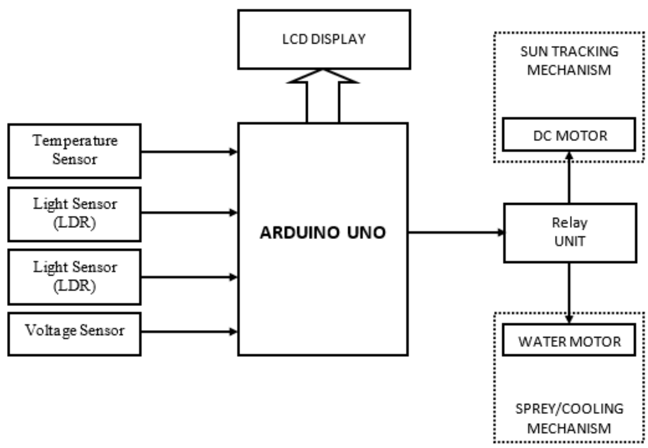


Fig- **Block Diagram of Solar Panel Efficiency Improvement By Temperature & Direction Control**

Figure above shows the Block Diagram of Solar panel efficiency improvement by temperature controlling and sun tracking. For this purpose we have used a LM35 temperature sensor which can measure temperature upto 155° C. LM35 is a analog output temperature sensor hence it is connected to the analog pin of the microcontroller. We will use Arduino Uno board as the main microcontroller. It uses ATMEG328 microcontroller in it. It has 6 analog input pins, i.e we can connect 6 different analog sensors to it. If the temperature of the solar panel reaches 30°C then the water pump will get activated. There will be a sprinkler which will spray the water on the surface of the solar panel. This will bring the temperature down as well as it will clean the panel surface. This will improve the solar panel output voltage.

In this project we will use a voltage sensor module to measure the output of the solar panel. The voltage sensor module can measure DC voltage upto 25V. Using this Sensor we can monitor the current voltage produced by the solar panel.

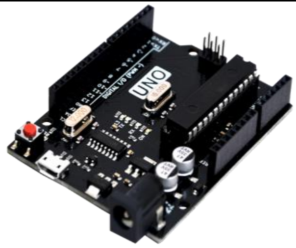
The other main part of the project is the sun tracking. For this purpose we can use 2 light sensors. The sensors will be placed on the two ends of the solar panel, one to the East side and other to the West side. They will detect the current position of the sun. The sensor which is on the side of the sun will produce more output than the other sensor. In this way we can detect the direction of the sun. There will be a 3.5 rpm DC geared motor which will rotate the solar panel to east or west. The motor will rotate the panel to adjust it till it makes an 90° angle with the sun rays, in this position the panel produces maximum output.

The Arduino Uno board has 14 digital I/O pins. We can use some of them to control the motors, relays and the water motor. The remaining pins will be used to interface the LCD dispay. The LCD will display all the necessary data like the temperature, sun direction and the output voltage of the solar panel.

II. Components

3.1 Arduino UNO

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduno, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform;



Technical Specification

Microcontroller A T-mega	328
Operating Voltage	5V
Input Voltage (recommended)	7-12
V Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB of which 0.5 KB used by
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

The Board

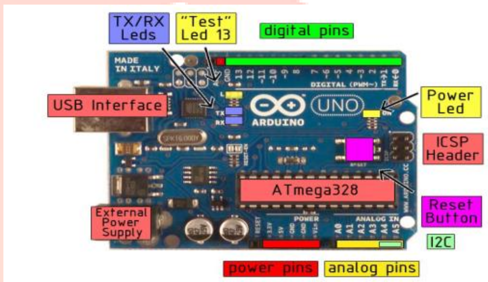


Fig – Constructional details of Arduino UNO

3.2 LCD Display JHD16x2A

- **FEATURES**

• 5 x 8 dots with cursor
• Built-in controller (KS 0066 or Equivalent)
• + 5V power supply (Also available for + 3V)
• 1/16 duty cycle
• B/L to be driven by pin 1, pin 2 or pin 15, pin 16 or A.K (LED)
• N.V. optional for + 3V power supply

3.3. Solar panel 12V/5W

❖ **Electrical data**

Nominal Peak Power	5wp
Maximum Power Voltage (Vmp)	18.0v
Maximum Power Current (Imp)	0.28A
Short – Circuit Current (Isc)	0.32A
Open – Circuit Voltage (Voc)	21.5v
Optimized Cell Efficiency (%)	17.2%

Power Tolerance ± 3%
STC: Irradiance of 1000W/m², Air Mass of 1.5, Cell Temperature of 25°C

❖ **Limits**

Operating Module Temperature: -40 to+85
Maximum system voltage: 600VDC

❖ **Temperature and Coefficient**

NOCT	-40° C to +85°	
Current Temperature Coefficient	% C	0.005
Voltage Temperature Coefficient	% C	-0.33
Power Temperature Coefficient	% C	-0.44

❖ **Additional Data**

Number of cells and type of connection = 36 series
Dimensions 291*160*25mm
Net Weight 0.74Kgs/pc

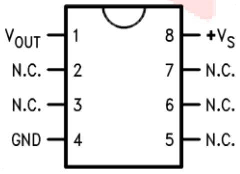
❖ **Cell Type**

Polycrystalline silicon photovoltaic cells

❖ **Warranty Period**

10 ears: Materials & workmanship

3.4 Temperature sensor LM35



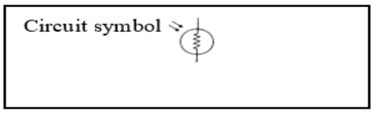
Features:

1) Calibrated directly in ˚ Celsius (Centigrade)
2) Linear + 10.0 mV/˚C scale factor
3) 0.5˚C accuracy guarantee able (at +25˚C)
4) Rated for full −55˚ to +150˚C range
5) Suitable for remote applications
6) Low cost due to wafer-level trimming
7) Operates from 4 to 30 volts
8) Less than 60 µA current drain
9) Low self-heating, 0.08˚C in still air
10) Nonlinearity only ±1⁄4˚C typical
11) n Low impedance output, 0.1 □for 1 mA load.

3.5 Light sensor LDR:

Guide to source illuminations

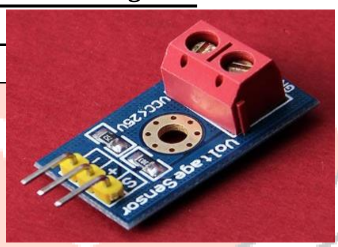
Light source (Lux)	Illumination
Moonlight	0.1
60W bulb at 1m	50
1W MES bulb at 0.1m	100
Fluorescent lighting	500
Bright sunlight	30,000



Light memory characteristics

Light dependent resistors have a particular property in that they remember the lighting conditions in which they have been stored. This memory effect can be minimized by storing the LDRs in light prior to use. Light storage reduces equilibrium time to reach steady resistance values.

3.6 Voltage sensor:



Special Parameters:

1- Voltage input range: DCO -25 V
2- Voltage detection range: DC 0.02445V-25 V
3- Voltage analog resolution: 0.00489 V
4- DC input interface: red terminal positive with VCC , negative with GND

3.7. Relays:

Channel 5V Optical Isolated Relay Module:

❖ **Brief Data:**

- Relay Maximum output: DC 30V/10A, AC 250V/10A.
- 2 Channel Relay Module with Opto-coupler. LOW Level Trigger expansion board, which is compatible with Arduino control board.
- Standard interface that can be controlled directly by microcontroller (8051, AVR, *PIC, DSP, ARM, ARM, MSP430, TTL logic).
- Relay of high Quality low noise relays SPDT. A common terminal, a normally open, one normally closed terminal.
- Opto-Coupler isolation, for high voltage safety and prevent ground loop with microcontroller.

3.8.DC motor:

DC motor specifications:

- Standard 130 Type DC motor.
- Operating Voltage: 4.5V to 9V.
- Recommended/Rated Voltage: 6V.
- Current at No load: 70mA (max)
- No-load Speed: 9000 rpm.
- Loaded current: 250mA (appro)
- Rated Load: 10g*cm.
- Motor Size: 27.5mm x 20mm x 15m

3.9 Water pump motor:

12V DC Water Pump with Brushless Motor DC40124 950mA Current & 4.5m Water Height 11.5W & 550L/H.

❖ **Features**

- Super long working life (more than 30000 hours)
- Adopt high performance ceramic shaft
- Amphibious design
- Submersible installation and entirely waterproof
- low consumption
- low noise (less than35db)

III. CIRCUIT DIAGRAM

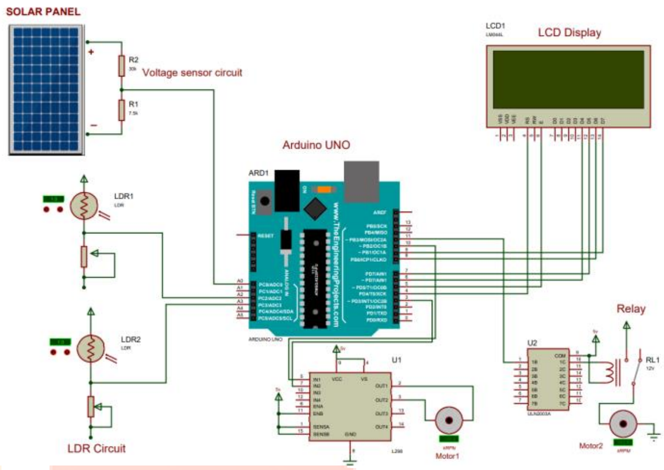


Fig.4 Circuit Diagram

IV. WORKING PRINCIPLE

Fig. 5 Working Prototype Model

The figure above shows the Block Diagram of Solar panel efficiency improvement by temperature control and sun tracking. For this purpose we have used an LM35 temperature sensor which can measure temperature up to 155o C. LM35 is an analog output temperature sensor hence it is connected to the analog pin of the microcontroller. We will use an Arduino Uno board as the main microcontroller. It uses an ATMEG328 microcontroller in it. It has 6 analog input pins, i.e we can connect 6 different analog sensors to it. If the temperature of the solar panel reaches 40oC then the water pump will get activated. There will be a sprinkler that will spray the water on the surface of the solar panel. This will bring the temperature down as well as it will clean the panel surface. This will improve the solar panel output voltage.

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V. ADVANTAGE AND APPLICATION

ADVANTAGES:

1) Using technology for Saving time and human efforts
2) Higher accurate and cleaning action is periodically repeated
3) Cost effective in long term
4) Increased efficiency of solar panels

6.2 Applications:

1) Photovoltaic power stations.

2) Rooftop solar PV systems.

3) Industrial Solar System

VII. CONCLUSION

An increase in the temperature of solar panels has a huge impact on their efficiency. Efficiency decreases with an increase in the temperature of a solar cell when it exceeds its rated operating temperature. This review concludes that by using the water cooling technique on the panel, efficiency can be increased around 16.5% with the temperature reduction from 54°C to 24°C. This technique is best among all others due to the highest efficiency improvement and simultaneously cleaning is achieved without any extra arrangement. Similarly, the tracking method also increases solar panel efficiency by a marginal amount. Combining these two techniques the results will be considerably high.

VI. REFERANCES

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