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AIR COOLING METHOD AND ORIENTATION TRACKING FOR THE ENHANCEMENT OF SOLAR PANEL EFFICIENCY USING ARDUINO

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ABSTRACT

Solar energy is playing a very important role in the present global energy production scenario. In this project, an experimental setup is designed to use an Arduino UNO to create an automated temperature-based cooling & tracking system for solar panels. The objective is to reduce the operating temperature of PV modules, as lower temperature leads to higher PV output efficiency. In this project, a CPU fans and temperature sensors are fitted to the solar panel to reduce its temperature and bring the temperature to a normal operating point. Before this, both the air-cooling conditions are investigated under normal operating conditions. After getting the results for the various models we compare the air-cooling results which is an Active Cooling with ordinary cooling techniques which is a Passive cooling technique of solar panel. This system will shorten the payback period of the investment and increase the longevity of the solar panels. The other method is the tracing of the sun in real time. By combining these two methods the panel can absorb a higher amount of solar power and increase power the solar panel's output.

Keywords: *Arduino Uno, Battery, CPU fans, DC motor, Liquid crystal display (LCD), Light dependent resistor (LDR), Motor driver, Relay module, Solar panel, Temperature sensor (DHT11)*

1.INTRODUCTION

The project "Air cooling method and orientation tracking for the enhancement of solar panel efficiency using Arduino" aims to enhance the efficiency and longevity of solar panels by implementing an intelligent cooling system. Solar panels are susceptible to performance degradation due to excessive heat buildup, especially in high- temperature environments. This degradation not only reduces energy output but also shortens the lifespan of the panels. To address this issue, we propose a novel cooling system that automatically adjusts cooling mechanisms based on real-time temperature data. At the core of our project is an Arduino microcontroller, which serves as the central processing unit for monitoring temperature variations and controlling the cooling system. Temperature sensors are strategically placed across the surface of the solar panel to provide precise temperature readings. These sensors continuously monitor the temperature levels, and when the temperature exceeds a predefined threshold, the Arduino triggers the cooling system to activate. When activated, the fans help dissipate excess heat from the solar panel, thereby reducing its temperature and improving overall efficiency**.** By dynamically adjusting the cooling process based on real-time temperature data, our project aims to optimize the performance of solar panels, enhance energy production, and prolong their operational lifespan. Electronic devices like Microcontrollers and Microprocessors in unification with Internet of Things (IoT) is an effective method to improve on these current shortcomings. Therefore, this paper presents an automated system completely dependent on temperature of the surroundings that uses the Arduino, Temperature Sensors and DC Fans to cool the solar panel.

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2. LITERATURE SURVEY

Although the temperature differs according to the season and location, the temperature of a solar panel is usually highest in summer [1]. Various solutions have been proposed to prevent the efficiency decrease due to such a temperature rise. There are various method to deal with efficiency problem, in this study, we choose the cooling fan method. The cooling fan is turned on and off automatically by the temperature of the solar panel. On the other hand, operating the cooling fan in the event of clouds or inverter failure is inefficient. Therefore, in some situations, real-time remote control is needed [2]. The IoT is an ecosystem of connected physical objects that are accessible through the internet. This is next generation technology that will soon be applied to society. [3] The IoT refers to the technology or environment, in which sensors are attached to transmit data to the Internet in real time.

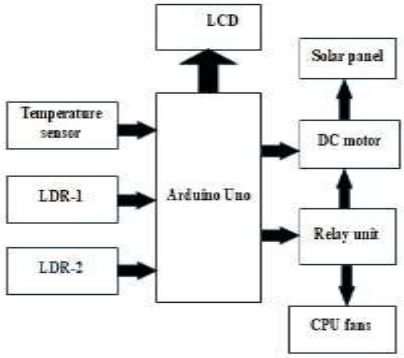
3.METHODOLOGY

We have gone through so many reference papers. There are several existing cooling systems that can be used for solar panels. Some common types are
Fan based cooling: This method uses fans to circulate air and remove heat from the system.
Heat sinks: These are designed to absorb and dissipate heat from the components.
In an existing system only one cooling method is used for solar panels. Hence, efficiency decreases. Nowadays still fixed solar panels are used majorly, which causes low efficiency.
First, it receives the temperature data through a temperature sensor as the main control part, activates the relay through an external interrupt, and controls the overall system operation. The second is the solar panel part. This part receives the signal from the relay and activates the cooling fan installed on the back of the solar panel.

4.PROPOSED METHOD

Design of proposed solar panels are using the air cooling technique on the panel, so efficiency can be increased with the temperature reduction. Design of proposed solar panels are rotated according to the sun rays. Similarly, the tracking method also increases solar panel efficiency. Solar panel efficiency improvement by temperature control and sun tracking. For this purpose we used a temperature sensor DHT11 which can measure temperature. In this DHT11is an analog input temperature sensor hence it is connected to the analog pin of the microcontroller. And also we use an Arduinouno board as the main controller (ATMEGA328P) microcontroller. This will bring the temperature down. From this it improves the solar panel output voltage. The other main part of the project is sun tracking. For this purpose we can use 2 light sensors. The sensors will be placed on the two ends of the solar panel. This will detect the current position of the sun**.**

Fig-Block diagram



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5. COMPONENTS DESCRIPTION

Arduino: The Arduino Uno is a microcontroller board based on the ATmega328P chip. It's popular for prototyping and DIY electronics projects due to its simplicity, versatility, and ease of use. It features digital and analog input/output pins, onboard power regulation, and a USB connection for programming and communication with a computer.

Fig(1)-Arduino Uno

CPU Fans: The CPU fan is typically mounted on the back of the solar panel, and its purpose is to dissipate heat away from the panel's surface. When the solar panel absorbs sunlight, it heats up. This heat can build up, especially on hot days or when the panels are operating at maximum capacity. By installing a CPU fan, airflow is created around the panel, which helps to carry away the heat and keep the panel's temperature within an acceptable range.

Fig(2)-CPU fan

Temperature Sensor: Temperature sensors in solar panels ensure efficient operation by monitoring panel temperature. They enable cooling systems to activate when temperatures rise, preventing overheating.

Fig(3)-Temperature sensor

DC Motor: DC motors are often used in solar panel cooling methods and tracking systems to adjust the angle of the solar panels throughout the day. This allows the panels to efficiently capture sunlight by facing directly towards the sun, maximizing energy production.

Fig(4)-DC motor

Motor Driver: The motor driver module in a solar panel cooling system and tracking setup serves to control the movement of motors responsible for adjusting panel positions and operating cooling mechanisms.

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Fig(5)-Motor driver

Relay Module: A relay is an electromagnetic switch that is used to turn on and turn off a circuit by a lowpower signal, or where several circuits must be controlled by one signal. Relays are simple switches which are operated both electrically and mechanically.

Fig(6)-Relay module

LDR (Light dependent Resistor): Light Dependent Resistors (LDRs) are integral components in solar panel tracking systems. Their purpose is to detect changes in light intensity. By measuring the amount of light, thesystem can adjust the position of solar panels. This optimization ensures panels receive maximum sunlight exposure.

Fig(7)-LDR

6.RESULTS

The effect of the cooling technologies, represented by a CPU fan were investigated. It has a difference in their installation location and the degree to which they enhance the efficiency and reduced the PV temperature. The CPU fan works as a technique for the air-cooling method which that by removes the hot air, which makes PV hot and replaces it with cold air because the density of cold air is higher than that of hot air, which cools the module from the external environment and makes it very close to the ambient temperature. To ensure complete cooling of the PV, fans must be provided that completely cover the module. In this two CPU fans were sufficient due to the small size of the module used for the project. Which draws heat from the front surface of the PV, causing it to cool it down to raise the energy productivity, which increases as, and this greatly increases the efficiency of the module.

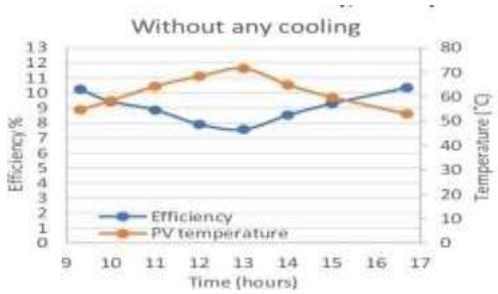

Fig - Solar panel without any cooling

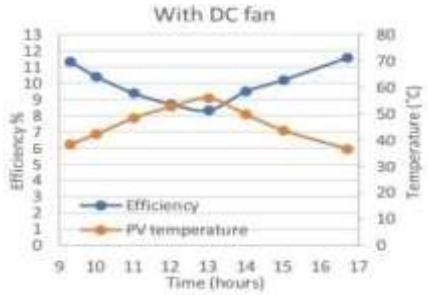

Fig -Solar panel with air cooling

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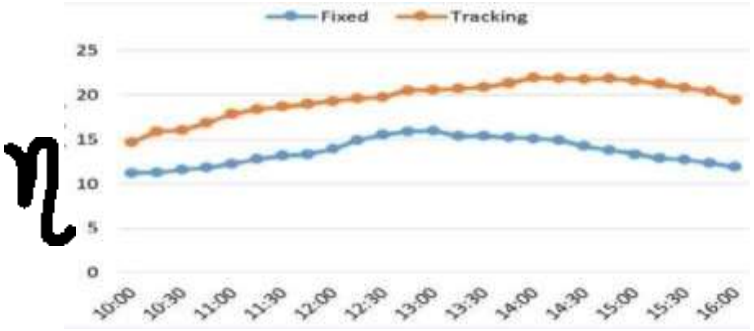

Fig -Solar panel in fixed &single axis Orientation tracking

7.HARDWAREMODEL

The figure (12), (13) below shows the Solar panel efficiency improvement by temperature control and sun tracking. For this purpose we have used an DHT11 temperature sensor which can measure temperature. We will use an Arduino Uno board as the main microcontroller. It uses an ATMEG328 microcontroller in it. This will bring the temperature down. This will improve the solar panel output voltage. The other main part of the project is 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 the 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.

Fig – Hardware model of the cooling system with air cooling and orientation tracking using Arduino

8.CONCLUSION

The need for cooling mechanisms that enhance the efficiency of the PV module appears when the event that the temperature of the PV exceeds the reasonable limit, i.e. more than 45 ° C, it will lead to a decrease in the electric energy produced. The aim of this paper is to present an efficient and optimized cooling method for Solar Panels, with the help of Arduino Micro-controller, Temperature Sensors and Arduino, offering the monitoring and control to the user from anywhere geographically, with the hope to gain prospect in design and application. To solve this problem cooling methods were used, namely air cooling, which work to draw heat from PV to reduce its temperature, which decreases the output voltage despite a slight increase in the output current. Additionally, this Cooling arrangement can be integrated with any existing system and large fitting expenses can be saved on. Also, this system is not cumbersome need for rewiring with the existing

system. This system is also so easy to make use that the limits of the ranges can also be defined as per the choice of user or environment of operation of Solar Panel. Adding the Microcontroller is helpful in saving energy as it automatically runs the cooling system when needed and switches it off when not needed. When using cooling technologies, there is an increase in the amount of electrical energy produced, which increases the efficiency of PV depending on the amount of solar radiation. It was concluded that this method used to enhance the efficiency and gain maximum amount of heat by the orientation tracking.

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