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# Enhancemetnt of Solar Panel Lifetime And Efficiency With Modified Cooling Technique

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***Abstract :*** *For Sustainable development of any country , electricity is the basic need for current civilization. With out hampering the environment , generation of electricity is very essential. Solar energy is completely natural, it is considered as clean energy source. In this work , an automation system for solar panel cooling is proposed on the use of a commercial sensor with RISC based micro-controller. An electro mechanism was designed and developed to enhance solar panel life time under different sunlight peak hours to evaluate it's voltage efficiency. The impact on the over all performance of solar PV panel caused by different temperatures at sunlight peak hours are analyzed. The developed cooling system is innovative in relation to the unusual cooling system already existing in commercial units. A mini prototype model was designed and experimented, field results have proven good enhancement. With this automation cooling technique, voltage efficiency is improved from 3% to 5%.*

***Keywords :*** *automation cooling technique, solar energy, solar PV panel , temperature, voltage efficiency, sunlight peak hours*

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## I. Introduction

Lack of sufficient electricity is always an immense problem in any developing country like Bangladesh. There is no other option instead of electricity, but the reality is natural resources like petroleum, gas, coal etc. are limited and obviously it would not last for a long time. For this reason thinking of alternative way for generating electricity is important to solve this problem. Solar energy can be very effective in generating electricity in Bangladesh as it is inexhaustible and eco-friendly. The Solar Energy is not new at all. It has been used several centuries ago for different functions. But it was replaced for crude oil in the Industrial Revolution. But now-a-days due to high costs of crude oil and its great environmental impact, the solar energy has returned. If oil had not replaced the solar energy, surely we would have more technology in renewable energy. One type of renewable energy source is the photovoltaic (PV) cell, which converts sunlight to electrical current, without any form for mechanical or thermal interlink. PV cells are usually connected together to make Modules, consisting of 72 PV cells, which generates a DC voltage between 23 Volt to 45 Volt and a typical maximum power of 160 Watt, depending on temperature and solar irradiation. Solar panel efficiency depends on various factor such as solar intensity (brighter the sunlight, the more there is for the solar cell to convert),temperature[1], dust which decreases the efficiency of panel etc.

### 1.1 Problem Definition

The sun offers the most abundant, reliable and pollution-free power in the world. However, problems with solar energy, namely the expensive cost and inconsistent availability, have prevented it from becoming a more utilized energy source. Another problem, it is well known that a decrease in the panel temperature will lead to an increase in electrical efficiency, so in recent years different cooling techniques have been proposed and tested experimentally. The efficiency drops with the rise in temperature, with a magnitude of approximately 0.5 %/°C. Increase in electrical efficiency depends on cooling techniques, type and size of the module, geographical position and the season of the year, and usually corresponds with a rise of 3-5 % in overall efficiency. In water cooling technique, amount of water consumption plays an important role. So in this work, efficient water cooling technique is proposed to improve solar panel life time along with reduced power to drive the water cooling system.

### 1.2 Importance and Objective of this Research

The importance and objective of this research is to identify and solve the problems like solar panel lifetime, solar power efficiency, performance, cooling system and dust cleaning within solar based system. These issues are raised from insufficient maintenance of solar panels and semiconductor photo voltaic cells. To solve these kinds of issues, maintenance of solar panel with less man power, water and power is needed. Reduction of power and water not only improves the solar panel life time, but it also improves the reliability, penalty of heat in high performance real-time based solar systems. Based on above discussions, the objective of the work is summarized as follows:

- To design and implement a 20w solar system with auto cooling to reduce the temperature of solar panel at an acceptable level.
- It will definitely improve the life time of solar panel.
- Amorphous silicon solar cell is considered in this work because it has lower life time compared to other solar cells.

### 1.3 Literature Review

Michaelo et al [1] developed a technique to improve solar panel life span. Overheating also has the potential to form electric arcs which can melt metal fixtures and burn away the module's insulating materials[1]. Michaelo [1] used the hollow fibre(hallow tubes of 1mm diameter attached behind solar PV panel) cooling system. But in these results were observed at temperature of 50°C. It is too high ie 38°C is STC(Standard Testing Temperature). Xiao Tang et al [2] developed a novelty in their work to cool solar panels using micro heat pipe array. Both of air-cooling and water-cooling conditions under nature convection condition were investigated in this paper. But they conclude that water cooling is the best technique to improve Solar PV panel efficiency. **Irwan et al[10]** discussed a work on solar panel cooling system by using DC brushless fan and DC water pump. To make an effort to cool the PV module, Direct Current (DC) brushless fan and DC water pump with inlet/outlet manifold are designed for constant air movement and water flow circulation at the back side and front side of PV module representatively. They showed that the efficiency of PV module with cooling system was increasing compared to PV module without cooling system; this is because the ambient temperature dropped significantly. The higher efficiency of PV cell, the payback period of the system can be shorted and the lifespan of PV module can also be longer.**MohdEhtishaan et al [3]** developed a work to reduce temperature of solar panels. Increases in temperature reduce the band gap of a semiconductor, thereby effecting most of the semiconductor material parameters. In a solar cell, the parameter most affected by an increase in temperature is the open-circuit voltage[3]. As the temperature increases, the open-circuit voltage decreases, thereby decreasing the fill factor and finally decreasing the efficiency of a solar cell[3]. They have used the two cooling systems as Air cooled Systems and water or refrigerant cooled systems. They have implemented the model on MATLAB. Finally they conclude that cooling effect on PV panel improves efficiency. **Sandeep Koundinya et al [4]** proposed a technique to improve the efficiency of PV panel. They told that efficiency of solar panel decreases due to reflection from the top surface, absorption of heat by the parts other than the cell, absorption of heat from the other portion of the spectrum. In their work, an attempt has been made to reduce the operating temperature of the panel by cooling the panel using finned heat pipe. Computational Fluid Dynamics (CFD) has been used to design the fins and model the solar panel with finned heat pipe assembly. The CFD analysis has shown a maximum decrease of 20K. Assembling of finned heat pipe is a complicated one.**B.Koteswararao et al [5]** experimented a work to improve efficiency of solar system. Even though, we are having plenty amount of solar energy availability but we are unable to utilize solar energy effectively due to temperature variation from time to time. To maintain constant power generation by the help of cooling, they suggest the best cooling method for solar PVC panels among two cooling methods that is water and air. In water cooling, cross flow and parallel flow used. Thermal sensor automatically switches on the motor after reaching panel over heat. The efficiency of the panel and Fill Factor were measured by them in all the conditions. Finally they conclude that cooling system is compulsory one to improve PV panel efficiency.

## II. Proposed Methodology

### 2.1 Block Diagram

Block diagram of proposed methodology is shown in Fig 2.1. In these, three sensors are used to detect temperature, dust and output voltage of the panel. LCD module is used to display indication. DC motor, Fan & Pump are used as interface devices to do necessary action in this arrangement. SCU (Signal Conditioning Unit), Relay Driver Circuits, two 12v batteries are also connected in this setup. ARM processor is heart of this setup. Solar panel is tracked by tracking switch in various directions, at one direction; it gives maximum voltage that voltage is called as MPPT (Maximum Power Point Tracking) voltage. At that point, it stops tracking and the corresponding voltage is stored in ARM. Reference temperature is previously calibrated. Panel temperature is measured with temperature sensor, if it exceeds the reference temperature, pump will automatically power the water. According to temperature in the solar panel, water spraying is given by pump. Pump will be automatically off if panel temperature reduces below the reference level. Minimum enough temperature level to operate solar PV panel is setup in the microcontroller set-up circuitry. Measure temperature from solar panel is compared with preset temperature in controller circuit, according to control circuit decision in microcontroller circuit, water flow level is adjusted. This technique saves water and energy. It will leads to improvement of solar panel life. i.e. during unnecessary cooling time water flow will be stopped. MPPT voltage is stored in battery via charging circuitry and ARM 7 controller.

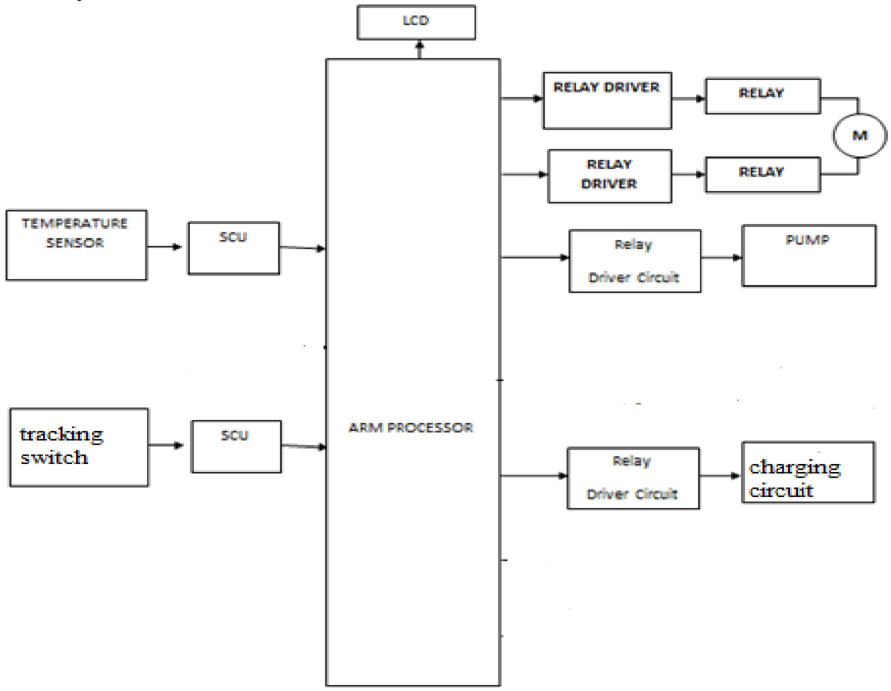


**Fig 2.1 Blocks Diagram Of Proposed System**

**2.1.1 Interfacing Temperature Sensor LM35 with ARM7**

It is a circuit for measuring temperature in the panel along with Data Acquisition System is shown in Fig3.2. Data acquisition block includes A/D converter, signal conditioning & amplifier. LM 35 temperature sensor is used to detect the panel temperature thenit converts into voltage. This voltage is manipulated by signal conditioning unit for further stage of processing i.e. it pre-amplifies the sensor output. LM 35 output is given to p0.28 of ARM 7 micro controller. It is the ADC input of ARM 7.

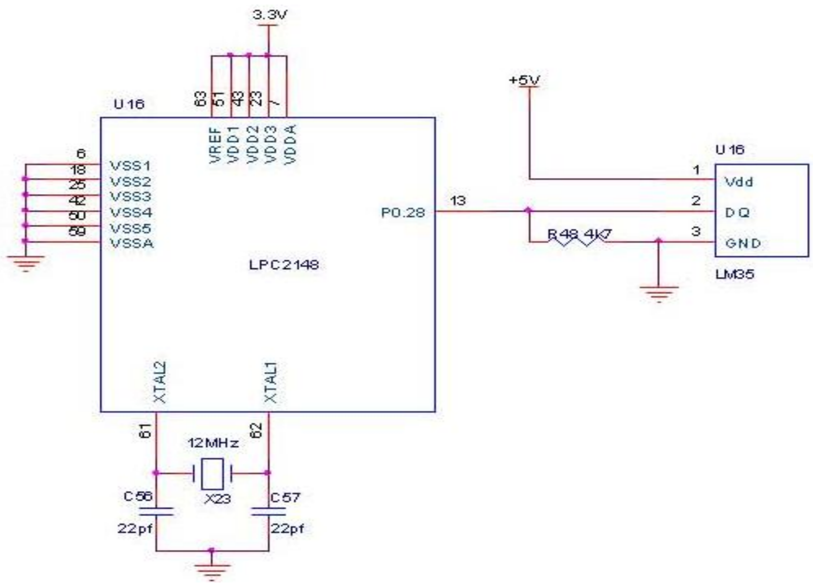


**Fig 3.2** Signal Conditioning Unit With LM 35

### 2.1.2 Relay Driver circuit

Relay Driver circuit is shown in Fig 2.3. For the function of relay, it must receive this voltage at its coil terminals. Thus, if a relay has a rated voltage of 9VDC, it should get 9 volts of DC voltage for its working. In order to eliminate voltage spikes from a relay circuit, a diode is required for its proper functioning. In order to drive the relay, transistor is used and only less power can be possibly used to get the relay driven. Since, transistor is an amplifier so the base lead receives sufficient current to make more current flow from Emitter of Transistor to Collector. If the base once gets power that is sufficient, then the transistor conduct from Emitter to Collector and power the relay.

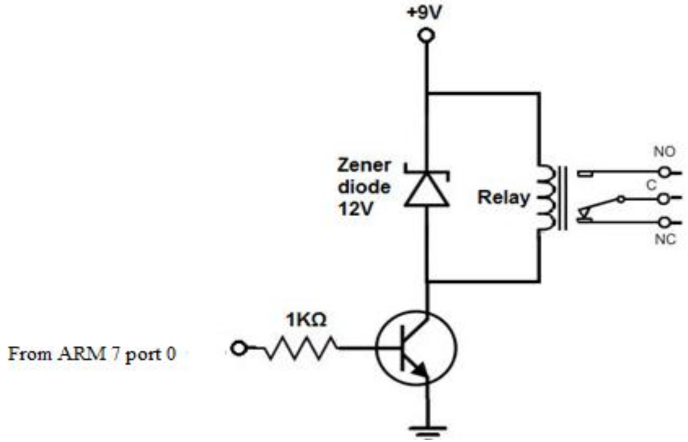


**Fig 2.3 Relay Driver Circuit**

The Transistor's emitter-to-collector channel will be opened even though no input current or voltage is applied to Base lead of Transistor. Therefore, blocking current flows through relay coil. The emitter-to-collector channel will be opened and allows current to flow through relay's coil if enough current or voltage is applied as input to the base lead. Driver Circuit is used to boost or amplify signals from micro-controllers to control power switches in semi-conductor devices. Driver circuits take functions that include isolating the control circuit and the power circuit, detecting malfunctions, storing and reporting failures to the control system, serving as a precaution against failure, analyzing sensor signals and creating auxiliary voltages.

## III. Results And Discussion

### 3.1Test setup

Home position of the panel is shown in Fig 3.1 In this prototype model,we have to reduce the overheating of panel.First, the setup can be done and we set the reference temperature ,At the time when it is reached the reference temperature, the water can flow around the panel to avoid excess of overheating in panel.According to the water flow we can avoid the overheating and improving the panel strength .According to panel voltage,solar panel is automatically tracked using servo motor.Iniially the panel is on the home position see in the below diagram.The first step of the tracking is, determination of solar panel higher voltage . In this prototype model ,we can give the manual panel voltage to the arm processor to track the corresponding voltage.


**Fig 3.1 Home Posisition of The Panel**

Initially MPPT (Maximum Power Point Tracking) is tracked from the sunlight to track the maximum panel voltage obtained direction. This image is shown in Fig 3.2


**Fig 3.2 MPPT tracking**

In LCD display Fig 3.3, three indications are there. First one is panel temperature, second one is reference temperature which is preset in the ARM processor , third one is panel voltage.

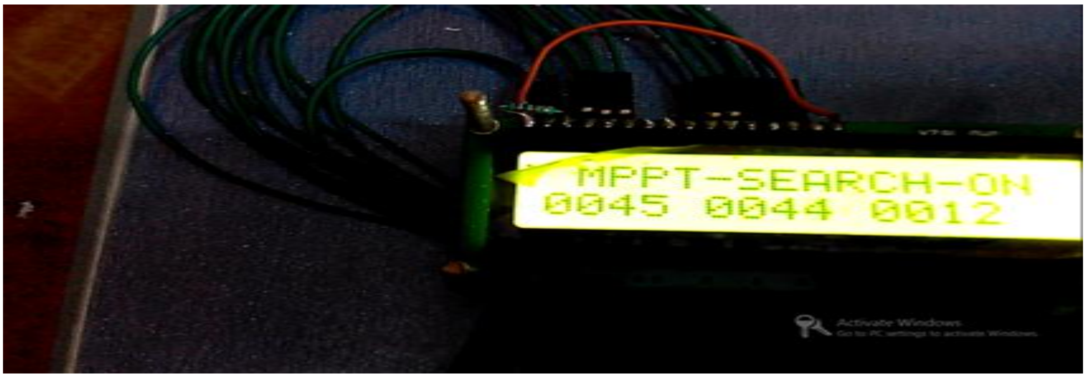


**Fig 3.3 Indications of LCD Display**

**3.1.2 Measurement Setup**

Panel volatge is measured at different intervals of sunlight peak hours. At 12.30 hours , temperature is measured as 43°C. At that time corresponding panel voltage is 18.5v for 21 v,5w soalr panel. It is shown in Fig 6.4. In this case reference volatge is set as 39°C. Measured temperature is higher than reference temperature. Now , water is sprayed through programmed pump over the surface of solar panel. It is shown in Fig 3.5 . Now panel voltage is displayed as 19.3v, panel temperature becomes 38°C.(Fig 3.6) . This is enough to work solar panel efficiently.

At 13.05 hours, similar observations are monitored. Panel temperature is 43.3°C, panel volatge is 18.7 v. After cooling , panel temperature becomes 39°C, panel voltage is 19.3v. Even though STC (Standard Testing Condition ) is 43°C, amorphous silicon PV panel gives good performance at 38°C to 39°C). Therefore we conclude that we can improve amorphous silicon PV panel life time by auto water spraying method. .

Before cooling and after cooling measured voltages are tabulated in table 1.

Proto type model is only constructed here. Panel output voltgae is measured in terms of no-load condition both before cooling and after cooling. No load voltage efficiency is improved from 88.04% to 91.9%.

**Fig 3.4 At 12.30 hours panel temperature and panel voltage measurement**

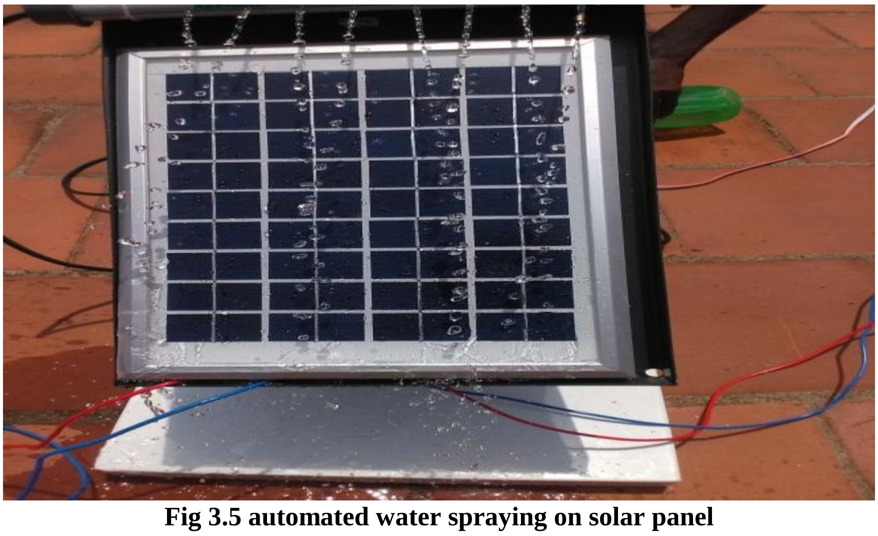

**Fig 3.5 automated water spraying on solar panel**

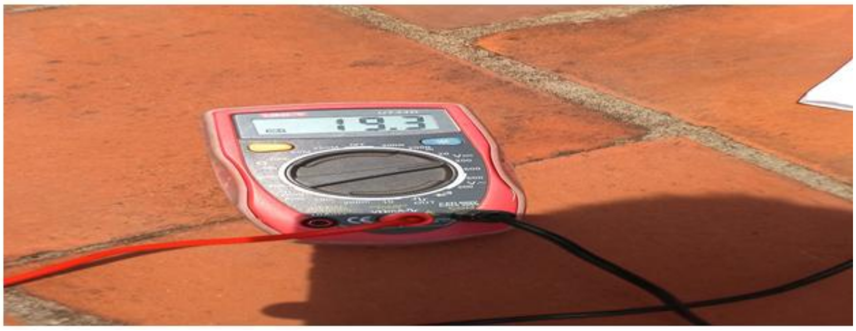

**Fig 3.6 After cooling panel volatge at 12.30 hrs**

**Table-1** comparison of panel voltage before and after cooling

| S.No | Time | Panel temperature and voltage before cooling | Panel temperature and voltage before cooling | Efficiency improvement |
|---|---|---|---|---|
| 1 | 12.30 hrs | 43°C, 18.5v | 38°C, 19.3V | 3.9% |
| 2 | 1.05 hrs | 43.3°C, 18.7v | 39°C,19.3v | 3% |

## III. Conclusion

This work was developed after conducting a number of simulations before finalizing the design. It reduces the bottleneck between hardware and software design. Entire simulation results are carried out using keil micro vision 7 in windows XP. After conducting experiments in various intervals of time it was concluded as it is an efficient technique to reduce solar panel temperature with minimum cost, power & water. No load voltage efficiency is improved from 88% to 91% with our proposed auto water cooling technique. Further it was noted as if voltage efficiency of solar panel is improved, definitely lifetime/ lifespan of solar panel will be definitely improved with minimum man power.

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