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A Combined approach Towards the Efficiency Improvement of Solar Photovoltaic Panel

Sujata Shivashimpiger, Sri Lakshmi C.S.

Assistant Professor, Dept. of EEE, NMIT, Bengalur, India[1]

PG Student [RE], Dept. of EEE, NMIT, Bengalur, India[2]

ABSTRACT: Renewable energy is gaining much global attention due to ever growing energy demand and rapid technological advancements. Solar energy is one of the major contributors with lot of on-going investigations to improve the efficiency of Photo Voltaic (PV) solar panels. This paper is mainly focused on improving the solar panel efficiency by adopting a combined approach in which the auto cleaning and tracking technology are working together within a well-defined operational limit. An experimental set up was developed in laboratory in which the cleaning of the solar panel is monitored by a series of sensor systems and simultaneous solar tracking procedure has been established. A significant improvement in efficiency of the experimental setup is observed and the final conclusions are given.

KEYWORDS: Auto Cleaning, dual axis tracking, Panel Efficiency and Intelligent controller**.**

I.INTRODUCTION

As the fossil fuel prices changing rapidly, so renewable power are rapidly gaining great significance as a renewable energy resource. But the overall commercial efficiency of such systems are always very less due to the very fact that higher exposure to the environmental conditions. Mainly the Photo Voltaic panels are having very poor operating characteristics till today despite the recent technological developments. Lot of research works are happening to improve the same and the main challenge is to keep the radiation panel surface clean and tidy always to accept maximum possible sun rays. M. Catelani, L. Ciani, L. Cristaldi, M. Faifer, M. Lazzaroni, and M. Rossi [1] are considered various operational parameters and limitations of the PV panels and suggested some innovative ideas about the efficiency improvement. Importance of Solar energy is emphasized in reference [2]. In order to progress that efficiency from demanding photovoltaic (solar panels), numerous researches were started investigations to create a few strategies. One such technique may be well utilizing a solar tracking system and self-cleaning method [3].

Presently development of the solar panel following frameworks has been progressing for a long time. The only advantages is that, throughout the day, sun moves over the sky, so that sunlight based panels i.e., Solar panels is used to keep up a perpendicular to the sun's rays [4], [5],[6] .

To make the solar energy much successful, the solar panel should always receive extreme force of light. For that the panel should always face opposite to the sun and there should not be any other particles on the solar panel. But in some overwhelming contamination cities the tidy particles are straight forwardly kept on the sun powered panel, so that the vast majority of the light originating from the sun is reflected in spite of refracting in the perspective of dust deposited on to the panel by making the front portion of the panel shaded. The efficiencies of the panels decrease because of the dust deposited on the panel.

The sun powered PV modules are large utilized in dusty situations which are situated in tropical nations like India. The tidy gets accumulated on the front surface of the module and blocks the occurrence light from the sun. It decreases the power limit of the module. When the module is not cleaned the produced power reduces as much as half of it, so as to regularly clean the tidy, So that a sun based tracker cum-cleaning system has been planned [7], [8], [9].

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The main aim of this work is to increase the efficiency of solar panel by self-cleaning and solar tracking system. In this paper the self-cleaning and tracking techniques and obtain the results of the panel for the different conditions such as cleaned panel with tracking, dusty panel with tracking, dustdeposited on the panel.

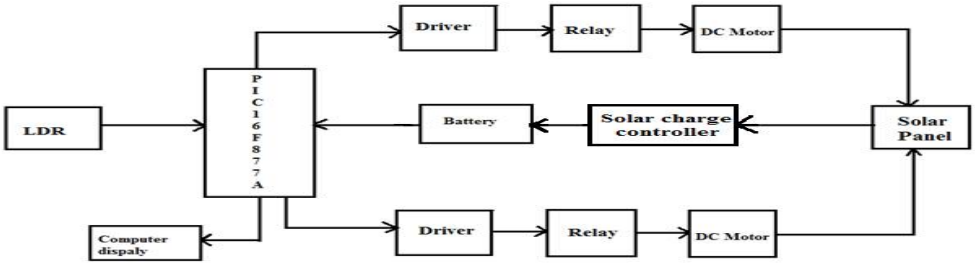

Fig.1 Basic block diagram of the proposed work

II.DESIGNDEVELOPMENT

The design development consists of solar panel, LDR, Relay, ULN2003A drivers, LM7805 regulator and 2 DC motors of 100 rpm for cleaning and 3.5 rpm for tracking mechanism. In this paper 3 LDR's are used to represent the main positions of the sun in a day i.e., morning (east LDR), mid-day (mid LDR), evening (west LDR), night (mid LDR). The DC motors is controlled by microcontroller. If light falls on the east LDR, the panel will rotate anticlockwise. If light falls on mid LDR, the position of the panel is parallel to the ground and also wiper which is placed on the panel will clean the panel, again if more light falls on west LDR, the panel will rotate clockwise and on the dark, the position of the panel is parallel to the ground.

III.IMPLEMENTEDALGORITHM

The algorithm for implementation tracking and cleaning arrangement has been explained by the following flowcharts.

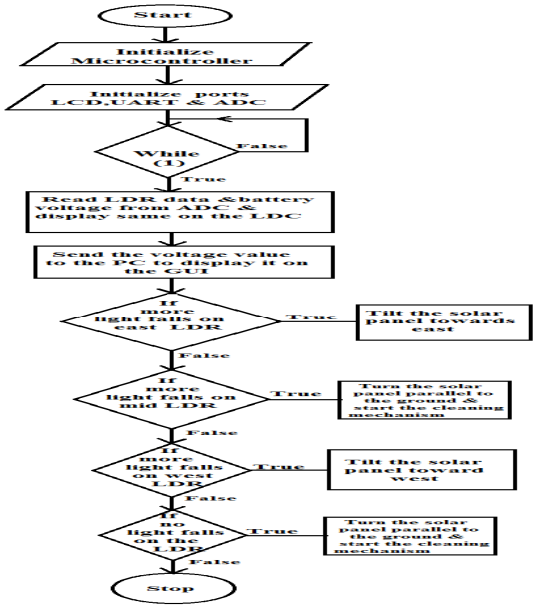

Fig: 4 flow chart of the auto cleaning system

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IV.EXPERIMENTAL SETUP

The complete functional system diagram is shown in the Fig 5. Using the flow chart shown in fig :4, the power flow process can be understood. The datataken from this setup that is cleaned panel with tracking has been compared with the dusty panel with tracking and tabulated in Table I and II.

HARDWARE REQUIREMENTS

- Solar panel
- PIC Microcontroller - PIC16F877A
- LDR
- ULN 2003A Driver
- Relays
- DC Motor
- Solar charge controller
- Battery
- Regulator LM 7805
- LCD Display 16x2

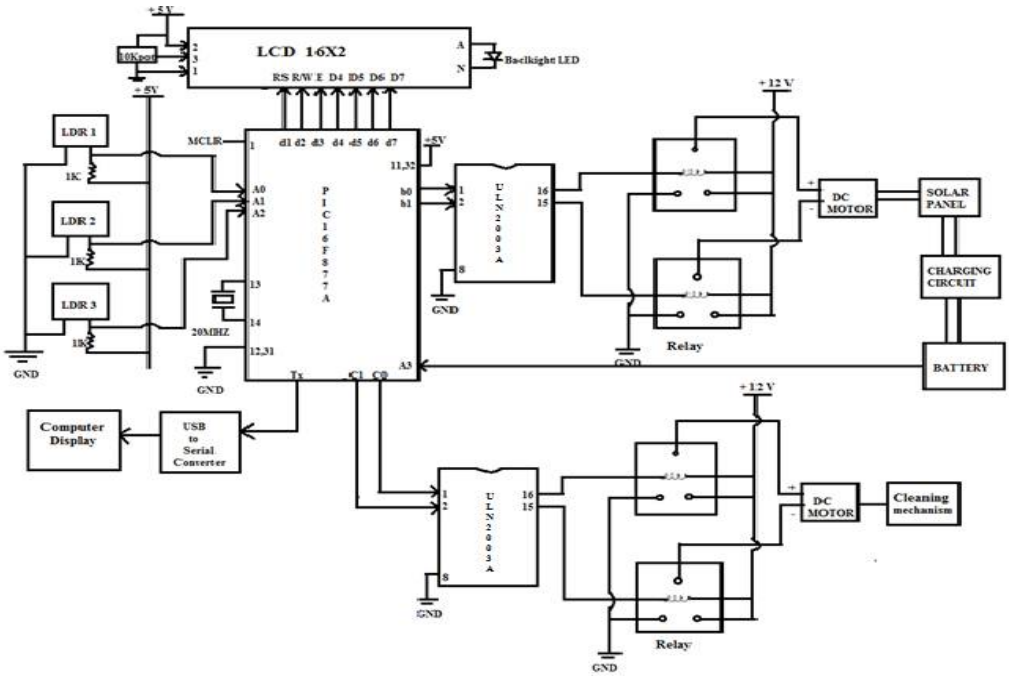

Fig:5: Functional connection diagram

The diagram shown above gives the physical connection diagram and working logic. initialize the component of Microcontroller, ports like LCD, UART and ADC .Read the LDR data and also panel voltage and display it same on the LCD. Here 3 LDR is using, if morelight falls on east LDR, and then the solar panel is tilt towards the east. If light falls on mid LDR and when there is no light falls on LDR i.e., dark then the panel is parallel to the ground and start the cleaning process. Again if more light falls on west, then the panel is tilt towards the west. Collect the readings by differentiating the cleaned panel and dusty panel. Compare the readings and conclude it using matlab.

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SL NO	Input			Output		Direection
	East	Mid	West	b1	b0	
1	1	0	0	0	1	Clockwise
2	0	1	0	1	0	Anticlkwise
3	0	0	1	1	0	Clockwise
4	0	0	0	0	1	Anticlkwise

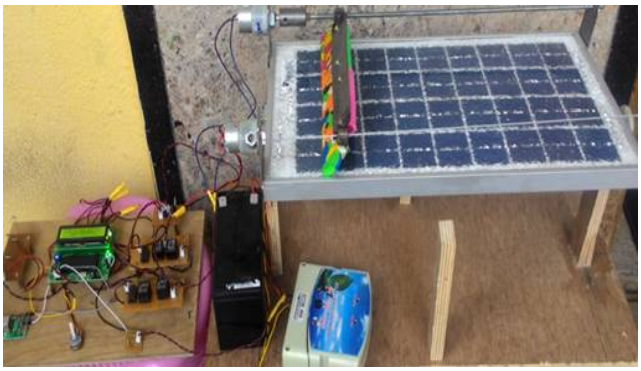

Figure 6: Laboratory set up

As shown in fig, a 10W HHV Solar, Model numbers HST12010 Panel has been used for the testing. The necessary Micro controller coding have been developed and programmed suitably. Required interfacing arrangements were done. To avoid the error due to atmospheric changes it was ensured that the meters have been well calibrated before installed for the testing.

V.RESULTS

Different readings of voltages and currents have been taken before and after the implementation of the proposed controller. It was found that approximately 30% to 35% improvement in the overall efficiency of the system. The following table shows the hour wise power production and the corresponding panel efficiency with and without controller.

TABLE I RESULTS FOR DUSTY PANEL

Time	Voltage(V)	Current(A)	Power(W)	Efficiency (%)
10:00am	14.52	0.31	4.5012	4.092
11:00am	14.76	0.34	5.0184	4.5621
12:00pm	14.93	0.37	5.5241	5.0219
01:00pm	14.89	0.32	4.7648	4.3316
02:00pm	14.53	0.27	3.9231	3.5664
03:00pm	14.26	0.23	3.2798	2.9816
04:00pm	14.07	0.19	2.6733	2.4302
05:00pm	13.98	0.14	1.9572	1.7792

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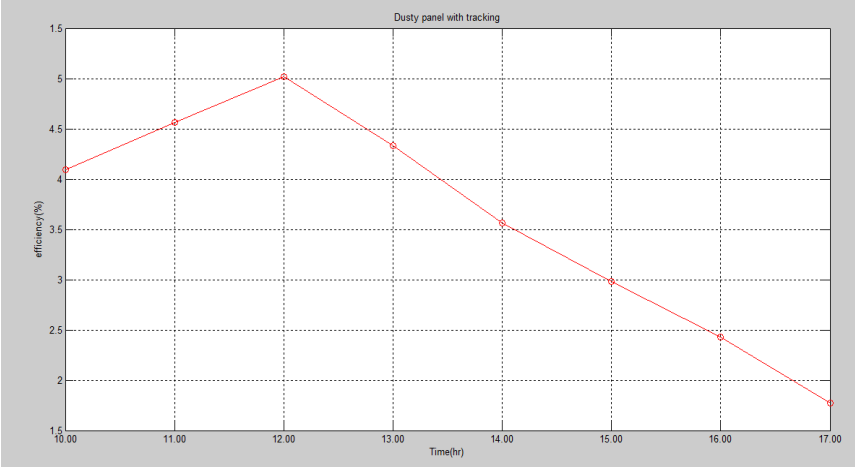

Figure 5 Graphical representation of dusty panel with tracking

TABLEII. RESULTSFORCLEANEDPANEL

Time	Voltage(V)	Current(mA)	Power(W)	Efficiency (%)
10:00am	16.64	0.39	6.4896	5.899
11:00am	16.89	0.43	7.2627	6.6024
12:00	17.02	0.48	8.1696	7.4269
1:00pm	16.97	0.42	7.1274	6.4794
2:00pm	16.83	0.40	6.732	6.12
3:00pm	16.78	0.37	6.2086	5.644
4:00pm	16.71	0.34	5.6814	5.1649
5:00pm	16.54	0.29	4.7966	4.3605

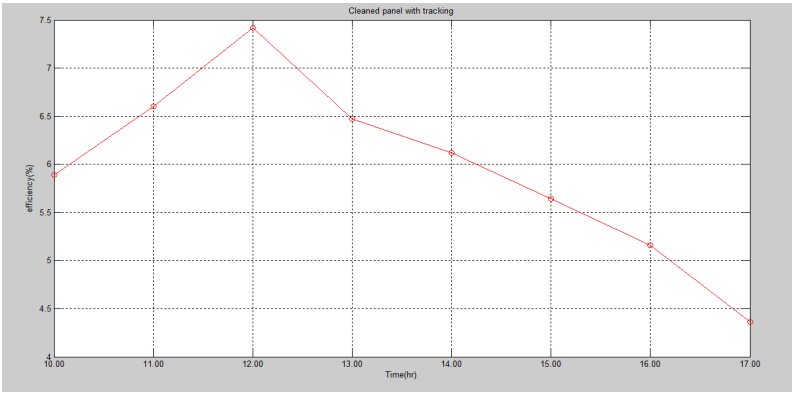

Figure 6 Graphical representation of cleaned panel with tracking

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For different conditions, panels are used with the same rating and with the same manufacturer. These results are taken during the rainy seasonforthewholedayfrom10amto 17 pm withanintervalof1hourtime But forth etracking panel the maximum intensity of light is falling everytime. Moreover, it is receiving the maximum light, but because of the dust particles that are deposited make the efficiency to decrease. The average efficiencies and the power for the different conditions are compared and tabulated inthe Table III. By observing the table III we concluded that cleaned panel with tracking is producing more power compare to dust panel with tracking.

TableIII. Efficiencies for different conditions

System	CPWT	DPWT
Power	**8.1696**	**5.5241**
Efficiency%	**7.4269**	**5.0219**

1. CPWT–CleanedpanelwithTracking
2. DPWT – Dusty panelwith Tracking

VI.CONCLUSION

Effective cleaning along with the proper tracking mechanism can produce better efficiency of the solar system. In this case, it was observed that the radiation efficiency was increased by 37% (average of hourly efficiency values) from its original values. The power output from the fixed input is the function of load current and hence a steady current with nonlinear loading ability can be considered for such applications. Also it was observed if the power rating of the panels were increased with the existing set up the error got increased which is an indication of the mal function of the sensor system. But this can be minimized by incorporating the intelligent artificial sensors where the non-linear variations can be easily mapped. Also it was proposed to develop an Artificial Neural Network based System predictor which will give an approximation of input-output power relations which can be considered as the future scope of the work completed. The efficiency of the panel has been improved when designing the tracking as well as cleaning system. This system can extend to dual axis tracking by that can achieve more efficiency.

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