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Independent Component Analysis and Sophisticated Distribution Control Algorithmsbased Improving the Efficecny of Solar Power Generation

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Abstract: Today, people are increasingly worried about environmental problems due to fuel shortage and generation of renewable energy sources. Among the renewable resources, wind generators and photovoltaic panels are primary competitors. For most of their applications, they have the advantages of having a load interface with different power converter circuits for maintenance and free of contamination, but their installation costs are high. Normally Photovoltaic modules also have relatively low conversion efficiency and Overall system cost of PV using Maximum Power Point Tracking (MPPT) techniques are high. The volume can be reduced by the use of high-performance power conditioners that allow for maximum energy consumption. Existing solar power generation systems have some disadvantages of being all day as a result of less direct exposure to true sunlight. This work is aimed at exploring the functions of a MPPT system that includes installations of sophisticated distribution control (SDC) and Independent Component Analysis (ICA) methods. The duty cycle of power converter is significantly controlled using proposed SDC and ICA algorithms and guarantee MPPT operation at its highest efficiency. The function of proposed ICA and SDC has been compared with widely used in traditional algorithms in the MATLAB Simulink environment. Over 97% of capacity is achieved through the respective SDC and ICA methods.

Key Words: Independent Component Analysis, Sophisticated Distribution Control, Power Converters, Maximum Power Point Tracking

I. INTRODUCTION

In the past two decades, energy-related aspects are becoming more and more important, such as the use of intelligent resources, through the use of renewable resources and the effect of polluting the environment. Along these lines, there is developing worldwide enthusiasm for economic energy generation and energy preservation. Among the innovations that can assume a job in producing economical and extended energy, interesting arrangements are spoken to by photovoltaic (PV) cells, wind generators and biomass plants [1]. In particular, the power generation system can be considered as one of the most widespread solutions to ensure that the development of electric power generation is low.

The PV field look into action and improvement normally focuses around solar power radiation investigation, proficient working methods, new modeling design and adjustment of these frameworks.Previous papers have examined group modeling and photovoltaic volume based on the I-V characteristic [2]. However, such basic features and external conditions as this organization may be involved in the PV power generation systemswere not taken. Solar powered cell proficiency is a significant information parameter in the plan of PV power supply items. Often, there is only space for solar to the synthesis. Cell potential can also be a criterion for the ability of a major organization.

As a basic parameter, the cell capacity, e.g., calculates the optimal system structure and serves as an input to the storage unit and its lifetime, PV. Size and its efficiency, and ultimately the cost-effective use of inter-product trade-offs.These computations are well known, especially when autonomous photovoltaic, device integrated photovoltaic, is only used for long distances.Power measurements of test laboratories and industry photovoltaic modules are usually done with a solar simulator. There is little acknowledgment that Dust significantly affects the efficiency of the installation of photovoltaic. Some studies have analyzed this effect and the resulting capacity degradation [3].

PV Due to the current research on the effectiveness of the system and the effects of dust deposition, the fact that powder is a different environmental and weather factor is a complex phenomenon [4]. In the PV structure, the test is appeared as a prologue to elements adding to the solvency in the dust of specific PV panels. A detailed analysis of the effects of dust on the performance of the module is presented in this document. This information is from PV Dust effects are highlighted and shown on the panel electrical show.

The remaining part of this work is organized in five section. In chapter one is discuss the introduction about solar power generation followed by the section two discuss literature review. In chapter three discuss the proposed solar power generation system and followed by section four discuss the results for proposed system with performance analysis. Finally chapter five discuss the conclusion of the proposed design.

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II. RESEARCH BACKGROUND

Different advanced methods are described from this literature survey to improve the efficiency of solar power generation. The researchers quickly talk about the most recent advancements in solar based maximum power point tracking system. These days, incredible advancement has been made in a several zones, getting to be advanced innovation used to create support work in free access spots to its extraordinary self-rule [5]. These systems are the best technology for heavy duty tasks such as detecting and repairing damage on solar panels, or cleaning them [6]. However, critical systems related to the damage detection and navigation system in PV-plant [7]. Various disadvantages of stemming from production, damage to internal module, improper connection and the shading effects of PV panel [8-10].

The early acknowledgment of these states of inability to locate the correct answer for improve productivity, while improving the photovoltaic framework and decreasing work costs [11]. Ultrasonic techniques [12], infrared examination [13, 14] and electroluminescence imaging [15] permit recognizable proof and dismissal of low quality cells in the beginning periods of the assembling procedure. But new damage is possible, it seems either within the assembly stage or during the lifetime of the operation

Invasive and noninvasive are the two types for Photovoltaic module maintenance technologies Invasion technology uses proprioceptive module information (eg, Voltage and current flow of the module, internal temperature) to feel the fault condition. To this end, methods based on the characteristics of AC parameters [16], comparison of PV models under normal and test conditions [17, 18], induced current laser beams [19], and electron beams are currently [20] and DC electric Derived parameters [21]. In literature survey discussed many methods to enhance the performance of solar power generation system but in all system have some issues to track the maximum power from solar, so in this work introduced two hybrid (ICA and SDC) approaches to overcome the all issues.

III. MATERIALS AND METHOD:

The proposed Sophisticated Distribution Control (SDC) and Indepeddnet Compoent Analysis (ICA) based maximum power tracking system can always screen the area of the sun during sunshine hours and the genrate the electrial energy. The solar power generation system offers can be continuously monitor the location of the sun during daylight hours, and electricity is stored in storage devices, located in several decentralized locatrions to control the location of the sun.Located in this model storage device can effectively redirect avilabe's power. The novelty of this paper is the new model with multiple adavantages, where many pre-existing techniques can be used. In this proposed work comprise five parts such as

a. Automatic dust cleaning
b. Automatic temperature control
c. Mirror reflection solar panel
d. MPPT tracking using ICA
e. Solar cell crack detection using SDC

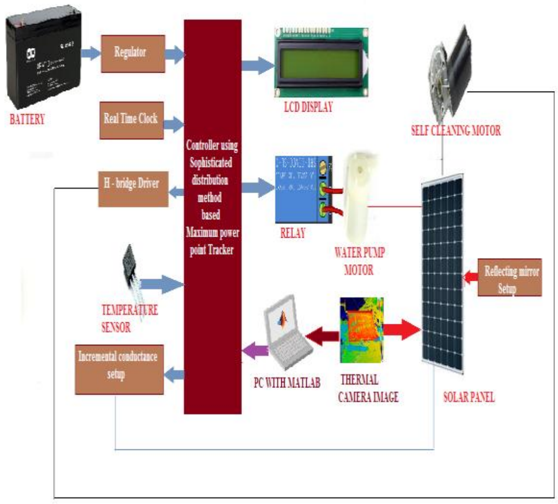

Figure 1: Block diagram – Proposed Solar Power Generation System

3.1 Real Time Clock Based Automatic Dust Cleaning System

The controller reads the real time clock (RTC) continuously into the automatic dust cleaning and compares it with the stored table values, and if it matches these values, the corresponding position value will cause the motor to rotate Send to a PWM generator that will work in the cleaning mechanism will achieve optimal efficiency of power generation. Preprogrammed data for controller motor operation with respect to the input signal of the driving circuit to rotate wise and rotate wise, as opposed to the clock motor's need to compare those signals. The wiper is connected to the motor which rotates clockwise and clockwise in the opposite direction. From this work it is assumed that the average efficiency of the solar panel increases by about 3.2% to 2.6% with regular cleaning.

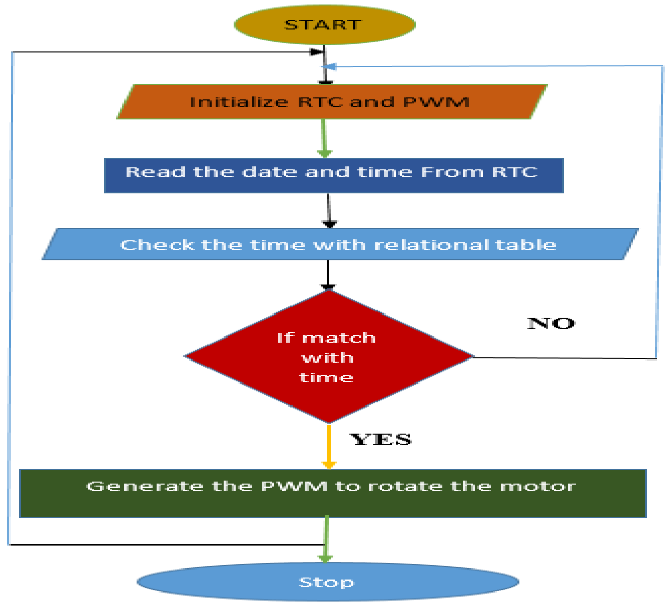

Figure 2: Working Flow Chart of Automatic Dust Cleaning

3.2 AUTOMATIC COOLING

It causes to reduce the effectiveness and builds the temperature of the photovoltaic board that assimilates solar radiation. The proficiency of the power and PV boards is commonly decreased to 0.5%/°C and a surrounding temperature increment up to ~0.05%/°C, respectively. To cool the PV panels, the programmed sunlight based cooling framework is planned with DC brushed non-fans and DC water pump motor with inlet and outlet manifolds. Uniform wind stream and water stream dispersion on the back and front surfaces required for the board. Temperature Sensor is used for Temperature Detection in PV. Controller DC brush non-fan and water pump temperature Used to control the activity depending on the group. For these control methods, PVs are used. When the group temperature reaches the setting that automatically detects the temperature sensors, we call it an intelligent system because it operates the DC composite cooling system and avoid the waste electrical energy. As a result, PV panels with an automatic cooling system showed higher power output terminology compared without cooling the system. High efficiency of PV panel, system recovery period can be short-circuited, and PV panel life can be extended.

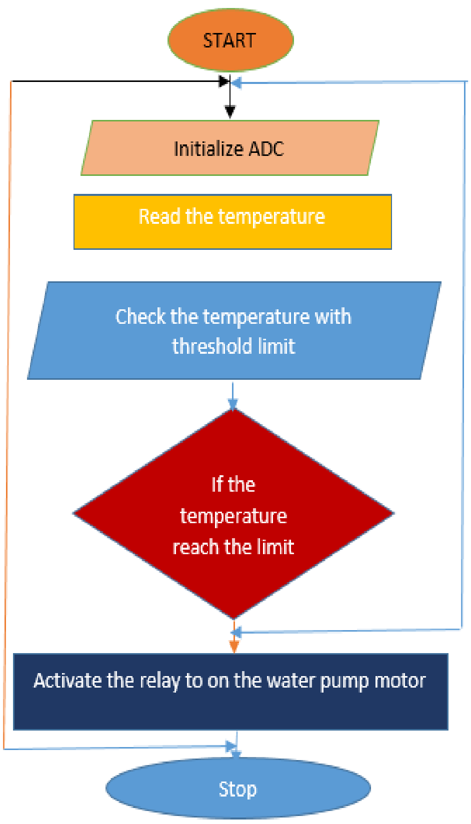

Figure 3: Working Flow Chart of Automatic Cooling

3.3 MIRROR REFLECTION

Mirrors were used in this study to increase the incidence of solar radiation in the photovoltaic panels. The intensity of solar radiation is small in the early hours and evenings compared to the afternoon. The increase in the intensity of the solar radiation is directed by the radiation from the mirror to the solar panel by reflection. The PV panels and mirrors are placed in a 2x1.5x3.5 inch size L-angle bracket. Solar panels and mirrors are arrested using rivets. This will help prevent the movement of solar panels and mirrors. Two rectangular crossbars are used to support the structure of the solar panel.

In the PV panel is attached to the line of a rectangular section using joints. Links to one line of the rectangular section are welded together using joints. On the other side of the pair are the posts that are attached by the threads. The bulletin is screwed to the bottom of the post to give the post support to the wind. This resolution will be attached to the court. The plate is tied to a concrete block to build a stronger one.

3.4 INCREMENTAL CONDUCTANCE METHOD:

The Incremental conductance method is based on the particularity of the P-V curve. This elimination algorithm provides some of the shortcomings of its Perturb and observe (P&O) algorithm. Incremental conductance (IC) method endeavors to improve MPPT tracking time and create more power in an enormous lighting condition. MPPT can utilize the connection between DI/DV and - I/V. On the off chance that DP/DV is negative to compute, MPPT is the lie on the correct side of the closest position and MPPT is on the left if maximum power is active. The IC method equation is

$$\frac{DP}{DV} = \frac{D(V.I)}{DV} = I\frac{DV}{DV} + V\frac{DI}{DV}\text{..........}1$$

$$\frac{DP}{DV} = I + V\frac{DI}{DV}\text{.........}2$$

MPP is reached when DP/DV = 0

$$\frac{DI}{DV} = -\frac{I}{V}\text{..........}3$$

$$\frac{DI}{DV} > 0 \; then \; Vp < Vmpp\text{........}4$$

$$\frac{DP}{DV} = 0 \; then \; Vp = Vmpp\text{..........}5$$

$$\frac{DP}{DV} > 0 \; then \; Vp > Vmpp\text{.........}6$$

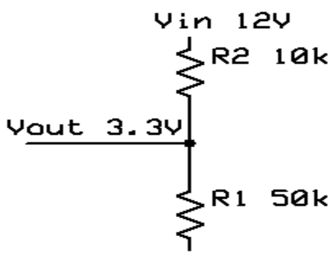

Figure 4. Voltage Divider circuit

$$Vout = \left(\frac{R2}{R2+R1}\right)xVin\text{........}7$$

Where

V_{out}=output voltage

V_{in}= Open Circuit voltage of PV panel

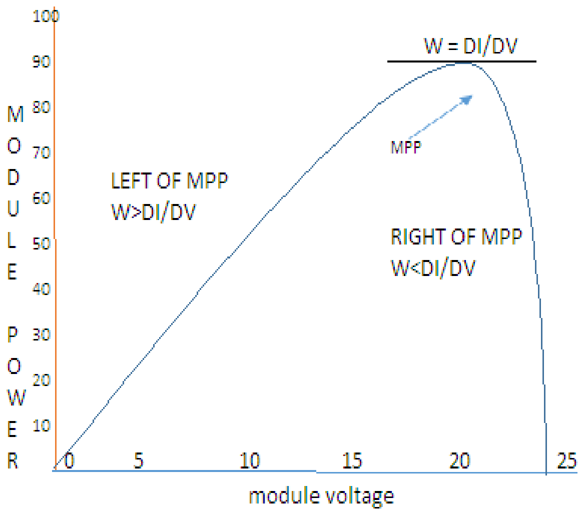

Figure 5: P-V curve Of a Solar Module using Incremental conductance

The incremental conductance method is based on the slope of such PV mass deviation by DP / DP = 0. The assumption given in Maximum Power Point (MPP) and left MPP is on the right side of the MPP and zero negative.

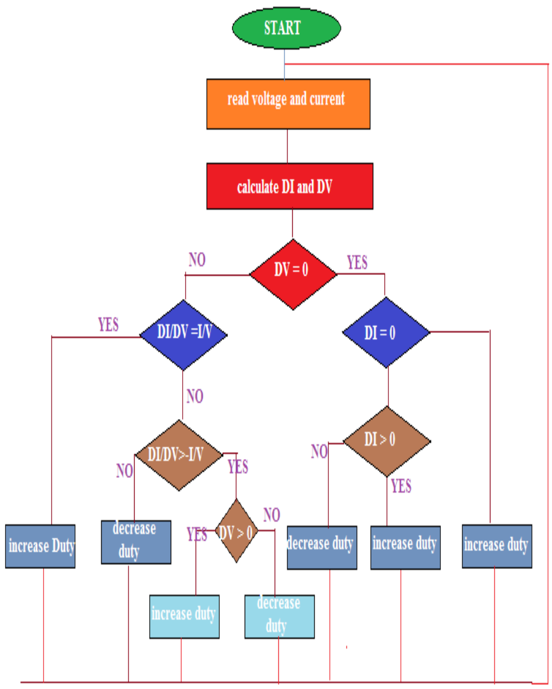

Figure 6. Flowchart of Incremental Conductance Method

The IC algorithm can be seen in the figure. 6. If MPP is on the right side, DI / DV <-I / V, then PV voltage reaches MPP .IC method can be used to find MPP, PV efficiency improvement, power loss and system In order to reduce the cost must be reduced. When compared to perturbation and observation, the IC mounted on the controller yields more stable performance (P & O). Ambient vibration in the MPP region can be suppressed by trading with the complexity of its implementation. Voltage increments and decrements were manually selected by trial and error, so tracking time not yet fast.

3.5 DEFECTS DETECTION

Consider two approaches to identify the presence or absence of defects in the solar cell sub-image. This method makes use of taking a thermal image camera first, ie taking a thermal image of a defective solar panel solar panel after taking a thermal image of a normal solar panel first. The method then uses independent component analysis (ICA) for feature extraction from non-overlapping sub windows of texture images, which sub windows depend on the Euclidean distance from the features obtained from the mean value of the features. Classify as defect or non-defect as features derived from defect-free sample and test image sub-window. The first ICA approach uses feature vectors as a linear combination of base images. It is then relative to each training sample set in the data passing distance measurement, and the minimum distance of all training samples is used as the discriminant measure. The ICA technique depends entirely on the first sunlight based sub-picture and recreation mistake under the remade picture from the review and reference pictures. In the event that a separation estimation or recreation mistake is discovered, it is recognized as a terrible sun powered cell sub-picture in the event that it is more noteworthy than a fixed limit. Else, it is recorded as a sub-picture without defects.

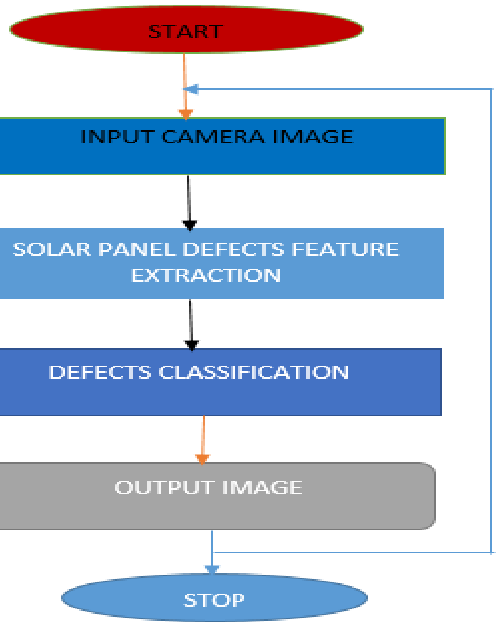

Figure7: Defects detection of Solar panel

3.6 SOPHISTICATED DISTRIBUTION CONTROLLER AS MAXIMUM POWER POINT TRACKER:

The SDC algorithm uses a relationship between the load line and the IV. The only voltage here and the current of the PV module are sensed by the MPPT controller. In the photovoltaic system, (8) and (9) can be rewritten to get the following:

$$\frac{VPV}{IPV} = \frac{(l-D)^2}{D^2} Rl \ldots\ldots.8$$

$$Rl = \frac{D^2}{(l-D)^2} \frac{VPV}{IPV} \ldots\ldots9$$

The load resistance can be calculated by calculating the duty cycle, voltage and current of the PV module (9). After obtaining the load resistance value, its (9) can be rewritten as (11). The duty cycle can then be calculated by replacing the voltage required for (11) (VMP) and the current of the PV module (IMP) as follows:

$$\frac{D^2}{(1-D)^2} = \frac{IPV}{VPV} Rl \text{.........} 10$$

$$D = \frac{\sqrt{\alpha}}{1+\sqrt{\alpha}} \text{.........} 11$$

$$\text{Where } \alpha = \frac{IPV}{VPV} Rl$$

Now, the response system and robust load can be calculated by changes in solar radiation (9) and (11). In the case of load fluctuations (9), it is used to calculate the new load resistance, then V_{MP} and I_{MP} are used with the new duty cycle (11).

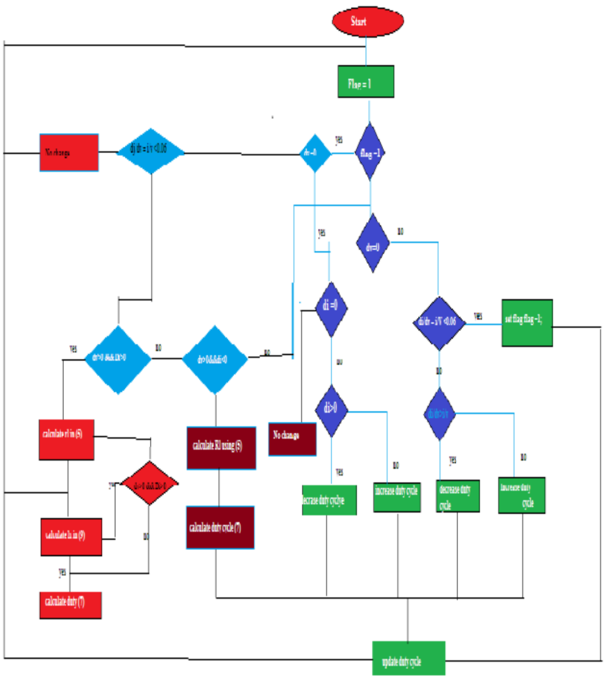

Figure 8: flow chart for SDC algorithm

IV. RESULTS AND DISCUSSION:

Based on MPPT the proposed sophisticated distribution control is modeled and simulated using MATLAB / Simulink. The developed Simulink model is shown in Figure.9. From this simulation study, the simulation was performed according to the SDC and ICA based MPPT control methods assumed under the assumption of constant temperature and constant isolation.

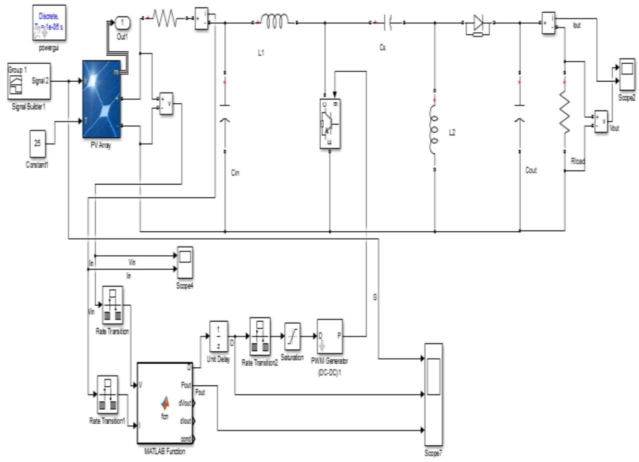

Figure9 .Simulation Model

A block diagram of the MATLAB / Simulink model of proposed system is shown in Figure 9. It demonstrates the SDC controller for an alternate enrollment work than that connected to the framework. The related simulation results are appeared in the following figures.

Figure. 10SDC-Duty Cycle Response

Figure 10 shows the controller function in the duty cycle of MPPT using SDC method, which is monitored during the function from the PWM signal generator and the simulated cell crack screen is in Figure 11.

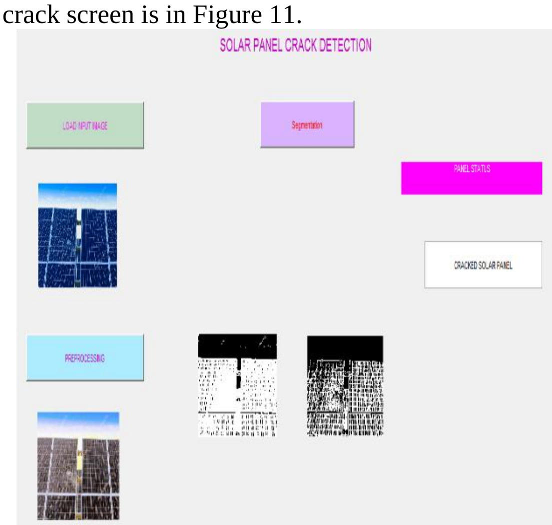

Figure. 11 Solar Panel Crack Detected Simulation

Table 1: Performance analysis

Date 08/16/19	Conventional INC mppt system	DRSS system	SDC system
Average sunlight	8H	8H	*H
Average current (A)	0.78A	1.21A	1.4A
Output voltage (V)	9V	12V	12V
Output power (W)	7.4W	11.58W	13W
Output energy(Wh)	65.56Wh	98.24Wh	100.2Wh

The performance analysis of solar power generation is discussed in table1. As compared with exiting methods (INC and DRSS) the proposed SDC system gives the best results against all working conditions.

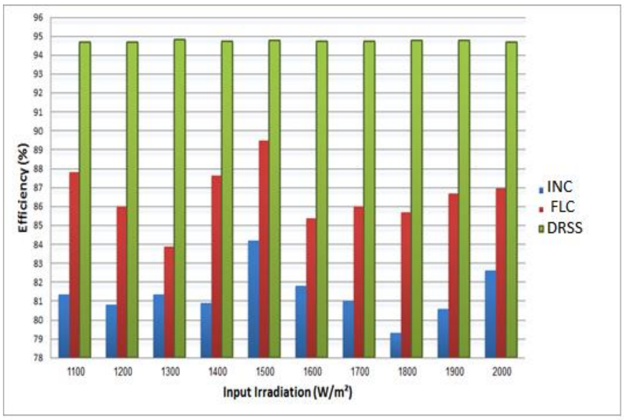

Figure.12. Comparative efficiency of MPPT using SDC controller with conventional INC, FLC for different irradiation and T = 25 ° C.

Figure 12 shows that power generation changes with the time of day in the existing and proposed way. As compared to existing methods, the proposed method offers maximum power output. Other MPPT controllers and inspections to track efficiency calculations, SDC utilize to get better tracking efficiency and almost the same tracking efficiency at all illumination levels with this MPPT at any load it has become clear that it is possible to prove and give enhanced results.

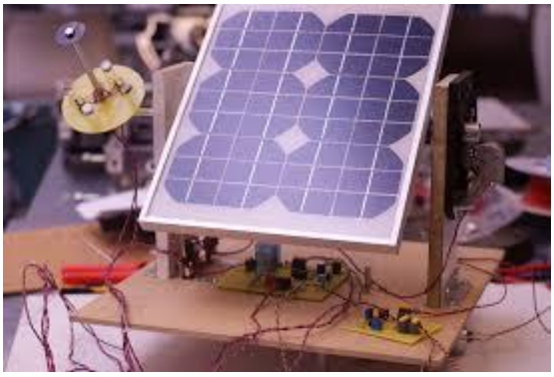

Figure 13: Experimental setup

The Experimental setup of proposed Maximum power pint tracking system is shown in figure 13. The proposed system has different blocks, such as Mirror Reflector based sun tracking, automatic dust cleaning and automatic cooling system.

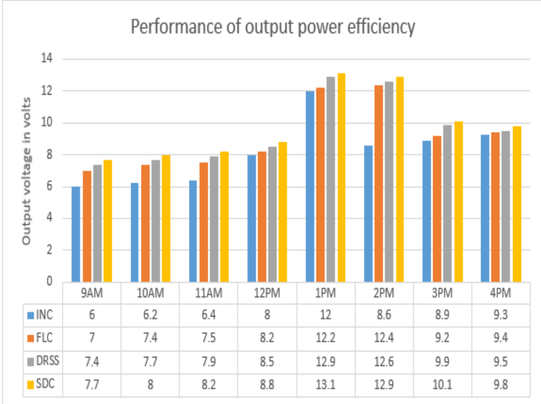

Figure: 14 Output Power Comparison

Figure 14 Provides information on the hourly comparison of the output voltage of existing and proposed methods to the changes in environmental conditions. Figure 14 clearly shows the change in time over the existing and proposed paths for one day of power generation. Unlike existing methods the proposed SDC and ICA method achieve the best results against all working condition.

Table 2: COMPARISON OF THE PROPOSED MODEL

S.No	Controller used	Output power in per unit	Switching Losses (%)	Maximum output Power Efficiency (%)
1	Conventional MPPT using INC method	0.84	16	84.72
2	Fuzzy logic controller	0.89	11	89.55
3	Dynamic Rule soft switching Controller	0.94	6	94.92
4	Proposed SDC control	0.98	4	99.25

The performance evaluation of proposed system with existing methods are discussed in table 2 with various parameters, such as switching losses, MPPT efficiency and output power per unit. As compared with existing INC (84.72%) and FLC (89.55%) methods the proposed SDC (94.92%) method is obtained the best result.

V. CONCLUSION

From this study, the efficiency of photovoltaic power generation was increased in various ways, such as self-cleaning, automatic cooling, fault detection and monitoring mechanisms were implemented. If we implement a MPPT system without the need for cooling and panel cleaning, the efficiency very low. In addition, the efficiency of the panel is reduced by 50% even if it follows untested, cooled or cleaned defects. Therefore this work is aimed at exploring the functions of a MPPT system that includes installations of sophisticated distribution control (SDC) and Independent Component Analysis (ICA) methods.

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The duty cycle of power converter is significantly controlled using proposed SDC and ICA algorithms and guarantee MPPT operation at its highest efficiency. The function of proposed ICA and SDC has been compared with widely used in traditional algorithms in the MATLAB Simulink environment. As compared with existing INC (84.72%) and FLC (89.55%) methods the proposed SDC (94.92%) method is obtained the best result

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