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CENTRALIZED MPPT CONTROLLER SYSTEM OF PV MODULES BY A WIRELESS SENSOR NETWORK

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Abstract

Renewable energy is a developing technology globally because of the current situation in the global environment. Solar energy can be used in different applications like the agricultural sector, Power generation stations. Fault identification and Maximum power tracking are major challenges from the source of solar panels. In the existing method Perturbation and Observation (P&O) technique are tracking the incoming voltage and current. The drawbacks are unconditional values, negative values and identifying the defects. So in the proposed method implementation of MPPT (Maximum Power Point Tracking) for identifying the fault and defects. Voltage and current are maximum tracking's without the negative value while getting the input source of the three P.V. (Photovoltaic) mechanisms are used in this method.

The condition analysis status in PV and caused by constraints such as Dust pollution, cell broken condition, cell temperature High, Partial cloudy, and raining season. If any defects of solar panels easily identify while using a centralized MPPT control technique. Better gain of source output and without any lagging are the main working operations of Maximum PowerPoint. IOT (Internet of thing) based wireless sensor network is the monitoring the voltage and current sensor value in between the P.V. (Photovoltaic) panel via a DC-DC converter The power produced the estimating values with better efficiency output and tested in Mat lab and Hardware experimental setup.

Keywords: Wireless Sensor Network, Maximum Power Point Tracking Algorithm (MPPT), Power Transmission, centralized control, Buck-Boost Converter.

1. Introduction

The centralized distribution of solar radiation influences the efficiency of a module. P.V. devices are typically evaluated concerning a standard spectral distribution. In most cases, specify standard conditions that performance comparisons between different parameters are provided in a datasheet.

Solve our energy problems could harvest even a small portion of the available energy at the earth's surface. A Photovoltaic (P.V) system converts sunlight directly into electricity. The P.V. cell is the fundamental component of a P.V. system. Panels or arrays can be formed by grouping cells. The purpose of this method is to model photovoltaic modules or panels made up of several basic cells because the power produced by a single module is rarely sufficient for commercial use; modules are linked to form an array to supply the load. The connection of modules in an array is the same as the connection of cells in a module. Modules can also be linked in series to increase voltage or in parallel to increase current. The electrons created in the conduction band are now free to move

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around. The action of the electric field present in the P.V. cells forces these free electrons to move in a specific direction. These flowing electrons form current, which can be drawn for external use by connecting a metal plate on the top and bottom of the P.V. cell.

The DC-DC converter, also known as the charge controller, is the device that allows a battery to be charged. There are two types of charge controllers on the market: MPPT (Maximum Power Point Tracking) and PWM (Pulse Width Modulation). PWM devices are less effective than MPPT charge controllers in terms of performance, they can deliver maximum power under constant irradiation conditions. Still, they cannot deliver maximum power under variable irradiation conditions without a required maximum power point tracker. A grid-connected P.V. system comprises two controllers, one on the source side and one on the grid side. To deliver maximum power to the load, the two controllers must work in perfect harmony

2. Literature Survey :

Maximum power point tracking (MPPT) is used by grid-connected inverters, solar battery chargers, and other similar devices to obtain the maximum potential power from one or more photovoltaic devices, typically solar panels. MPPT P-V and I-V curve a comparative analysis of widely used MPPT algorithms; their performance is calculated based on energy generation capability. [1], [2].

Recently, another small computerized relative humidity sensor used to develop a situation estimation strategy. The concentration of water in Photovoltaic (P.V.) modules introduced to improve test conditions in the meteorological chamber during the assessment process and for long-distance open-air testing in field conditions. Double-intersection Photovoltaic (P.V.) cells and modules on a sub-millimeter scale are shown for bio-implantable application under Remote for Move and Low-Motion Enlightenment, manufacturer of Internet of Things. [3], [4].

The survey and details of, at least, the most common faults in photovoltaic systems are an important point for evaluating fault occurrence and impact. An extensive study of those faults is presented in this context, with faults on the Direct Current (D.C.) side and faults on the Alternating Current (A.C.) side divided into two categories. [5], [6].

Faults on the A.C. side are caused by issues. The double intersection approach meets the prerequisite requirement for these applications by increasing the yield voltage per cell while compensating for the declining field from disconnection and interconnections. [7], [8].

An open-circuit fault occurs when there is a disconnect at some point in the system, causing the flow of electrical current to be interrupted. This fault has the greatest impact on power generation because it can affect anything from a single string of modules to the entire system, depending on the location of the disconnection and the topology of the P.V. system. The sensor hub in a Heterogeneous Wireless Sensor Network (HWSN) can be bombed due to battery power depletion or sudden damage. [9], [10].

The hand-hub hub position is intended to add a new transfer hub to the split, with the organization's ultimate goal being remote correspondence. An energy expert directing is

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useful for network lifetime and security delays Correspondence standards, such as machine-type correspondence, exploded in instant applications that required availability in remote organizations' hubs [11], [12].

The mismatch of cells or modules occurs when there are cells or modules in the P.V. system with electrical properties that are very different from the others, causing the system to malfunction. Mismatch faults are classified into two types: temporary and permanent. The temporary mismatch is typically caused by events such as the deposition of dust or snow and shadowing caused by buildings or other structures. [13], [14].

The degradation and damage to the affected cells and modules cause a permanent mismatch. In the current work, both cases are considered, with shadowing and degradation serving as examples of temporary and permanent mismatch, respectively, occurring at the module level. The permanent mismatch is caused by the degradation and damage to the affected cells and modules. Both cases are considered in the current work, with shadowing and degradation serving as examples of temporary and permanent mismatch at the module level, respectively [15], [16].

A static model based on a single diode model is used to detect faults and predict energy production in the modeling process. However, the representation of a generic and static P.V. cell is the main limitation of this group of models. [18], [17]. The buck/boost converter model is created using a governing equation that allows the input voltage of the converter, i.e., the output voltage of a specific P.V. module, to be changed by varying the duty cycle, allowing the maximum power point to be tracked as environmental conditions change Based on the above literature survey the PV cell module controlled by a centralized MPPT method using to control and monitor the PV modules by wireless network to deliver the Maximum output and monitoring the other parameters such as current, Voltage of the PV modules during various conditions like nature, Electrical and Mechanical problems [19] [20].

3. Centralized MPPT Controller of PV Modules by Using WSN Method

PV power feedings to utility grids are gaining popularity due to the development of efficient power electronic conversion devices. To meet the increasing load demand, the grid-connected system must operate at full power. It can deliver maximum power under constant irradiation conditions, but maximum power cannot be delivered under variable irradiation conditions without a required maximum power**.**

The system presented in this paper is made up of two distinct components: A Wireless Smart Portable System (WSPS) and a Centralized Wireless Control (CWC). The system evaluates the efficiency of photovoltaic modules and streamlines the manufacturing process. The proposed technology will present the progress of the sensor network for investigation and will be incorporated into the Internet of Things (IOT). Following the transmission interaction, the estimated data is transferred to the unified hub, where the MPPT control calculation determines the reference boundaries to properly retrieve each P.V. module.

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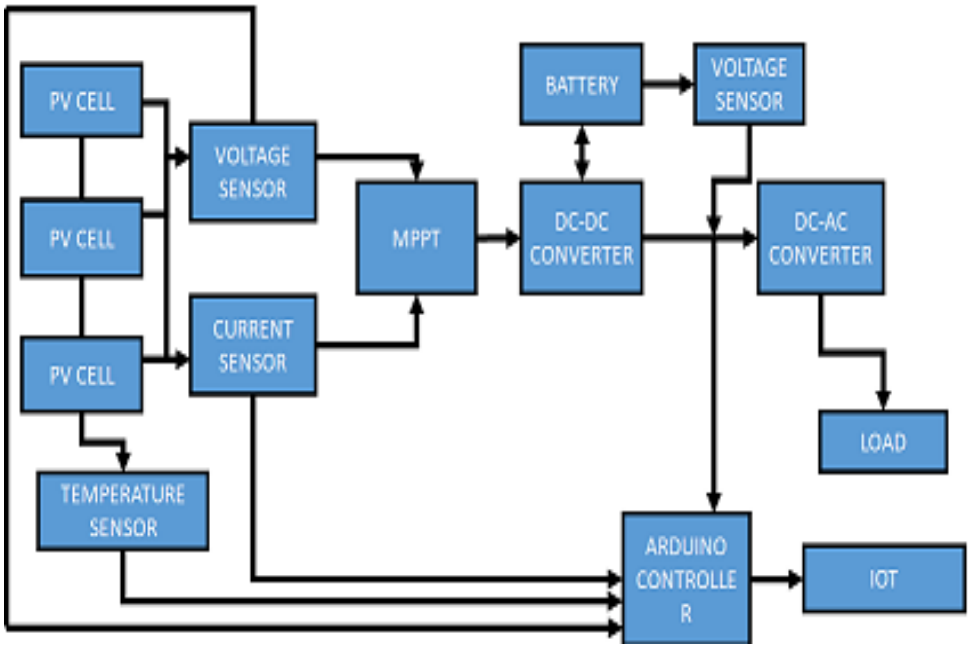

Figure.1: Block Diagram

The condition analysis status in PV and caused by constraints such as Dust pollution, cell broken condition, cell temperature High, Partial cloudy, and raining season. The maximum power point tracking algorithm-based extreme seeking controller uses natural inverter ripple to optimize solar array performance under variable irradiation conditions. A three-level three-phase neutral point clamped voltage source inverter is also used to connect the P.V. system to utility grids. A complex switching technique for configuring. An alternating current converter (A.C. converter) or inverter is a power electronic device or hardware that converts direct current (D.C.) into alternating current (A.C.). The information is determined by the voltage, yield voltage, iteration, and overall design of a specific gadget or hardware. The officers' or the battery's power is used to store the sun-oriented store. Transmission should be in charge of the interconnection.

3.1. PV MODULE

A sun-controlled board that generates force movement by allowing photons or light particles to deliver them from the function of the particles, thereby accelerating the electrons. The sun-controlled board weighs and includes a smaller unit known as a sun-configured battery. (They suggest photovoltaic that convert sunlight into energy.) Various cells are involved, Sun-based boards are related.

$$I = I_l - I_o\left(e^{\frac{\emptyset[V-IR_S)}{AKT}} - 1\right) - \frac{V-IR_S}{R_{sh}} \quad \ldots\ldots\ldots (1)$$

Each solar-based cell essentially has two semiconductor materials, similar to the sandwich commonly used in silicon microelectronics. For work daylight-based cells, an electric field needs to be collected. In addition, another attractive field, as the field of appeal, is the electric field; when the alluring rear posts come in, the converse charge is

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limited. Manufacturers have to give a positive or negative charge on each piece of sandwich, silicone, and various materials to get to this area. In particular, the phosphorus of this layer species, the property is charged contrastingly on the electron, the top layer of extra silicon is ranged.

3.3. BATTERY

Batteries are an electrochemical energy storage device that converts reaction energy into electrical energy. Power modules function similarly to batteries, except that the reactants are not withdrawn, and the cell is constantly monitored. The anode compartment (negative terminal) handles the fuel, whereas the cathode compartment (positive terminal) handles the oxidant. A charge partition inside the microscopic pores of the anode material removes the large surface area, depending on the electrochemical super-capacitor. They charge stock filing devices, which can be charged and released at a faster rate.

3.4 ARDUINO CONTROLLER

Increasing power demand, diminishing fossil fuels, new load kinds, rural electrification, and electricity security are just a few of the incentives for power places to jump right into a sustainable energy adventure. The renewable energies will play a significant role. Solar Energy is expected to contribute to the power blend significantly because it is considerable and easy. Because it is abundant and simple, solar energy is predicted to play a significant role in P.V. solar systems.

3.5 DC TO DC CONVERTER

A DC / DC converter is a class of power supply that varies from a voltage level to a good position of Direct Current (D.C.) starting at a later point. There are two types of DC / DC converters: direct and switched. The direct DC / DC converter uses a resistive voltage drop to generate and control a given output voltage; the exchange mode puts the DC / DC changing information energy rays one by one and then delivers the output to the alternating voltage.

Capacity can be either in the field of an attractive field such as a spectator or a transformer or in a part of an electric field such as a capacitor. Transformer-based converter distinguishes between data and yield. Although special bank-support converters can flow in one particular way, the force in a bilateral converter can flow both ways. A bilateral DC-DC converter is a gadget that ventures below the voltage level with the ultimate goal of step-up or with the ability to flow current or with regressive bearings in the forward paths. The converter works in both ways, D.C. In the energy age of the energy component structure, the yield changes due to the changing natural conditions.

3.6 MPPT CONTROLLER

The MPPT (Maximum Power Point Tracking System) is an electronic DC-to-DC converter that improves the match between solar-powered displays (P.V. boards) and a battery bank or utility system. A charge regulator is a voltage or current regulator that keeps the voltage and current flowing from the sunlight-based board to the batteries, preventing cheating. See our MPPPT charge regulators for more information.

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$$V_{oc} = \frac{AKT}{q} \ln\left(\frac{I_l}{I_0} + 1\right) \ldots\ldots\ldots (2)$$

The importance of the MPPT Sun Oriented Charge Regulator cannot be overstated. Any sun-based force system must remove most of the severe force from the P.V. module before it can work at voltage. MPPT's conversion efficiency is typically 30% higher than that of Pulse Width Modulation (PWM).

Because an MPPT charge regulator uses more force than a PWM charge regulator, any force you see can be absorbed by the regulator. Voltage at maximum power (Vmp) regulators have approved the configuration needed. MPPT regulators, it turns out, become more effective as data voltages rise.

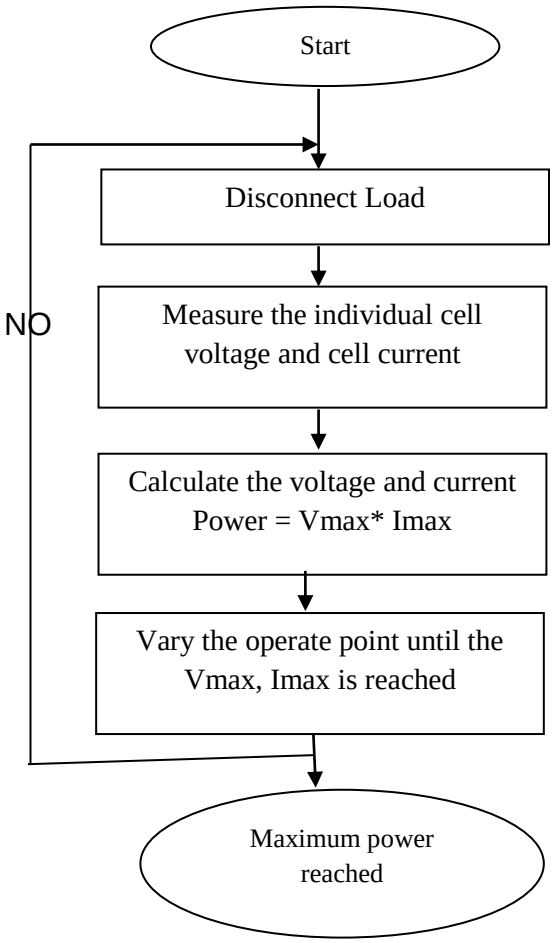

Figure.2: Flow chart of MPPT Controller

3.9 IOT (Internet of Thing) Wireless Sensor Network.

The proposed IoT-based solar energy monitoring system collects and analyses solar energy parameters to predict performance and ensure reliable power output. The system's key benefit is determining optimal performance for improved solar P.V. maintenance (photovoltaic). The primary goal of a P.V. monitoring system is to provide a cost-effective solution that shows real-time data.

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4. RESULTS AND DISCUSION

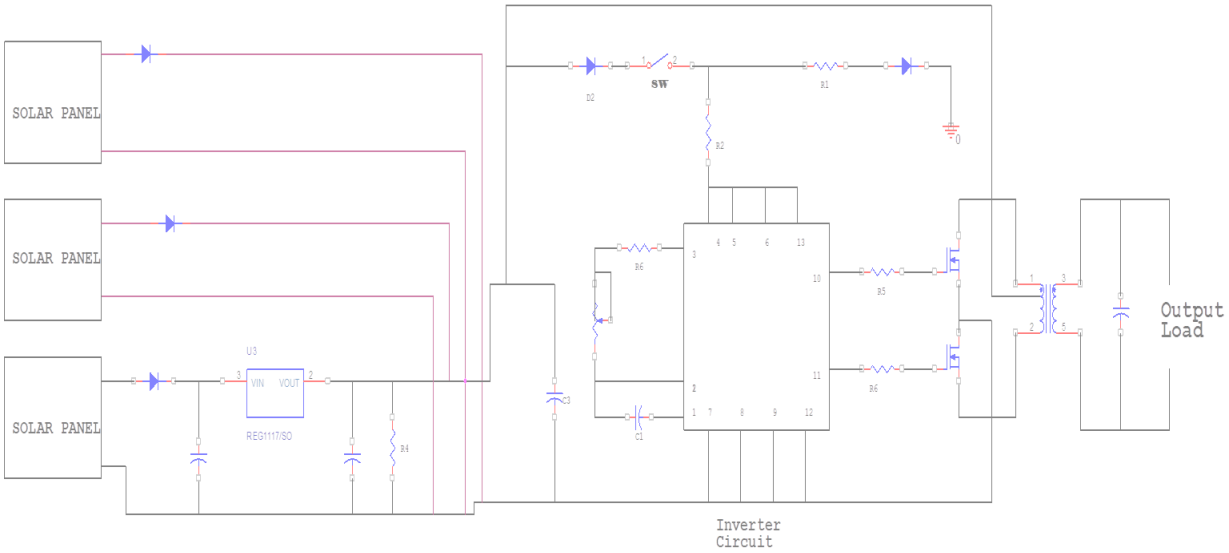

Figure 3: Hardware Circuit Diagram

Then, the main calculation focuses on the yield characteristics of photovoltaic modules and the most common outrageous PowerPoint in general and later another MPPT. Investigates the torment of the responsibility cycle and proposes a dream technique based on factor estimates. The technique (controller) follows the great force point using the Arduino board and the improvement of the P.V. module were shown. In MPPT, there is a contradiction between manufacturing and execution of administrative gadgets. MPPT is configured as a controller using Simulink programming. Plans have been downloaded and tried in Arduino Mega. Arduino is the equivalent of a re-item from Mega that brings the Proteus Simulink. Lift converter circuits' I-V characteristics and P-V properties are assessed for the P.V. board using the regenerative curvature of the space of the models.

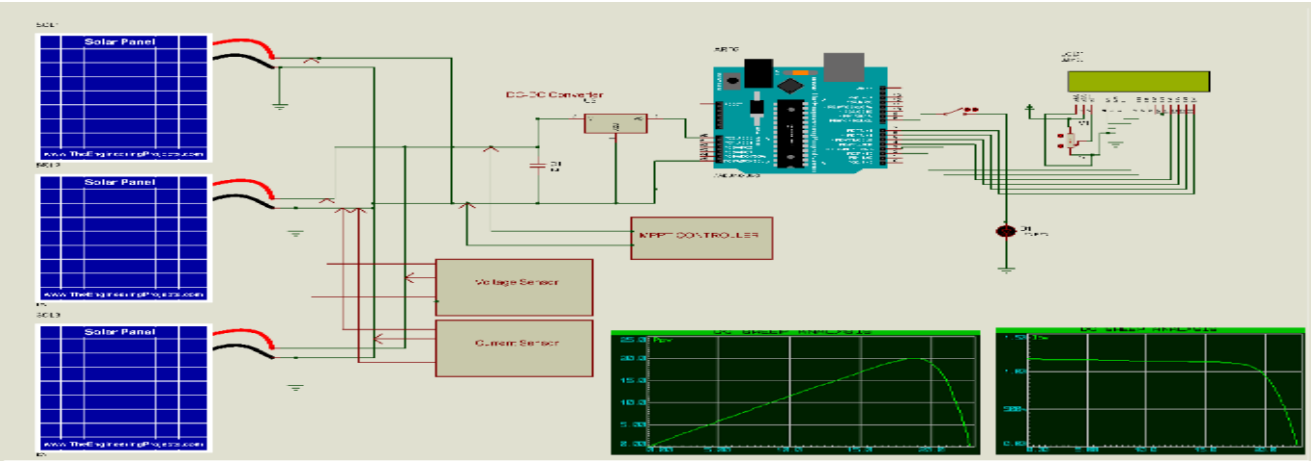

Figure 4: Simulation Output

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The diversion effect is as follows: This estimate eliminates the annoying errors of the duty cycle based on fixed advances and enables construction to quickly follow large force points by continuously reducing the power term and ensuring its uninterrupted quality. It is a competent control method to distribute the liner properties of photovoltaic modules and improve the adequacy of the photovoltaic power era structure.

When D.C. to D.C. converter yield voltage increases, the irradiance increases and it comes down when the irradiance is too high, and the sensitivity decreases as the P.V. voltage drops. It is shown that the P.V. bolt voltage refers to a fault at the DC / DC converter input which aligns with the reference signal and guarantees a fault power, then, the results let the regulator work.

A. PV CELL OUTPUT BASED ON MPPT

Table 1: Several data cases MPPT based PV

Parameters	Test Case value 1	Test Case value 2	Test Case value 3	Test Case value 4
Temperature (/$^{\circ}C$)	25.5	24.6	24.1	28.5
Isolation (W/M^2)	541	548	524	553

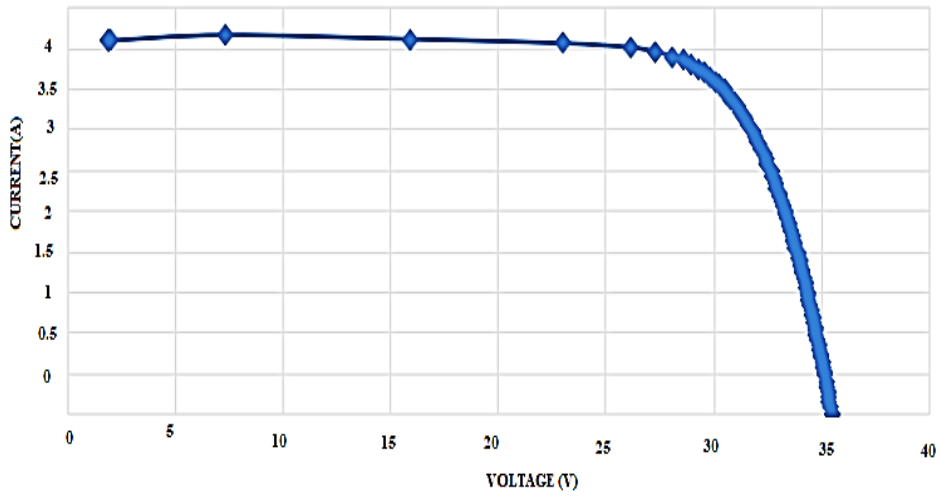

Figure 5 PV module of Dust Pollution Condition

The majority of the tests performed covered electrical execution perspectives and boundaries, which were addressed in estimating a few boundaries of dusty/contaminated PV modules. The dusty/contaminated PV boards was estimated

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and introduced in accordance with the thickness of the residue on their surfaces Furthermore, a portion of these investigations demonstrated the conveyance's relationship to various boundaries, such as unique slant points of PV modules.

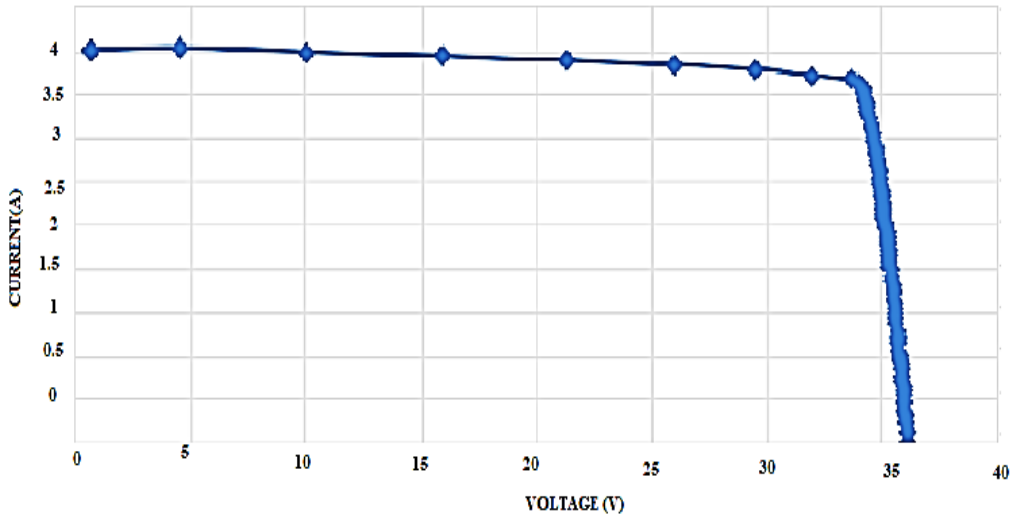

Figure 6 PV module of Cell broken condition

A measurable methodology is used for distinguishing the critical effect of breaks on

Photovoltaic (PV) module yield power execution. There are a couple of information factual examinations for investigating the effect of breaks in PV modules on long haul field information estimations. The flaw could potentially harm the photovoltaic module

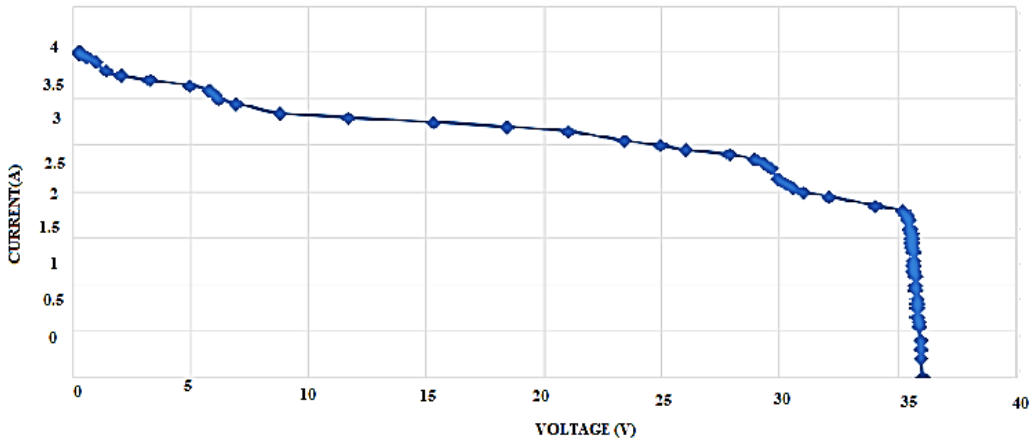

Figure 7 PV module of High Cell temperature

Sun-powered cell execution decreases with increasing temperature, which is primarily due to increased inner transporter recombination rates caused by increased transporter focuses. The working temperature is an important factor in measuring photovoltaic change. The working temperature has a direct impact on the electrical effectiveness and force yield of a photovoltaic (PV) module.

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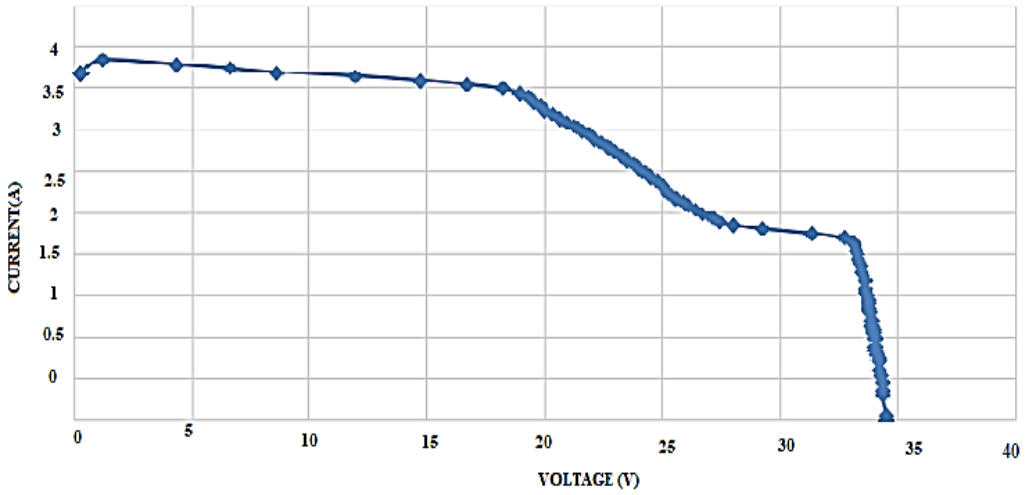

Figure 8: PV module of Partial cloudiness, and raining

The accompanying utility factor exceeds in addition to climatic conditions, indicating that it assigns a ratio between the shown voltage and the reference voltage. From that point, the controller can handle the buck-support converter input voltage coming in MPPT for every sense and temperature.

Table 2: different condition analysis

Parameters	**Irradiation Level G [$\frac{w}{m^2}$]**	**I_{mp} [A]**	**V_mp [V]**	**Cell Efficiency (%)**
Dust Pollution Condition	413	3.15	7.4	45 %
cell broken condition	412	0.56	2.1	35%
Cell temperature High	212	0.38	1.6	42%
Partial cloudy, and raining season	98	0.54	3.2	25%

A. Accuracy Monitoring

It is the indicator of closeness to MPP with the proposed MPPT system that operates the articulated PV setup.

$$\text{Accuracy}_{\text{MPPT}} = \frac{\text{I}_{\text{ss}}}{\text{I}_{\text{max}}} \quad \text{..... (3)}$$

B. Efficiency of conversion

It depicts the maximal PV method power exploitation using our proposed MPPT system under various temperature and irradiation conditions, as described.

$$\sigma_{\text{mppt}} = \frac{\text{P(out)}}{\text{S x area}} \quad \text{..... (4)}$$

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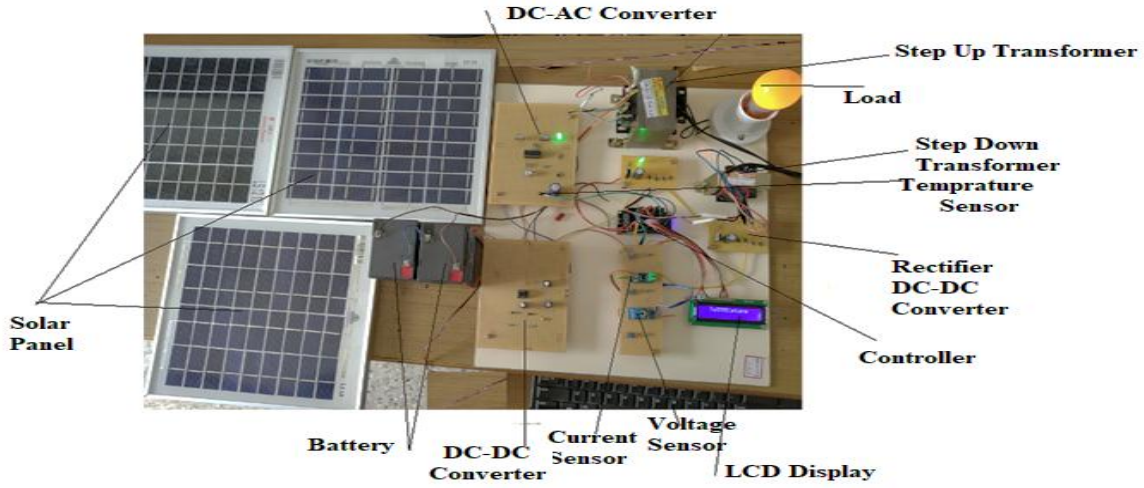

Figure 4: Hardware Output of Experimental Kit

As fast as construction is followed, special execution, albeit better, asks for a wider dip in the intelligent mode, which reduces the dependence of the design and reduces the typical yield strength. The DC-DC converter, also known as the charge controller, is the device that allows a battery to be charged.

There are two types of charge controllers on the market: MPPT (Maximum Power Point Tracking) and PWM (Pulse Width Modulation). PWM devices are less effective than MPPT charge controllers in terms of performance, they can deliver maximum power under constant irradiation conditions. Still, they cannot deliver maximum power under variable irradiation conditions without a required maximum power point tracker

The voltage and current of the P.V. module vary directly from the faculty. Voltage and current expansion when the effectiveness increases and the sensitivity decreases.

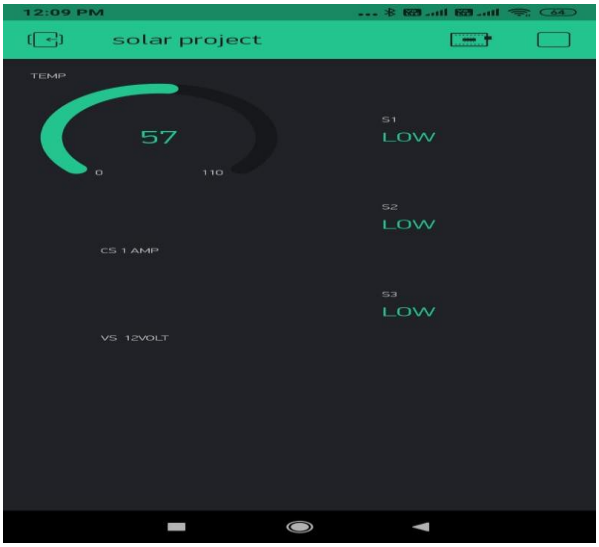

Figure 5: IOT (Mobile Application)

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However, a better stable state does not fail and disrupt. This shows that, for the inflammatory system of the responsibility cycle based on fixed development, if the progress is too wide, there is a more significant execution in the composition, despite the more unfortunate static execution; For any situation, primarily static execution is satisfactory, but exceptional execution is powerless; As it happens, the P.V. module shifts inversely with the voltage and current temperature. Voltage and current increase when the temperature decreases and they decrease when the temperature increases. To deliver maximum power to the load, the two controllers must work in perfect harmony.

Table 2: Hardware Output Ranges

Hardware	Specification	Input Ranges	Output Ranges
Power generation	Solar Power	-	12V
Microcontroller	Input power	5V D.C.	5V D.C.
Inverter	Output Power	10V D.C.	10V-AC
Transformer	Step up	10V D.C	230V A.C.
Temperature Sensor	Monitoring the device	4V DC	−40°C to 110°C range
Load Output	Load (Incandescent Lamp)	230V	O.58 A- 72 watts

The process of the intersection cycle can prompt for errors in the design of dynamic and stable execution of the flames of the contingency and fixed-experience-based duty cycle of the charging cycle. ; About a fixed development, approximately the system may have a more general assumed state error and the swing is perfect, although it reacts more slowly to external change, influencing the full use of solar-powered aligned energy rays; As the factor progresses, construction will not necessarily recognize regular changes more quickly.

5. Comparative Study of Simulation And Hardware Results

The PV cell Module simulation and Hardware results are studied below with and Without MPPT .The both output are not matched the exact capacity of the PV module when compared to simulation the rates are found to be high. But the values of efficiency and the Power Output of the PV cell compared and successfully satisfies the Maximum Power deliver When the Electrical, Mechanical and natural Calamities occurred.

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Table 5: Hardware and simulation output compared with and without MPPT

S. No	Conditions	Simulation Output cell efficiency		Hardware Output in efficiency	
		Without MPPT	With MPPT	Without MPPT	With MPPT
1.	Dust pollution	34%	46%	18%	26%
2.	Cell broken condition	22%	35%	17%	20%
3.	Cell Temperature High	30%	42%	28%	36%
4.	Partial clouding and rainy season	14%	25%	12%	21%

The comparative study of simulation and Hardware results with and without MPPT controller are compared in the table. In the simulation data's are get from theoretical and standard values and the hardware output the electronic components are depending upon the various parameters. The result of both conditions the maximum output delivered by the PV system module.

6. Conclusion

The Maximum power point tracking methods provide comparable performance integration of a fault detection and defects approach with an centralized PV plant monitoring system, allowing the online identification based IOT (Internet of thing) and classification of different PV faults as monitoring of voltage and current parameters. When a fault occurs in MPPT, the output voltage and power are reduced. Maintaining continuous energy production in PV systems is a frequently discussed topic in power utilities. It has piqued the interest of academics, particularly in the context of proposing mitigation techniques and automatic analysis of potential production deviations in PV Units. Both simulation and experimental test results validate the proposed methodology.

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