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Investigation of Maximum Power for Tracking Photovoltaic System

Fotovoltaik Sistem Takibi İçin Maksimum Gücün İncelenmesi

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Abstract

Due to the daily increase in energy demand and the sequential lack of nonrenewable sources of energy, the whole world is looking forward to finding new substitutes. The PV systems are one of the best alternatives for supplying power to individuals and utility. In our project, for better performance and for collecting more solar radiations, we installed a PV – orientation system resulting in higher efficiency with lower losses in the PV system. This can be achieved by supplying the solar panels with sensor and motor that guarantee facing the sun during day hours. Then we will hold a comparison between the power achievements in case PV solar panels are fixed and the PV –oriented adjustable type. We will also include a general study On the design and structure of assisted equipment's that are used are used in sensing and measuring as pyrometer we also developed a MATLAB program that controls the PV panels orientation in order to collect maximum solar radiation by tracking the sun path. The results show that the PSO-based MPPT controller is simple, quick, and effective, and that it locates the maximum PowerPoint faster. Because the MPPTs shown are 93-98 percent efficient, they can produce a power boost of up to 10% to 43%.

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Keywords: DC/AC Power Conversion, Inverters, Photovoltaic system.

Keyword: DC/AC Güç Dönüşümü, İnvertörler, Fotovoltaik sistem.

1. Introduction

a) Brief history of PV system

Among the recent decades the whole world is looking forward to finding and developing efficient substitutes to the conventional nonrenewable sources of energy as coal, natural gas and petroleum. [1] One of the most important issues that is subjected to continuous developments and updates and grapping enormous concern and attention is the

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photovoltaic system. The global installed capacity of solar power is more than (100GW) and that makes it the biggest renewable source of energy just after Hydro and wind power [2].

For exploitation of spaces and areas, installation of PV cells may be floor fastened integrated with farming and grazing or roof or wall fixed of a building.[3] The working value of PV is nearly negligible as there is not any gasoline used and maintenance value is low as there aren't any transferring parts a few of the gadget and sun panels life time > 30 years and inverter could also be changed simplest two times.[4] The set up cost is still relatively top however because of executive policies and recent traits there's vital price aid happens about (5-7 %) in line with year. And is also connected to the software grid depending at the software and economics that fluctuate from position to position and from one nation to every other. Connecting the PV gadget to application is most often most popular because of ease of installation where there is no wish to hooked up battery gadget as a should plus being extra economic because it reduces price of invoice by promoting further electrical energy to the electrical corporate[5].Recent tendencies and researches are in steady progress the place PV packages are not restricted to supplying energy to small constructions and appliances best however they integrated huge scale of applications as mega power stations, spacecraft, telecommunication, waft voltaic, transportation, hybrid techniques and lights roads techniques. The best possible efficient sun mobile was produced on April 2011 with (η=43.five%) using multi-junction concentrator while the absolute best potency without concentrator was produced on 2009 reached (35.eight%) using triple junction era. we will be able to see the percentage of production of Photovoltaic modules among the global.

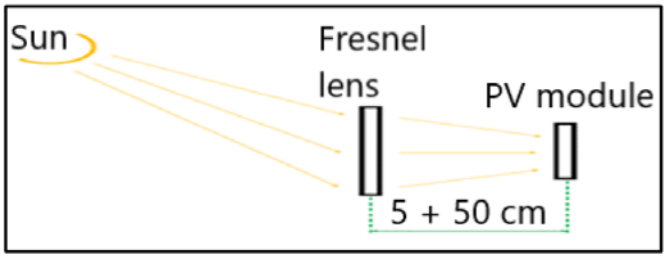


Fig. 1 Photovoltaic Cell configurations.

2. Materials and Method

2.1 Basic Components of PV system

- **PV modules/arrays:** single solar cells connected in combination to shape a module and then modules attached in combination to form a PV array.
- **Solar tracker:** for more efficient machine, solar trackers purpose to receive extra gentle on the surface through adjusting the panels to face solar rays in a perpendicular angle.
- **DC-DC converter integrated with MPPT controller:** as a way to generate a managed duty cycle to succeed in most energy tracking
- **Inverter:** Responsible for converting the produced DC current from the PV into AC so it that may be attached successfully to the application grid.
- **Rechargeable Battery:** Rarely used because of prime price but at the moment they are more and more used these batteries for power storing so as to be used at night time or feed the grid in case of additional top call for
- **Utility Meter:** measure the amount of energy intake and even the ability fed into the grid.
- **Monitoring:** for monitoring the performance of the PV device.

Tracking sun panels have the best potency of the 3 types as the panels are designed to track the solar trail in all places for day time. By the use of single axis tracker, the panels can observe the solar from east to west. [6] While the usage of double or 2 axis trackers, the sun panels can monitor the sun from east to west plus an additional axis for seasonal adjustments for the declination of the solar. [7]. although the tracking solar panels document the absolute best efficiency, the fee will have to be regarded and calculated. The tracking solar panels can give a mean increase in energy output from 20 to 30 % however this extra value can also be paid by buying 25 % extra panels of less expensive type that produce this difference in power build up[8,9]. Moreover, evaluating the mechanical disasters due to technical or environmental results, it is most popular to install adjustable mounting form of solar pane. The voltage drop across the wires will have to be additionally calculated and to be minimized as May just as conceivable whereas voltage drop decreases, energy losses decrease as well. It is recommended that the voltage drop alongside the wires don’t exceed 4

%. Generally for a house installed PV gadget, copper conductors are recommended and preferred over aluminum conductors.

- Modules and array configuration
- Specifications of the inverter
- Presence of junction box or not
- Coldest and hottest temperature
- Number and specifications of overcurrent devices
- Type of conductors used in wiring
- Distance will be extended/ traveled by wires

Conductor and wire types

- USE-2 and PV wires are preferred for outdoor wet conditions as they can resist ultraviolet12 rays and moisture
- THHN wires are preferred for indoor and dry locations
- USE and UF are preferable for underground and moisture applications
- THW,TW and THWN are used in conduits and are preferable for outdoor wet applications

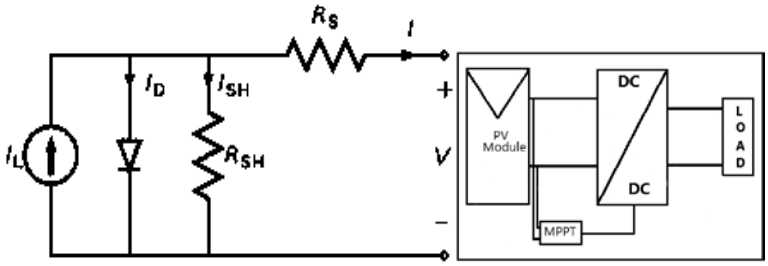


Fig. 2: Equivalent Circuit and Photovoltaic system

Current produced by solar cell

$$I = I_L - I_D - ISH \quad (1)$$

Voltage across element governed by the current through the elements

$$V_j = V + IR_s \quad (2)$$

Shockley diode equation, current directed through the diode

$$I_D = I_0\{\exp[\frac{qV}{nkT^j}] 1\} \quad (3)$$

Maximum power point tracking

$$\frac{dI}{dV} = -\frac{I}{V} \quad (4)$$

3. Tables and Figures

The maximum power efficiency is attainable if a scaling factor is used to compensate for a change in weather conditions and a periodical sweep operation during partial shading conditions. In the PSO technique, the system efficiency is higher due to the high convergence accuracy between the particle positions and zero steady-state oscillations under the PSC

3.1 Monitoring and Performance Analysis

The FDR comprises essentially of three sections: the disappointment identification framework, the disappointment profiling strategy and the impression technique. On the off chance that the observed vitality yield is fundamentally lower than the reenacted vitality yield, a disappointment is distinguished [10]. The FDR assesses the example of the vitality misfortune by making a profile of the real disappointment and contrasting it and predefined profiles of a few much of the time happening disappointments. Contingent upon the connection between the genuine disappointment profile and the predefined profiles, the FDR surveys the probability of various disappointments. The impression strategy serves for investigation of examples in reliance of three unique areas: standardized observed force, time (hour of the day), and sun rise.

PV with tracking System and without tracking System difference

Some major difference between a fixed and a tracking solar panel is the amount of electricity they produce. Solar panels generate electricity based on the amount of sunlight that strikes them. The output will be greatest if the rays are perpendicular. If you install a solar panel without a tracking system, it will not track. Only 4–5 hours a day will a significant amount of energy be generated. Let's say you have a fixed panel that can output 250 watts. In a day, 250 watts multiplied by 5 hours multiplied by 0.77 equals 962.5 watts. If you place the same panel on a solar monitoring system, it can generate energy for up to 8 hours every day. Because it follows the sun throughout the day. In a day, energy created =250wx8hx0.77 = 1540wh

There is a discrepancy of 575 watts. There is an almost 45% increase in energy production.

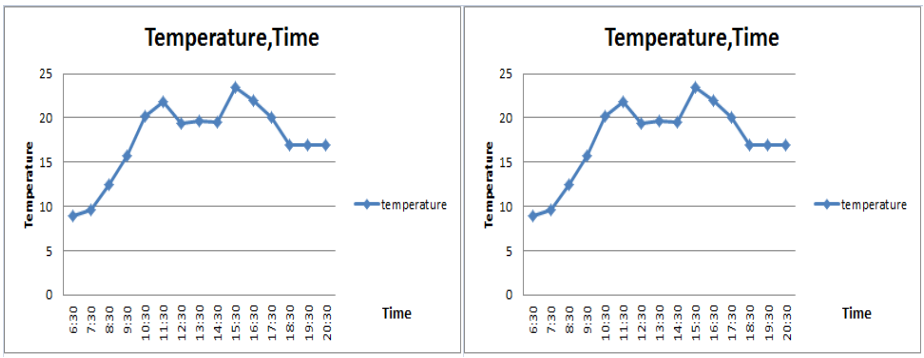
3.2 Experimental Results and Analysis

We did an experiment using pyranometer at NEU solar laboratory for couple days and we measured temperature for each hour then we choose temperature value from 6.30 until 20.30 every day and took the average for modeling and analysis as shown in the figures below: Value of air temperature at NEU University in solar laboratory indicated in the graph. Using a specific panel with panel specification with a grid tie of 60 cells, the 60 with a 20V norminal panel. With a traditional charge controller to charge a battery bank of 24V. MPPT power stations may modify the output voltages, allowing them to be employed in a battery system. For more information on the benefits of an MPPT charge controller over a PWM charge controller.

Performance at 800 W/m^2, NOCT, AM 1.5

- Nominal – 20V
- Number of cells – 60
- Open Circuit Voltage (Voc) – 38 V
- Max Power Volts (Vmp) – 28.7 V
- Short Circuit Current (Isc) – 7.96 A
- Maximum Power Point Current – 7.43 A
- Maximum Output Power – 210 W

(a) (b)



(c)

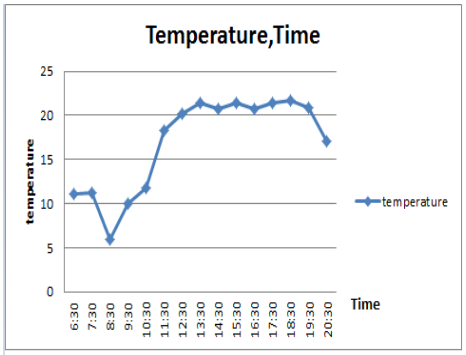


Fig. 3: Temperature variation graph for the Value of air temperature at NEU in solar laboratory (a), (b) and (c)

Radiation in Cyprus from meteorological office. Daily Radiation – Clearness Index average solar radiation in Cyprus throughout the year (kWh per square meter per day).

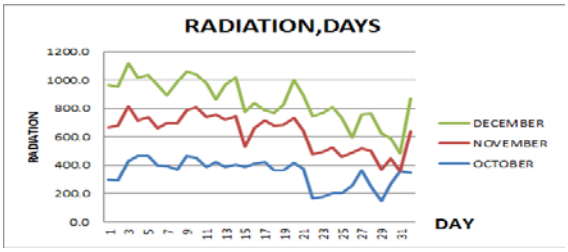


Figure 4: The radiations in Cyprus (meteorological office).

The Maximum output seems to be the photovoltaic vout high point, which is positioned at the "knee" of the curves in the graph above. The maximum wattage is achieved when the volts and amps are combined (Volts x Amps = Watts).

This is the point where the MPPT electronics tries to keep the volts and amps to maximize the power output when using a Maximum Power Point Tracking MPPT) charge controller or inverter. The Pmax is the wattage that a solar panel is listed as, where Pmax = Vmpp x Impp.

3.2 Experimental values in Cyprus without orientation with inclusive the Solar tracking and PV panels efficiency.

A mobile PV panel driven by a solar tracker is kept under the best possible insolation for all positions of the Sun, as the light falls close to the geometric normal incidence angle. Automatic solar tracking systems (using light intensity sensing) may boost consistently the conversion efficiency of a PV panel, thus in this way deriving more energy from the sun. figure (4) for an experimental average of several days. We put the panel facing the sun oriented toward south direction and slope angle of 32°, then we measured both of current and voltage by using voltmeter for each hour, starting at 6 o'clock morning until sunset at 5 o'clock and also calculate power for each hour the values obtained was represented in the graphs. Figure 5 (a) and (b) respectively.

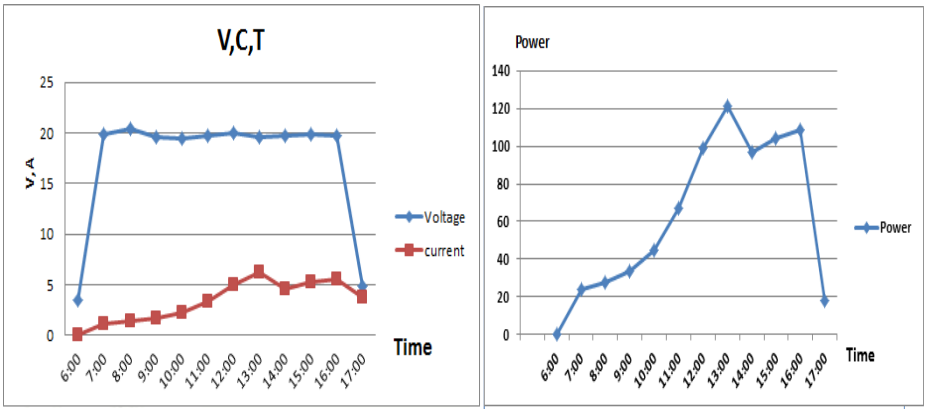


Fig. 5: Experimental values in Cyprus (voltage, current) and Experimental values in Cyprus (power). (a) & (b).

The PV Panel's P-V and I-V characteristics are shown in Figure 5. The approach was able to successfully track a peak power of 210 W, with Vmpp and Impp of 28.7 V and 7.96 A, respectively.

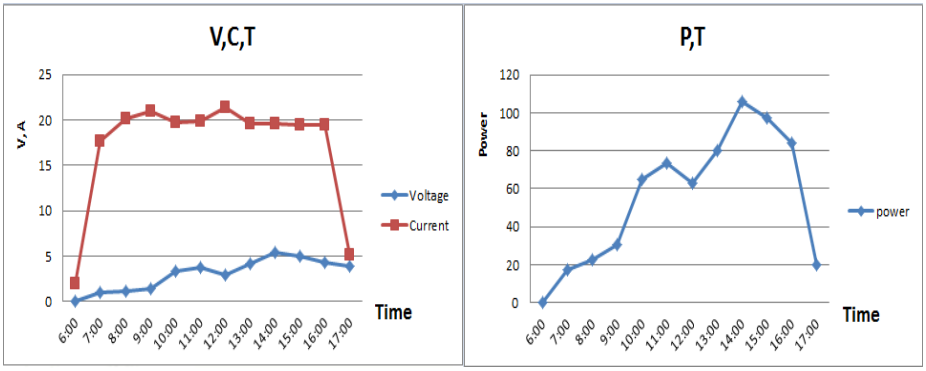


Fig. 6: Experimental values in Cyprus (voltage, current) and Experimental values in Cyprus (power). (a) & (b).

Figure 6 depicts the obtained Power Vs Iteration curve. The peak power of 210.1 W is achieved using the P&O method at this iteration, and the curve of Power Vs Iteration is obtained using the P&O method. At this iteration, the convergence is achieved, yielding a peak power of 210.4 W.

We put the panel facing the sun oriented toward south direction and slope angle of 32°, then we measured both of current and voltage by using voltmeter for each hour, starting at 6 o'clock morning until sunset at 5 o'clock and also calculate power for each hour the values obtained was represented in the graphs. Figure 6 (a) and (b) respectively. The results demonstrate result simulates the PSO-based MPPT controller is simple, rapid, and effective, and that it finds the maximum PowerPoint more quickly. The MPPTs presented are 93-98 percent efficiency and therefore can produce a power boost of up to 10% to 43%.

3.3 Implementation of MATLAB program

By adding an IC-ship, connected to the sensor that senses the maximum radiation from the sun, the motor can be rotated accordingly to achieve maximum power[11]. Though by giving the values of the geographical latitude of the exact place, the time and the date as input values to the MATLAB program as the figure 7(a) and (b), we get the following:

- **The Input Description**:

1. UTC (Coordinated Universal Time)
2. Lat (Site Latitude in degrees)
3. Lon (Site Longitude in degrees)
4. Altitude of the site above sea level (km).

- **the output will be** :

1. (Azimuth location of the sun in degrees)
2. (Elevation location of the sun in degrees)

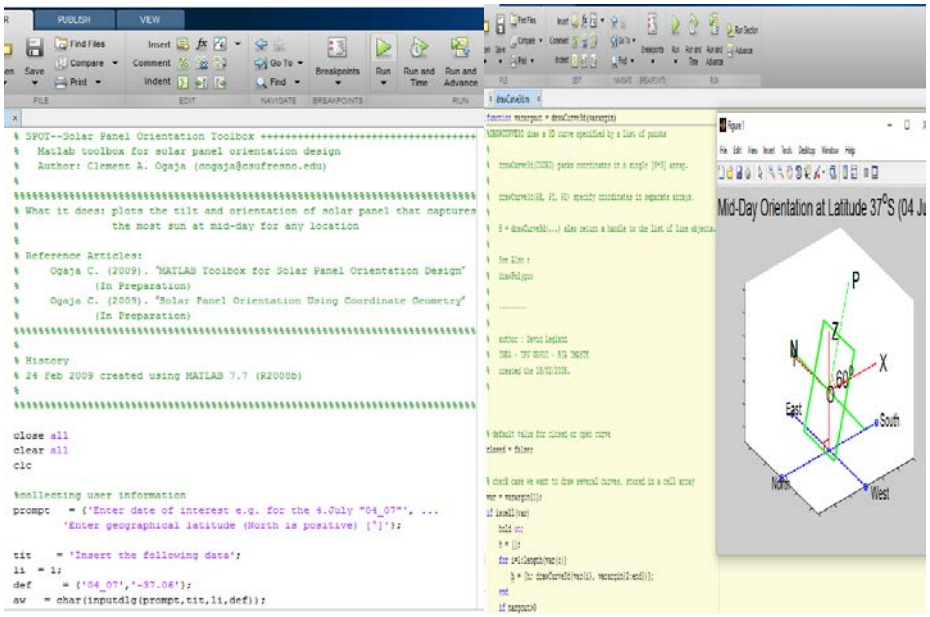


Fig. 7: Implementation of MATLAB program (a) and (b)

Based on the design configuration presented in the previous section, we executed a completely operational small scale experimental model of a single-axis solar Tracking system. With this model we were able to evaluate the specific control Components using the Techno soft Easy Motion Studio platform[12]. Starting from this Small scale equipment, we can go forward and implement the proposed technology within larger power PV systems.

4. Conclusion

The study encompasses a functional block diagram as well as detailed MPPT methods using P&O, PSO, and GA methodologies. MATLAB. was used to successfully model a solar cell. P&O, PSO, and GA techniques are used to track the greatest power point. Simulations are used to evaluate the performance of the suggested MPPT methods under various irradiation and temperature conditions. The outcomes are contrasted and analyzed. It very important to control the instabilities of the voltage to avoid transmission losses in other to avoid voltage collapse, the paper proposes a basic strategy that requires just estimations of improve conductance. The proposed MPPT calculation progressed conductance. In any case, by utilizing this MPPT technique now we have expanded productiveness through 42.5%.This technique figures the most excessive power and controls legitimately the extricated energy from the PV. The proposed technique gives various preferences which can be applicable following scalability, response is prime and neatly keep watch over for the separated force [13, 14]. According to the simulation results, a PSO-based MPPT controller is

simple, fast, efficient, and has a faster convergence rate. The MPPTs that have been discussed are approximately 92-97 percent efficient. In the winter, a power gain of 20 to 43 percent can be reached, while in the summer, a gain of 10 to 20 percent can be accomplished. Thinking about the selection within the lots, the consonant segments of PV present are expanded, which makes the operating level move away from the MPP. In this way, any other legal responsibility cycle should be chosen to maintain the following exactness, the effectiveness of a PV framework may also be stepped forward with a precise following job and fast union toward GMPP for each local weather condition. We can see the significance of this work in ceconomic-scale benefit with generation of more power amid peak demand hours.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Acknowledgments

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