MPPT PV MODELING WITH ANN USING MATLAB SIMULINK

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A BSTRACT

Paper this presents the Matlab /Simulink model of PV module and maximum system tracking point power (MPPT). Maximum Power Point Tracking (MPPT) is something method for track (track) the point power a source energy to produce power maximum . one _ MPPT method that can applied to a photovoltaic system is fractional open voltage method . Common problems _ happen to the system source voltage using photovoltaic is not suit Among load and power generated . _ This thing occur due to source sourced voltage _ of photovoltaic is strongly influenced by the conditions radiation and temperature around . For resolve Thing this so required something battery for keep the power that will used as source voltage . There are various methods and ways for realize MPPT control , including perturb and observe, incremental conductance, constant voltage, and parasitic capacitance . Method the have many disadvantages , among others , quite expensive and difficult implemented . There are various method for realize MPPT controller , one of them is with use network nerves imitation (ANN). MPPT ANN technique effective increase speed tracking and upgrading power output per day from one PV modules from 3.37 kW h to 3.75 kW h, i.e. percentage 11.28%. Enhancement power output from PV prove tested advantages _ with techniques that can reduce sufficient cost _ big of the generated kWh .

KEYWORDS MPPT, Photovoltaic, JST, Matlab Simulink

INTRODUCTION

The development of renewable energy that is growing fast lately this a lot of domination with source of energy originating from wind , hydropower and photovoltaic. These energy sources proven many help Public in fulfillment needs of renewable energy . Photovoltaic technology is a lots of technology and can applied everywhere because _ source light the sun that can be seen almost ordered surface earth . Highly flexible installation and installation techniques where could applied good on house nor land . Common applications _ can our look at the source power on station outside space , vehicle electricity and lighting road . [3][8]

Power ray the sun received by the earth outside the atmosphere is about 1300watt/m2. Efficiency conversion energy Sun Becomes energy electricity through PV cells include low , a maximum of 20% in commercial PV cells [1]. one _ effort for increase efficiency conversion energy photovoltaic cell is with use Maximum Power Point Tracking (MPPT) method .

MPPT is something method / algorithm for track (track) the point work a source energy to produce power maximum [2]. On condition load and condition different atmosphere , maximum output power _ PV cells occur at a value of current and voltage certain different . _ With MPPT control is expected occur conversion energy max on various condition load and condition atmosphere .

preferred PV system because low cost and flexibility _ compared with turbine wind . The application of Photovoltaic is choice best in number big the cities where they could with easy placed above _ housing and building roofs commercial and can integrated to in structure other buildings like windows and walls with efficiency [5]. Generated power _ from system this could with easy integrated to network so that advantages existing energy _ could managed and controlled .

For get power maximum from Photovoltaic can conducted with To do simulation Suite filler battery use Simulink Matlab . On simulation this could designed and seen how many score maximum possible _ in accordance desire .

RESEARCH METHOD

On research this for simulation use Simulink Matlab . Method used _ is make design in Matlab simulink, then To do studies comparison with results measurement , Is occur enhancement power system average output . Steps taken _ _ cover preliminary data collection , design device , test device , then analysis comparison . Data used for study is in the form of primary data. This data in the form of initial data , network test results data nerves dummy , and result data simulation . These three data obtained from results experiment . Initial data taken _ is the data of the output voltage and current of the solar panel at various condition irradiation and temperature . Current and voltage data this then processed for get power peak (P max and voltage maximum power point ($_{Vmpp}$) .

Results of preliminary data analysis this then shared Becomes two . Mostly _ used as input in testing network nerves imitation and the rest called with test data, used for test network parameters nerves imitation result .

Test data obtained from testing parts system nor testing tool by whole . parts _ tested system _ more formerly is a temperature sensor and a buck converter. Block diagram system shown in Figure 10. Algorithm genetics used for practice network nerves imitation .
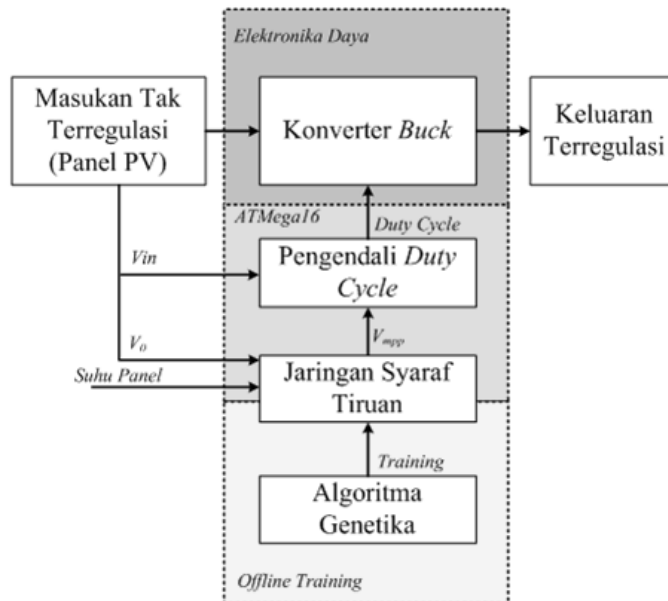
Figure 10. Block diagram system

Test data obtained from testing parts system nor testing tool by whole . Part part tested system _ more formerly is a temperature sensor and a buck converter.

Initial data taken _ in the form of data voltage , current , temperature as well as irradiation sun . From current and voltage obtained power solar panel output . Initial data this then processed for obtain training data and test data for necessity training / testing network nerves imitation use algorithm genetics .

Training and testing network nerves imitation use input in the form of voltage burden zero (V $_0$), temperature , and maximum power point voltage (V $_{mpp}$). Output training in the form of MSE value (*mean squared error*). The more small MSE value is getting good results his training . While testing parameters is MSE value and average error value . The more small the more good .

Temperature sensor testing conducted for calibration of the sensor . Test results compared with theory , then conducted linear regression for get equality characteristics sensor output . Buck converter test done for get score make a loss voltage from converters. The more small make a loss voltage , the more good . Test tool by whole conducted for get score power solar panel output and value power load on various score resistance load . This result then will compared with fractional open voltage method for get percentage increase power

RESULTS AND DISCUSSION

I. tree Discussion / Theory

A lot of effort study about MPPT has been developed . in between study that among others, Yusivar , and Tito [6] proposed technique MPPT based on PI controller with *feedback error* for get it fast time tracking . Matsumoto et al . [7] illustrates the MPPT of a system use boost converter for ultra -low input voltage . Askarzadeh and Rezazadeh [11] proposed MPPT using optimization *bird Mating* - parameter based approach identification . Destination from study this is needs will fast and accurate MPPT technique for followed point power maximum PV modules . Paper this propose implementation device soft from

tracking point power maximum system cell solar . *duty signal* needed for determine PWM duty ratio , because our want to control power with refers to the point power irradiation - dependent maximum . _ The MPPT algorithm determines MPP with look for derivative dP / dV = 0. If power no change and voltage no change , derivative will Becomes zero and dot will maximum .

A. PV System Modeling

Simulation proposed PV system has conducted using MPPT based network nerves imitation . Tracker based on ANN has been used for identify score current (I_{mpp}) which gives point power maximum . PV system can classified Becomes two group that is stand-alone systems and grid -connected systems . On a stand-alone energy system power generated solar _ customized with Request energy . Because of energy power generated solar _ no could Fulfill needs energy on one time , then system storage additional (battery) is used . If the PV system is connected with source other power (diesel generator or wind) then Thing this called with hybrid PV system . Stand-alone PV systems use battery for keep energy . On system this could added a generator for power supporter or back-up power. On system this inverter convert battery DC voltage Becomes AC voltage for necessity electricity house stairs , will but for simple system is possible _ equipment for use DC voltage so that no required the presence of inverters. In isolated areas , *stand-* alone PV systems could Becomes very effective choice compared with using a generator made from burn very expensive oil . However _ system this have a number of weakness among them losses battery and facts that PV is usually operate not at the point efficient operation [9][10].

Simulation simulated PV system using MPPT based network nerves imitation . Also for destination comparison , *Perturb and Observe (P&O) is* also addressed . Tracker based on ANN has been used for identifyvalue current (Impp) which gives point power maximum .
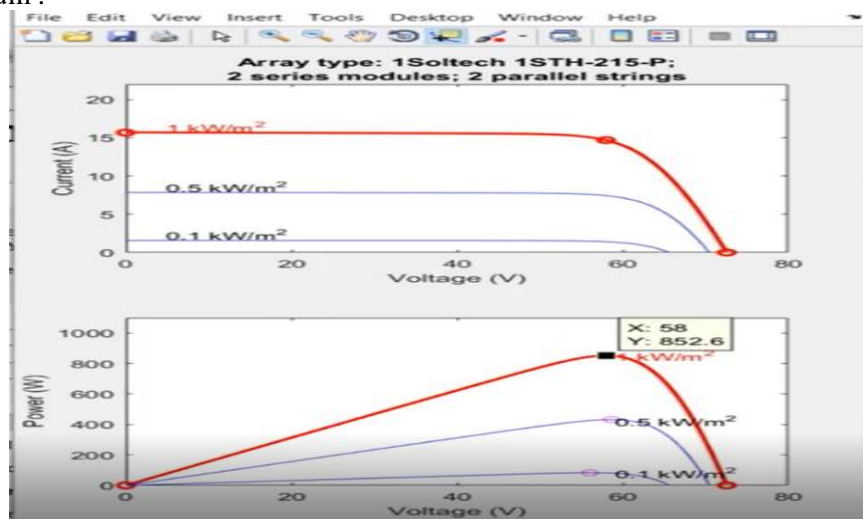

Figure 1. Maximum value on Photovoltaic

From picture 1. it can be seen power maximum 852 Watts at 1000 W/m ^{2}

B. Maximum Powerpoint Tracking

MPPT is a method for get power maximum from a source energy (solar , wind , and other energy) in various condition environment and conditions load . Point power maximum at various condition lighting showed in figure 1. Lighting level highest shown on the topmost curve , while level more lighting _ low shown in the curve below . Point

power maximum from various condition lighting this connected with a line that is almost vertical .

The techniques used _ in MPPT , among others, protrude and observe, incremental conductance, fractional open-circuit voltage, fuzzy logic control, network nerves duplication , ripple correlation control, current sweep, and so on [11]. Voltage maximum power point (Vmpp), varies to temperature and intensity light sun . A DC–DC converter can installed between the solar panel and the load . This converter used for maximize power transfer from solar panels to load . DC–DC converter used depends from solar panel specifications and installed loads . _

Converter One method enough simple is fractional open voltage method . In PV cells made of from ingredient silicone voltage point power maximum ranged from 70 – 80% of voltage Suite open . With decide cell from burden During a number of milliseconds by periodic and measure

voltage Suite open , voltage optimal PV cells can determined with multiply voltage Suite open with k factor of 0.75. With method this point power maximum no truly achieved , however only approached course . Voltage Suite can also be open obtained with use pilot PV cells , which have characteristics same with primary PV cell . With thereby no need conducted disconnection power by periodic .

similar approach can also be conducted with use current connect short . Other methods can use network nerves imitation . DC-DC converter controlled with use network nerves imitation that has been trained (train) more first , so optimal voltage of PV cells can estimated . Network input nerves imitation could in the form of temperature , irradiance , current connect short , and voltage Suite open [12].

C. Network Nerves Imitation

Network Nerves Imitation (ANN) is system processor information that has characteristics similar with

network nerves biology . JST formed as generalization of mathematical models from network nerves biology with assumptions that processing information happens to many element simple (neurons), signal sent between neurons via liaisons , liaisons between neurons has the weight to be strengthen or weaken signal , and for determine the output of each neuron using function activation . ANN is determined by 3 things , pattern connection between neurons (architecture network), method for determine weight link (method / algorithm learning / training), as well as function activation .

For maximizing energy PV system , then need for extract available energy _ as much possible from PV . So for operation PV system in MPP is done through the hour light sun . The resulting output in the form of power from PV module change with voltage and current operation on each score radiation and temperature . MPPT is used for track point where dot power maximum happen .

Network nerve mock (ANN) is used in find right solution _ for non-linear system . Network Engineering propagation come back is most extensive technique used in engineering network nerves [13]. ANN customized with good for microcontroller . System this have three layers : *input* , *hidden* , and *output* as shown in Fig. 2. Number of nodes in each layer is standing variable _ alone . Input parameters are PV Array parameters such as V_{OC} and Isc , atmospheric data like radiation and temperature , or combination among them . Output usually one or a number of signal reference . This can in the form of voltage , current , power on MPP or signal duty *cycle* used for move converter power for operate on or close to MPP. Link between all nodes worth . The link between nodes i and j is labeled with symbol W $_{ij}$. For identify MPP directly accurate .
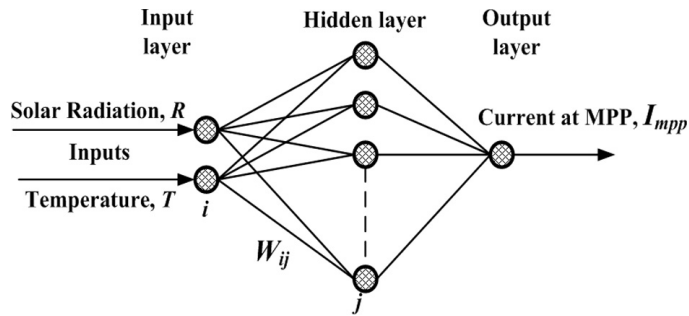
Figure 2. Construction from network nerves imitation

Network nerve bait advanced multilayer introduced in paper this . The number of neurons in the input and output layers is two and one , respectively . Number of neurons in layer hidden will determined with trial method [14] . The neurons in the input layer get input signal from measurement radiation sun and temperature environment . Neurons in layer hidden count the output use function sigmoid activation and pass it on to neurons in the layer output . Nodes in the output layer provide identified current in MPP.
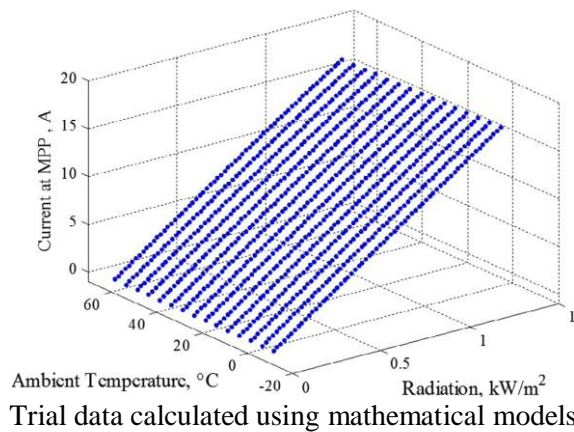
Trial data calculated using mathematical models
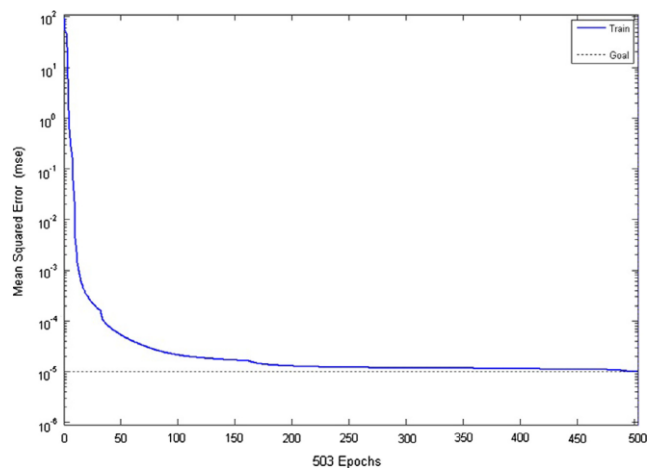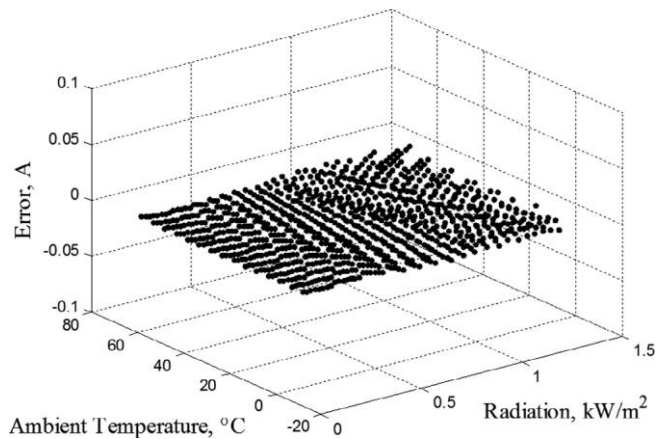

Figure 4. Error convergence on trial network nerves .

Figure 5. Network nerve produce error moment tested with test data .

Output from ANN and target output on kth instant represented by { y_i (k)} and { d_i (k)}, where i = 1, 2,.. etc.

$$e_i(K) = d_i(K) - y_i$$
(1)

The size error occurred _ are :

$$E(K) = \sum_{i=1}^{N=1} [e_i (K)]^2$$
(2)

Algorithm *back-propagation* used for minimize function E(k) in recursive with renew weight from network . After test network _ with desired accuracy , a set of patterns testing separated provided as input for JST for evaluate its performance . It need for JST for could generalize situation from give test pattern and identify the optimal at points operation .

JST has tested try with the value of the data obtained of mathematical models PV modules . Big parameters is as following :
- Speed parameter = 0.1 .
- Amount iteration trial = 1000
- Error value (performance) = $1e^{-5}$

D. DC-DC Converter Modeling

Input power for boost converter originated of connected PV array output to storage battery . A converter riser voltage is DC to DC converter with output voltage over big from voltage source . Sometimes is called an up- converter voltage due to " increase " the voltage source . Simulink mathematical model from converter riser voltage discussed in [15][16]. Voltage transfer function from boost converter declared as following :

$$V_i = V_b (1 - D) \quad (3)$$

Where :
V_i is PV terminal terminal voltage
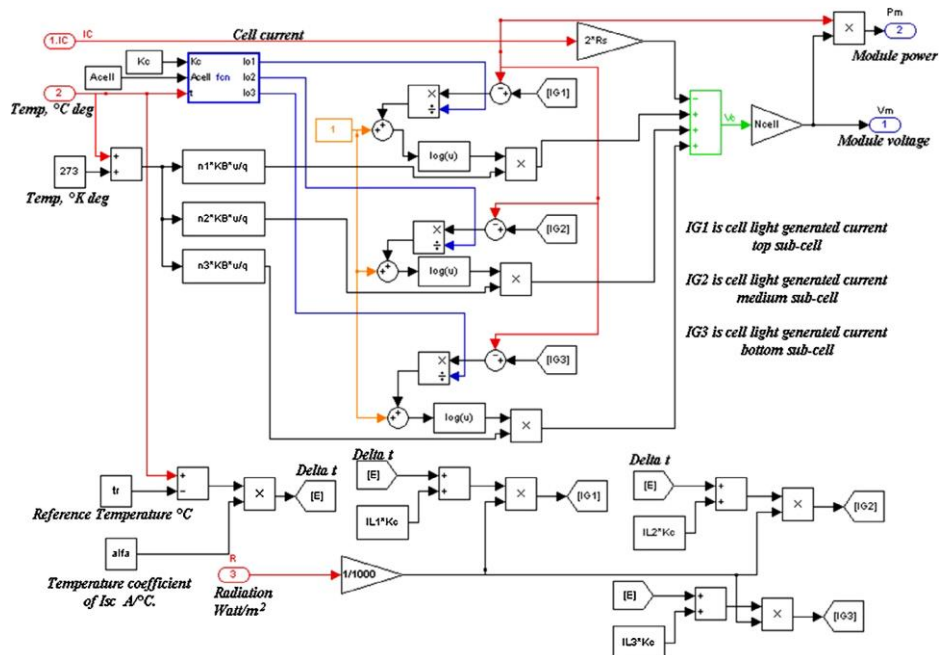V_b is voltage battery and
D is duty cycle

Figure 6. Matlab / Simulink Model Design from PV module

Table 1. InGaP / InGaAs /Ge triple-junction PV parameters

	Top sub-cell InGaP	InGaAs . sub-cell medium	Bottom sub-cell Ge
Eg (eV) at 298 K	Eg1 =1.976	Eg2 =1.519	Eg3 =0.744
Isc (mA)	Isc1= 6.7522	Isc2=7.7126	Isc3= 10,094
K (A/cm2 K4)	K1= 1.86 10 $^{-9}$	K2 = 1,288 10 $^{-8}$	K3= 10.5 10 $^{-6}$
n	n1 =1.97	n3 = 1.75	n3 =1.96
⏷	2	2	2
⏷	7.5x10 $^{-4}$	5.504x10 $^{-4}$	4.774x10 $^{-4}$
☐	500	204	235

Calculated trial data _ with using mathematical models shown in Fig. 3. While error convergence for the trial process shown in Fig. 4. After learn network nerves , is important for test for ensure that that truly could predictable score desired output _ with other input data that is not used in the learning process .

A error relative (ΔE) is used as criteria validation for network nervous and defined as following :

$$E = \frac{I_{cal}}{I_{cal} - I_{JST}}$$

(4)

Where

I_{cal} is calculated current _ based on equality math

I_{JST} is current simulation on the network condition imitation

Comparison Among percentage error expected output _ with results calculation could seen in Figure.5.

Table.2 Specifications PV module parameter simulation

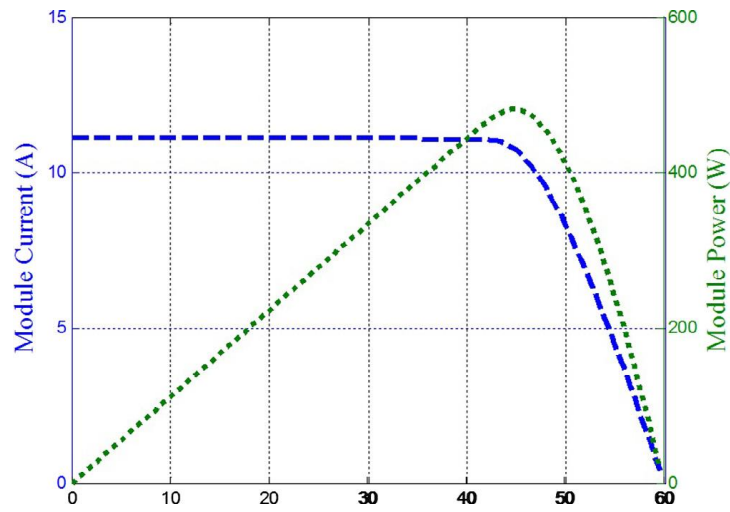| Characteristics	Specification
Maximum power	480W
Short circuit current	11.12 A
Open circuit voltage	60 V
Current at MPP	10.7 A
Voltage at MPP	45 V

Figure 7. P–V and I–V characteristics of PV Module
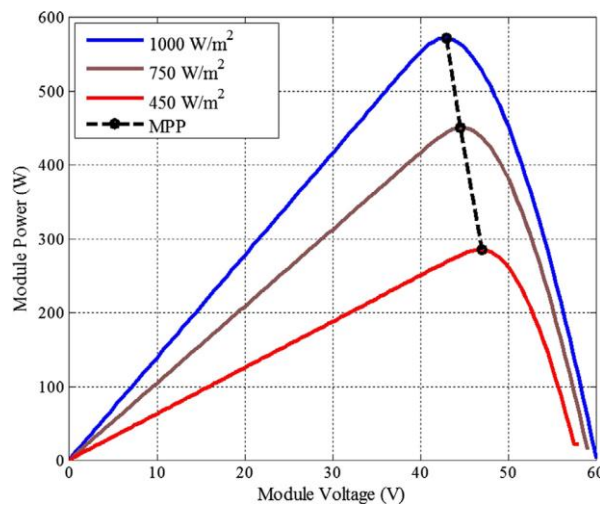on condition standard (800 W/m ^{2} and 20 C).

Figure 8a. curve power-voltage PV module on
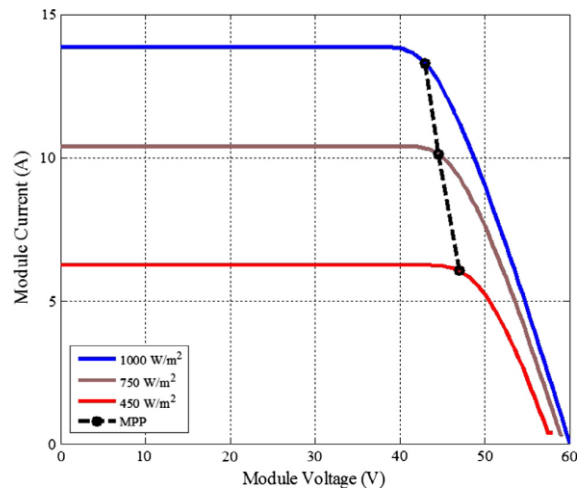Different radiation and temperature _ constant 25 C.

Figure 8b. curve current-voltage PV module on radiation different and temperature constant 25 C.
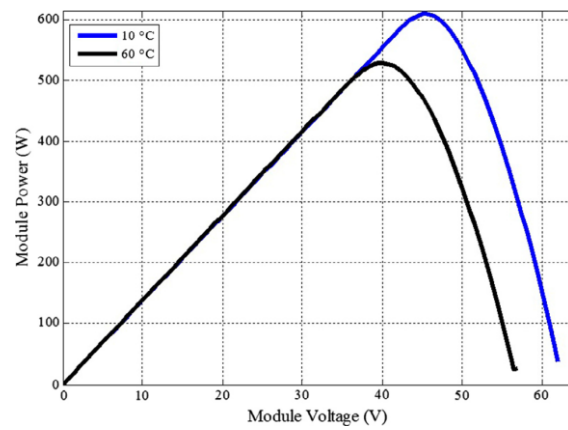

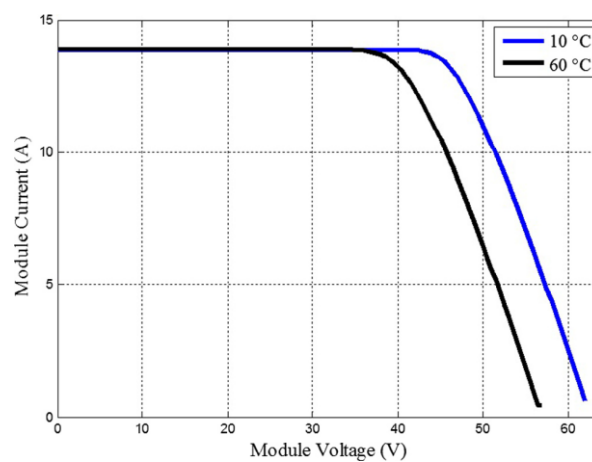Figure 9.a Curve power-voltage PV module on temperature and radiation constant 1000 W/m2.

Figure 9.b. curve current-voltage PV module on temperature different and radiation constant 1000 W/m2.

II. Simulation Results
A.   Simulation PV module on MATLAB/Simulink

cell model triple-junction solar is implemented in MATLAB/Simulink as shown in Figure 6. PV tested on the module made of from 20 cells triple- junction solar series and provide power nominal maximum 480 W at 800 W/m2. Characteristics power photovoltaic shown in Fig. 7. With quantity varied with level radiation sun and temperature . Tested PV module in condition standard have the characteristics shown in Fig. 7. There is a point unique to the curve called point power maximum , at which the PV module operates with efficiency maximum and yield maximum power output .

With use effect radiation sun and temperature Becomes consideration , result simulation power output characteristics voltage and characteristics current-voltage PV model output below enhancement radiation the sun and at the temperature constant shown in Fig. 8a and b. Strength point maximum is greatly affected with vary radiation sun . MPP changed from 280 W to 570 W because radiation sun varied from 450 W/m2 to 1000 W/m2. On the other hand, the I–V characteristics of cells could changed with vary solar radiation before voltage output cell reach point where point power maximum occur after that a little influenced by variation radiation sun . Picture. 9a and b are P–V characteristics and I –V characteristics at different temperatures and radiation constant sun . _ MPP affected with vary cell temperature . MPP value changed from 530 W to 612W when temperature changed from 60 C to 10 C For radiation given sun , when _ temperature increases , I–V characteristics remain constant until score voltage Suite open reach value at point where power maximum happen . Characteristics I–V shifted to lower along with drop temperature .
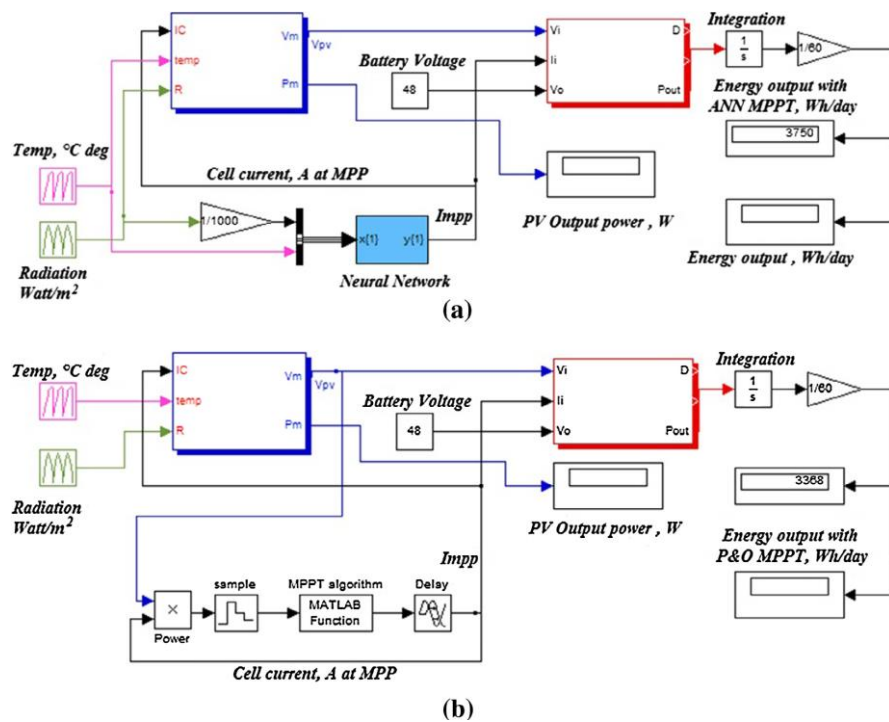
Figure 10. (a) Matlab /Simulink PV system model with MPPT ANN technique .
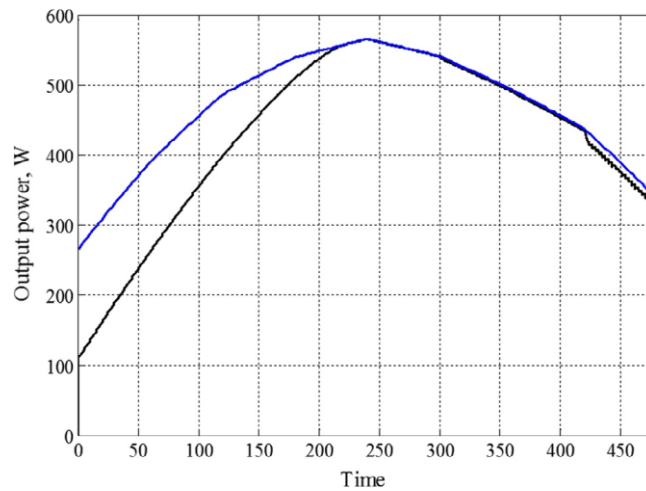(b) Matlab /Simulink PV system model with MPPT P&Ontechnics .

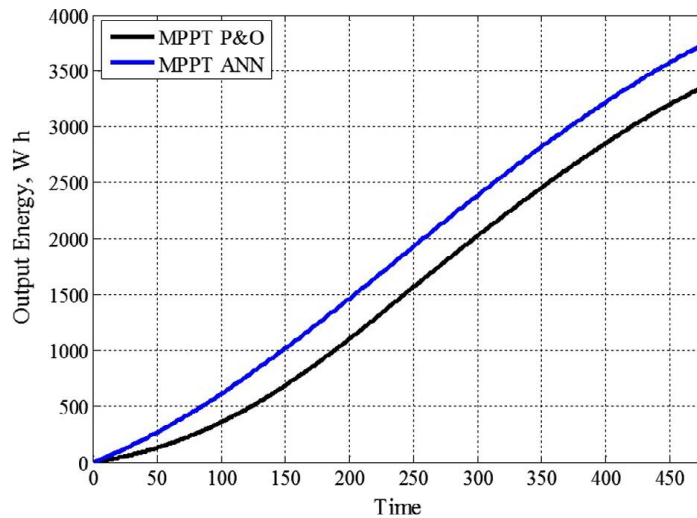Figure 11. Power output from PV system with and without use MPPT ANN technique

Figure 12. Power output from PV system using MPPT ANN technique compared with MPPT P&O technique

B. Simulation PV system on MATLAB/Simulink

Simulation tested system _ has held using MATLAB/Simulink programs like shown in Fig. 10 simulations conducted for learn influence PV system operating with MPPT ANN technique on power output and energy . Fig.11 shows power output PV system as function time with and without MPPT ANN technique . Figure 12 shows energy output from PV system as function time for the proposed ANN MPPT compared with the MPPT technique P&O . Clear from numbers that use proposed MPPT ANN technique, power and energy output from more PV modules big from power and energy output in Thing use MPPT P&O technique . Energy output per day from one PV module increase from 3.37 kW h to 3.75 kW h, that is percentage 11.28%.

CONCLUSION

Use Matlab /Simulink PV module for get efficiency cell triple-junction solar InGaP / InGaAs /Ge where the model being tested represent easy PV cells and arrays used on the

simulation platform . Model pick up radiation sun and temperature cell as input parameter and generate I–V and P–V characteristics in various conditions and also includes effect from variation temperature at characteristics cell solar . Based on Network Nerves Imitation technique tracker tested . Whole PV system with MPPT implemented in MATLAB/Simulink. Power and energy yield from PV system with ANN compared with what is obtained with common P&O techniques used .

Simulation results show that , with use MPPT ANN technique effective increase speed tracking and upgrading power output per day from one PV modules from 3.37 kW h to 3.75 kW h, i.e. percentage 11.28%. Enhancement power output from PV prove tested advantages _ with techniques that can reduce sufficient cost _ big of the generated kWh .

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