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Design and Implementation MPPT based PV System using PID Controller

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Abstract **-**The power output of the photovoltaic (PV) cell system depends on the two vector factors of solar irradiance and cell temperature. A procedure for the efficient use of PV cells is known as the Maximum Power Point Monitoring (MPP) method using PID. This paper introduces MPPT controllers that are traditional proportional integral derivatives (PIDs). A circuit based MATLAB / SIMULINK model for PV cells with IV photovoltaic-panel curves for improvements in cell parameters and environmental parameters (irradiance & temperature). We boost PV device efficiency of peak power and maximum voltage using the PID controller. According to the results, PID controller is shown to have superior performance compared to other MPPT algorithms.
Keywords: Photovoltaic (PV) system, Maximum powerpoint (MPP) tracking, DC/DC converter, solar cell system.

I. INTRODUCTION

Increasing energy demand to population growth, industrial expansion and technology development, has ledto exploring alternative energy sources for energygeneration. Environmental issues with the concerns ongreenhouse effects, global warming, depletion of naturalreserves like natural gas, fossil fuels, coal, etc. ismotivating research to invest in technology that cangenerate energy from renewable energy sources.Renewable energy is energy generate from the renewablenatural resources, such as wind, solar radiation, rainfalltides, geothermal heat etc. The PV solar energy is directway to convert, solar radiation into electricity and is basedon the Photovoltaic effect.PV system technology has the following advantages 1) Nopollution , it does not produce carbon dioxide, 2)Nomechanical moving parts, no noise, direct conversion ofsolar radiation into electricity and Disadvantages 1) solarenergy is somewhat more expensive to produce thanconventional sources of energy due in part to the cost ofmanufacturing PV cell devices and in part to the conversion efficiencies of the equipment 2) solar power isa variable energy source, with energy productiondependent on the sun.A solar PV cell generates DC current from the sunlight. The output current of a solar array depends on the ambienttemperature, solar insolation, the size and configuration ofthe PV array.

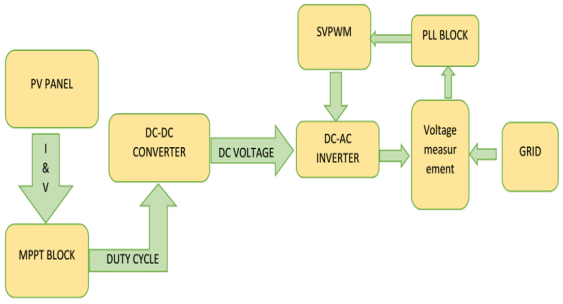


Figure.1. Block Diagram of PV Model

A. PV modules modeling

A photovoltaic PV cell can be represent by an equivalentcircuit, shown in Fig.1.The PV cell characteristics can beobtained using by standard equations . For simulation anentire PV system array the model of a photovoltaic PVmodule is developed first. The each PV system moduleconsidered in this paper. The PV cells connected in seriesare providing an open circuit voltage (*Voc*) and a shortcircuit current (Isc).Diode PV cell is shown in Figure.2 Equation-4 showsoutput current-voltage characteristic of a ideal PV cell in asingle diode model.

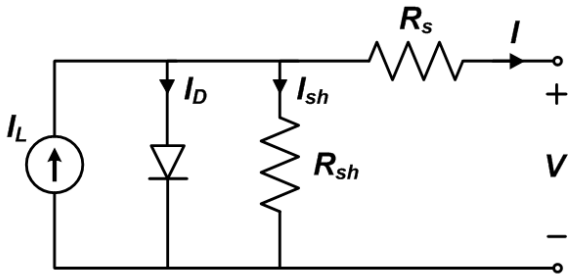


Figure. 2. Solar cell equivalent circuit

The equation is solved by designing a program in MATLAB, taking into account the number of solar cellswhich has the photovoltaic panel.

$$I_{ph} = (G/G_{ref}) [I_{sc} + Ki (T-25)] \quad (1)$$

$$Ir = I_{rT1} (Ta/Tref1)^3 \times e^{[-b\left(\frac{1}{Tref}-\frac{1}{T}\right)]} \quad (2)$$

$$Ir_{-T1} = I_{SCT1}/\left(\frac{Voc}{e^{AVt1}}\right) \quad (3)$$

$$I_{pv} = I_{ph} - I_r[\exp\{q (V_{pv}+I_{pv}Ra)/AkT\}]-1]-(V_{pv}+IR_a)/Rsh \quad (4)$$

The diode voltage is Vg equal to 1.2 V for crystalline silicon < 1.7 V for amorphous silicon. Where b= Vg*q/ (A*k)PV system is gives the output Voltage & Current that willbe vary with the change in solar temperature and sunIrradiation. Hence to get constant voltage at the load dutycycle of the DC-DC converter should change with changein PV system voltage. In order to get constant voltage atthe load MPPT Controller are design that can control the duty cycle of DC-DC converter.1.2.

B. Boost (DC/DC) Converter

The boost converter is also known as the step-up converter. It can be used in the cases where the outputvoltage more than the input voltage, essentially thefunctioning like are versed buck converter. The practicalapplications which use a boost type converter appear ingrid systems.

$$\mu = V_0 / V_i = T/T_{off} = 1/1-D \quad 1.2$$

Where Toff is the duration that the switch is not active, D isa duty ratio, T is the time period.

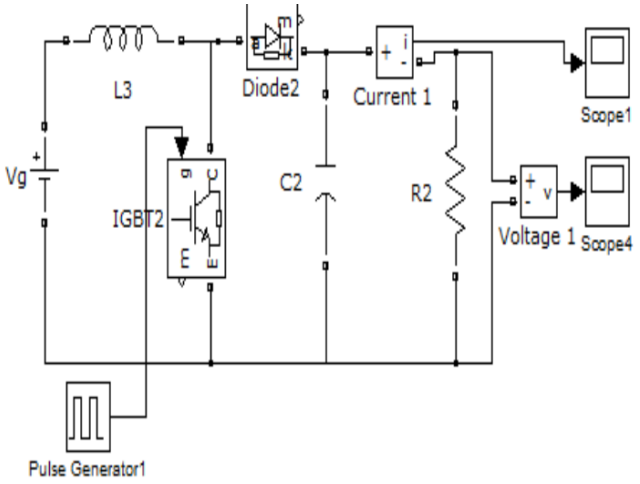


Figure.3. Boost converter

There are two different modes of operation works a boostconverter. The converter are based on close and open the switch. The first mode when the switch is closed known as charging mode, second mode when the switch is opened known as discharging mode.

II. MPPT ALGORITHMS

The MPPT (maximum Power point) is a greater frequency DC/DC converters .They take the DC input fromsolar panels change to higher frequency AC & convert itback down to different DC current & voltage to exactlymatched to system of the batteries. MPPT' operating athigher audio frequencies usually in 30- 80 KHz range. Theadvantage of greater frequency circuits that we can bedesigned with higher efficiency & small components .The conventional controller is charging discharge battery, it simply connected the modules directly to the battery.This forces the modules system to operate at batteryvoltage, typically is not the ideal. The main principle of incremental conductance method is that the derivative ofthe output power (P), in terms of voltage (V), at the peakpower points equal to zero (dP/dV = 0). Therefore, fromthe equation P=I.V, the following equation is obtain;

$$\frac{dP}{dV} = V\frac{dI}{dV} + I = 0 \quad (\text{at the MPP}) \qquad 2.1$$

at the MPP, the opposite of theinstantaneous conductance of PV array system on the left side of the equation equals to the increment al conductance on the right hand side. Thus, the derivative of the pointsshould be greater than zero on the left of the MPP while,less than zero on the right side:

$$\text{If} \quad \frac{dP}{dV} = 0 \quad \left(\frac{dI}{dV} = -\frac{I}{V}\right), \text{then MPP is reached.} \qquad 2.3$$

$$\text{If} \quad \frac{dP}{dV} < 0 \quad \left(\frac{dI}{dV} < -\frac{I}{V}\right), \text{then decrease Vref.} \qquad 2.4$$

$$\text{If} \quad \frac{dP}{dV} > 0 \quad \left(\frac{dI}{dV} > -\frac{I}{V}\right), \text{then increase Vref.} \qquad 2.5$$

III. PID CONTROLLER

A PID (proportional-integral-derivative) controller is acontrol loop feedback mechanism. Feedback mechanismmainly used in industrial control systems. The PIDcontroller attempts to correct the error between a desiredsetpoint& a measured process variable by calculating &then output of a corrective action that can adjust theprocess according. As the PID controller involvescalculation three different (separate) parameters,Proportional(P), Derivative(D) and the Integral (I) values.The Proportional (P) value is determing the reaction tocurrent error, the Derivative (D) value is determing reaction based on the rate at which the error has beenchanged and the Integral (I) value determines thereaction based on the sum of the recent errors. The addthis three actions are used to adjusting the process via a control elements. We are using PID controller for improvethe performance of the voltage and peak power. PIDcontroller gain change the value of the output will changebut after a fixed gain the value cannot be change.

$$u(t) = Kp\, e(t) + Ki \int e(t)\, dt + K_d \frac{d}{dt}(t)$$

IV. RESULTS

The PV system the value of the peak power, current andpeak voltage are getting increase by control to the gain ofPID controller. Results are showing to the difference inbetween existing design and proposed design. For theimproved performance the PID controller is using.

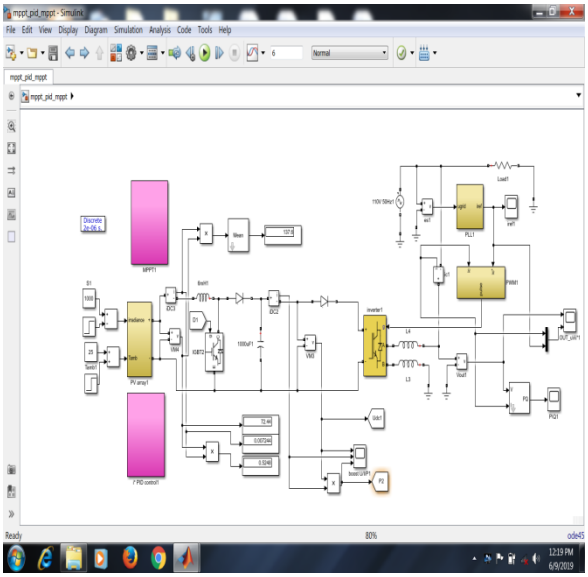
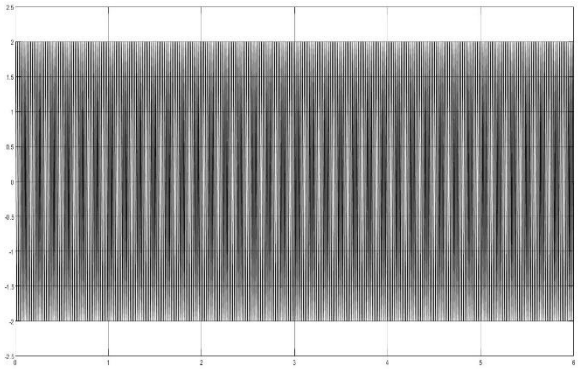
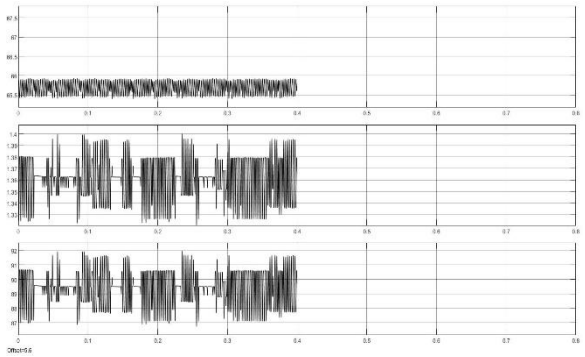


Fig 4.System Representation in MATLAB



(a)



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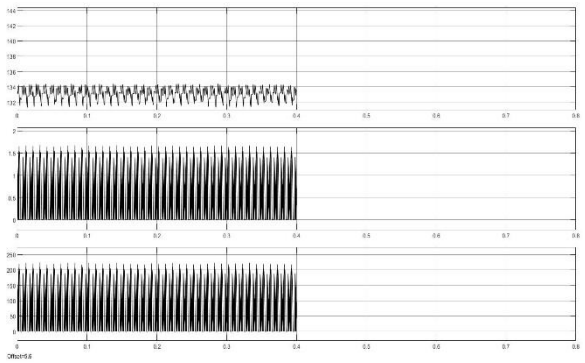
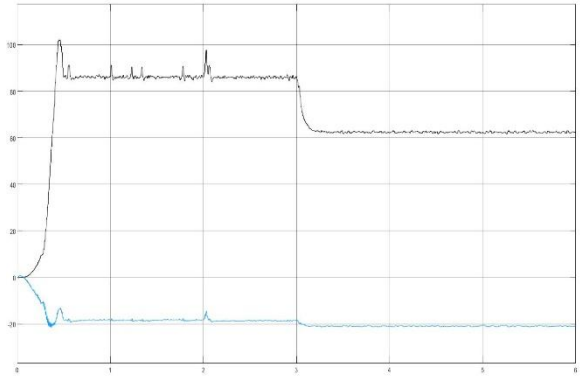
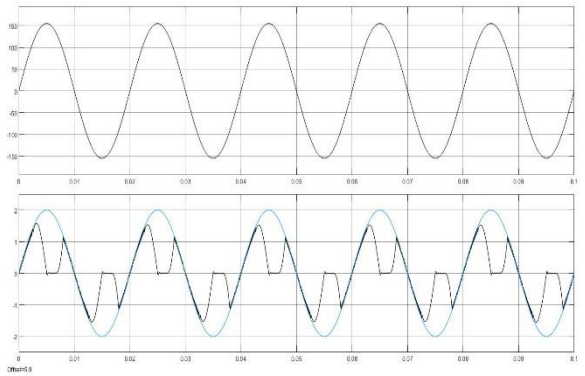


(c)



(d)



(e)

Fig 5-(a)-(e) figures shows various waveforms for current voltage and power from different sections.

CONCLUSION

The PV cell-generate DC current from the sunlight. Thesolar array is generated by connecting individual solarcells system together. The output current is a solar arraydepends on the ambient temperature, solar insolation, the size and configuration of the PV array. In general, thelarger area PV panels will produce more energy, andsmaller PV panels produce less energy. From the simulation result, the PID controller has shown the better performance than other MPPT techniques. In the paper, we apply PID controller is improving the performance of the output power. When we do not apply PID controller the output power is getting 66.45 W. It gets improved when we apply the PID controller and getting the output power is 79.24 W. For further improve the performance of PV system we can apply Neural network which can further improved the performance of output power. After apply neural network controller the results of the current, voltages and power get improved.

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