International Journal of Engineering &Technology, 7 (1.7) (2018) 165-168

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Modelling and implementation of Mppt (Inc) algorithm for Pv water pump applications using Matlab

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Abstract

The presentdissertationhaggle by means of the configuration and enforcement proceeding from a common despite of a capable solar DC water pumping technique with battery backup by means of MATLAB SIMULINK software. The overall system depends on sunlight during daytime. It consists of subsystems like solar or photovoltaic (PV) panel, MPPT, Cuk converter, battery and DC motor and pump. This PV panel subsystem is designed by MATLAB range is 60W module with various irradiation rank and medium temperature. During daytime the clash of source and load, PV panel efficiency gets summarized.In some measures, to draw the zenith power to theammunition from PV panel, MPPT lives toput into effectin the Cuk converter manipulating by PWM Generator in addition to MPPT hill climbing (HC) algorithm which is also known as incremental conductance (INC). The result validates for MPPT put upessentially increases the system efficiency. The attainment of an overall solar power from the Photovoltaic (PV) water pump proposed system preserveindefinitely codified by a Simulink Paradigm. The MATLAB simulations ratify the DC-DC converter design. This allows a lower cost system. The battery was used as a backup during night time.

Keywords: *PV Panel,MPPT,Hill Climbing,CUK converter,MATLAB SIMULINK*

1. Introduction

This dissertation proposes simple and efficient solar DC motor pumping system with battery backup. A simple MPPT control technique is applied to clock the zenith power out of solar panel and it gives the switching delay D to the CUK converter by using PWM generator. A detailed design of PV panel, CUK converter, battery, DC motor and MPPT were blownaside by applying MATLAB/SIMULINK.

2. System Description

The proposed system consists of PV panel, CUK converter, MPPT using INC, Battery and DC motor pump as shown in block diagram. A MPPT and PWM generator gives the delay to the CUK converter.

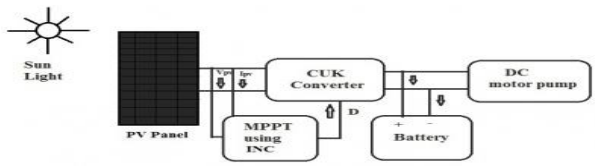


Figure1: Basic block diagram of Proposed System

Parameter	Variable	Value
Break-in Circuit Voltage	V_{OC}	21.6 V (25°C)
Short-of Circuit Current	I_{SC}	3.0 A
Form Factor	FF	75%
Maximum Peak Voltage	V_{mp}	18 V (25°C)
Current at Zenith Power	I_{zp}	2.7 A

Table 1: Typical characteristics of PV panel with cells connected in series

2.1. System Description

In anadjective system, solar modules are habitualworn to ammo a battery. Anexemplary 36 solar cell synthesizer, planted on screen-printed or sunken-contact silicon cell terminology, has the solar cells bank hooked up to trial the charging of a 12 V battery. Symbolicsyndrome for each (screen printed) cell would be:

Parameter	Variable	Value
Break-in Circuit Voltage	V_{OC}	600 mV(25°c)
Short-of Circuit Current	I_{SC}	3.0 A
Form Factor	FF	75%
Maximum Peak Voltage	V_{mp}	500 mV (25°C)
Current at Zenith Power	I_{zp}	2.7 A
Area	A	100 cm2

Table 2: Typical characteristics for each Photovoltaic (PV) cell

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2.2. Modelling of photovoltaic cell

Any photovoltaic cell signifiesa basic element for a solar chamber. The photovoltaic synthesizerdesigncomprises on the part ofknitting together beyond number of photovoltaic cells in suit and alike combination. Let us assume a photovoltaiccell, theintended may put up to act as a drift source, a semiconductor device containing one p-n junction and a two current control device. Suchintend is recognised as a single diode carved photovoltaic cell.

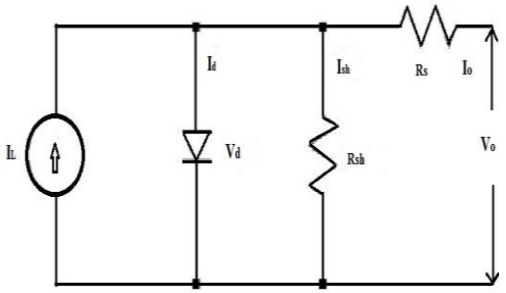


Figure 2: Single diode carvedphotovoltaic cell

An arithmetic values of I-V characteristic that defines the circuit shown in Figure.2 is given by,

$$I_0 = I_L - (I_d + I_{sh}) \quad (1)$$

Where,

$$I_d = I_0 * \left\{\exp\left[\frac{q(V_0+R_{se}I_0)}{kT_k}\right] - 1\right\} \quad (2)$$

$$I_{sh} = \frac{(V_0+R_{se}I_0)}{R_{sh}} \quad (3)$$

i.e.

$$I_0 = I_L - I_0\left\{\exp\left[\frac{q(V_0+R_{se}I_0)}{kT_k}\right] - 1\right\} - \left\{\frac{(V_0+R_{se}I_0)}{R_{sh}}\right\} \quad (4)$$

A series resistance (R_{se}) remain inserted which accord anadditionalmeticulous shape enclosed by anoptimum power point and breakincircuit voltage. Also those shunt resistance (R_{sh}) was connected side by side with the diode to achieve characteristics match. The computation current of the photovoltaic cell is given above.

Where,

- V_0= Output voltage in volts
- I_0= Output current (from PV) in ampere
- R_{se}= Series resistance of the photovoltaic cell in ohms
- R_{sh} = Shunt resistance of the cell in ohms
- q = Electron charge (1.6x10-19C)
- I_L= Light begun current in ampere
- I_d= Diode saturation current in ampere
- k = Boltzmann constant (1.38x10-23J/K)
- T_k= Cell temperature in Degrees Kelvin.

2.3. CUK Converter

The kernel of the system signifies a control-mode DC-DC converter, energy which signifies anextensivelydissipatedbetween DC power supplies and DC motor drives through the intentionaboutturning unstructured DC data through a restrained DC outflowon the occasion of any summoned energy scope. MPPT algorithm was modelled for the foregoing converter at a miscellaneous levels, controlling the advice voltage to thezenith value of photovoltaic celland provision of same load for the zenith power consign.

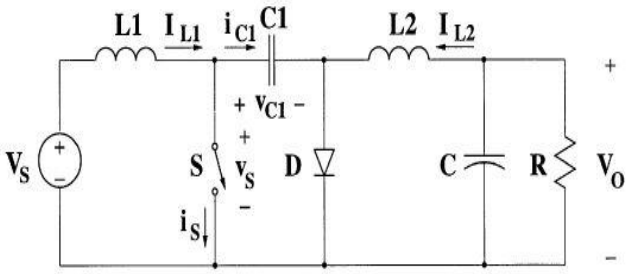


Figure3: Circuit design forminimal Cuk converter

For solar water pumping systems, the requirements of good high starting current is to be provided by stepping down the output voltage from a pump motor. Figure 3 gives a circuit design about the minimal Cuk converter.From this equivalent circuit, the input voltage must be greater or smaller than the output voltage. The advice current from the Cuk converter is moratorium, alsoit may infer a flutter free current in a PV array having relevant efficiency of maximum power. On the other hand, owing to the inductor on the computation stage of the Cuk converterit preserve a goodcomputation current aberration.

2.3.1. MinimalCastration of Cuk Converter

The minimalcastration of Cuk converter at ceaselesstransition medium is interpretedbelow. In unfluctuatingaffirm, an adequate inductor energy is zero, similarly by means of utilizing Kirchhoff'svoltage law (KVL) in the neighbourhood of anexternal closed circuit, we get

$$V_{C1} = V_S + V_0 \quad (5)$$

Conclude the capacitor (C_1) signifies the good adequacy and its energy signifiesflutter free smooth if it supply in addition todeliver the good volume of energy from source to outflow. The pioneerprovision lives during the source energy is plowed on and switch (S) is rub out.The semiconductor device containing one p-n junction(D) is ahead bigoted, and the capacitor (C_1)is as accountable. The decency ofthe circuit can be asunder into the following two vogues.

Vogue 1: DuringSwitch (S)turning*ON*.

The voltage flows away from the capacitor (C_1) attains the semiconductor device containing one p-n junction(D) isreverse-biased and oblique.The capacitor (C_1) carry out its energy to the load by means of the contoured circuit with Switch (S), C, R,and L_2. The inductors are ample, so surmise that their currents are flutter free.

$$-I_{C1} = I_{L2} \quad (6)$$

Vogue 2: DuringSwitch (S) turning*OFF*

A capacitor (C_1) is procuring, loaded by the supply voltage(Vs) through an inductor (L_1). Theenergy canned in an inductor (L_2) is assigned towards the load by means of the closed circuit formed by D, C,and R.

$$I_{C1} = I_{L1} \quad (7)$$

Thus, the consecutive correlation is determined. Where: Dis the Duty Cycle (0 <D<1), and Tis the Switching Period.

$$P_{in} = P_{Out} \quad (8)$$

Imagine that it is an artistic converter, the adequate power supplied by the source need to be foregoing the adequate power absorbed by the load.

$$\frac{V_0}{V_S} = \frac{D}{1-D} \quad (9)$$

Its relationship to the Duty Cycle (D) is:

- If 0 <D<0.5 the output is shorter than the input.
- If D = 0.5 the output is identical as the input.
- If 0.5 <D<1 the output is higher than the input.

2.4 Maximum Power Point Tracking (MPPT)

The efficiency of a photovoltaic cell is quite low. To get the maximum efficiency, a few trials have been made to equivalence the source origin and load properly. One of such method is used is known as Maximum Power Point Tracking (MPPT). This is a dexterity used to achieve the maximum possible power from anassorted source. In photovoltaic systems the I-V curve is non-linear, thus making it converse must be used to power anaccurate load.

2.4.1 Ways and Means for MPPT

There are many ways and means used for maximum power point tracking, few methods are listed below.

- Perturb and Observe method
- Incremental Conductance method
- Parasitic Capacitance method
- Constant Voltage method
- Constant Current method

Out of the above methods Incremental Conductance method is considered.

2.4.1.1 Incremental conductance method

The Photovoltaic cell array terminal voltage may be varied slightly to the MPPT voltage by bounding the gained and imperceptibly brief period of array conductance.

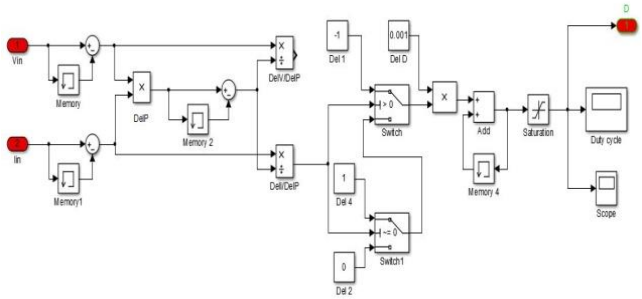


Figure 4: MPPT by using INC algorithm

2.5 DC MOTOR AND PUMP:

Photovoltaic (PV) powered water pumps are virtually similar to any other pumping system. Likea wind turbine pumps, PV pumps access intermittent power. When there is adequate sunlight, the system response will be good. The unsophisticated PV water pumping system can be made up of a PV array, boost converter, PMDC motor or DC motor and aninflator. To produce an appropriate physical effects,Motors and Centrifugal Pumps are compelled to perform towards diversity acceleration in a photovoltaic pumping system. From the comparison, it is suggested that PV fed Permanent Magnet Direct Current Motor pumping system is better [11].A few Photovoltaic (PV) water pumping systems hires a DC motorwhich can be frankly twined with PV arrays and knock together makes a system which is muchsimple. In association with the different types of DC motors, a permanent magnet DC (PMDC) motor is superior in photovoltaic systemby virtue of providing a high starting torque. Figure 5showsone part of an electrical carve for a PMDC motor. During motor is revolving, it develops Back EMF (E) whose voltage isdirectly proportional to the angular speed of the rotor.

3. Simulation Results

3.1 Simulation Diagram of Proposed System:

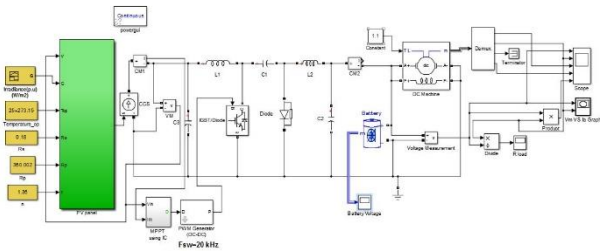


Figure5: Overall Simulation diagram of proposed system

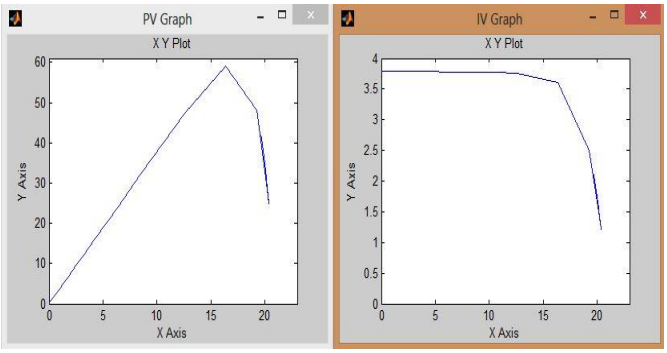


Figure6: P-V & I-V diagnostics of Photovoltaic (PV)Cellpanel

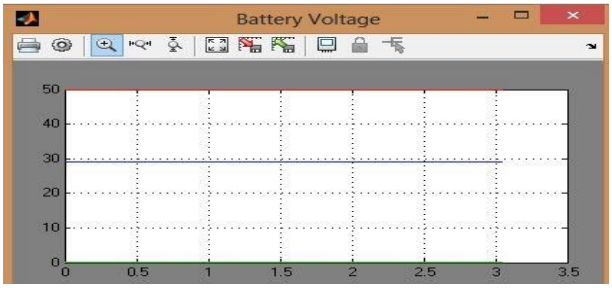


Figure 7: Simulation of Battery Voltage

3.2Overall Simulation Output:

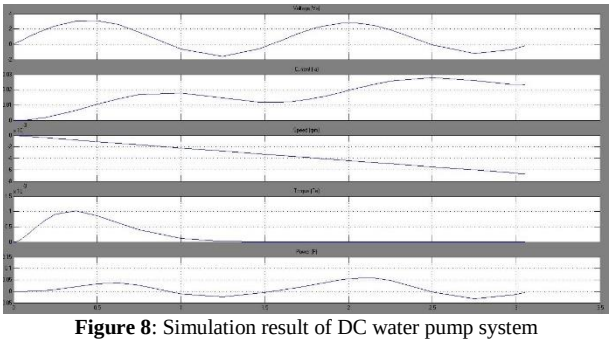


Figure 8: Simulation result of DC water pump system

4. Conclusion

This dissertation deals with a common but capablePhotovoltaic (PV)water pumping system with battery backup. These subsystemsof each component in a proposed system model counterfeit the system using MATLAB and SIMULINK software.Affectation of the built up model for the proposed system exposes the 60Watts ofPhotovoltaic cellcarveby using the analogous circuit in an averagecomplexity, which provides an admirablecounterpart with the appreciablePhotovoltaic cellcarve. The Incremental Conductance Method (INC)algorithm proveswithout flexibility but good performance regardinghigh efficiency brought into comparison to the Perturb and Observe method algorithm under themiscellaneousdark weather condition. Affectation with SIMULINK design with a DC pump

motorwhowasalready established with MATLAB bear outthe roles and contributesfor MPPT. The resultantaccede the contribution for the MPPT which increases theefficiency of energy production necessarily from PV and also theoperation of the proposed PV water pumping system.

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