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Renewable Energy-based Induction Motor Water flow control

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ABSTRACT---Water flow measurement is very important in some specific applications like water craft, house hold applications, submarine and etc, in some applications renewable energy is used as source because it is pollution free and easily available, Solar panel yield is not sufficient to drive induction motor due to irregular temperature and irradiance, solar panel production improved by boost converter to control by using MPPT Controller, MPPT Controller controlled by different algorithms in that P&O Algorithm is design to maintain constant voltage, induction motor require AC supply but boost converter gives DC supply, to convert DC to AC by using IGBT inverter, water pump is connected to the induction motor through flow sensor, inverter firing angle control PWM technique, that PWM controller design by DSPIC30F4011,flow measurement by yf-s201 flow sensor is used, result compare by Software and hardware Keywords: Induction motor, MPPT Controller, Water Pump, Flow Sensor

I. INTRODUCTION

We have renewable energy sources and non-renewable energy sources, non-renewable energy has some drawbacks that are not available due to long run, global warming etc, to overcome this problems by using renewable energy sources like, solar , wind and etc, in that solar energy is easily available and easy conversion, solar radiation is converted into electrical energy, the solar cells are design by using different materials like Mono-crystalline PV Cells, Poly-crystalline PV Cells, Thin Film Solar Cells and etc, solar panel is designed by number of series and parallel connection of solar cells, generally solar cells are design by one diode model or two diode model

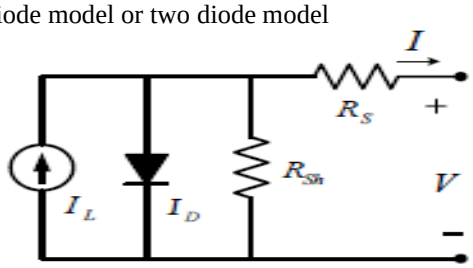

Fig-1: One Diode Model

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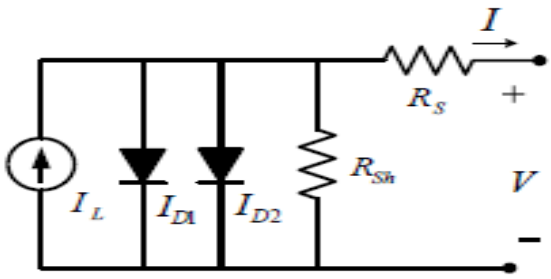


Fig-2: Two Diode Model

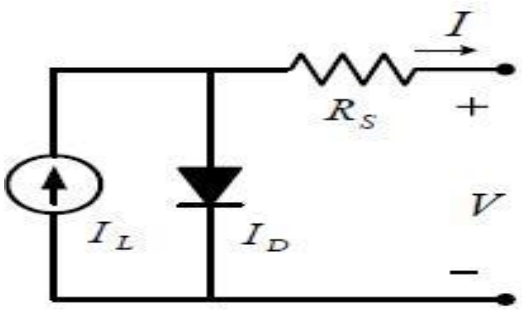
MPPT is a power electronic system, to get the maximum power of PV through MPPT controller, depends on light intensity and temperature the MPP is not on one point it changes on P-V curve, to generate MPP by different algorithm are incremental conductance method, constant voltage method, constant current method and perturb &observe method

In most of domestic, agriculture and industrial applications using induction motor, because induction motor has a greater number of advantages as compare to other motors, induction machine is a rotating machine which converts electrical power into mechanical power [induction motor] and mechanical power to electrical power [induction generator],

Induction machine operate two modes, If speed less then synchronous speed it act as motor, if speed greater then synchronous speed it act as generator, if induction machine speed equal to synchronous speed it want act as generator or motor, induction motor is two types based on rotor construction one is slip ring induction motor and second one is squirrel cage induction motor

II. MATHEMATICAL MODELLING

Solar panel mathematical modelling:



$I = I_L - I_D = I_L - I_0[\exp(\frac{V+IR_S}{\alpha})\text{-}1]$

$Where\ I_{L=}light\ current(A)$

$I_{0=}saturation\ Current(A)$

$I_{=}load\ current(A)$

$V = output\ voltage(V)$

Flow sensor: Flow sensor is used to measure flow

Power (P)=Q*H*g* /Pump Efficiency

Where Q is discharge, H is head

G is gravity 9.81

density is 1000 kg/m^3

Frequency=flow rate in litters/min*7.5

MPPT controller:

the widely Used MPPT is P&O algorithm, It measure PV power Through current(I) and voltage(V) in this algorithm compare Previous power with present power that is Δ if Δ is not equal to zero, it find out the optimal point in the left (or) in the right side of recent position, if Δ is equal to zero, maximum power is obtained, if previous power is greater then present power it decrease the duty cycle of boost converter otherwise previous power is less then present power it increase the duty cycle of boost converter

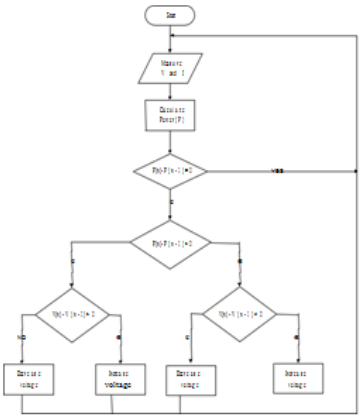


Fig-4: Flow Chart of P&O Algorithm

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Boost converter: Solar irradiance is not constant it changes based on weather condition but load required constant powersupply to maintain that one by boost converter, the boost converter is dc to dc converter, it is power electronics circuit it has resistor, inductor and capacitor and in this boost converter two parallel paths to boost the voltage it as four MOSFET switches that four switches are control by MPPT controller

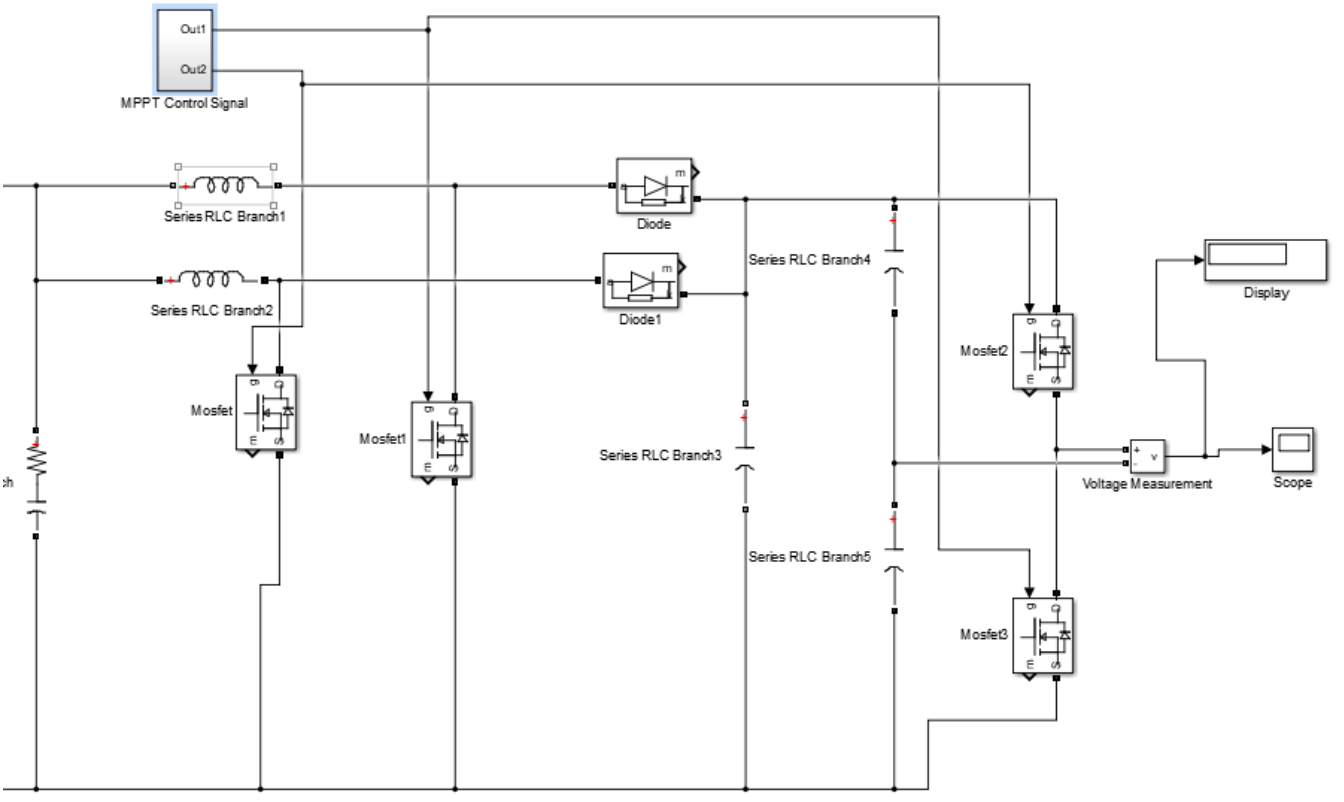

Fig-5: Boost Converter

PWM Generator: PWM generator is used for generating firing pulses for the inverter, it compares the analogsignal with reference triangle waveform then it generates firing pulses, based on analog signal magnitude the firing pulses duration is depends, that firing pulses are generated by DSPIC30F4011 micro controller

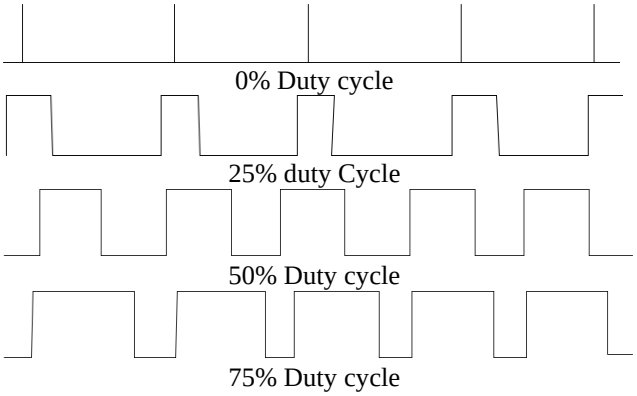

Fig-6: PWM Pulse Generation Based on duty cycle

III. BLOCK DIAGRAM

In this work solar panel generate electrical energy but that energy is not constant to maintain electrical energy as constant by dc to dc boost converter, that boost converter is controlled by MPPT P&O algorithm, boost converter output is constant that is given to the three phase MOSFET inverter that inverter firing pulse is controlled by firing pulse control generator ,the firing pulses generation written code in MPLAB software that program damp in DSPIC30F4011,this pic pin numbers RE0 toRE5 PWM signal points, inverter output is given to the induction motor and induction motor drive the pump ,pump has flow sensor YF-s201 is used to measure flow, flow can be controlled two ways one is voltage control another one is frequency control, in this work voltage control is possible through MPPT controller and frequency control is possible through PMW controller.

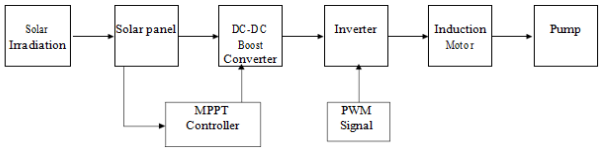

Fig-7: Block Diagram of Complete System

Simulation Model:

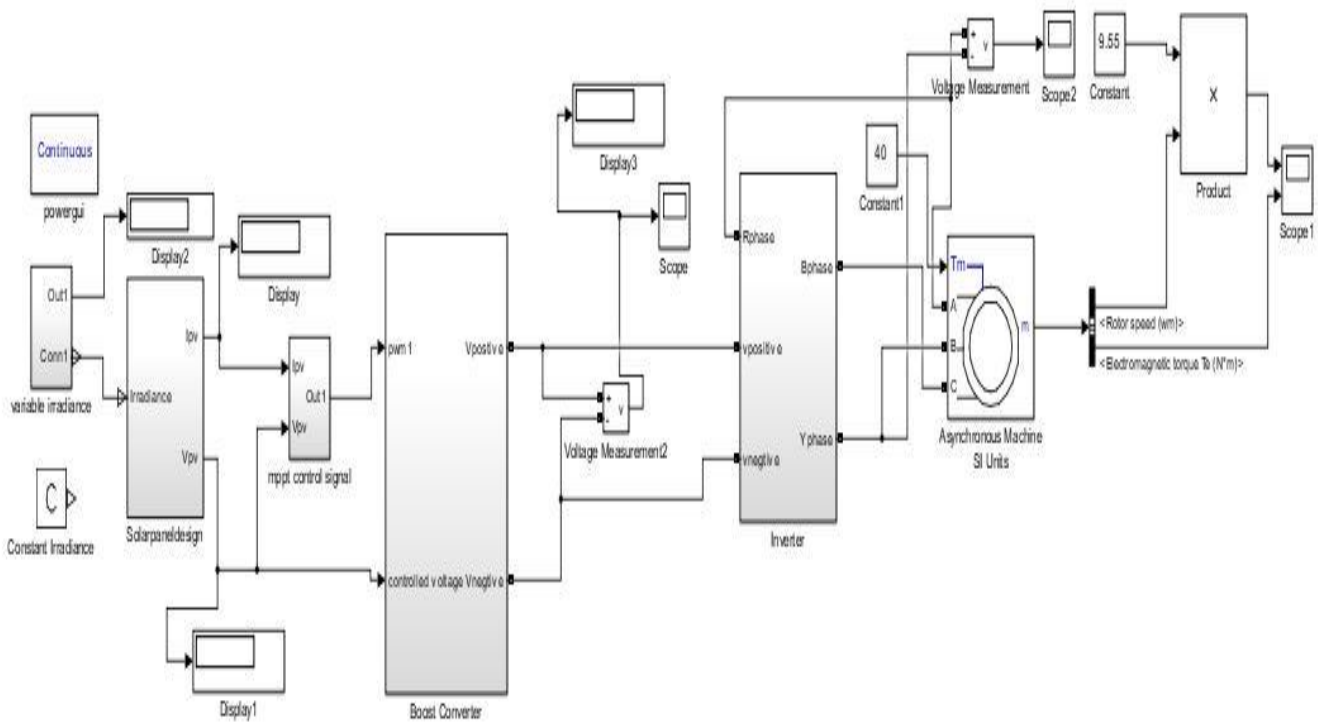

Fig-8: Simulation Model of the System

Specifications of the components:

Parameter	Rating
Supply voltage	415
Frequency	50
Power (KW)	0.75
Ampere	1.7 star
RPM	1390
Efficiency	79.8
Power factor	0.77

Table-1: Rating of machine

Maximum power (P max)	315w
Open circuit voltage (V oc)	44.67v
Short circuit current(Isc)	9.15A
Maximum power voltage(Vmp)	36.42
Maximumpower current(Imp)	8.65

Table-2: Rating of solar panel

IV. EXPERIMENTAL MODEL

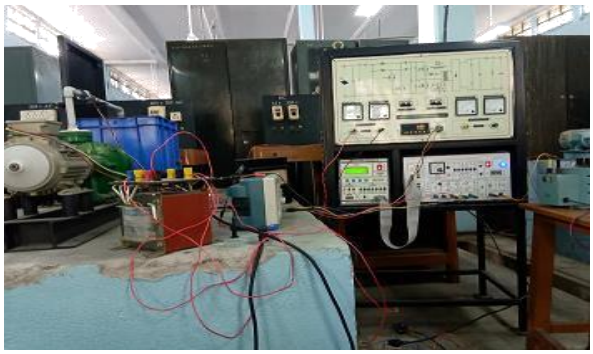

Fig-9: Hard ware model of the system

V. RESULT AND DISCUSSION

Simulation Results:

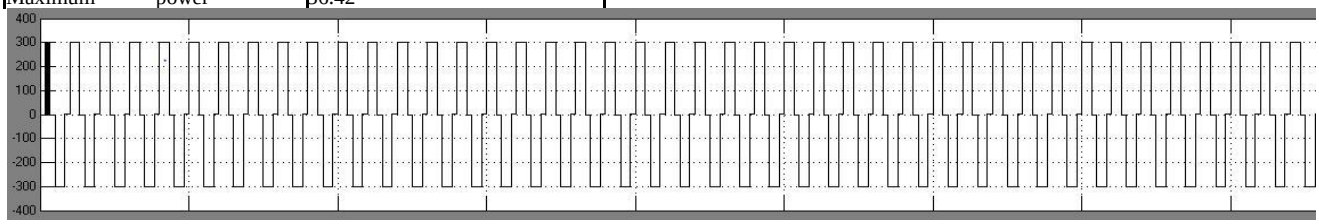

Fig-10 :Line to Line Voltage wave form

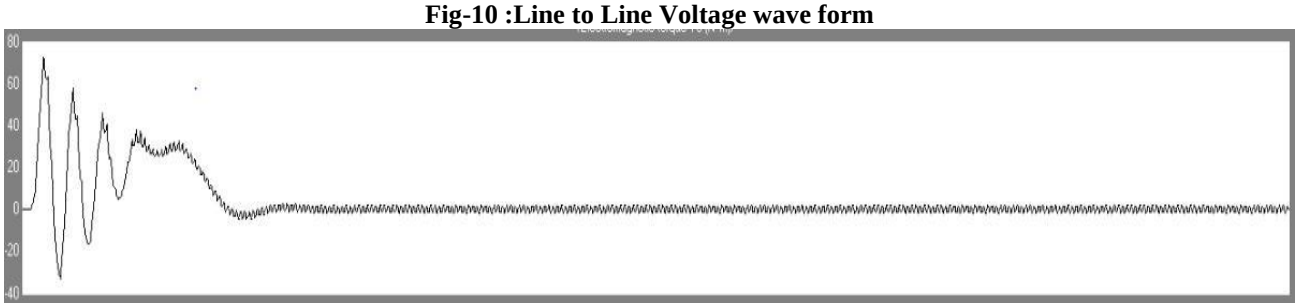

Fig-11: Electromagnetic torque Waveform

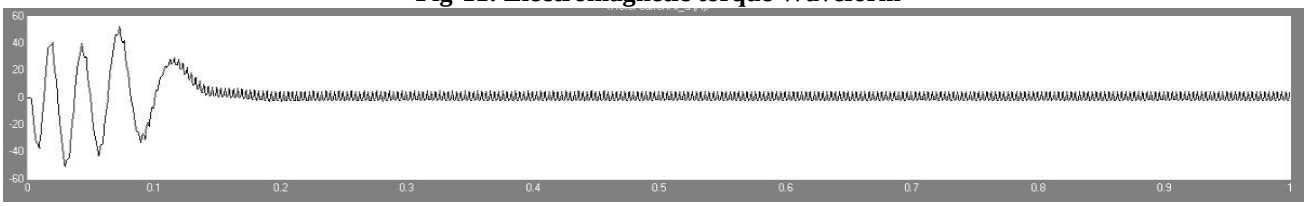

Fig-12: Rotor current waveform

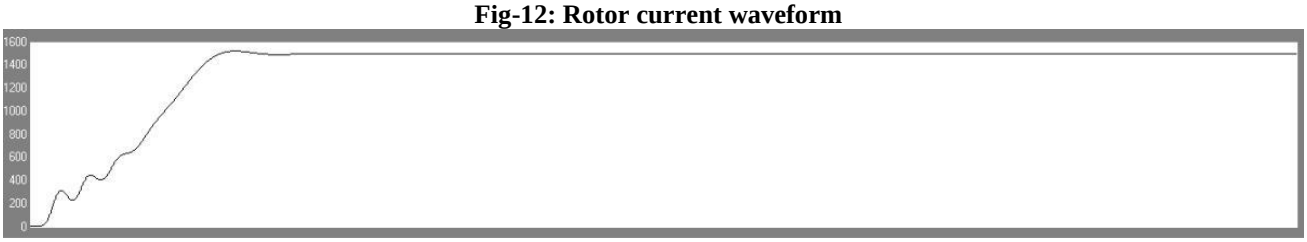

Fig-13: Rotor speed in RPM

VI. EXPERIMENT RESULTS

Induction motor operated into two modes one is constant voltage and variable frequency and second one is variable voltage and constant frequency

Input voltage (Volts)	Speed(rpm)	Frequency (Hz)	Modulation index	Rate of flow (Litters)	Output voltage (Volts)
120	941	50	0.95	13.8	86.6
140	1066	50	0.95	15.6	93.3
160	1192	50	0.95	18.0	102.9
180	1282	50	0.95	19.3	115.3
200	1324	50	0.95	20	129

Table-1: constant frequency and variable voltage

Input voltage (Volts)	Speed(rpm)	Frequency (Hz)	Modulation index	Rate of flow (Litters)	Output voltage (Volts)
200	1206	45	0.85	18.2	121
200	1088	40	0.76	16.2	111.8
200	963	35	0.67	14.2	101.6
200	824	30	0.57	12.1	90
200	730	25	0.48	10.1	81
200	533	20	0.38	7.7	69
200	364	15	0.28	5.3	53

Table-2: constant voltage and variable frequency

Input voltage (Volts)	Speed(rpm)	Frequency (Hz)	Modulation index	Rate of flow (Litters)	Output voltage (Volts/ph.)
300	258	10	0.19	3.6	48
300	449	15	0.3	6.4	51
300	572	20	0.38	8.2	44
300	723	25	0.48	10.5	43
300	876	30	0.57	12.8	41
300	1006	35	0.66	14.6	39
300	1152	40	0.76	17	38
300	1320	45	0.86	19.4	33

Table-3: constant voltage and variable frequency

Flow control possible in two ways one is frequency control that is possible through PWM pulse control and second one is voltage control that is possible through MPPT Controller, In the above Result flow control both the ways, for example flow maintain 10.5 L/min, for that case in frequency control the speed is723,frequency 25Hz , modulation index is 0.48 and voltage is 73.8volts,for the same flow measurement 10.5L/min for that case frequency as constant and voltage is varied then speed is 700 ,voltage is 110volts,frequency 50Hz and Modulation index is 0.95

The future scope of this work is closed loop speed control then with respect to flow in some applications like submarine, water missiles, that closed loop is possible through different control equines like PLC is use for water missile control.

VII. CONCLUSION

Water flow measurement is used in some applications, that system is design in simulation with some specifications, that system consist solar panel feed MPPT controlled Boost converter that one connected through inverter that is feed to induction motor water pump, same system is implanted in hard ware and compare the result, this system is open loop control in the future it is converted in closed loop system through controller to used novel application

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