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Solar Powered Water Pump with Improved Efficiency

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ABSTRACT
In this paper it deals with speed sensor less induction motor drive with improved efficiency. A solar PV array is used for water pumping using IMD. In order to increase the efficiency and reduce the cost many sensors are eliminated. Also an additional boost converter that is used to increase the voltage from PV. Rotor flux oriented control is used for speed estimation in stationary reference frame. The proposed system is simulated in MATLAB/Simulink environment.

KEYWORDS: *Induction Motor Drive, Photovoltaic*

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I. INTRODUCTION

In the present world induction motor is widely used for various purposes. Being cost effective and rugged makes its key properties for it to this reliable. Field oriented control is a very famous technique that is used for high performance applications. But if this is used the amount of sensors used should be controlled, so as to make it cost effective and robust. In order to make the model more efficient we need to reduce the number of sensors used. This is one of the main aim of the proposed model.

As the irradiance is changed the output voltage and all the parameters that comes after it will also change. We need to see the variation that comes during the different intensities of irradiations. For finding the maximum peak power there are various techniques. P&O method is used in the conventional paper. In this paper Golden Section Search Method is used here and made to compare with the previous model.

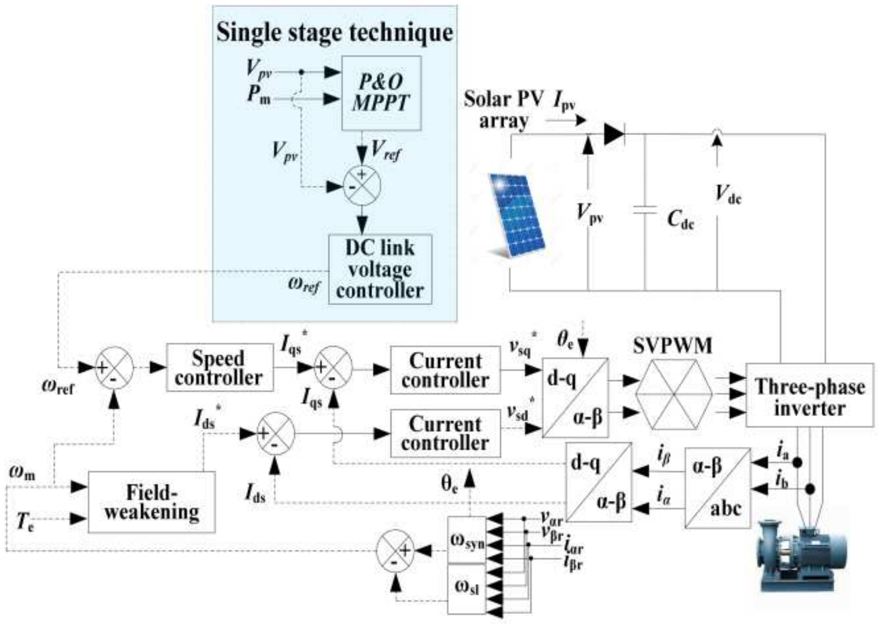
PV array is extensively used in various parts of the world. Here the motor drive is fed from a Solar Photovoltaic (SPV) array. The SPV mainly consist of 2 stages , a two stage and single stage with and without DC-DC converter. The conventional method which is the P&O method keeps the operating point near the MPP so as to get the maximum energy from the PV array. The switching signals of three-phase voltage source inverter (VSI) are generated by space vector pulse width modulation (SVPWM), which has the merit of 15% greater DC-link voltage utilization over sine pulse width modulation technique

Many methods have so far been proposed addressing the different techniques used for speed-sensor less control. The major challenge of implementing a vector control scheme without speed sensor is estimation of rotor-flux position. As the rotor-speed information is not available, the current model of an induction motor cannot be used for flux-position estimation. The other option is to estimate flux from a stator-voltage model of an induction motor.

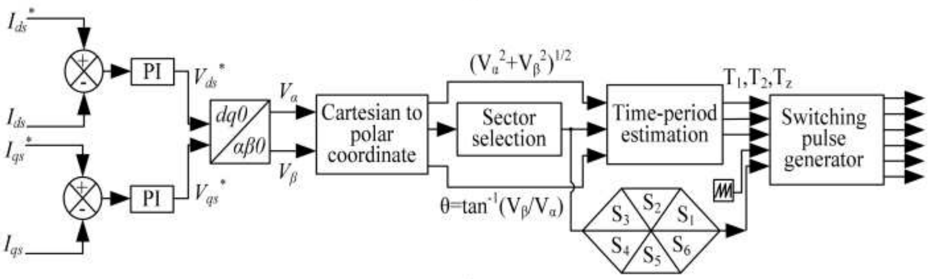
This paper is arranged such that subsequent sections deal with overall control schematic of an IMD system. It comprises of design of SPV array feeding speed sensor less drive. The IMD is fed from solar PV array and MPPT is achieved by a three-phase VSI. The switching of the inverter is controlled by SVPWM technique. The three-phase VSI is also responsible for DC bus voltage regulation. The proposed system is designed in order to optimize the performance of the drive feeding a water pump in terms of improved efficiency.

At higher frequencies, this low-pass filter gives good accuracy but at lower frequencies this scheme introduces considerable phase and magnitude errors. As the estimated phase, i.e. the estimated flux position is responsible for field orientation, error in its estimation leads to field disorientation. Again, if there is an error in the stator-resistance value used in the flux estimator, then at low speed, where the applied voltage is also much less, the error in the estimated resistive drop becomes comparable to the voltage applied to the motor. Hence, it gives a significant error in the estimated flux magnitude and position at low frequencies.

II. SYSTEM CONFIGURATION



a



b

Fig 1a: Solar power fed IMD

Fig 1b: Switching signals generated through SVPWM

This figure 1:a shows gives the overall idea of the proposed model. In this a water pump is being operated. The motor used to operate here is induction motor. Here the induction motor is operated with the help of an inverter. This inverter is switched using space vector pulse width modulation. The implemented SVPWM (as shown in Fig. 1*b*) is used for VSI control, which has reduced even-order harmonics in line voltage The main source for this circuit is from the PV panel. This PV array is operated by MPPT. There are various methods of MPPT. In the conventional method P&O is used along with boost converter.

III. SENSOR LESS MODEL

The basic block diagram of the torque-control loop of speed-sensor less control is given in Fig. 2.

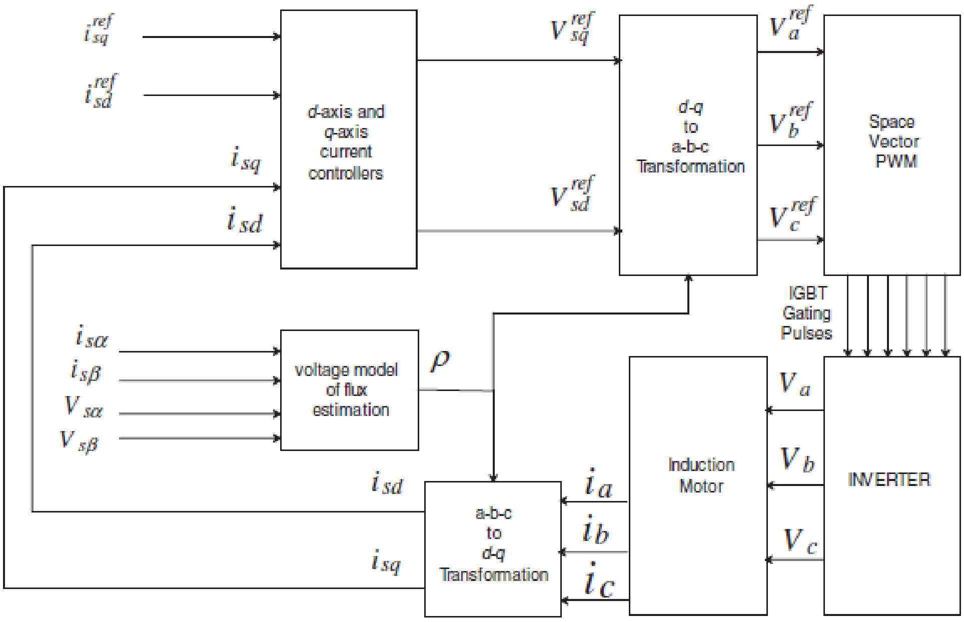


Fig: 2: Block diagram of sensor less torque control

IV. SPACE VECTOR PULSE WIDTH MODULATION

Space vector modulation (SVM) is an algorithm for the control of pulse width modulation (PWM).[1] It is used for the creation of alternating current (AC) waveforms; most commonly to drive 3 phase AC powered motors at varying speeds from DC using multiple class-D amplifiers. There are variations of SVM that result in different quality and computational requirements. One active area of development is in the reduction of total harmonic distortion (THD) created by the rapid switching inherent to these algorithms.

Space Vector PWM (SVPWM) refers to a special switching sequence of the upper three power transistors of a three phase power inverter. Main function of SVPWM is to approximate reference voltage (Vref) vector using inverter's eight switching pattern and this approximation is done by generating output voltage of inverter in small sampling period, to be same as that of Vref in same period. This Vref voltage vector has discrete movement in complex plane between positions portioned at 60 degree sectors hence forms hexagon trajectory. Decomposition of this vector on Real and Imaginary axis indicates that it coincides with the switching vector that has generated it. Following figure represents relationship between Vref and voltage sectors.

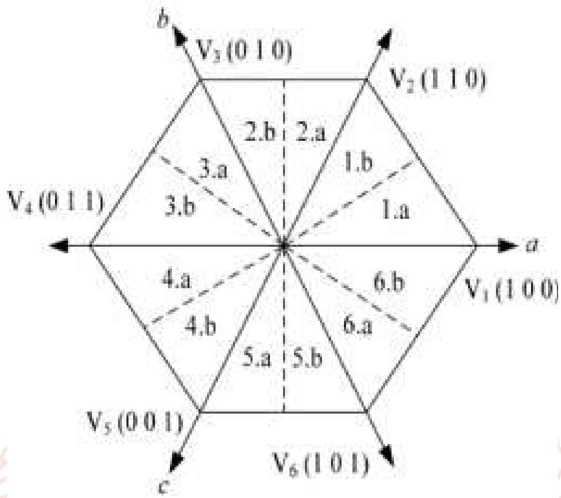


Fig 3: SPWM sector

Voltage Vectors	Switching Vectors			Line to neutral voltage			Line to line voltage		
	a	b	c	V_{an}	V_{bn}	V_{cn}	V_{ab}	V_{bc}	V_{ca}
V_0	0	0	0	0	0	0	0	0	0
V_1	1	0	0	2/3	-1/3	-1/3	1	0	-1
V_2	1	1	0	1/3	1/3	-2/3	0	1	-1
V_3	0	1	0	-1/3	2/3	-1/3	-1	1	0
V_4	0	1	1	-2/3	1/3	1/3	-1	0	1
V_5	0	0	1	-1/3	-1/3	2/3	0	-1	1
V_6	1	0	1	1/3	-2/3	1/3	1	-1	0
V_7	1	1	1	0	0	0	0	0	0

Fig 4: Different switching states in SVPWM

V. MPPT methods

The weather and load changes cause the operation of a PV system to vary almost all the times. A dynamic tracking technique is important to ensure maximum power is obtained from the photovoltaic arrays. The following algorithms are the most fundamental MPPT algorithms, and they can be developed using micro controllers.

The MPPT algorithm operates based on the truth that the derivative of the output power (P) with respect to the panel voltage (V) is equal to zero at the maximum power point. In the literature, various MPP algorithms are available in order to improve the performance of photovoltaic system by effectively tracking the MPP. However, most widely used MPPT algorithms are considered here, they are

1. Perturb and Observe (P&O)
2. Incremental Conductance (InCond)
3. Constant Voltage Method.

Going in detail on the first method which is P&O method

The most commonly used MPPT algorithm is P&O method. This algorithm uses simple feedback arrangement and little measured parameters. In this approach, the module voltage is periodically given a perturbation and the corresponding output power is compared with that at the previous perturbing cycle [17]. In this algorithm a slight perturbation is introduce to the system. This perturbation causes the power of the solar module various. If the power increases due to the perturbation then the perturbation is continued in the same direction. After the peak power is reached the power at the MPP is zero and next instant decreases and hence after that the perturbation reverses as shown in Figures 5(a) and 5(b). When the stable condition is arrived the algorithm oscillates around the peak power point. In order to maintain the power variation small the perturbation size is remain very small. The technique is advanced in such a style that it sets a reference voltage of the module corresponding to the peak voltage of the module. A PI controller then acts to transfer the operating point of the module to that particular voltage level. It is observed some power loss due to this perturbation also the fails to track the maximum power under fast changing atmospheric conditions. But remain this technique is very popular and simple

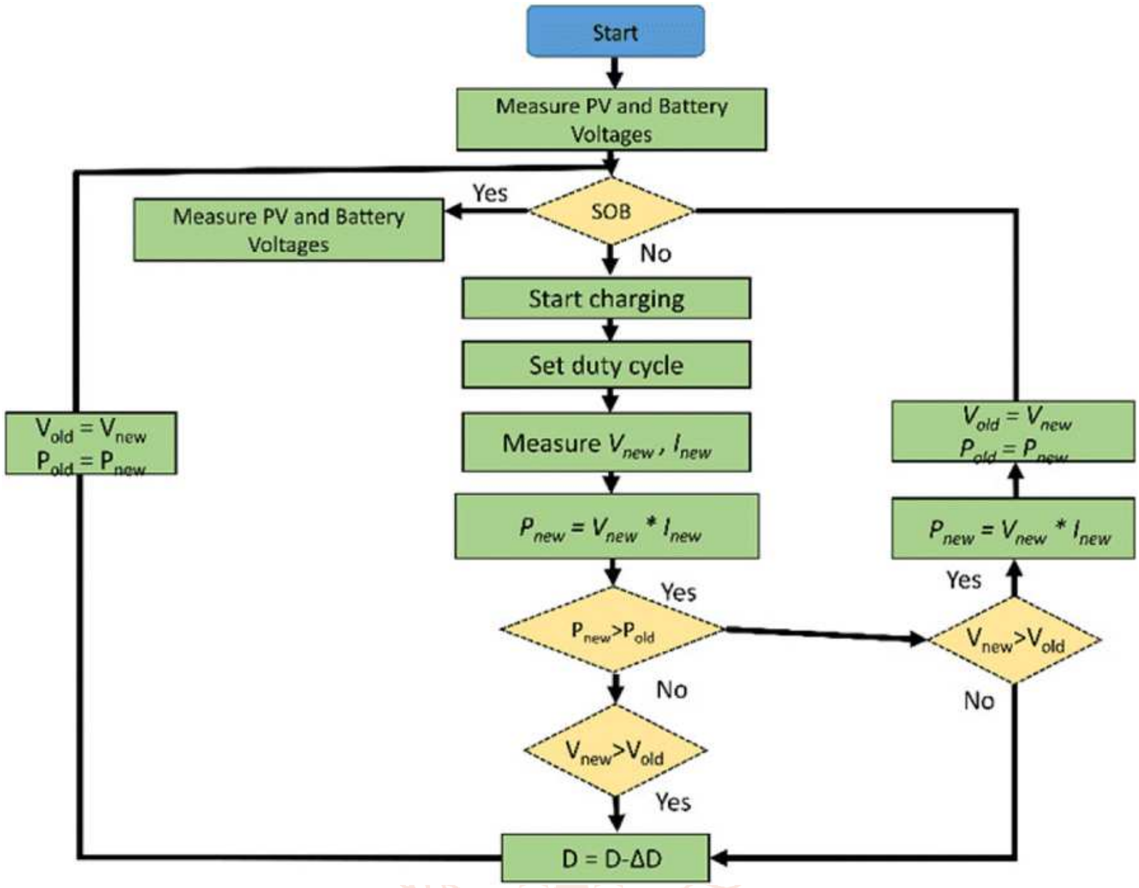


Fig 5: Flow chart of P&O

VI. Simulation and Results

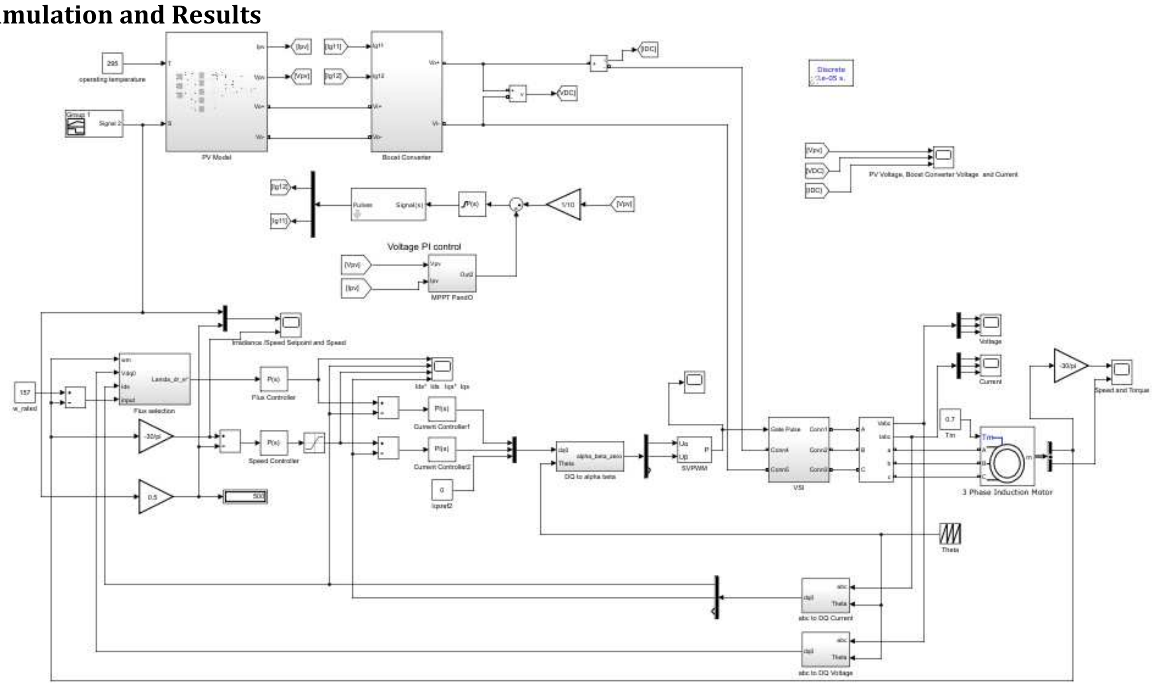


Fig 6: Overall simulation diagram.

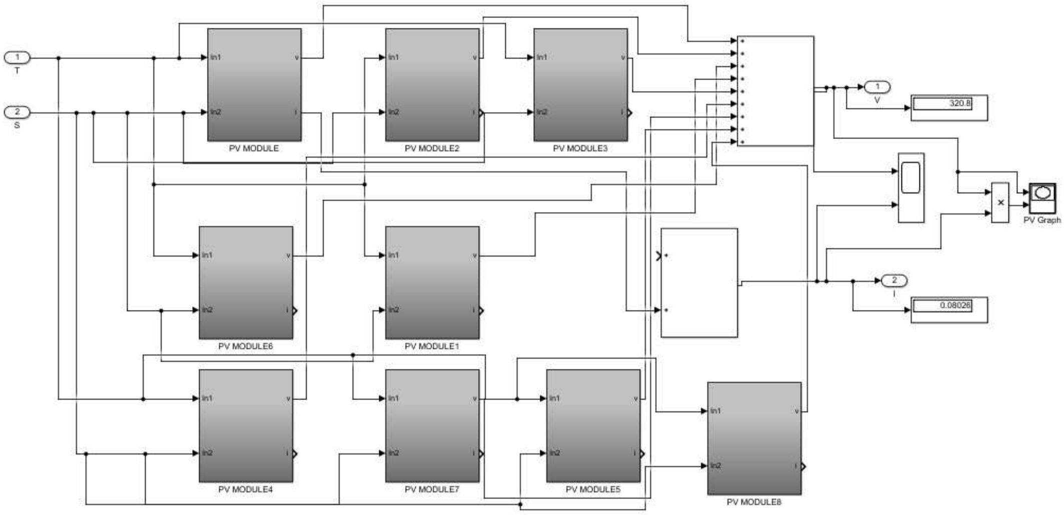


Fig 7: The simulation of PV cells

The different configuration of solar cells so as to obtain the required output current and voltage.

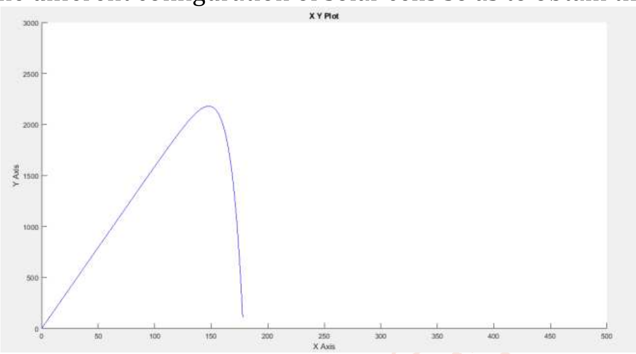


Fig 8: PV graph

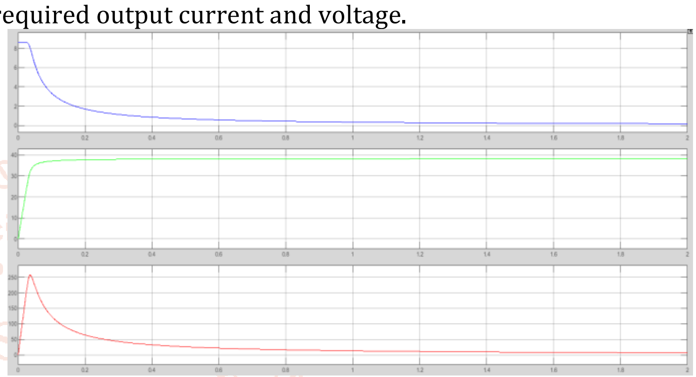


Fig 9: PV parameters

The above graph(Fig:8) shows the PV graph. The power is obtained by multiplying the voltage and current. With this value the voltage is kept in the other axis and the graph is obtained. the voltage reaches close to 2.2 KW and voltage around 300V. The above graph(Fig:8) shows the values of a solar cell; its parameters. The first graph shows the current i.e., the short circuit current and the second graph is the open circuit voltage. The third graph is the power generated by a cell.

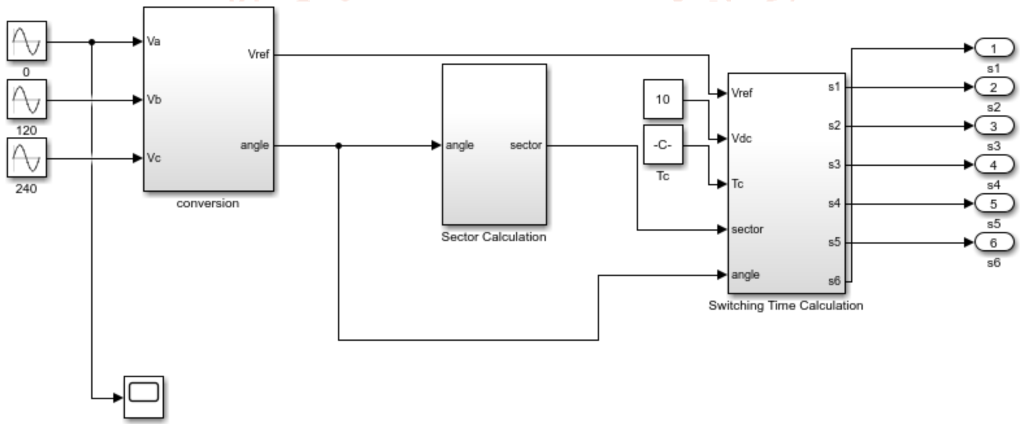


Fig 10: SVPWM simulation blocks

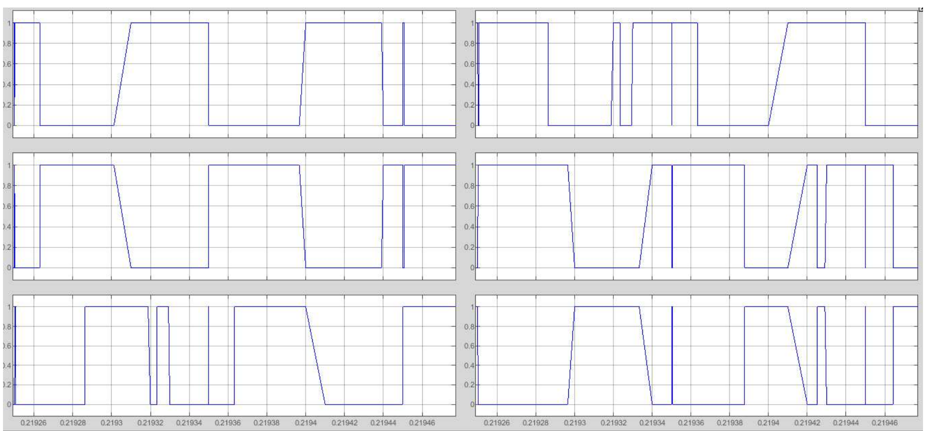


Fig 11: Output pulses obtained from the space vector block

The above figure shows the obtained pulses from a SVPWM. Where the transformation like Park, Clark and their inverse transformation happens.

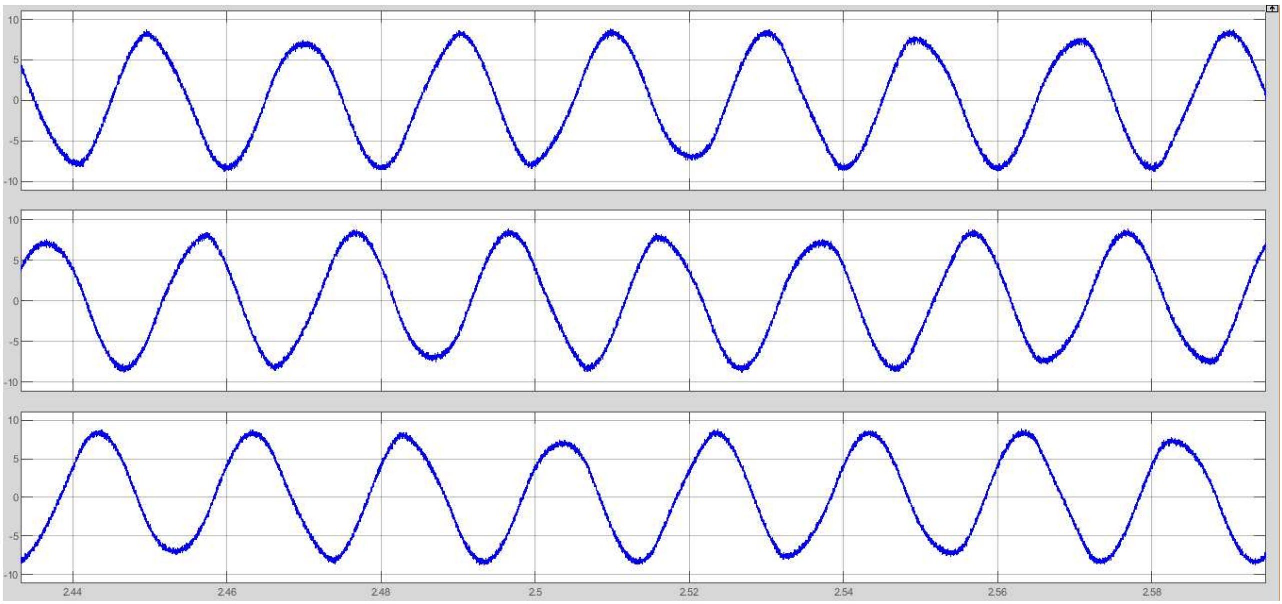


Fig 12: Inverter output current

In this figure it shows the output current obtained from the inverter.

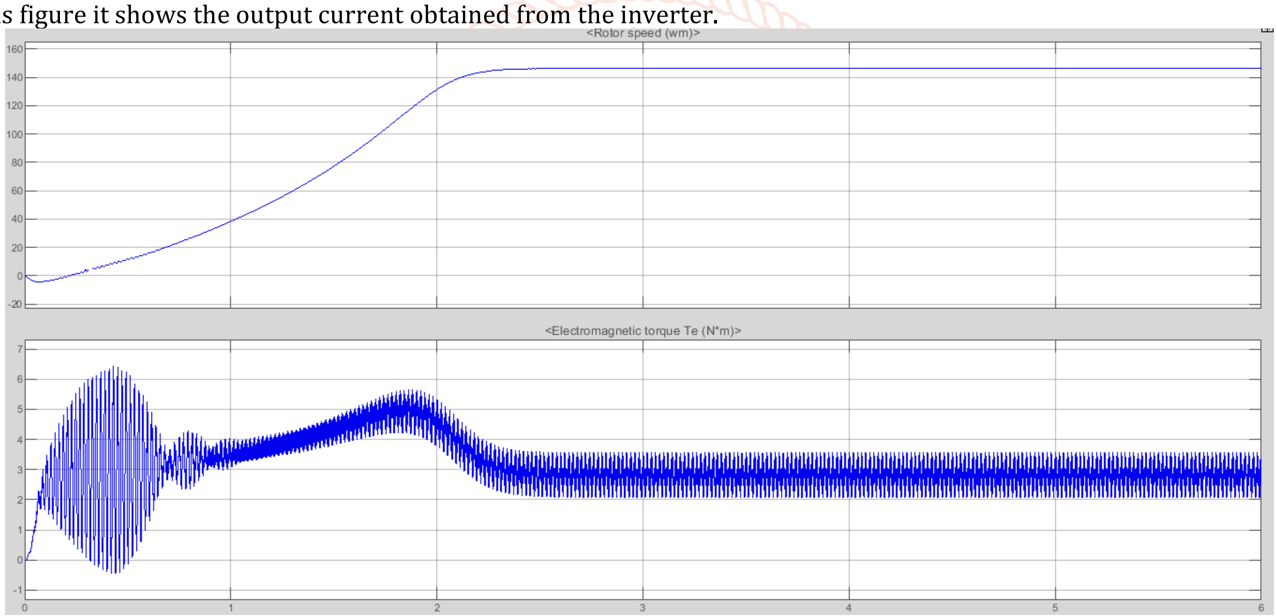


Fig 13: output parameters for an open loop system at 1000W/m²

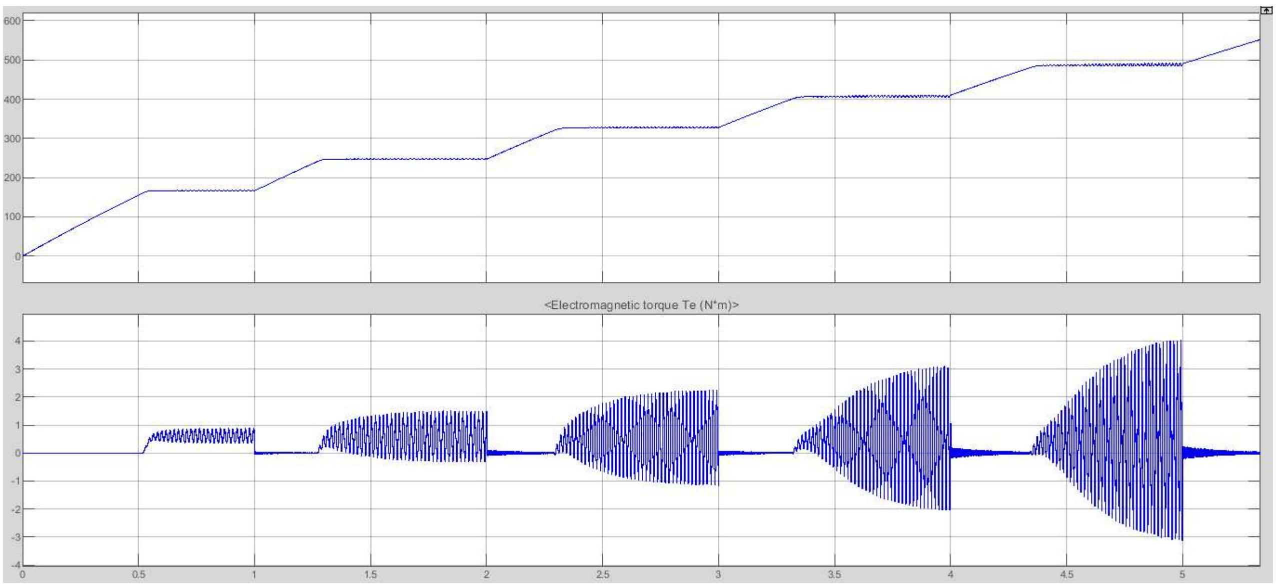


Fig 14: output parameters for an closed loop system at various irradiation

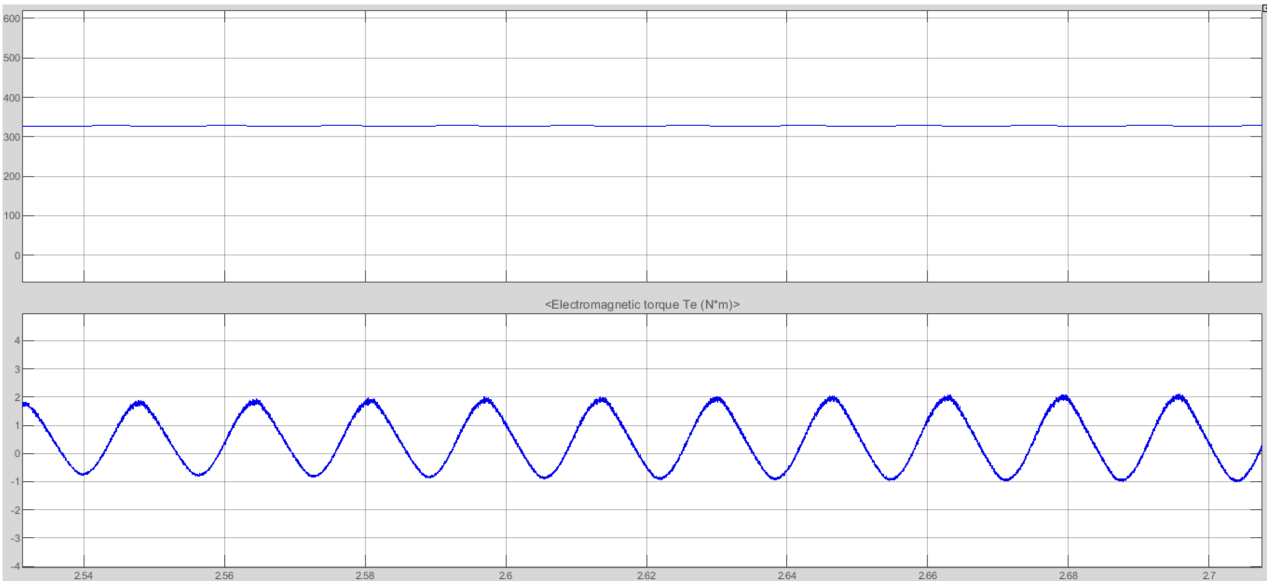


Fig 15: output parameters for an closed loop system at 640 W/m²

The torque and speed of the induction motor is obtained. It is seen that there is smooth starting capability present. And with the help of closed loop operation considerably better performance and by checking the efficiency of the motor alone with these parameters as the input it is seen that the efficiency is commendable.

VII. CONCLUSION

The Matlab simulation of a closed loop operation of a solar powered water pump is shown here. The better performance is seen here with the help of the additional boost converter present so as to help it run for heavier industrial application. For future application using various efficient MPPT method like Golden Section Search methods the efficiency of the overall system can be increased.

VIII. REFERENCES

[1] d Bhattacharya, T., Umanand, L.: 'Improved flux estimation and stator resistance adaptation scheme for sensorless control of induction motor', IET Electr. Power Appl., 2006, 153, (6), pp. 911–920

[2] Verma, V., Chakraborty, C., Maiti, S., et al.: 'Speed sensorless vector controlled induction motor drive using single current sensor', IEEE Trans. Energy Convers., 2013, 28, (4), pp. 938–950

[3] Attaianese, C., Perfetto, A., Tomasso, G.: 'A space vector modulation algorithm for torque control of inverter fed induction motor drive', IEEE Power Eng. Rev., 2002, 22, (5), pp. 65–65

[4] Sahoo, S. K., Bhattacharya, T.: 'Field weakening strategy for a vector controlled induction motor drive near the six-step mode of operation', IEEE Trans. Power Electron., 2016, 31, (4), pp. 3043–3051

[5] Xu Zhang, Guoqiang Zhang, Bo Wang 'Maximum torque increase and performance optimization for induction motor field-weakening control', ICEMS,2018, pp.1268-1272