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Study of MPPT with PMSG based Wind energy conversion systems

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Abstract: This paper aims at comparison of three MPPT algorithms in terms of various parameters like voltage and power output. Comparison with regards to various parameters like voltage,current, electromagnetic torque and power output are made and appropriate results are obtained through modelling in MATLAB simulink.

The algorithms taken into consideration are:

1) **Perturb and Observe**
2) **Incremental Conductance**
3) **Fuzzy Logic**

Keywords: MPPT: Maximum Power Point Tracking, Permanent Magnet sychronousgenerator, wind turbine.

I. NTRODUCTION

There is already a need for generating energy by using renewable energy sources. In India we generate around 38 GW of electricity through windmills.

This can be increased by using the best suitable MPPT algorithm. We have made comparisons regarding the output of various algorithms in this paper by making use of permanent magnet synchronous generators (PMSG) because of lesser maintenance requirement and higher reliability. In the literature, there are two main types of MPPT algorithms, direct and indirect methods. The direct techniques do not depend on the generator characteristics and other factors like climatic conditions, the ones used in this paper include, P&O,Incremental Conductance and Fuzzy Logic control (FLC) [4]-[8].

II. LITERATURE REVIEW

The rotor side converter provides active and reactive power control of the machine while the grid-side converter keeps the voltage of the DC-link constant. The simulation results show the total harmonics distortion using fuzzy logic controller is less than the conventional control techniques [1].

By measuring generated power, the corresponding optimum rotor speed can be calculated. This is the base of the well-known Maximum Power Point Tracking (MPPT). It is deduced that in order to extract the maximum amount of power from the incident wind, power coefficient (Cp) should be maintained at a maximum [2]. Opportunity to learn about WECS and how to analyze it in MATLAB [3].

When the wind speed is constant or changes in a small scale, both of the two control strategies can realize good performances and have nearly the same controller output responses. The plant model remains [4]. The proposed MPPT control gave 1.5% more electrical energy than the indirect torque control for the considered sine-random wind profile; The proposed MPPT control gave 3.1% more electrical energy than the indirect torque control for the considered coherent gust [5].

III. METHODOLOGY

Turbines are expected to generate power over a wide range of wind speeds. A typical blade of a turbine is shown in the figure. It can be seen that it consists of a lot of cross sections. These crosssections are of aerofoil shape. The aerofoil structure reduces drag and generates lift force to propel the turbine in an efficient manner. The blades have different linear speeds at different points. so that every part of blade should be at optimum angle of attack to the wind.therefore, a twist is provided to the blade the power produce by wind turbine is given by

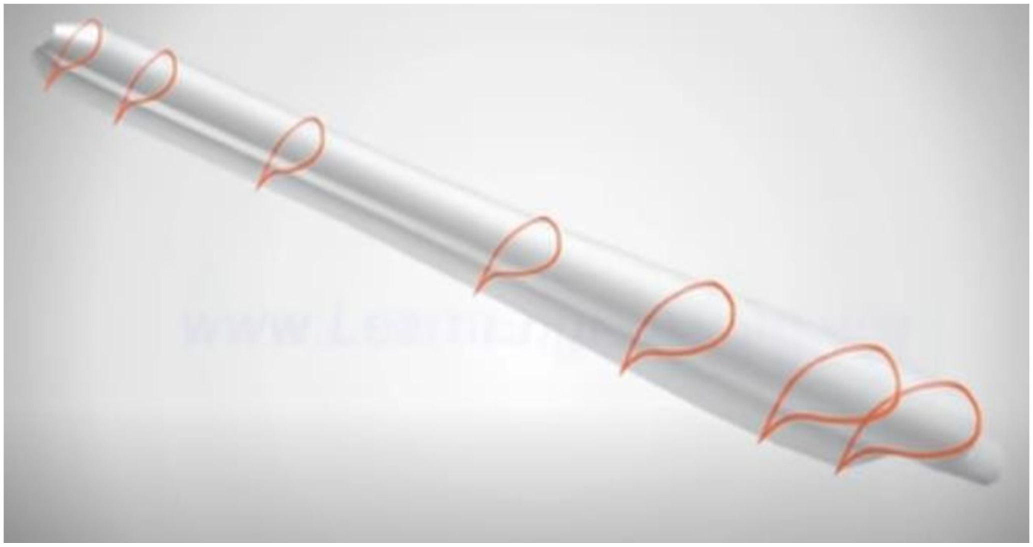

Fig. 1 Wind turbine blades

where,
Cp - PowerCoeffcient ρ - Air density
A - Turbine swept area V - Wind speed
where Cp is function of tip speed and pitch angle

$$c_p(\lambda,\beta) = c_1(c_2/\lambda_i - c_3\beta - c_4)e^{-c_5/\lambda_i} + c_6\lambda$$

$$\frac{1}{\lambda_i} = \frac{1}{\lambda + 0.08\beta} - \frac{0.035}{\beta^3 + 1}$$

λ - Tip speed β - Pitch angle

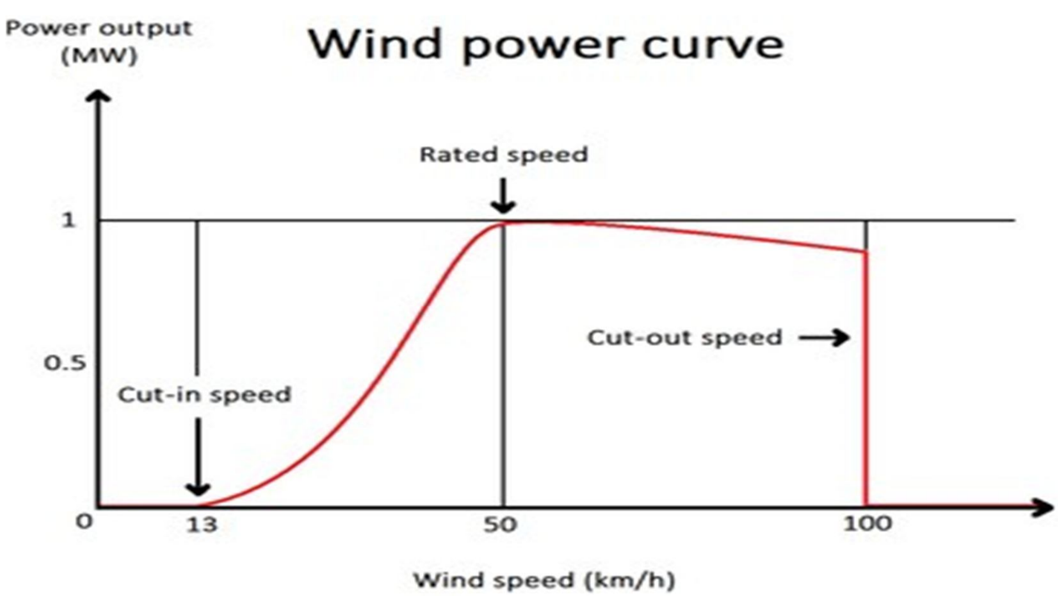

Fig. 2 Power Output vs Wind speed

- Cut in speed- speed below which turbine does not produce any power
- Rated speed- the rated speed at which a turbine generates power. We have to maintain the speed ofthe turbine at rated speed for maximum power generation.
- Rated power- It is the power produced at rated speed
- Cut out speed - It is higher speed experienced during stormat which the wind turbine is stoppedpreventing it from mechanical damage cut out

Different levels of operation of a wind turbine and are as follows:
1) Blowing wind is not sufficient to start rotating the turbine. (Wind speed < Vcut-in)
2) Wind speed is sufficient to rotate the turbine(Vcut - n<Wind speed<Vrated)
3) Wind speed>Vrated. At this point the power generated is maximum for the generator, any moreincrease in the rotation of turning would not be beneficial, so to maintain the power output maximum we adjust the pitch angle.
4) At an even higher wind speed a point is reached where either it is not safe for the wind turbine to rotate or the pitch angle is close to zero while generating max power According to the generator.

At this point if wind is increased slightly the pitch angle has to become 90 and thus the turbinestops rotating. (Wind speed>V cut-out)

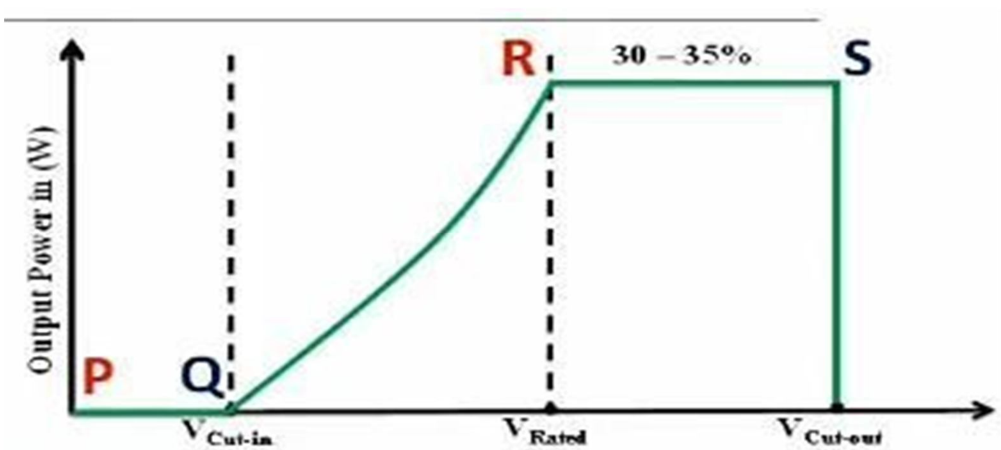

Fig. 3 Power Output vs Voltage

As we have understood the different levels of wind conditions for a wind turbine, the region whereMPPT works is during the stage where wind speed lies between Vcut-in and Vrated.

A. Parameters

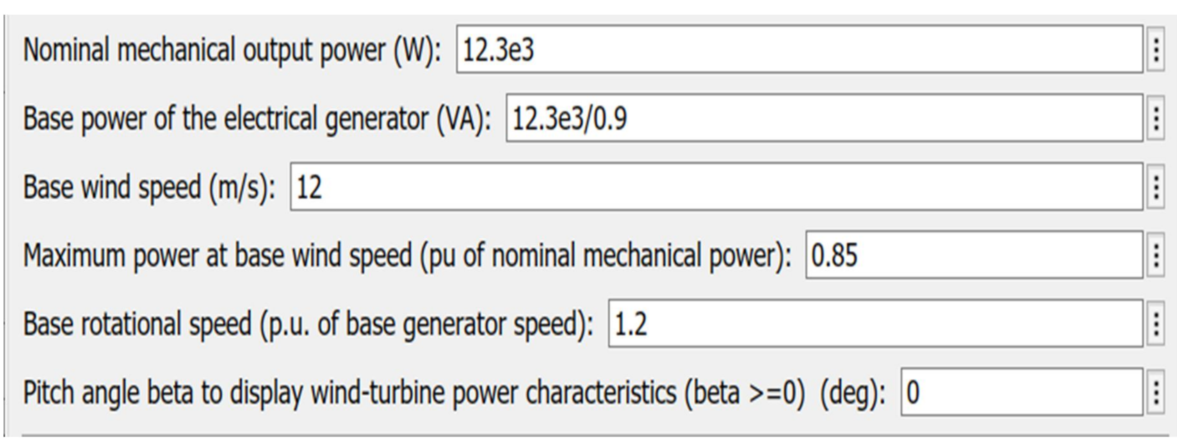

Fig. 4 Parameters of Wind turbine used in the simulink model

B. *What is MPPT?*

It is observed that during a particular wind speed the output power vs generator speed (w) is of ahill shape.

MPPT has the objective to maintain the output to the peak point of the hill in the graph betweenoutput power vs generator speed.

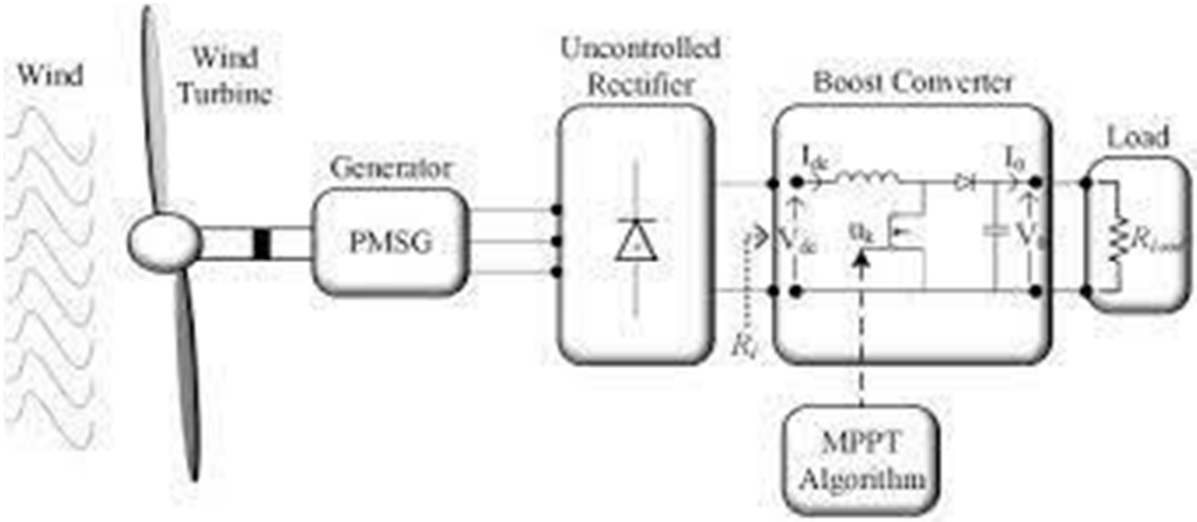

Fig. 5 Block Diagram of final model

IV. MPPT ALGORITHMS

A. *Incremental Conductance*

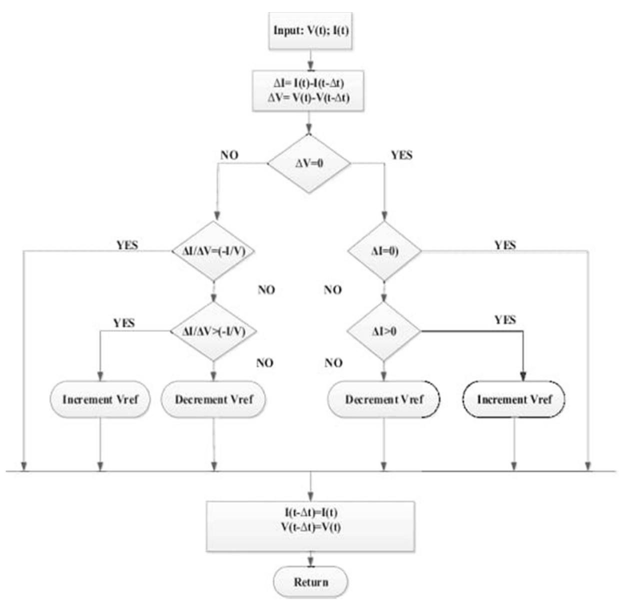

Fig. 6 Incremental conductance

B. *Perturb and Observe Method (P&O)*

It is Simplex method of maximum power point tracking. Also known as Hill Climbing method or two-point power comparison method, only applicable to PV array uniform irradiation conditions. The relation among PV modules output energy and its voltage. The conduct of sun panel indicating MPP and working precept is proven which suggests that the ensuing extrade of PV energy is determined as follows: When the PV module working factor is at the left aspect of the curve ($\Delta P/\Delta V$is positive), this means that the PV module output energy increases, the perturbation of the PV module voltage ought to be multiplied in the direction of the If the working factor of the module turned into at the proper aspect of the curve ($\Delta P/\Delta V$ is negative), then the perturbation of the PV module voltage ought to be reduced in the direction of the MPPT

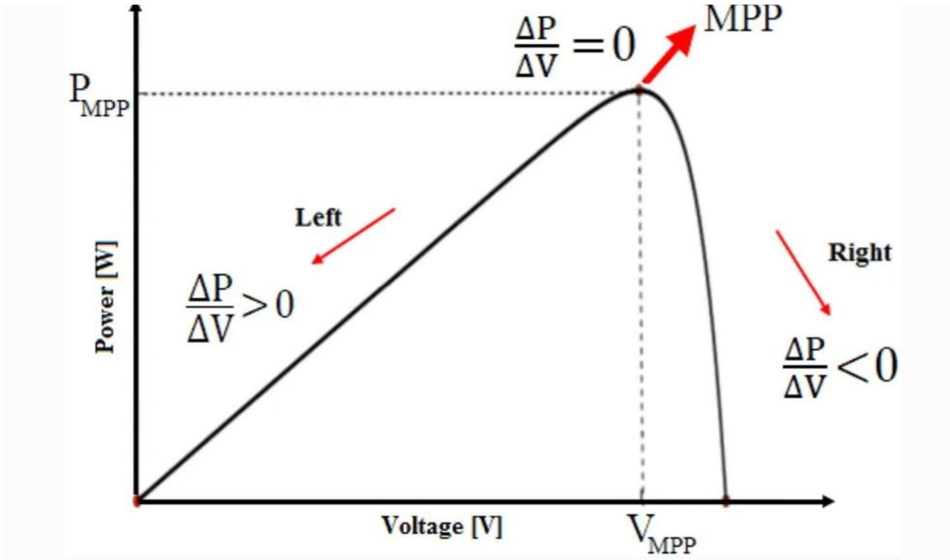

Fig.7. Power output vs voltage

First, the realistic voltage and current from the PV array are measured. After that, it is made of voltage and contemporary offers the real energy of a PV module. Then, it'll take a look at whetheror not ΔP = zero or not. If this is satisfied, then the working factor is on the MPP. If it isn't satisfying,then it'll take a look at some other repute that ΔP > zero. If this repute is satisfied, then it'll take a look at out that ΔV > zero. If its miles satisfied, then it suggests that the working factor is on the left aspect of the MPP. If ΔV > zero repute isn't satisfied, then it suggests that the working factor is on the proper aspect of the MPP. This technique is constantly repeated till it reaches the MPP. So, always there may be a compromise among the increments and the sampling fee withinside the P&O set of rules.

C. Fuzzy Logic Controller

Fuzzy logic is recently introduced in the wind system to find and track the operating point corresponding to the maximum power according the wind speed and is one of the most intelligent methods in MPPT technique .when we compare with the other conventional control methods the control does not require exact knowledge of the mathematical model of the system .FLC controller consists of three functional blocks like fuzzification, inference engine and last one is Defuzzication.so these is characterized by input variables, output variables, membership function and last is fuzzy rules

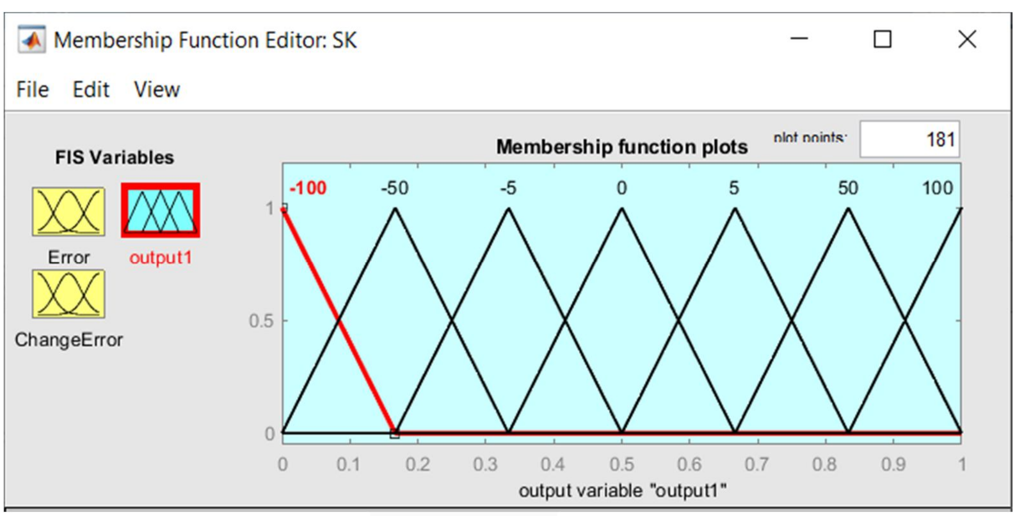

Fig.8 Fuzzy logic

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D. DC-DC Boost Converter

A DC/DC boost converter is a popular converter used in a wind energy conversion system, which transforms a lower input voltage into a higher output voltage. It consists of an adaptation interfacebetween the PMSG generator and the electrical load in order to operate the system for MPP condition by controlling its MOSFET transistor using the MPPT algorithm. Proper calculations were made to calculate its parameters to get effective results

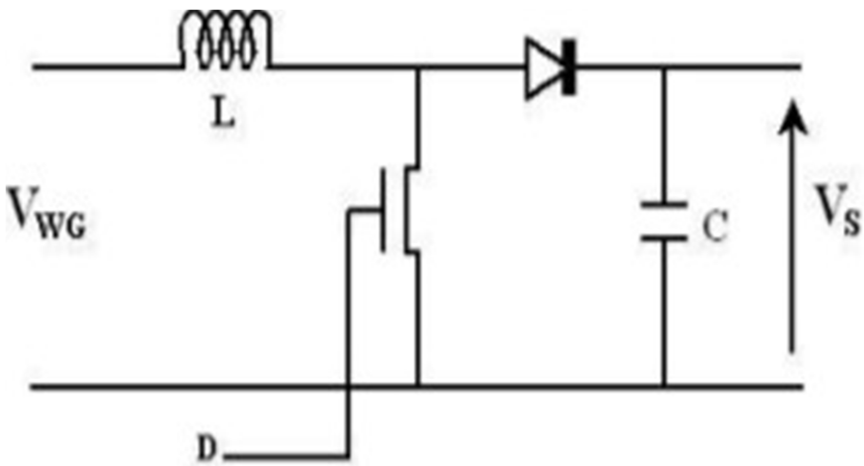

Fig.9 DC-DC boost converter

Parameters-

Inductor	4.5573×10^{-5} H
Capacitor	6.6094×10^{-4} F
Load	13.33 Ω

V. RESULTS

Firstly, the rotor speed, electromagnetic torque and AC voltage/ current plots for all three MPPTalgorithms were plotted. comparison of all three MPPTs in terms of power output was done

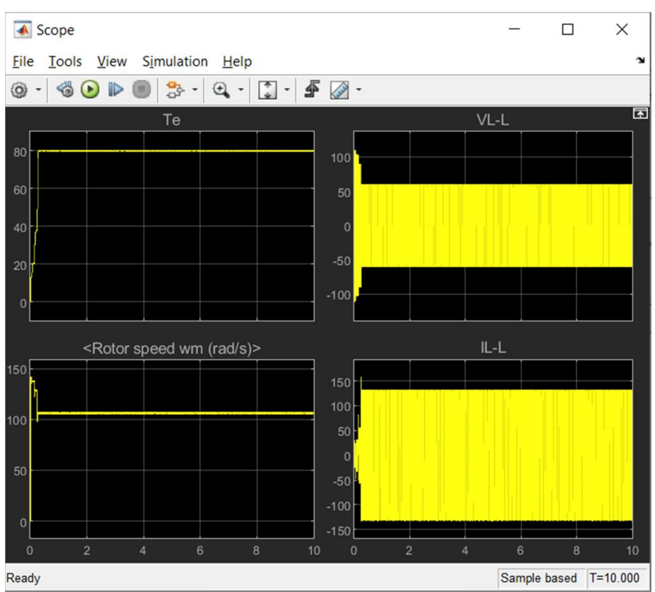

Fig.10 P&O MPPT plots

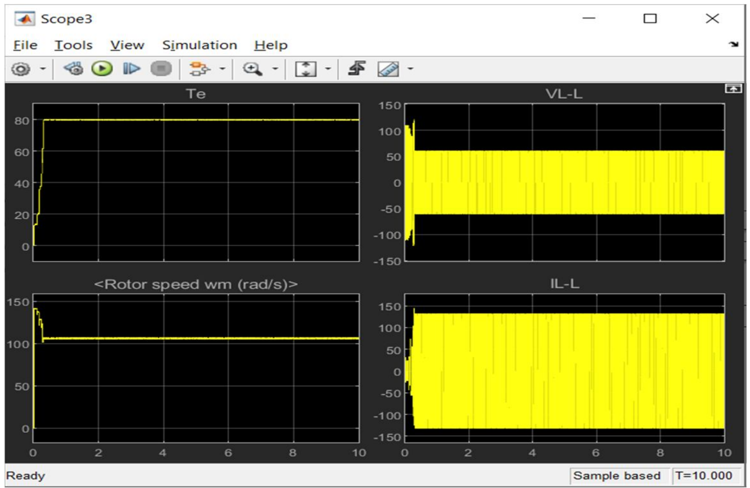

Fig.11 INC MPPT plots

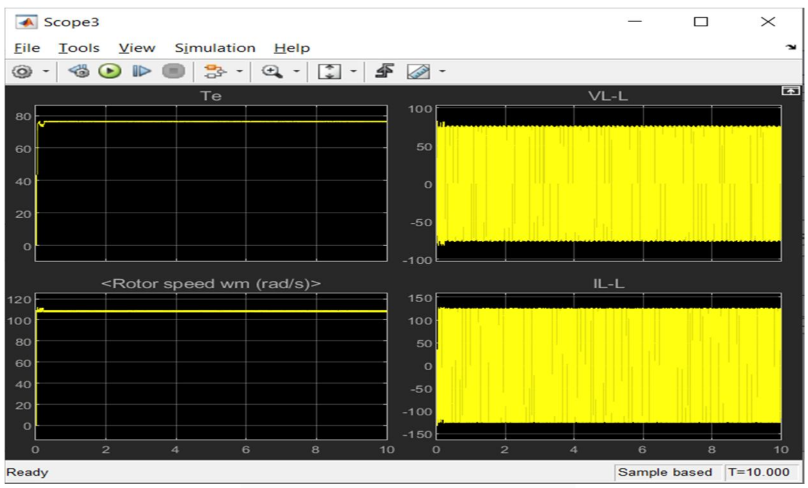

Fig.12 Fuzzy logic MPPT plots

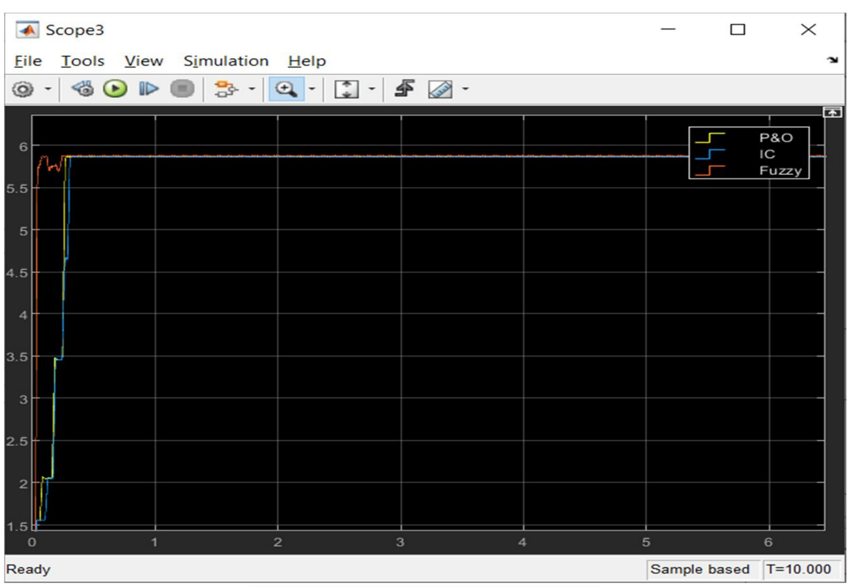

Fig.13 Power output comparison

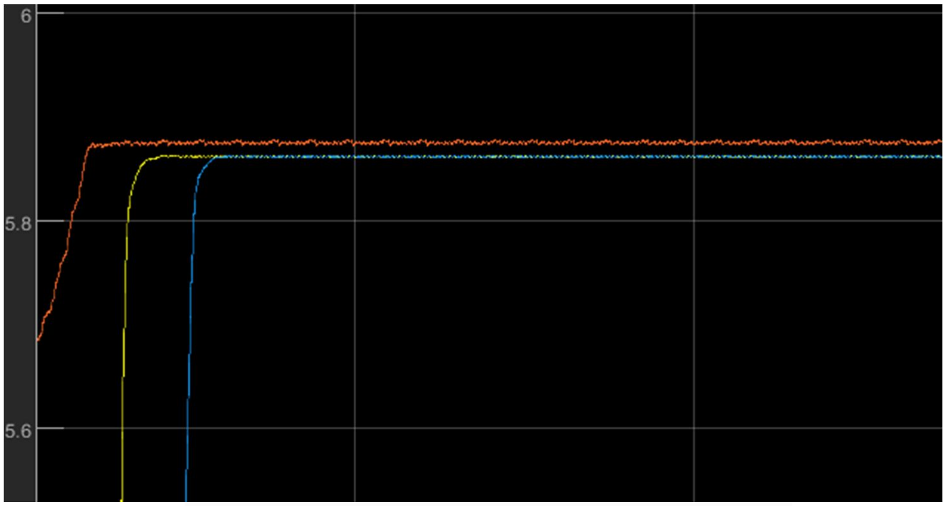

Fig.14 Power output comparison (With increased clarity)

Algorithm	DC voltage	DC Power
P&O	281.32 V	5.862 kW
INC	281.32 V	5.862 kW
Fuzzy logic	281.63 V	5.875

VI. CONCLUSION

The electromagnetic torque for Fuzzy logic was observed to be slightly lower as compared to otheralgorithms, slight variation in AC voltage and currents were also observed for all three algorithms.In terms of final DC power output, P&O and INC performed somewhat equally, however P&O MPPT reached the maximum power point faster in comparison. Fuzzy logic however proved to besuperior in terms of power output and time required to reach maximum power point.

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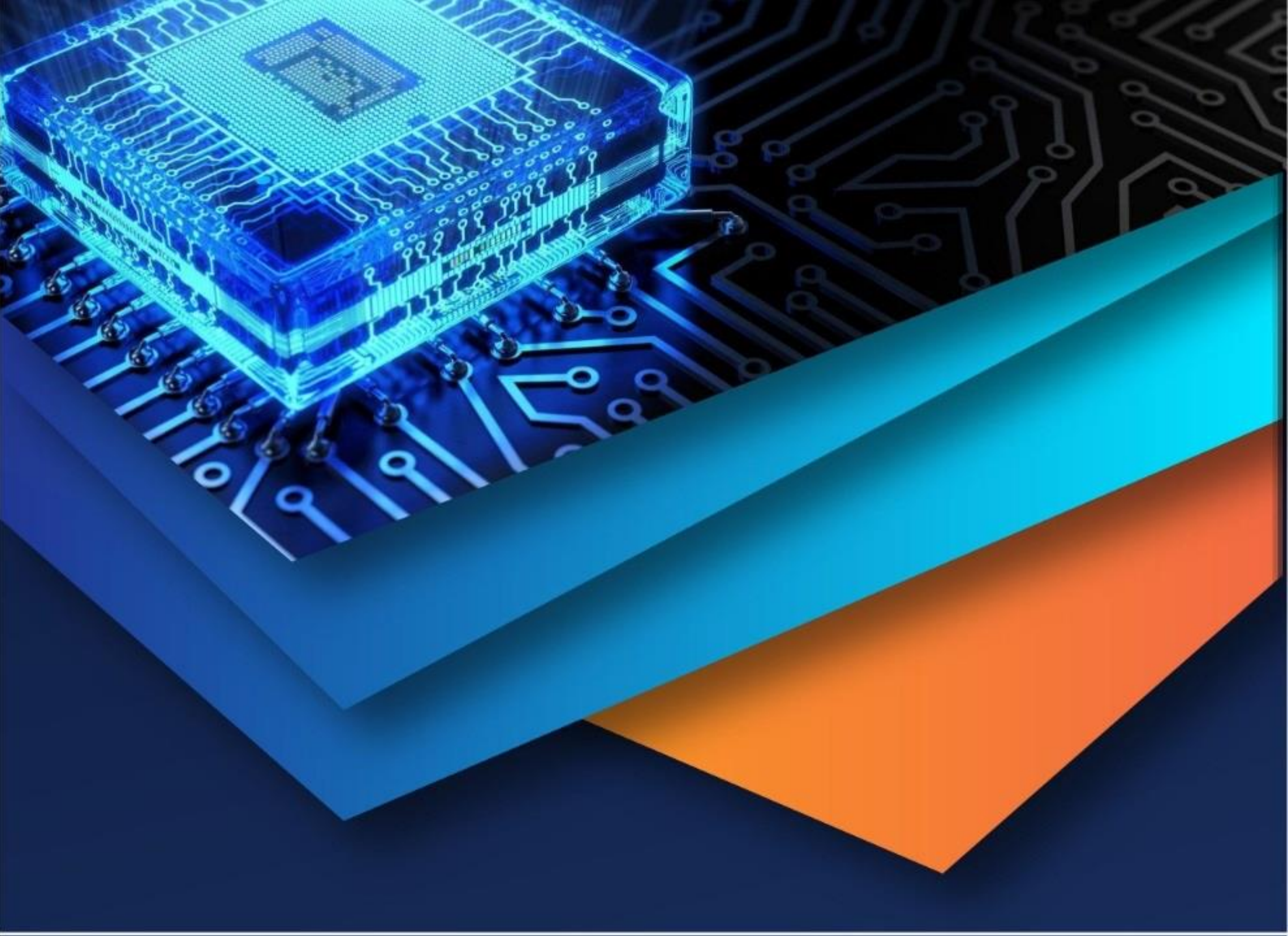
REFERENCES

[1] B. Bhandari, S.R. Poudel, K.T. Lee and S.H. Ahn, "Mathematical modeling of hybrid renewable energy system: A review on small hydrosolar-wind power generation," International Journal of Precision Engineering and Manufacturing-Green Technology , vol. 1, pp. 157- 173, April 2014.
[2] Y. Abdel-Raheem, M.A. Sayed, M.N. Abdelwhab, G. Shabib, "Generator side converter for five-phase PMSG based wind turbine generators using perturbation and observation technique," International Journal on Power Engineering and Energy, vol. 7, n°1, pp. 610- 618, January 2016.
[3] Rekioua, Wind Power Electric Systems: Modeling, Simulation and Control, London, England: Springer-Verlag, 2014.
[4] H.Q. Minh, N. Frederic, N. Essounbouli and H. Abdelaziz, "A new MPPT method for stand-alone wind energy conversion system," IEEE 2nd International Symposium on Environment-Friendly Energies and Applications (EFEA), Northumbria University, UK, 25-27 June, pp.335- 340, 2012.
[5] X-P. Li, W-L. Fu, Q-J. Shi, J-B. Xu and Q-Y. Jiang, "A fuzzy logical MPPT control strategy for PMSG wind generation systems," Journal of Electronic Science and Technology, vol. 11, pp. 72-77, March 2013.
[6] S. Javadi and M.H. Hazin, "An improved MPPT method of wind turbine based on HCS method by using fuzzy logic system," International Journal of Smart Electrical Engineering, vol. 3, pp. 29-35, 2014.
[7] H. Sefidgar and S.A. Gholamian, "Fuzzy logic control of wind turbine system connectionto PM synchronous generator for maximum power point tracking," International Journal of Intelligent Systems and Applications, vol. 6, pp. 29-35, June 2014.
[8] R. Rathi and K.S. Sandhu, "Comparative analysis of MPPT algorithms using wind turbines with different dimensions & ratings," IEEE 1st International Conference on Power Electronics. Intelligent Control and Energy Systems (ICPEICES), Delhi, India, 4-6 July, 2016



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