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A REVIEW ON MAXIMUM POWER POINT TRACKING ALGORITHMS FOR HYBRID GENERATION SYSTEM

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ABSTRACT

Renewable energy sources can offer isolated communities the chance for employment to regulate their energy use in a manner that best suits their needs. This paper presents the various Maximum Power Point Tracking (MPPT) algorithms for a hybrid power plant consisting of solar and wind. Using MPPT algorithms maximum power is tracked from PV and wind energy sources. However, choosing an exact MPPT algorithm for a particular case is required for sufficient proficiency because each algorithm has its own merits and demerits. The merits, demerits and comprehensive comparison of the different MPPT algorithms are presented in the terms of complexity, wind speed requirement, response curves, switching rate, higher lifetime and efficiency. And also the ability to acquire the maximal energy output is recommended.

***Keywords* – Renewable hybrid power plant, Maximum Power Point Tracking, Photo Voltaic, Incremental conductance, Perturb and Observe.**

I INTRODUCTION

Recent developments and trends in the electric power consumption reveals about the increasing use of renewable energy. Practically all regions of the world have any one type of renewable resources. With this consideration studies on renewable energies focuses more and more attention. Solar energy and wind energy are the two renewable energy sources most commonly preferred. Wind energy has become the least expensive renewable energy technology in reality [1].

1.1 Wind Energy Conversion System

In Wind Energy Conversion System (WECS), the energy is produced from the wind by employing the wind turbine and an electric generator. The wind turbine is coupled with the prime mover directly or by a gear box setup. The prime mover is coupled with rotor shaft of the generator. And the stator is connected to the standalone load or to the

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grid by some means of power electronic interface. This setup converts mechanical energy to magnetic energy and later to electrical energy for the utility grid. The block diagram of a typical Wind Energy Conversion System is shown in Fig. 1. Output power from the wind turbine can be controlled effectively within a specific range of the wind speeds bounded by cut-in (V_{w_in}) and cut-out(V_{w_out}) speeds [2].

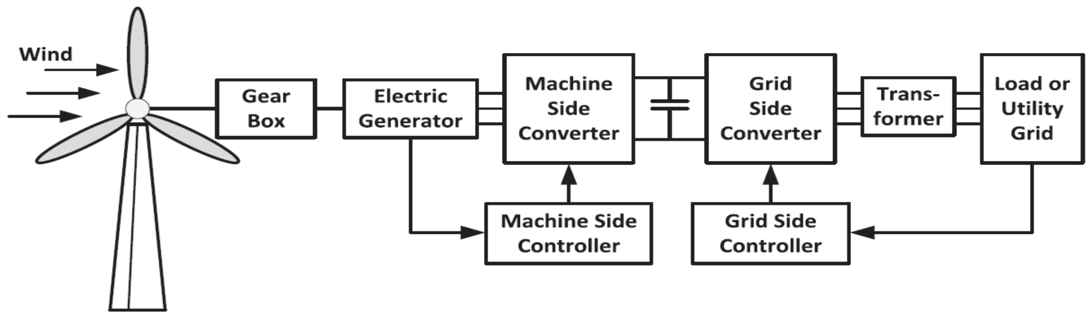

Fig. 1. Block Diagram of a Typical Grid-Connected WECS

1.2 Photo Voltaic (PV) Conversion System

In association with various renewable sources, solar PV system is dominant nowadays due to its simple structure and maintenance. A photovoltaic (PV) system is solid state semiconductor devices which produces electricity when it is exposed to the light. The structure of a solar panel mainly consists of solar cells. A photovoltaic module is formed by connecting many solar cells either in series or parallel. If PV modules are connected in series, maximum output voltage is attained, and for getting maximum output current PV modules are connected in parallel. Solar PV power systems have been recommended in many countries due to their advantages such as long term benefits and maintenance free. The major problem which lies in using the PV power generation systems is to tackle the nonlinear characteristics of PV array module. The block diagram of PV generation system is shown in Fig .2. The PV characteristics relies on the level of irradiance and temperature. PV array senses different irradiance levels as a result of passing clouds, neighbor buildings, or trees [3].

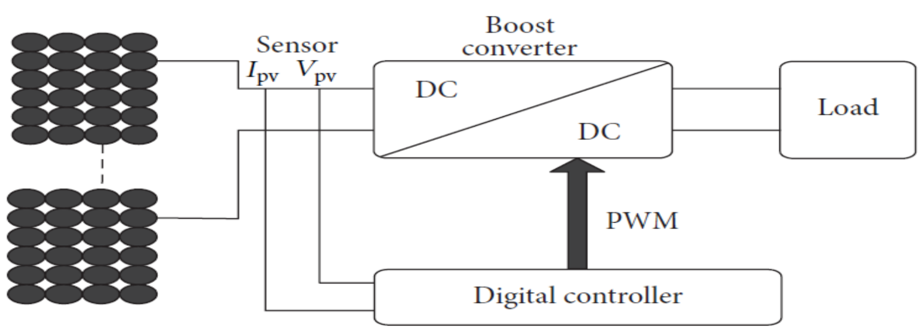

Fig .2. Block Diagram of PV Generation Systems

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II MPPT ALGORITHM

Maximum power point tracking is used to extract the maximum capable power at a particular instant of time by Maximum Power Point Tracking Controller. Many number of algorithms are developed to track the maximum power point from the available power efficiently. Most of the existing MPPT algorithms having the drawback of being slow tracking, due to which the utilization efficiency is reduced [4].

2.1 Incremental Conductance (INC)

The incremental conductance algorithm is proposed to obtain MPP operating point for an adaptive voltage step changes based on the slope. To vary the voltage step value from the curve, acceleration and deceleration factors are applied in the next iterations. The adaptive voltage step change enables the system to quickly track the environment condition variations. In this way more energy can be harvested from the renewable energy systems. It is easy to implement since it does not require knowledge of I-V characteristics of specific PV panels or wind turbines. This algorithm prefers the instantaneous conductance I/V and dI/dV for MPPT. Flow chart of the algorithm is as shown in Fig. 3. Using these two values, the algorithm determines the location of the operating point of the system showing that the PV module or wind module operates at the MPP along with left and right sides of the MPP in the curve [5].

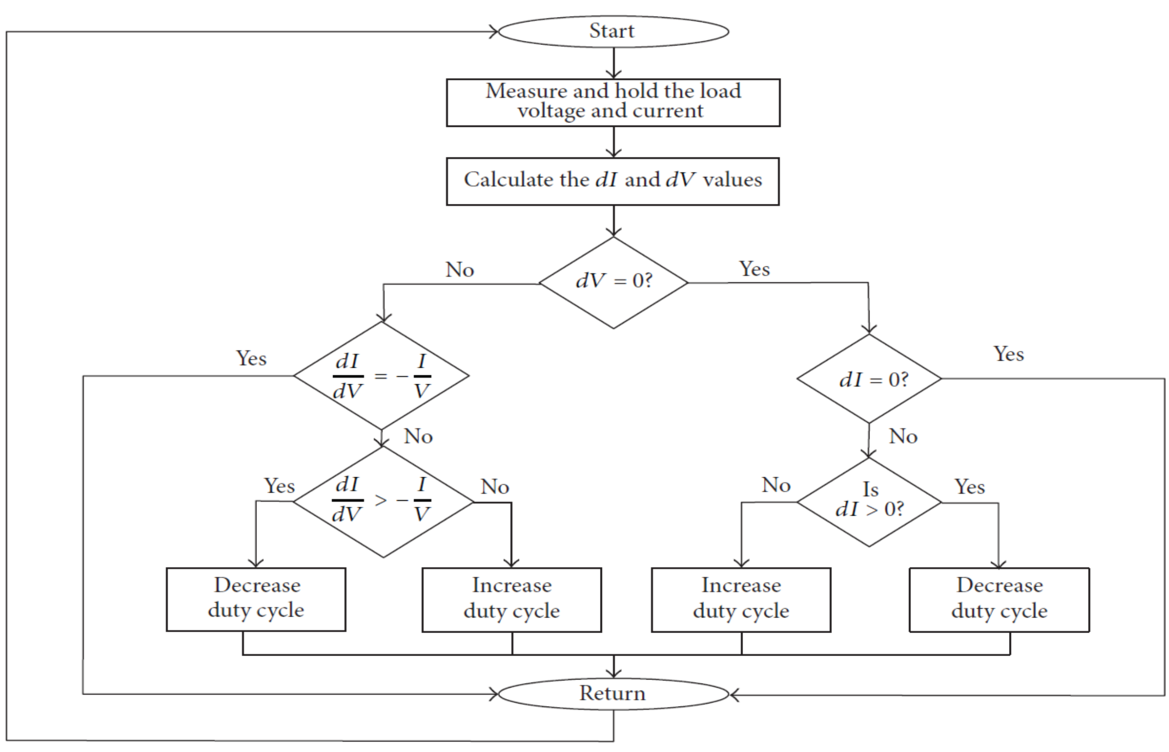

Fig. 3. Flowchart of Incremental Conductance algorithm

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The concept of INC algorithm deals with the comparison of the instantaneous panel conductance (G_S = I/V) with the incremental panel conductance (G_d = dI/dV). Hence the MPP can be achieved when instantaneous conductance is equal to the incremental conductance which means the slope of the power curve is equal to zero [6].

- When $G_d > G_{S,}$ the slope of the power curve is positive so that the operating point is at the left side of the MPP but perturbation in the same direction is needed to reach the MPP.
- When $G_d < G_{S,}$ the operating point is at the right side of the MPP and the perturbation in opposite direction is expected to reach the MPP.
- When $G_d = G_{S,}$ the slope is zero and the operating point is at the MPP.

2.2 Perturb and observe (P&O)

The Perturb and Observe method operates based on the PV array which is perturbed of a radiation of direction and the wind speed and the direction of wind. If the power dragged from the array increases, the operating point varies towards the MPP, as a result the working voltage will be in the similar direction. If the power drained from the PV array decreases, then the operating point varies away from the MPP, and the direction of the working voltage perturbation will be in opposite direction [7].

The operating point oscillates in the region of the MPP which will giving rise to the waste of energy. A number of improvements of the P&O algorithm have been developed in order to decrease the oscillations in steady state, but this hang up the speed of response during the atmospheric changes [8]. The flow chart of the Perturb and observe method is shown in Fig. 4.

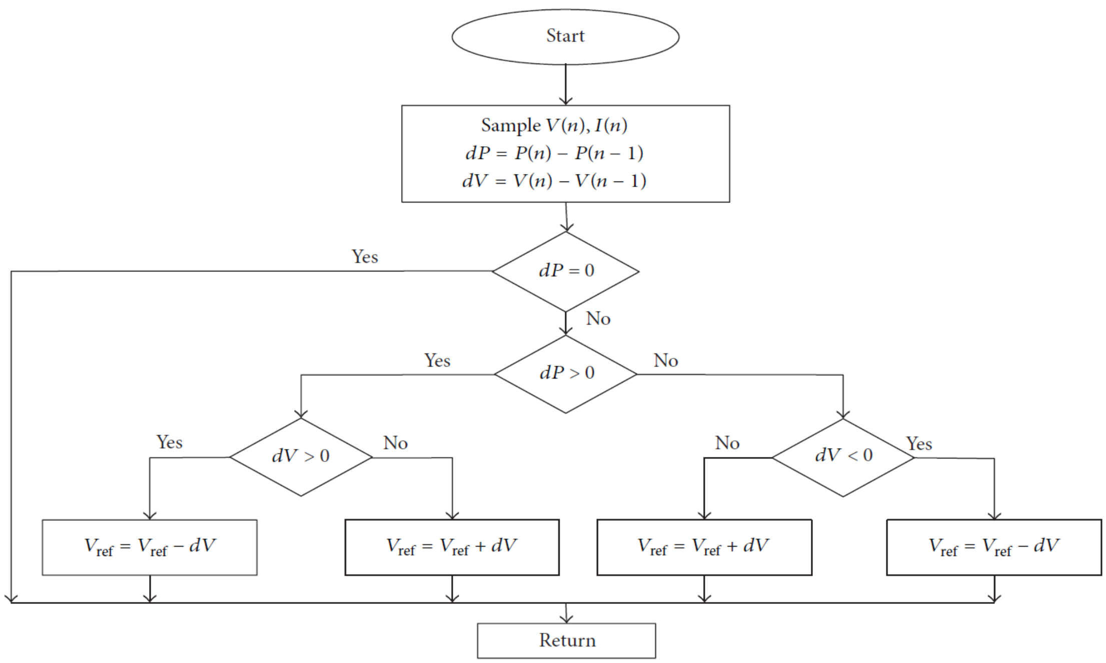

Fig. 4. Flow chart of Perturb and Observe algorithm

- When dP/dV > 0, the operating point is considered to be at the left side of the MPP and moving towards the MPP and the direction of the perturbation will be in the same direction to achieve the MPP.
- When dP/dV < 0 the operating point is located at the right side of the MPP and moving away from the MPP, then the direction of the perturbation should be in opposite direction to achieve the MPP,
- The MPP is achieved when dP/dV = 0 [9].

2.3 Hill Climb Search (HCS)

HCS method of MPPT deals with an inverted U shaped graph between power and rotor speed of the wind plant. There is a definite peak power corresponding to a particular rotor speed, this algorithm compares the present power at a particular time instant to the power obtained at the previous iteration. If the power is keep on increasing, then the duty cycle of the gating pulse applied to the converter switches are also increased to drive the operating point towards the peak power. If the power is decreasing, then the duty cycle is reduced. The major advantage of this method is its simplicity and the performance is independent of wind turbine characteristics. A severe limitation of the HCS method is its inability to track the maximum power point during suddenly varying climatic conditions. In normal HCS methods the increments/decrements given to the duty cycle are fixed [10].

2.4 Tip Speed Ratio (TSR)

TSR method modifies the rotational speed of generator in order to maintain an optimum TSR. The major limitation of this method is that wind speed should be known in prior along with the turbine rotational speed measurements. This makes the system costly, especially when considered for use with small scale wind turbines [11].

2.5 Power Signal Feedback (PSF)

PSF method makes use of reference power, which is the maximum power at that particular wind speed. This method also had an issue with the need of prior knowledge of the wind turbine characteristics and wind speed measurements. Once the reference power is achieved from the power curve for a particular wind speed, a comparison with the present power yield is done. The error is calculated then drives a PI controller based on PI control algorithm. PI control refers to Proportional (P), Integral (I) control [12].

2.6 Fractional open circuit voltage (FV_{OC})

The Fractional open circuit voltage method MPPT is based on the linear relationship between the maximum power point voltage (VMPP) and open circuit voltage (V_{OC}). This algorithm concentrated on the voltage of PV generator at the Maximum Power point which is linearly proportional to its open-circuit voltage. The proportional constant mainly depends on the material and the fabrication technology of the solar cells fill factor and the climatic conditions [13].

III CONCLUSION

With rising concerns and demands over rising energy prices, depletion of natural resources and pollution, environmentally friendly energy resources like wind energy and solar energy are becoming more important. Renewable energy is inexhaustible, safe, has no harmful by products and is capable of supplying substantial amounts of power. The unpredictable availability of those sources like wind and solar is a limitation in power generation by renewable resources. Obtaining the maximum power from the plants are possible when those are implemented with intelligent control strategies Technological advancements in wind turbine aerodynamics and power electronic interfaces, solar energy can be considered to be an excellent renewable supplementary energy sources. Power electronic interfaces and intelligent control strategies make wind and solar energies more reliable and attractive. In this paper, different MPPT algorithms and control schemes has been discussed in order to enable maximum power transfer under fluctuating environmental conditions. The basic P&O algorithm is easy to implement but it is difficult to get the accurate MPP due to oscillations in natural resources. So there is a requirement to invent some modifications in basic P&O algorithm. Voltage and current are the sensed parameters in P&O and INC algorithm. In FVOC algorithm only voltage is to be sensed also this technique is easy to implement but having disadvantage of loss of power on the disconnection of load. The INC algorithm having no oscillation like P&O and this technique can track MPP even under the sudden change in atmospheric condition unlike P&O. The disadvantage of INC is its implementation complexity, relatively large computational time and requires relatively more hardware, so this technique used for large PV array.

REFERENCES

[1] E. Koutroulis and K. Kalaitzakis, “Design of a Maximum Power Tracking System for Wind-Energy-Conversion Applications”, IEEE Transactions on Industrial Electronics, Vol. 53 [2], April 2006.

[2] Iglesias RL, Arantegui RL, Alonso MA. Power electronics evolution in wind turbines – A market based analysis. Renew Sustain Energy Rev 2011;15: 4982-93.

[3] S. Kamaruzzaman, “Optimization of a stand-alone wind/PVhybrid system to provide electricity for a household in Malaysia,” in Proceedings of 4th IASME/WSEAS InternationalConference on Energy and Environment (EE ’09), pp.435–438,2009.

[4] D. P.Hohmand M. E. Ropp, “Comparative study of maximum power point tracking algorithms,” Progress in Photovoltaics: Research and Applications, vol. 11, no. 1, pp. 47–62, 2003.

[5] A. Safari and S.Mekhilef, “Simulation and hardware implementation of incremental conductance MPPT with direct control method using cuk converter,” IEEE Transactions on Industrial Electronics, vol. 58, no. 4, 2011.

[6]Ting-Chung Yu, and Yu-Cheng Lin. "A Study on Maximum Power Point Tracking Algorithms for Photovoltaic Systems." Lunghwa University of Science and Technology, 2010, pp. 3-4-5.

[7] M. Quamruzzaman and K. M. Rahman, “A modified perturb and observe maximum power point tracking technique for single-stage grid-connected photovoltaic inverter,” WSEAS Transactions on Power Systems, vol. 9, pp. 111–118, 2014.

[8] S. Go, S. Ahn, J. Choi,W. Jung, S. Yun, and I. Song, “Simulation and analysis of existing MPPT control methods in a PV generation system,” Journal of International Council on Electrical Engineering, vol. 1, no. 4, pp. 446–451, 2011.

[9] Pawan D. Kale, and D. S. Chaudhari. "A Study of Efficient Maximum Power Point Tracking Controlling Methods for Photovoltaic System." International Journal of Advanced Research in Computer Science and Software Engineering, 2013, p. 2.

[10] Rishabh Dev Shukla, Dr. R. K. Tripathi, Maximum Power Extraction Schemes & Power Control in Wind Energy Conversion System, International Journal of Scientific & Engineering Research, Volume 3, Issue 6, June-2012.

[11] Yuanye Xia, Khaled H. Ahmed, and Barry W. Williams, Wind Turbine Power Coefficient Analysis of a New Maximum Power Point Tracking Technique, IEEE Transactions on Industrial Electronics, Vol. 60, No. 3, March 2013.

[12] Esram, T.; Chapman, P.L., "Comparison of Photovoltaic Array Maximum Power Point Tracking Techniques," Energy Conversion, IEEE Transactions on , vol.22, no.2, pp.439,449, June 2007.

[13] [5] D.P.Hohm and M.E.Ropp, “Comparative Study of Maximum Power Point Tracking Algorithms Using an Experimental, Programmable, Maximum Power Point Tracking Test Bed,” in Proc. Photovoltaic Specialist Conference ,2000, pp.1699-1702.