

Analysis of MPPT for Wind Energy Conversion System using ANN

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Abstract— This paper based on comparative study of widely-adopted MPPT techniques and using wind generator applied to wind energy conversation system. The comparison of different generator systems in literature is discussed with the criteria based on the energy yield, cost, and weight. And also for different generator and MPPT have own advantage and dis advantage. Here also some MPP techniques has cost also plays big role and more complexity in Selection procedure of MPPT technique for particular application like domestic, industrial etc.

Keywords: Wind Turbine, PMSG, Maximum Power Point Tracking, and Perturb & observe.

I. INTRODUCTION

Wind energy is gaining increasing importance throughout the world. This fast development of wind energy technology and of the market has large implications for a number of people and institutions: for instance, for scientists who research and teach future wind power, and electrical engineers at universities; for professionals at electric utilities who really need to understand the complexity of the positive and negative effects that wind energy can have on the power system; for wind turbine manufacturers; and for developers of wind energy projects, who also need that understanding in order to be able to develop feasible, modern and cost-effective wind energy projects.

Wind turbines can operate in two different ways: with fixed speed or with variable speed. Fixed-speed wind turbines are equipped with an induction generator; they are designed to operate with the maximum efficiency at one particular wind speed. This type of wind turbine has the advantage of being simple and cheap, but the disadvantage of being poor controllable and unstable. On the other hand, variable-speed wind turbines are designed to work with maximum efficiency over a wide range of wind speed. They are typically equipped with an induction or synchronous generator, and even when their electrical system is more complex than that of a fixed speed wind turbine, they have the advantage of increasing the captured energy and improving power quality through control actions implemented on the power interface.

MPPT algorithms have been widely studied, not only for wind systems, photovoltaic systems are also a typical application area for MPPT techniques it can be said that the implementation of those techniques, for PV systems or WECS is the same, except for the variables involved in the algorithms[11].

In the P&O method, the voltage is being increased or decreased with a fixed step size in the direction of reaching the MPP. The process is repeated periodically until the MPP is reached. At steady state, the operating point oscillates around the MPP.

Use automatic hyphenation and check spelling and grammar. Use high resolution (300dpi or above) figures, plots, drawings and photos for best printing result.

II. DIFFERENT TYPES OF GENERATOR

Various wind turbine concepts have been developed and built to maximize the energy harnessed, to minimize the cost, and to improve the power quality during the last two decades. Such turbine concepts can be classified with a view to the rotational speed, the power regulation, and the generator system

A. Double Fed Induction Generator (DFIG)

A second scheme to achieve variable speed is a doubly-fed induction generator (DFIG), a variation of an induction generator with a wound rotor. Note that although this is an asynchronous generator, the relative speeds of magnetic field are zero. This is because the slip (difference is speed of magnetic field of stator and the rotational speed of the rotor) is compensated by the speed of the frequency of the current in the rotor. Traditional induction generators work on a small amount of slip.

However, the DFIG works with a slip in the range of 60 to 110% During the 60 to 100% slip zone, energy is provided to the rotor from the power electronics at a frequency that ensures zero relative speed; note that the stator is still producing energy. During the 100 to 110% slip zone, energy is extracted from the rotor and fed to the grid. Above 110%, the blade pitch mechanism is triggered to limit the energy that is delivered to the rotor. The current in the rotor is at the slip frequency; hence, it must be rectified and then inverted before delivering to the grid.

B. Squirrel-Cage induction Generator (SCIG)

Fixed-speed WECS are typically equipped with squirrel-cage induction generators (SCIG), soft starter and capacitor bank and they are connected directly to the grid. This WECS configuration is also known as the “Danish concept” because it was developed and widely used in Denmark. Initially, the induction machine is connected in motoring mode such that it generates electromagnetic torque in the same direction as the wind torque. In steady-state, the rotational speed exceeds the synchronous speed and the electromagnetic torque is negative. This corresponds to the squirrel-cage induction machine operation in generation mode. That means that an increase in the active power production is possible only with an increase in the reactive power consumption, leading to a relatively low full-load power factor. In order to limit the reactive power absorption from the grid, SCIG based WECS are equipped with capacitor banks. The soft starter’s role is to smooth the inrush currents during the grid connection.

C. Permanent Magnet Synchronous Generators

The inherent nature of wind energy demands variable speed generators. The reason may be seen in the torque-rotor speed curves for different wind speeds. A constant-speed generator is able to capture energy most efficiently only for

single wind speed. The constant-speed generator captures the maximum power only for wind speed of 6 m/s; at other wind speeds, this type of generator does not operate at peak power. A variable speed turbine that can change rotor speed such that the turbine is operating at peak power for all wind speeds will yield higher energy output.

III. COMPARISON OF DIFFERENT MPPT METHODS

A. Tip Speed ratio (TSR)

The tip speed ratio, is the relationship between the speed at the tip of the turbine blade and the speed of the wind and, the power is a function of the wind speed and the rotor speed. When the TSR is optimal, the extracted energy will be of wind speed. The principle of this method is to force the system to remain at the optimal TSR by comparing with the actual operating point and sending this information to the controller [1] [2]. This method is mainly use in large systems due to the need of measuring the wind. It is one of the major drawbacks of this method.

B. Online Methods

In online methods, also known as model-free methods, usually the instantaneous values of the PV output voltage or current are used to generate the control signals. The online methods Perturbation and observation method (P&O), as well as the incremental conductance method (IncCond) will be reviewed [3].

C. Perturb and Observe

This technique can be implemented perturbing the rotational speed and observing the mechanical power, perturbing the inverter input voltage and observing the output power or perturbing the DC-DC converter duty cycle D and observing the output power.

Choosing an appropriate step-size is the main task to implement the algorithm and sometimes is not an easy task. Larger step-size can generate faster responses and more oscillations around the MPP which can represent low efficiency; on the other hand, smaller step size improves efficiency but reduces the convergence speed [5]. The Initialization of parameters is also an important aspect of this technique, some reported works suggest running a related algorithm to find the suitable values and then run the P&O algorithm.

One of the main advantages of this technique is that it does not require knowledge of system characteristics, which makes it cheap and easy to implement. But on the other hand, one significant drawback is the possibility of failure to quick changes in wind speed [1] [4]. To improve the conventional P&O algorithm, several modifications have been proposed, one of the most representative is the variable step-size [4] [5] [6], where the step-size is automatically updated depending on the operating point, then if the system is working on a point far from the MPP, the step-size should be increased to accelerate the searching and if the system is working on a point near to the MPP the step-size must be reduced. With this principle the algorithm will be fast, little oscillating, therefore efficiency will be improved.

D. Artificial Neural Networks (ANN) Method

A neural network is an artificial representation of the human body that tries to simulate its learning process. In other

words, ANN is an adaptive system that changes its structure based on external or internal information that flows through the network. However, the advantage of using ANN here is to increase the tracking efficiency of the WCES. To do so an ANN has been developed using MATLAB and trained using input dc voltage and dc current. a feed forward and also another neural network is used to train the input samples.

This network consists of three layers called an input, an output and one hidden layer. The input and output layer consists of one neuron. The hidden layer consists of ten neurons. The weight which is multiplied with input value and added together to produce a combined value as the input to the output layer. Initially the weights are chosen in such a way that to avoid symmetry problem. This situation happens when all the weights are same then the propagated errors will be the same. Therefore, the initial weights are selected as small values so that the unit activations closest to 0.5. The corresponding point of maximal weight change occurs thereof.

E. Fuzzy Logic Method (FL)

This system implements the fuzzy logic control in three stages: fuzzification, decision-making and defuzzification. During fuzzification, crisp input variables are converted into linguistic variables based on a membership function In the Decision-making stage, the rules which are specified by a set of IF-THEN statements define the controller behavior. In the defuzzification stage, the fuzzy logic controller output is converted from a linguistic variable to a numerical Variable still using a membership function. The fuzzy-logic based controllers have shown better performance and also some others advantages.

Sr.	MPPT methods	Efficiency	Sensed parameters
1	Fuzzy logic	High	Depends
2	Artificial neural networks	High (=98%)	Depends
3	P&O(fixed perturbation size)	Low	Voltage & current
4	P&O (variable perturbation size)	High(=96%)	Voltage & current
5	Tip speed ratio	Low	Wind Speed

Table 1: Comparison of characteristics of MPPT method

IV. CONCLUSION

In this paper, discussion on different types of the generator and MPPT. Generator using in WECS when scaling up, the total mass of conventional PMSG construction is significantly increased and the inactive mass (structural mass) is to be more dominant. The PMSG with the minimum cost has been defined as the most suitable generator concept. An enhanced MPPT technique using ANN will reduce system cost and increase reliability by removing the need for shaft speed sensing. Wind speed

measurements are not needed for P&O algorithms. Prior knowledge of the system parameters is not needed for the algorithm to work, making this method more reliable and less complex. Moreover, the conversion efficiency of the proposed ANN method is increased while comparing with the conventional P&O method.

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