

AN ENHANCED MPPT TECHNIQUE FOR SMALL-SCALE WIND ENERGY CONVERSION SYSTEMS

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Abstract

This paper proposes an enhanced Maximum Power Point Technique (MPPT) based on Artificial Neural Network (ANN) for small-scale wind energy conversion systems using Permanent Magnet synchronous Generators (PMSCs). The conventional MPPT technique which used a Perturb and observes (P&O) method is compared with the proposed ANN method. For this, MATLAB/Simulink is used to simulate both the conventional P&O method and the proposed ANN method. The proposed ANN uses the dc-link voltage and duty cycle as the control variables for MPPT. The advantages of the proposed MPPT are low system cost, increase reliability, less mechanical stress of the generator and no need for shaft speed sensing. Moreover the conversion efficiency of the proposed ANN method is increased while comparing with the conventional P&O method.

Keywords: Maximum Power Point Technique (MPPT), Perturb and Observe Algorithm (P&O), Artificial Neural Network (ANN), Wind Energy Conversion System (WECS).

1. INTRODUCTION

In recent years, the demand for renewable energy has been increased since the prices of conventional fuels are increased. There are different kinds of renewable energy sources available. Wind, solar, biomass renewable resources are clean whereas it reduces green house gases. Among all other sources wind energy get more attention since the easy access and fast implementation of WECS. In case of wind energy source, a wind turbine and a power conversion system are used to produce the electrical energy. For this, a number of Wind Energy Conversion Systems (WECS) are implemented as research projects. Especially in remote areas where grid access is not possible, small-scale WECS are used for residential applications. To design such type of WECS, permanent-magnet synchronous generators are used since the advantages of their compact size, high efficiency, high power density, low maintenance cost and easy control.

To extract the optimum power point in the WECS, a maximum power point tracking (MPPT) algorithm has to be implemented. The accuracy of peak power points tracked by MPPT algorithm is responsible for the amount of power output from a WECS. The maximum power extraction algorithms can be classified into three main control methods, namely Tip Speed Ratio (TSR) control, Perturb and Observe (P&O) control, and Optimum-Relation-Based (ORB) control.

TSR control method is simple. But it needs the accuracy of the wind speed measurement, which is a difficult process for such methods. The TSR control method regulates the rotational speed of the generator in order to maintain the

TSR to an optimum value at which power extracted is maximum. In this method, optimal TSR is maintained using measured wind speed and turbine shaft speed [4] and [6].

In ORB control, the MPP is tracked with the aid of optimum relation between different system variables. Many researchers use the power versus the shaft speed and the power versus the torque as the curve for MPP tracking. The power versus the shaft speed is used [9], [11] and [12]. The power versus the torque is used [7] and [13]. The use of the power versus the rectified dc-link voltage curve for MPP tracking is proposed in [14] and [15]. ORB algorithms have good dynamic response and simple implementation. Though ORB control is mostly used for WECS, it needs the prior knowledge of accurate system parameters that varies from one system to another and also may change due to system aging. This is the main drawback of this method. Therefore such methods requires continuous simulations and lab testing to acquire the prior knowledge of the system parameters.

The P&O control algorithms use the optimum relationship of the system to track the MPP by continuously changing the maximizing variable and observing the power captured. Based on the power measurements variation with the perturbation introduced, the next perturbation size and direction may be determined until the algorithm reaches the MPP. Most of the work done for MPPT using P&O has used the power-speed relation of the wind turbine [1]. But there is a possibility of using other system parameters as control variables for the MPPT, like the dc-link voltage and the duty cycle [5] which in turn will reduce the cost of system and increase reliability by removing the need for shaft speed

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