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MPPT for Wind Energy Conversion with Simplified Curve Fitting Approach

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Abstract: This paper proposes a simplified curve fitting approach to decide the duty cycle of the dc-dc converter used in WECS and thereby to track maximum power available in the wind turbine. Converter control control is another key aspect in a wind energy conversion system. A novel stand-alone wind energy conversion system based on MPPT and control curve fitting method is developed in Matlab/Simulink software in this paper. Results of simulation show that the novel wind energy conversion system can have good performance of MPPT and the high quality of output voltage.

Keywords: MPPT, wind, energy, curve, fitting

I. INTRODUCTION

Due to the increasing concern about the environment and the depletion of fossil fuels the renewable energy have been a major focus of research. To preserve our planet for the future generations, natural renewable sources are being closely studied and harvested for our energy needs. Wind energy is environmentally friendly, inexhaustible, safe, and capable of supplying substantial amounts of power. However, due to wind's erratic nature, intelligent control strategies must be implemented to harvest as much potential wind energy as possible while it is available. Because of its advantages, erratic nature, and recent technological advancements in wind turbine aerodynamics and power electronic interfaces, wind energy is considered to be an excellent supplementary energy source Research to extract the maximum power out of wind energy is an essential part of making wind energy much more viable and attractive WIND GENERATORS (WGs) have been widely used both in autonomous systems for power supplying remote loads and in grid-connected applications. Although WGs have a lower installation cost compared to photovoltaic, the overall system cost can be further reduced using high-efficiency power converters, controlled such that the optimal power is acquired according to the current atmospheric conditions. The WG power production can be mechanically controlled by changing the blade pitch angle [1]. However, WGs of special construction are required, which is not the usual case, especially in small-size stand-alone WG systems. A commonly used WG control system [2]–[4] is shown in Fig. 1(a). This topology is based on the WG optimal power versus the rotating-speed characteristic. The WG rotating speed is measured; then, the optimal output power is calculated and compared to the actual WG output power. The resulting error is used to control a power interface. In a similar version found in [5],the WG output power is measured and the target rotor speed for optimal power generation is derived from the WG optimal power versus rotor-speed characteristic. The target rotor speed is compared to the actual speed, and the error is used to control a dc/dc power converter. The control algorithm has been implemented in Lab VIEW running on a PC. In permanent-magnet (PM) WG systems, the output current and voltage are proportional to the electromagnetic torque and rotor speed, respectively. In [6] and [7], the rotor speed is calculated according to the measured WG output voltage, while the optimal output current is calculated using an approximation of the current versus the rotational-speed optimal characteristic. Pre-training by providing wind generator power characteristics is needed in the neural network based control system [8]. Due the rapid change in wind speed under real online operation conditions, the pre-training results need to be compared for proper output, which reduces the speed of control system. In [9-10], wind energy conversion systems with fuzzy-logic-based control have been presented. In which the controllers were tuned based on a polynomial curve fitting equation of the wind generator speed. In this paper a simulation studies of MPPT tracking of wind turbine have been investigated by using a simplified curve fitting approach. The primary objective of the work is to study the wind turbine model and investigate the MPPT for maximum power extraction from Wind Energy Conversion System (WECS)..

II WIND ENERGY CONVERSION SYSTEM

Fig. 1 shows the schematic diagram of PMSG based W. Wind turbine using PMSG consists of PM generator and AC-DC-AC IGBT based PWM converter. Stator winding is connected to dc load. In this paper the details of reliability analysis of the converter system is presented with load as IM. In next sections the details of modeling and power loss calculation of switching device IGBT which is integral part of the converter system is carried out.

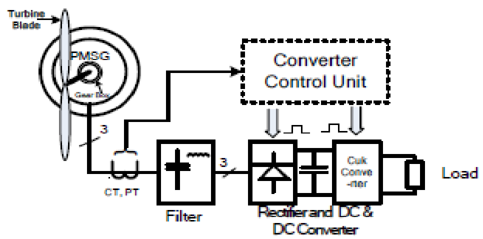

Figure 1 Schematic diagram of PMSG based WECS

III. MODELING OF WECS

The main focus of t his paper is to provide a simplified curve fitting approach for wind energy system s to extract a s much power as possible from the wind. The most important function of system modeling in this paper is t o ensure that the torque and power transfer from the wind turbine to the generator relationship is correct . It suffices to have the designed system to behave similarity to the WECS presented in literature. The system was also modeled in such a way that effects, such as tower shadow, et c., were neglected so that the system can reflect the performance of the curve fitting approach clearly.

As mentioned in Section I, the MPPT process in the proposed system is based on directly adjusting the dc/dc converter duty cycle according to the result of the comparison of successive WG-output-power measurements. Although the wind speed varies highly with time, the power absorbed by the WG varies relatively slowly, because of the slow dynamic response of the interconnected wind turbine/generator system. Thus, the problem of maximizing the WG output power using the converter duty cycle as a control variable can be effectively solved using the Curve fitting approach. In this curve fitting approach a cubic relationship has been developed between the wind speed at which we can track the maximum power available in the wind and that speed the rotor speed. This method helps us to track the maximum power available in the wind without complicated mathematical calculations.

IV. SIMULATION RESULTS

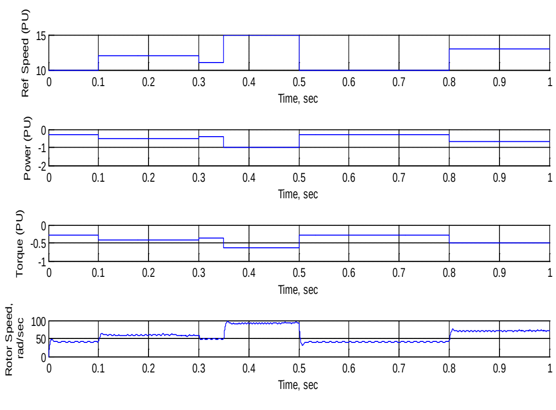

Figure 2 Simulation results of wind speed(P.u), power (p.u),output torque(p.u) and rotor speed in rpm.

First figure shows the simulation results of wind speed output power, output torque and rotor speed of the wind turbine. From figure it can be seen that even though the wind speed is varying continuously the output power does not vary by a large amount in this way we can track the maximum power available in the wind.

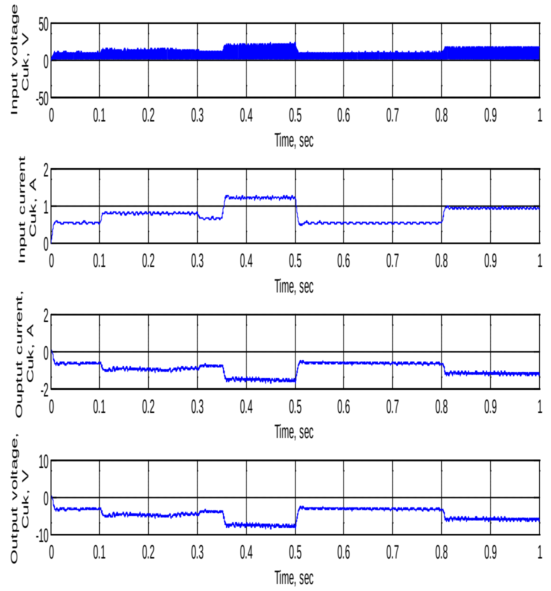

Figure 3. Simulation results of input voltage, input current, output voltage and output current.

Figure 3. shows the simulation results of input voltage , input current, output voltage and output current with respect to time. Here it can be seen that the simulation results obtained are good in which input voltage and current are always positive however output voltage and current may go negative which are very used full in many small scale dc applications.

V. CONCLUSION

From the above discussion it is concluded that the wind energy conversion system can be used for Dc application by using the by using a simplified curve fitting approach. The results show that the dc-dc converter also gives the better response by using the simplified curve fitting method and thereby maximum power can be tracked by developing a cubic relationship between the wind speed and rotor speed with the help of curve fitting approach.

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