Generation of Constant Wind Speed and Power using Fuzzy Logic Controller

Sangita Das Biswas
Department of Electrical Engineering
Tripura University
Agartala, India

Rimi Chakraborty
Department of Electrical Engineering
Tripura University
Agartala, India

Surajit Debnath
Dept.of Electrical Engg.
Tripura University
Agartala, India

***Abstract*— This paper describes a small wind energy conversion system where wind speed and as well the rotor power output is estimated to be constant with the help of Fuzzy Logic Controller. Here a 5.5 KW wind energy system is introduced with feded rotor and permanent magnet dc generator to get the constant output. A wind turbine is directly driven to a permanent magnet DC generator (PMDCG) that is considered for the proposed small wind generation system in this paper. The new control methodology means the fuzzy logic controller has been developed and evaluated in detail. Finally, the proposed method is applied to the 5.5 kW wind generation system and the experimental results are presented. This paper presents an incremental speed and output power control method which is independent from both wind speed measurement and specific systems characteristics. The control is based on the dynamic behaviour of the PMDC generator and uses fuzzy logic with constant membership function. The simulation results are obtained with the controller to show that it is possible to increase the efficiency by converting variable wind power to constant speed and output power.**

Keywords--Wind turbine, Rotor Aerodynamic, PMDC generator, FLC, Constant speed.

I. INTRODUCTION

One of the important non-polluting and demandable renewable energy sources of the world is wind energy. The application of this energy has been spreaded by wide ranges of applications. The design requirements for those applications provide high efficiency, low cost, light weight, little or no maintenance. When the wind turbine converts wind energy into electricity we need to measure wind speed .The conventional way to measure the wind speed is by the sensor named anemometer. With the help of anemometer we can easily calculate the speed of wind speed but the sensor is used to make the system bulky because we have to place number of anemometers at some distances away from and surrounding the wind turbine to get proper information .Also this sensor increases the cost .So to overcome this problem we need one controller to measure the speed and generate the constant output in the distribution section.

Depending upon the requirements one of the most promising control strategy is to use fuzzy logic controller.

In fuzzy logic controller different variables and logic is used to control the system in this paper fuzzy logic controls are applied to sense the wind speed and makes the output of the turbine constant at 5.5 KW. This controller maintains or controls the rotor side and generator side output .In this paper a complete simulation has been done for a PMDC wind generation system .All the control techniques have been verified by simulation results and system performance has been evaluated in detail.

II. EXISTING SYSTEM

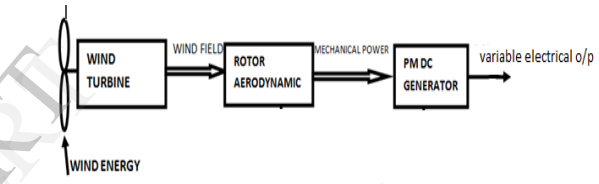

Fig 1 Existing system without controller

The wind speed is collected by the blade of wind turbine. To produce maximum wind energy, the blade angle must be turned with wind straight forward using pitch angle control of wind turbine blades. This wind energy will rotate the rotor which is actually present in the wind turbine. This rotor will generate a mechanical input power and this power will be helpful to rotate the armature which is present in the PMDC (permanent magnet dc generator). When rotor speed increases then the armature also rotates in full speed and it cuts the maximum flux flowing from N pole to S pole and by faraday law generator generates a emf. But the output of generator is an ac. By commutator we convert it into dc. If we connect a load that is load resistance RL so the circuit is closed and the current flows through the output and we get the electric output power (VIL).This output power we can use as a source voltage for any circuit. But here the wind speed is variable so for that the rotor and electrical power as output is continuously changing. If the output power is always varying so we cannot generate constant power to the grid. So for generating a constant power output we need controller to get constant power in the generating station. For we have introduced a model or new technique that is our proposed method where one new controller is come in action to generate the constant output at the generating station.

III. SIMULATION OF EXISTING SYSTEM WITHOUT CONTROLLER

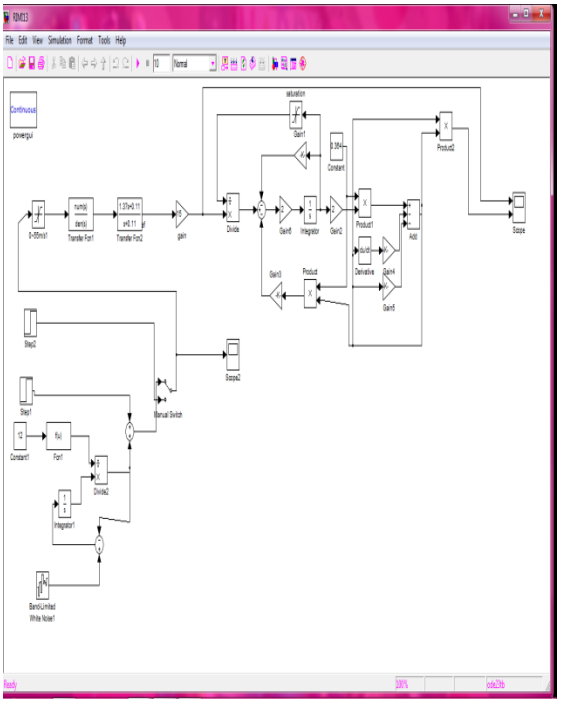

Fig 2 Simulation model of Existing system without controller

IV. GRAPH OF ROTOR SPEED AND POWER WITHOUT CONTROLLER

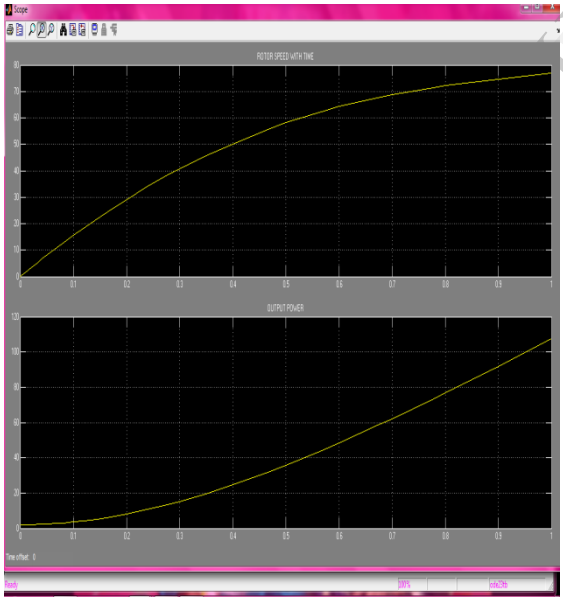

Fig 3 Results of uncontrolled speed and power

V. WIND FIELD VARIATION & CORRESPONDING POWER WITH VARIABLE GAIN WITHOUT CONTROLLER

Table 1 Results of uncontrolled speed and output

GAIN OF ROTOR	NOISE POWER (watt)	WIND SPEED MAX. (m/s)	ROTOR SPEED MAX. (m/s)	GENERATOR OUTPUT(watt) MAX.	GAIN OF THE GENERATOR	
15	0.1	4.0074	3.3	14.32	10	5
20	0.2	4.0102	4.4	62	15	10
25	0.7	4.0188	5.5	154	20	15
30	10	4.074	6.7	304	25	20
35	15	4.090	7.8	530	30	25
40	20	4.109	8.9	860	35	30
45	25	4.116	10	1320	40	35
50	30	4.123	11.2	1940	45	40
55	35	4.139	12.4	2780	50	45
60	50	4.264	13.6	3700	55	50

VI. WIND FIELD VARIATION & CORRESPONDING POWER WITH CONSTANT GAIN WITHOUT CONTROLLER

Table 2 Results of controlled speed and power

GAIN OF ROTOR	NOISE POWER (watt)	WIND SPEED (m/s)	ROTOR SPEED (m/s)	GENERATOR OUTPUT(KW)	GAIN OF THE GENERATOR
200	0.1	4.0074	43	2.62	2
150	0.1	4.0074	33	2.45	2
100	0.1	4.0074	23	2.36	2
15	15	4.09	3.4	2.134	2
8	10	4.066	2.3	2.121	2
6	5	4.057	1.17	2.1072	2
4	0.3	4.048	0.068	2.0947	2
2	0.2	4.033	0.044	2.09469	2

VII. DISADVANTAGES OF EXISTING SYSTEM

The main disadvantage of the existing system is that it is not having any controller so that there is no control in its output. For that the output is gradually increasing and time by time the power is also increasing so we cannot get any constant output power in the distributing section which we will not send to the customer as per our demand.

VIII. PROPOSED SYSTEM

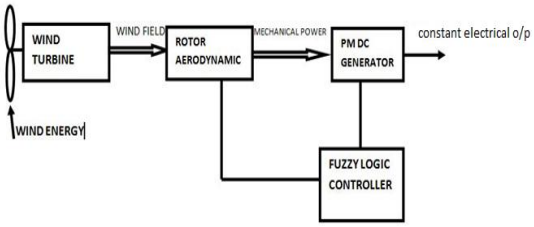

Fig 4 Proposed System with Controller

The proposed system that is wind turbine model with the controller gives us a constant electrical output that is the overcome of the existing system. Here the controller we used is a intelligent system that is Fuzzy logic controller (FLC).The FLC is used as a sensor because it sense the maximum power at a particular wind speed. So when wind speed varies then it just collect the wind speed at which power is maximum so to design such type of FLC we need a membership function. It works on the principle of 0 or 1,in membership function the input is variable and the output is always constant that is 1.So it is very helpful to generate a constant output for variable input .By if we can generate different types of wave and have a maximum constant value 1 always for a input value. Such types of waves are trapezoidal, sigmoidal, dissigmoidal, triangular etc.

IX. SIMULATION OF PROPOSED BLOCK WITH CONTROLLER

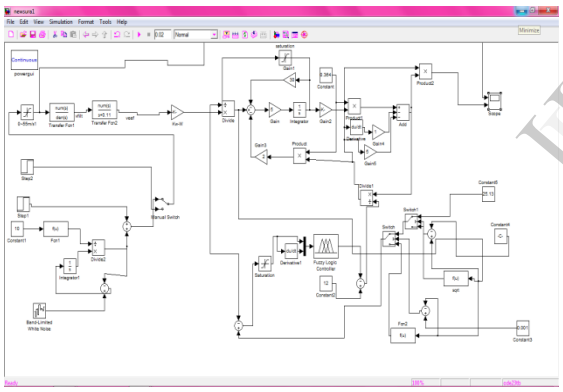

Fig 5 Simulation model of proposed block with controller

X. GRAPH OF SIMULATION OF PROPOSED BLOCK WITH CONTROLLER

Fig 6 Results of controlled speed and power

XI. ADVANTAGES OF PROPOSED SYSTEM

With the help of the controller that is the fuzzy logic controller is used to stable the system. It gives the constant wind speed and as well as the constant output power that is the only aim of the proposed system. That means by the use fuzzy logic controller the electrical output will be always constant.

XII. CONCLUSION

In this paper the fuzzy control of wind energy conversion system in order to get constant output power is obtained and verified through the simulation. The main goal of implementing fuzzy controller is to continuously adapt the constant power of the generator and the wind speed in a way that the turbine operates at its optimum. The advantages of using fuzzy controller are verified by its simulation results, fast response, and parameter insensitivity. Implemented system has satisfactory, dynamic and static performances.

REFERENCE

[1] H. Karimi-Davijani,1A. Sheikholeslami, H. Livani and M. Karimi-Davijani," Fuzzy Logic Control of Doubly Fed Induction Generator Wind Turbine", World Applied Sciences Journal 6 (4): 499-508, 2009, IDOSI Publications, 2009

[2] Simoes, M. G., Bose, B. K., Spiegel, R. J., Design and Preformance Evaluation of a Fuzzy Logic-based Variable Speed Wind Generation System, IEEE Transactions on Industry Applications, Vol. 33, pp. 956-965, July/August. 1997

[3] Xibo Yuan, Fei (Fred) Wang, Dushan Boroyevich, Fellow, Yongdong Li and Rolando Burgos, Member, IEEE "DC-link Voltage Control of a Full Power Converter for Wind Generator Operating in Weak-Grid Systems" IEEE Transactions On Power Electronics, September 2009.

[4] Wei Qiao, Wei Zhou, José M. Aller, and Ronald G. Harley, Fellow, IEEE "Wind Speed Estimation Based Sensorless Output Maximization Control for a Wind Turbine Driving a DFIG" IEEE transactions on power electronics, may 2008.

[5] Yuanye Xia, Khaled H. Ahmed, and Barry W. Williams "A New Maximum Power Point Tracking Technique for Permanent Magnet Synchronous Generator Based Wind Energy Conversion System" IEEE transactions on power Electronics, vol. 26, no. 12, december 2011

[6] D.Aouzellag , K.Ghedamsi,, E.M.Berkouk " Power Control of a Variable Speed Wind Turbine Driving an DFIG" Electrical engineering Department, A.Mira University, Bejaïa, Algeria.

[7] Y¨uksel O¨GUZ1, ¨Irfan GUNEY2 "Adaptive neuro-fuzzy inference system to improve the power quality of variable-speed wind power generation system" Turk J Elec Eng & Comp Sci, Vol.18, No.4, 2010, _c TU¨BI¨TAK.

[8] Evgenije Adzic*, Zoran Ivanovic*, Milan Adzic**, Vladimir Katic "Maximum Power Search in Wind Turbine Based on Fuzzy Logic Control" Acta Polytechnica Hungarica Vol. 6, No. 1, 2009.

[9] Marcelo Godoy Sim˜oes, Member, IEEE, Bimal K. Bose, Life Fellow, IEEE, and Ronald J. Spiegel, Member, IEEE, "Design and Performance Evaluation of a Fuzzy-Logic-Based Variable-Speed Wind Generation System" , IEEE Transactions On Industry Applications, Vol. 33, No. 4, July/August 1997.

[10]. Simoes, M. G., Bose, B. K., Spiegel, R. J., Fuzzy Logic-based Intelligent Control of a Variable Speed Cage Machine Wind Generation System, IEEE Transactions on Power Electronics, Vol. 12, pp. 87-95, Jan. 1997