International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 02, February-2019

Maximum Power Generation in Horizontal Axis Wind Turbine using Wireless System

Subashri M S
PG Scholar,
EEE ,Coimbatore Institute of Technology
India.

Dr. Devi Shree J
Associate Professor ,
EEE, Coimbatore Institute of Technology,
India.

Abstract: **Renewable energy is regarded as one of the major source for cleaner energy. Among all, Wind energy have become an important indispensable force in solving the world's energy issues. Real time monitoring and wind power generation is important due to the rapid development of wind energy. The wind direction and speed momentarily change, inorder to maintain the stable operation of wind, the control technique is integrated with wireless sensor. The PSO based MPPT algorithm is used to improve the performance by generating maximum power in variable wind velocity. The optimal value of output power is tracked by this technique. ARM controller is used for interfacing sensor and control the process in wind system.**

Keywords: HAWT, PSO, Stable Power, wireless system.

I. INTRODUCTION

Wind energy is one of the bountiful and economical renewable energy technology for new electricity generation in the world today. The electricity generating wind turbines employ proven and tested technology and therefore provides a secure and sustainable energy supply. At windy sites, wind energy successfully competes with conventional energy production [3]. Energy demand, in particular electricity production, has resulted in creation of fossil fuel based power plants that let out substantial greenhouse gases into the atmosphere causing climate change and global warming. The growth of Renewable Energy in India is enormous and Wind Energy proves to be the most effective solution to the problem of depleting fossil fuels, importing of coal, greenhouse gas emission, etc.Wind energy as a sustainable, non-polluting and inexpensive source, directly avoids dependency of fuel and transport, which leads to green and clean electricity. India continues to be the second largest wind market in Asia. The worldwide installed wind power capacity reached 435 GW by the end of 2015. China (148,000 MW), US (74,347 MW) and Germany (45,192 MW) are ahead of India in fourth position. The Indian wind industries has created a record with an installation of 3414.65 MW in 2015-16. This surpasses the installation of 3197 MW in 2011-12. The wind energy share is 63% of the total renewable energy capacity of 42752 MW and 8.86% in total energy installation of 302 GW as on 31st March 2016. Wind power accounts nearly 8.6% of India's total installed power generation capacity and generated 28,604 million kWh (MU) in the fiscal year 2015-16 which is nearly 2.5% of total electricity generation. The Government of India has announced a of 175GW by 2022 over renewable energy technology from which 60GW will be from wind power. The government has also indicated its support for rapidly growing renewables power sector. It is The state of Tamil Nadu has set a record for itself. Muppandal, a small village in Kanyakumari District is the most important site of wind farm in the state of Tamil Nadu. The unexploited resource availability sustains the growth of wind energy sector in India in the years to come.

An aggregate wind power capacity of 71 MW has been set at 33 locations in 9 states such as Tamil Nadu , Andhra Pradesh, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Rajasthan and West Bengal. Demonstration projects are executed through the Governments, Nodal Agencies or Electricity Boards of the state.

The state consists of various renewable energy sources such as Wind, Solar, Biomass, Biogas, Small Hydro, etc. Municipal and Industrial wastes could also be useful sources of energy while ensuring safe disposal.

TABLE I: Monthly Electricity Generation in India

MONTH 2017	Total (GWh)
January	2,308.45
Febrauary	2,485.97
March	2,355.65

II EMERGING TECHNOLOGY

Latterly, inexpensive and flexible wireless sensors have appeared as an enabling technology for monitoring applications [2][3]. The sensors are installed within a large structure to measure the dynamic response and from the embedded computational abilities collocated with the sensor itself, performs engineering level monitoring algorithms [4][9].

Wireless pervasive computing is a rapidly growing area that has attracted significant attention in recent years because of its ubiquitous deployment throughout our society. It is widely accepted that pervasive computing is having a tremendous impact on the way live our life, conduct businesses, communicate with each other, and many other areas of life. Most of the technology enablers that make wireless pervasive computing feasible have been deployed with little consideration to the energy they consume during their operations.

Wireless sensor network is regarded as a viable technology for data collection and monitoring large structure as well as structures located in remote locations [11] .Wireless sensors also determine wind speed and kilowatt-hour production automatically so that the supervisors take less time to collect data and make insightful analysis and decisions[15].

A. Advantages Of Wireless Power For The Wind Industry:

- Overcome the operational constraints of power cables and mechanical components.
- Enable the creation of highly differentiated products with unique competitive advantage.
- Solve continuity of delivery and equipment maintenance problems.
- Provide new design options for new and existing products.
- Reduce operations and maintenance costs in wet, dirty work environments and in applications with moving components.

III. PROPOSED CONFIGURATION

In order to capture stable wind energy, smooth the wind turbine torque fluctuation and eliminate the unbalanced loads on the wind turbine, the individual pitch control strategy which directly controls the edgewise moment, is proposed based on the multi-stage dynamic weight, coefficient distribution of the pitch angle, and according to the blade. The robust efficient remote maintenance strategy to guarantee uninterrupted power in the modern wind systems. This wireless surveillance allows an early detection of mechanical faults. It must be able to prevent major component failures. That facilitates a proactive response, anticipates the final shutdown of wind generators, minimizes downtime and maximizes productivity by analyzing continuously the measured physical signals collected from different types of sensors. To maintain the stable operation in the wind turbine, wireless sensor are used. In the proposed system, the single wind system is controlled using the wireless sensor. The wired technologies have the greatest drawback of using cable and it is impossible to use for long distance and not a reliable one also. The figure1 shows the block diagram of the proposed system.

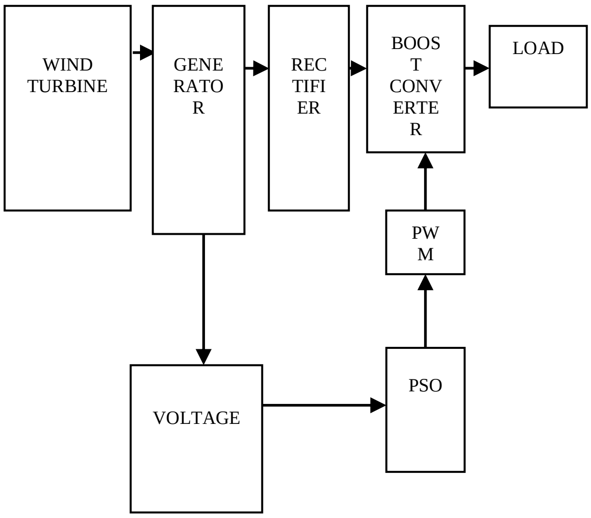

Figure 1: Block Diagram

A.PSO

PSO technique for wind Energy is proposed [8]. The feasibility of the proposed method was demonstrated for Boost converter and inverter. The results indicate the applicability of the proposed method to the wind energy system. In the multidimensional space where the optimal solution is sought, each particle in the swarm is moved toward the optimal point by adding a velocity with its position[5][7]. The particles move around the multifaceted search space until they find the optimal solution. The modified velocity of each agent is calculated using the current velocity and the distance from Pbest and Gbest as given below in equation (1)

Vik+1 = wVik +c1 rand1(…) x (pbesti-sik) + c2 rand2(…) x (gbest-sik) (1)
i=1,2,3,....N_D

Where, Vik=Velocity of agent i at iteration k,
w=weighting function,
c1,c2 = acceleration factor, rand uniformly distributed random number between 0 and 1
sik= Current position of agent i at iteration k, pbesti of agent i, gbest of the group.

Using the above equation, a certain velocity, which gradually gets close to Pbest and Gbest, is calculated. Each individual moves from the current position to the next one by the modified velocity in (2) using the following equation:

$$X_{ij}^{t} = X_{ij}^{t-1} + V_{ij}^{t} \qquad (2)$$

Where,t = Iteration count
V_{ij}^{t} =Dimension i of the velocity of particle j at t iteration t
X_{ij}^{t} = Dimension i of the position of particle j at t iteration t
w = Inertia weight

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 02, February-2019

Finally, PSO algorithm maintains the best fitness value achieved among all particles in the swarm[6]. It is called the global best fitness. The PSO algorithm consists as follows:

1. Initialize the population, location and velocity.
2. Evaluate the fitness of the individual particle (P_{best}).
3. Keep track of the individual highest fitness (G_{best}).
4. Modify velocity based on P_{best} and G_{best} location.
5. Update the particle position.
6. Terminate if condition is met else go to step 3.

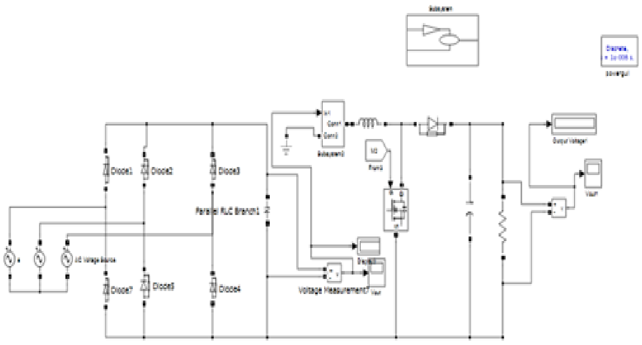

Figure2:Simulation Circuit for proposed system

The proposed system shown in figure 2 is simulated and the result are shown in figure 3,figure4,figure5 using MATLAB R2014a software.

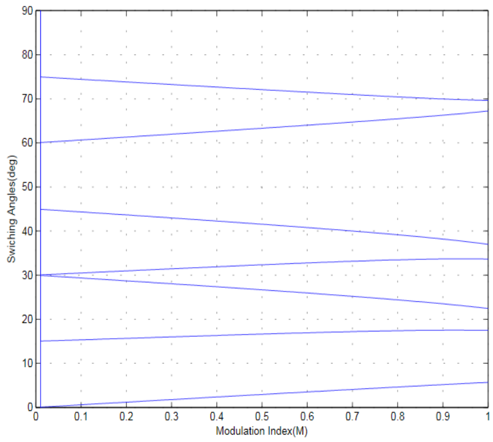

Figure 3: Simulation Output of Modulation Index Result for Proposed System

The switching angles are obtained for the entire possible range of modulation index (between 0and 0.9).

The following objective function should be minimized to obtain the solution:

$$F=\text{Min}\left\{\frac{16}{\pi^2}\left[\left(1+\sum_{i=1}^{7}(-1)^i\cos(\alpha_i)\right)-M\right]^2+\left[\left(1+\sum_{i=1}^{7}(-1)^i\cos(n\alpha_i)\frac{4}{n\pi}\right)\right]^2\right\} \qquad (3)$$

The objective function F is subjected to the following constrain:

$0 < \alpha 1 < \alpha 2 < \alpha 3 < \alpha 4 < \alpha 5 < \alpha 6 < \alpha 7 < \pi/2$

IV SIMULATED SYSTEM AND PERFORMANCE EVALUATION

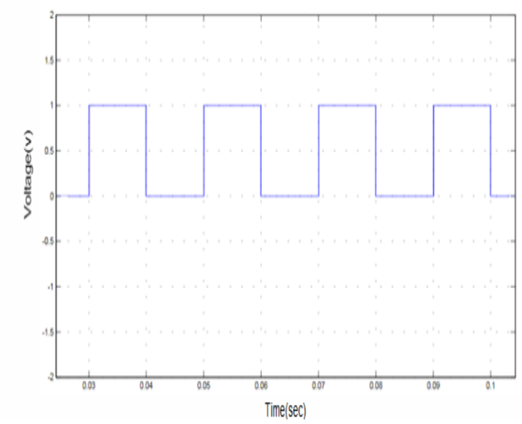

Figure 4: Pulse output

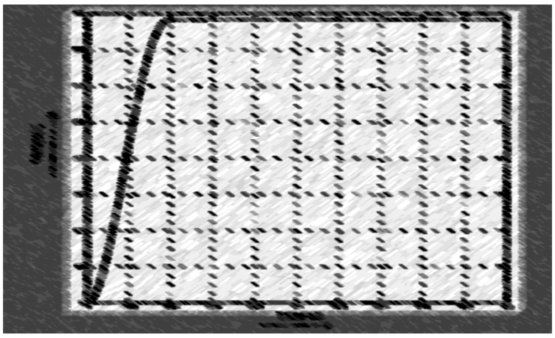

Figure 5: Simulation Output Result of converter

The system is tested with different input voltages. The output of the wind generator is given as the input to the rectifiers. The rectifier which rectifies the AC and the DC output is obtained. The PSO code is compiled and the modulation index is generated, the optimum value of pulse is obtained and given to the boost converter, from the converter, the boosted and stable output is obtained for varying voltage input. The DC voltage is boosted by boost converter and thus always maintains a constant output voltage of 391V.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 02, February-2019

V HARDWARE DESIGN

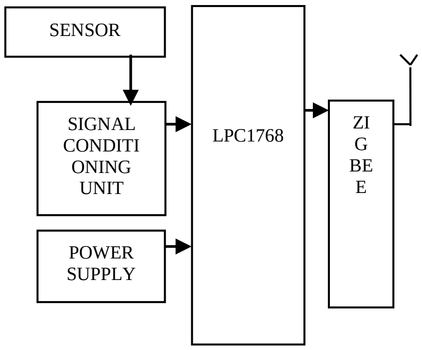

Figure 6 : Transmitter Block

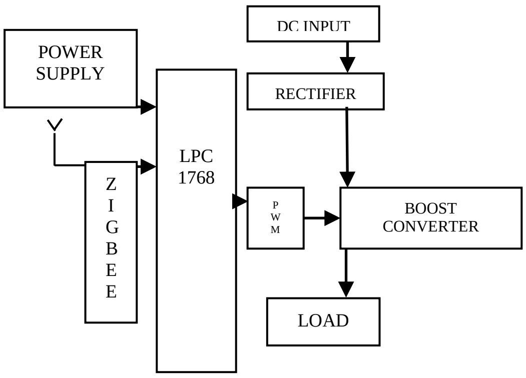

Figure 7: Receiver Block

The wired technologies have the greatest drawback of using cable and it is impossible to use for long distance and not a reliable one also. In the proposed work, the sensor is fixed near the wind blades to sense the wind speed, the zigbeeTrasmitter transmit the sensed data from the turbine to the control unit.The Transmitter unit shown in figure 6 is placed in turbine to sence the wind speed.

The zigbee receiver shown in figure 7 is placed at the control unit, the receiver receives the signal and give the output signal to the controller, based on the wind speed input the controller output is obtained. In this work for varying wind speed the constant output is obtained. The zigbee is low power as compared to other wireless technology.

The table2 shows the components used for hardware. The holes type pulley is attached in the motor shaft. The pulley is rotated across the USLOT. The USLOT consists of IR transmitter and receiver.

Infrared transmitter is one type of LED which emits infrared rays generally called as IR Transmitter. Similarly IR Receiver is used to receive the IR rays transmitted by the IR transmitter. One important point is both IR transmitter and receiver should be placed in straight line to each other.

The IR receiver LED is conducting due to the IR rays received. Now the VCC +5V is given to the input of the NOT gate (IC7404) and zero taken as output. When motor is rotating, the pulley attached in the shaft also rotating, so it interprets the IR rays between transmitter and receiver. So more than 0.7V is goes to the base of the transistor. Now the transistor is conducting so it shorts the collector and emitter terminal. The zero voltage is given to inverter input and +5v is taken in the output. When supply is ON, the IR transmitter LED is conducting it passes the IR rays to the receiver. Then it is given to microcontroller in order to count the pulse.

This pulse rate converted into speed by calculating with respect to Time. If it is calculate with respect to minute or second then it is a RPM/RPS respectively. Hence depends on the motor speed the zero to 5v square pulse is generating at the output.

The transformer is connected, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.
A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies
CC2500 is wireless transmitter receiver is used which It has 30m range with onboard antenna. It
is always used with microcontroller which supports SPI communication. LPC1768 microcontroller is used.
The results of hardware is shown in figure9, its shows the stable output for varying wind speed.

COMPONENTS	**DETAILS**
Motor	**12V**
Sensor	**U slot**
Microcontroller	**LPC1768**
Zigbee	**CC2500**
Power LED	**5V**
Display	**LCD**

TABLE II: Components of Hardware

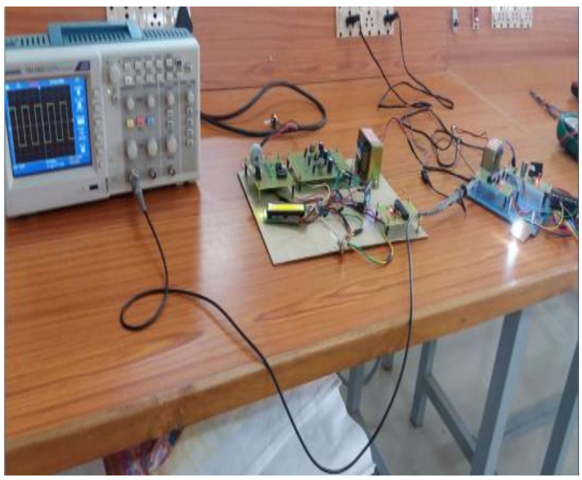

Figure 8: Hardware Model

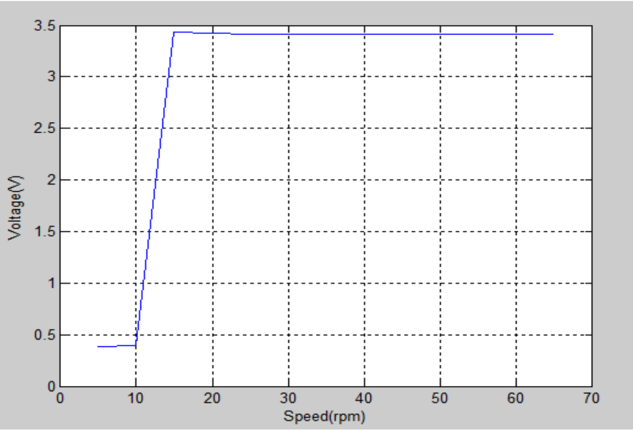

Figure 9: Voltage Output

CONCLUSION

The Real time monitoring wind power generation system is important due to the rapid development of wind power turbine. The wireless system such as sensor and Zigbee are used. The sensor sense the wind speed and send to the controller. To maintain the stable operation of wind, the control technique is integrated with wireless sensor. The PSO based MPPT algorithm is used to improve the performance by generating maximum power in variable wind velocity. Soft computing technique is used to track the optimal value of output power in simulation. ARM controller is used for interfacing sensor and control the process in wind system. In the proposed work, the single wind system is controlled using the wireless sensor. To maintain the stable operation of wind, the control technique is integrated with wireless sensor where the efficient output is obtained. The stable output is obtained in both simulation and hardware.

In addition to overcome and detect the problem within the time period, the wind farm in future is to be protected with wireless system and also to obtain the optimized output, the efficient control technique is to be implemented in wind system using wireless.

REFERENCES

[1] Bin luyaoyu, xinwu and zhongzhou yang (2009), "A review of recent advance in wind turbine condition monitoring and fault diagnosis ",in *IEEE Power Electronics and Machines in Wind* Application,978-1-4244-2487-0/09.

[2] Weixuan Li, Daoyong Sun (2009), "The Design of Automatic Control System for Wind Turbine " in *IEEE Power Energy Engineering Conference*,978-1-4244-4936-1/09.

[3] Chandra Bajracharya, Robin Grodi, Danda B. Rawat(2015), "Performance Analysis of Wireless Sensor Networks for Wind Turbine Monitoring Systems", in *IEEE South East Conference*.

[4] LI Lin SHEN Ming-xia (2010), "Design of a Wind Power Generation Monitoring System Based on Wireless Sensor Network" in *IEEE International Conference on Intelligent System Design And Engineering Application.*

[5] M.A. Abdullah, A.H.M. Yatim, C.W. Tan, A.S. Samosir(2012)," Particle Swarm Optimization-Based Maximum Power Point Tracking Algorithm for Wind Energy Conversion System ",in *IEEE International Conference on power and Energy,2-5.*

[6] Kishore Kumar Das, DrMrinal Buragohain(2015), "An algorithm approach for Maximum Power Point Tracking of wind turbine using PSO" in *IJAREEIE*,vol.4.

[7] Haytham Abdelgawad and Vijay Sood(2016),"Boost converter controller Design based on Particle Swarm Optimization(PSO)",in *International Journal on Power Engineering and Energy,vol.7-No.2.*

[8] BhagyashreeMendhule, Swati Kantode, DeepaliKadu(2014), "Monitoring System for Wind Power Generation Based on Wireless Sensor Network", Discovery, Volume 19, Number 59.

[9] Chilamkurti, Sherali Zeadally, Abbas Jamalipour and Sajalk Das(2010), "Enabling Wireless Technologies for Green Pervasive Computing And Networking",in *EURASIP journal on Wireless communications and Networking*,20102009:230912.

[10] Z. Hameeda, Y.S. Honga, Y.M. Choa, S.H. Ahnb, C.K. Songc(2009), "Condition monitoring and fault detection of wind turbines and related algorithms: A review ", in *Renewable and Sustainable Energy Reviews , ELSEVIER*, volume 13.

[11] Wu Chunming, Cheng Liang(2012), "Monitoring System for Wind Power Generation Based on Wireless Sensor Network", in *International Conference on future Electrical Power and Energy System*, Energy Procedia 17.

[12] N.Yogesh Murthy (2013)," A Review On Power Electronics Application on Wind Turbines",*International Journal of Research in Engineering and Technology*, Volume: 02 Issue: 11.

[13] Zhenlan Dou, SiminPeng, Zhibin Ling and XuCai(2013), "Reduction of Wind Turbine Torque Fluctuation Using Individual Pitch Control Based on Edgewise Moment" in *Research Journal of Applied Sciences, Engineering and Technology* 5(24): 5665-5676.

[14] SaadChakkor, MostafaBaghouri, Abderrahmane Hajraouibine(2014), "wind Turbine Fault Detection System in Real Time Remote Monitoring", in *IJECE*, Vol.4, No.6.

[15] K.Vigneswaran, DrP.Suresh Kumar(2016)," Maximum Power Point Tracking (MPPT)Method in Wind Power System",in *International Journal of Innovative Research in Science, Engineering and Technology*,Vol. 5, Issue 1.