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Indigineous Vertical Wind Turbine

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Abstract: An indigenous vertical wind turbine is designed to overcome the need of electricity especially in remote areas since it can be installed easily anywhere. Conventional wind turbines are huge and expensive to install at homes or in the areas where there is no electricity especially in rural areas. This wind turbine is designed with an idea of easy installation and it can be de-assemble by a common man. Alternate source of energy will be capable of producing substantial annual power as well as it can give financial savings also. Portable wind turbine can be installed in areas where grid connectivity is not present i.e. rural areas, it works great in remote locations where short fall of electricity is high or no electricity is present [1]. Wind turbine is an "eco-friendly" source of producing energy since it doesn't emit toxic gases which is harmful for the environment.

Keywords: Vertical wind turbine, Energy, renewables, distributed generation.

I. INTRODUCTION

Pakistan is not using alternative resources of energy as its major source of producing electricity. The cost of energy resources have been on the rise, and we depend heavily on oil, natural gas, hydro and nuclear as primary source of energy. Now it's time to start looking at other resources of energy i.e. Wind, Solar etc. Wind energy is considered to be more reliable and feasible source of energy since there is plenty of potential places available in our country where wind turbine can be installed easily. It is the world's fastest growing energy resource since it is clean and renewable. Pakistan Meteorological Department (PMD) has already completed one of the project entitled "Wind Power Potential Survey of Coastal Areas of Pakistan (Phase-1)" to find out the available potential of wind energy in Pakistan [2].

As demand for energy has been increasing day by day, this increase will be further in next ten years. Currently 45% of energy is being produced by Oil, natural gas produces 34% of energy, while hydro and nuclear accounts for the remaining 21%.

Wind energy is consider to be a cheap and emissions free source of producing electricity. Alternative resource of energy have never been explored on the serious basis in Pakistan [2]. Energy produce from wind can reduce dependence on fossil fuel and also provide better way for expanding the supply of power to the remote locations where grid cannot be connected.

A recent survey conducted by Pakistan Meteorological Department (PMD) found that there is a potential exists for harvesting electricity from wind energy especially along Sindh coastal belt [2].

II. OBJECTIVE

The main objective of this project is to find out the available options that are available to replace grid-powered system with a single system that could be able to produce required energy under challenging conditions. Renewable energy source selected for this project is a vertical wind turbine.

Most of the power infrastructures increase the use of renewable energy resources in addition to the current generators to make the environment less polluted. The size of the system is kept smaller as to make it a portable system with an easy foldable mechanism. Vertical Wind Turbine prototype was designed to see the usage of wind energy as a possible source of electrical power.

III. DESCRIPTION

Wind turbine is used to harvest electrical energy through wind. It is divided into different parts including blades and generator. Wind turbines are categorized into two types which are vertical and horizontal wind turbine. Wind turbine can be used for many purposes, a smallest wind turbine can be used to charge batteries, slightly larger turbines are used for domestic needs having following configuration as shown in figure 2.

II. LITERATURE REVIEW

Types of Wind Turbines:

Two types of wind turbine are widely used all over the world, one is horizontal axis turbine which is consider to be most commonly type and other type is vertical axis turbine which are consider to be unconventional turbines since they are used widely for special purposes [3].

- It is a type of turbine in which rotor shaft is transverse to the wind, while the other components are installed at the base of it as shown in figure 1. Such arrangement let the generator installed to the ground [3]. VAWTs do not need to be pointed into the wind which removes the need for wind-sensing and orientation mechanisms.

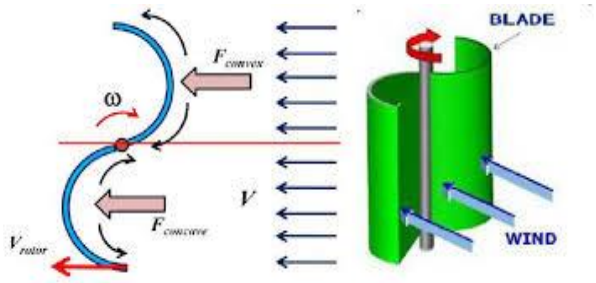

Fig. 1: Vertical Axis Turbine (VAWT)

- In horizontal Axis Wind Turbines, rotatory part of wind turbine is directly connected with electrical generator through shaft at the top of tower and faces wind directly. Small turbines are pointed by a simple wind vane, while large turbines generally use a wind sensor coupled with a servo motor [3]. Gearbox is used to turn the slow rotation of the blades into a quicker rotation in order to derive the electrical generator.

Alternator:

It produces an alternate current (AC) by converting mechanical rotation into electrical voltage. They are used in automobiles for battery charging and to power the electrical system of an automobile including lights, sensors and other parts. Diode rectifiers are used to convert AC into DC, in addition voltage control IC is also used so the when the battery is fully charge it will cut off the system from further charging.

Inverter:

It is used to convert DC into AC for different purposed, by means of switches direct current is converted into alternating patters. Inverter can be square wave, sinusoidal or quasi sine wave.

Classification of Inverter:

Inverters are divided into three different types,

1. Standalone Inverter
2. Grid-tie inverter
3. Battery backup inverter

In isolated systems stand-alone inverters are used where it takes supply from batteries which are charged by Wind turbines or solar energy systems. Grid-tie inverters are another type of inverter which are widely used nowadays since there is no need to install batteries generated energy will go to the grid directly after converting into AC. Battery backup inverters are special category type device, it manages the battery charging with the help of charge controller.

V. FEATURES

This project consists of a portable compact wind turbine with an improved rotation on slower wind speed that is connected to an alternator with a DC to AC converter (inverter) based on switching of field effect transistors (FETs) connected to the system. The project also has automatic switching circuit that shuts the load from renewable power whenever the battery level falls down. This system offers the following advantages:

- Reduce inverter cost
- Reduce cost of inverter filter
- Improved system's efficiency.

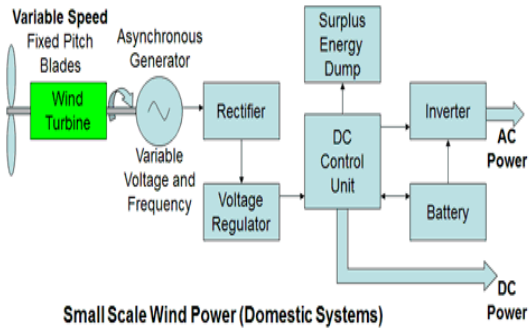

Fig. 2: Wind Turbine Block diagram

Turbine design is the main component of this project. The turbine design tells us that whether the wind force will move the blades or not. While choosing the blades design for our wind turbine we chose the Savonius type design. As we are working on portable design so we prefer Vertical Axis Wind Turbine having following specifications as given in table below.

Table 1: Vertical Wind turbine specifications

Turbine	Vertical axis
No of blades	4
Height	24 inches
Width	22 inches
Area of base	5 sq. feet
Length of mover	6 feet
Gears ratio	1:10

The alternator we used in this project is the same as described above as it is cheaper and is easily available [4]. This alternator required to be charged as the stator needs to be magnetized so a mechanism is designed to produce an electromagnetic field so that current start to generate as the turbine moves [5].

Fig. 3: Alternator used for the project

Table 2 : Alternator specification

Speed (Rpm)	200
Voltage (V)	12V
Current (I)	16-20A
Pulley diameter (d)	3 inches
Height (h)	8 inches

Inverter designed for this project is connected with the DC battery to power it up. A dry battery of 12V and 100Ah is used as the power source which inputs the inverter as shown in figure 4. This inverter is operated on 12V battery. The working of the inverter is mentioned below. The output generated by this inverter is 220V ac. The output is a square wave output which is filtered out by the capacitor at the output side. A modified sine wave output is thus obtained by this inverter.

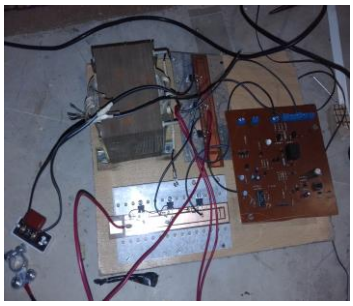

Fig. 4: Designed Inverter

Stand-alone inverter is used which is based on PWM technique. PWM inverter has the following components.

- IC SG3524
- LM358N

SG3524:
Switching regulator is required to perform a push pull operation, SG3524 is chosen since it meets the requirement for an inverter. It is an integrated switching regulator circuit [6] that has all essential circuitry.

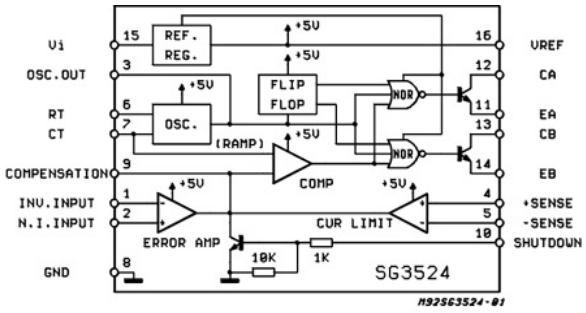

Fig. 5: Internal Circuit of SG3524 [6]

LM358N:
Although SG3524 provides overload protection, LM358 Differential amplifier is also used for improved protection in which reference is set at one input and on the other pin feedback is attached, a comparison is made between two of these voltage levels and signal is sent to the pin-10 of SG3524 which is a shutdown pin and has the ability to shut down the whole inverter circuit [7].

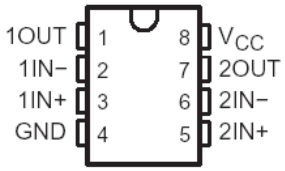

Fig. 6: Pin configuration [7]

VI. METHODOLOGY

Wind Turbine Structure:

This prototype parachute wind turbine has many advantages in comparison with conventional rotor wind turbines. The criteria for the proposed wind turbine is summarized to the followings areas which are Mobility, Survivability, Traceability, and Operation Easiness [8]. Energy produce by conventional wind turbine depends on the area the blades can cover, therefore, its performance directly related with its size. The parachute blade type wind turbine are designed to cover the same wind area and produce the same energy with a much larger conventional wind turbine. So this paper states that the proposed parachuted wind turbine can have better characteristics which surpass the conventional wind turbines on the criterion of mobility, survivability.

Fig. 7: Mechanical Structure

Fig. 8: Parachute fabric based blades

Panel Designing:

The front of this mechanical structure is covered with a wooden panel in which all the displaying parameters are fixed.

- The switch to power on or off the inverter.
- The voltmeters to show the voltages.
- The over load protection indicator.
- The ON status LED of inverter.
- The load bank.

Fig. 9: Wooden panel

VII. PROJECT IMPLEMENTATION

A wind power system or a wind turbine is a power system designed to supply usable wind power by means of blades rotation. As the wind blows it forces the blades of the turbine and exerts force on them, the blades utilize the wind force and start rotating. As the rotation started the gear increases up these rotations and a ten times more rotation is obtained, gear is attached with the alternator which is the main part of our project.

The movement of gears moves up the rotor of the alternator and the alternator field is excited by sensing up the rotations. The alternator starts to move and due to movement of internal rotor of the alternator the current starts to generate. This current is an alternation current which means it changes its polarity at every half cycle. To ensure a uni-directional current a rectifier is used.

The rectifier converts the ac current produce by the alternator into the DC current. We know very well that the battery needs DC to charge. This DC current is then regulated as to charge up a 12V battery which we have used as a battery bank. The current is stored in the battery.

The inverter then uses the power stored in the battery and converts it to AC which is our supply for running the appliances. We have design an inverter based on SG3524 which is capable of maintaining a constant 220v at its output independent of variation in load at its output. This is done by comparing the feedback voltages with the standard voltages and by adjusting the frequency through its internal oscillator. This will further adjust the frequency of driving circuit which help's in maintaining the constant voltages at its output. Although we have provide the overload protection in this inverter circuit which will cutoff the system when the load is increased by prescribed limit. For this purpose we have used LM358 Differential amplifier in which at one input we have set the reference and on the other pin feedback is attach, a comparison is made between two of these voltage levels and signal is sent to the pin10 of SG3524 which is a shutdown pin and has the ability to shut down the whole inverter circuit.

VIII. ANALYSIS

We performed the test of alternator by checking the speed of wind. The more the wind blows the more the alternator generates the output current. So we conclude that to get more current high rate of wind flow is required.

Battery Test

A test was done to see the charging capability of the designed wind turbine using 12V battery and a 200W load, following results have been obtained as shown in table 3.

Table 3: Battery charging test results

Percentage Of Charge	(V) At Rest	(V) Charging	(V) Under load
100%	12.73	14.75	12.51
90%	12.62	13.75	12.41
80%	12.51	13.45	12.31
70%	12.37	13.31	12.25
60%	12.24	13.21	12.15
50%	12.11	13.11	12.11
40%	11.96	12.95	11.91
30%	11.81	12.75	11.71
20%	11.66	12.55	11.51
10%	11.51	12.55	11.25

IX. CONCLUSION

In this project, a wind turbine system and its monitoring system is designed. All the necessary requirements for designing a vertical wind turbine is fulfilled. Blades are made of parachute fabric in order to make it lighter in weight since it's a portable wind turbine. Implementation results show that the system is able to work under nominal condition with a satisfactory performance. The project can be used as a prototype for making low cost wind energy systems which can be used in the areas where grids connectivity is not possible. Challenges have been encountered and a working wind power system with portability has been manufactured. In addition a review of various experimental and simulation research is done. From the literature review, it can be concluded that VAWTs are an important area of future research in order to meet the energy requirements [9].

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