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Wind Turbine with Variable Blade Length

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ABSTRACT:In the modern world,demand for energy is increasing progressively and in future it is going to increase further. To meet the demand, it is required to focus on means of harvesting renewable energy sources. In this paper, the focus is on design of modern wind turbine. Since, the intensity of wind keeps on varying based on geographical conditions, hence it is required to vary the diameter of the rotor. In order to extract maximum power, the rotor diameter should be able to extend in low wind conditions and retract in high wind conditions. This feature will enable the turbine to withstand any weather conditions and enhance the production capacity.

KEYWORDS:Extend, Retract, geographical conditions, Rotor, Weather conditions.

I. INTRODUCTION

Windmills have been used from ages to convert wind's kinetic energy into mechanical energy. In the early 200 B.C. windmills were used for specific tasks like: Grinding Grains and Pumping Water. Nowadays wind turbines are used specifically for generation of electricity by converting winds kinetic energy into electricity via a generator.

However, there are some major concerns with this technology. The whole assembly consists of tower, generator, transmission shaft, rotor and the turbine blades. The blades are the most crucial part of the whole assembly. It is a nexus between the wind and its conversion from kinetic energy into electrical energy. Since, each blade is around 30m long and typically transported by road creates an extremely challenging situation for the transport authority and the truck drivers.

Another concern in blade design is their efficiency. According to the Betz law, the maximum attainable efficiency for a wind turbine blade is 52%. Hence, the practical solution is the use of extendable and retractable blades instead of conventional blades. Its potential is enormous from enabling easier way to transport to providing higher energy output.

II. RELATED WORK

Currently, there have been tremendous amount of research going on regarding wind turbine technology. The turbine blades play an important role as it directly comes in contact with the wind. Wind turbines are shaped to generate maximum power at minimum cost. The blades should be designed for longer life as they are subjected to continuous fatigue load.

1. D.T. Yen Nakafuji, C.P. Van Dam used MEM Microtabs to attain better aerodynamic characteristics resulted in the increase of section lift coefficient with a minimal drag. The wind tunnel test demonstrated the significant potential for using microtabs. The rotating frame technique was also used, where the blades are fixed to the rotating frame. The computational result has shown the promising results with the experimental results.

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2. P. Migliore described the results of wind tunnel Aeroacoustic tests conducted on a very small turbine blade in the open- jet. Tim Fischer studied the influence of the integrated design of the rotor nacelle assembly for obtaining the optimizing structure at reduced cost.

III. FABRICATION OF TURBINE BLADE

There are plenty of materials available in the market like: glass reinforced plastic, wood epoxy, carbon filament reinforced plastic. However, in the project PVC piper were used because of their added properties. They were light in weight and most importantly if cut at an angle along the longitudinal axis, one can get a complete aerofoil geometry. Along with that, it is also budget friendly.

Components Required:

1. Stepper Motor
2. Dynamo
3. Relay
4. Remote Control

Specifications:

Battery

1. Output Voltage 12 Volts
2. Current 7.5 ahc

Dynamo

1. Output voltage when high speed 18 Volts
2. Output current when full speed 1 amps
3. Output voltage when low speed 12 volts
4. Output current when low speed 500 milli amps.

Calculations:

Formula to calculate power from wind turbine:

$$Power = kCp1/2\rho AV^3$$

We know, Power available from wind (P) = $\frac{1}{2} \rho A V^3$

Where, $\rho = 1.25 \text{ kg/m}^3$

A= Swept Area in $\text{m}^2 = \pi R^2$

So,

$$P = \frac{1}{2} \rho \pi L^2 V^3$$

$$P = 1.93 L^2 V^3$$

For low Speed (6 km/hr)

Since, power at low speed = 6 Watts

Therefore,

$$6 = 1.93 L^2 (6 \times 1000 / 3600)$$

$$L = 0.8 \text{ mt}$$

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The blade is designed as per the above calculations.

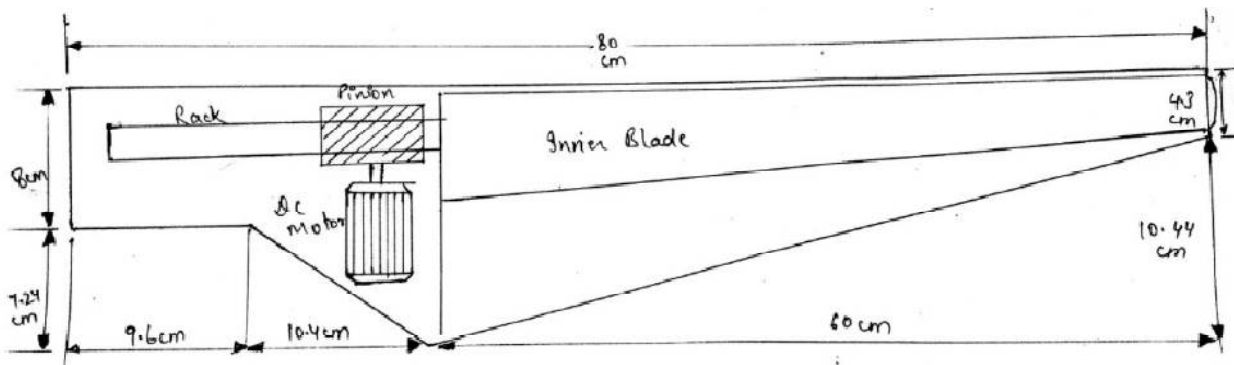


Fig 1: Final Blade Design



Fig 2: After Cutting PVC Pipes



Fig 3: Blades after Fixing Mechanism

IV. EXPERIMENTAL RESULTS

The prototype was tested in our college laboratory. Strong wind condition were formed using blower which has a duct of 0.12m^2 . Since, the duct area was not sufficient enough to support the swept area of the turbine so the achieved results were not up to the mark. In addition to that, the overall weight of the turbine got increased due to the mechanism and motor fitted inside the blade.

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Fig 4: Working Prototype

V. CONCLUSION

The purpose of this project is to develop a turbine that can withstand any weather condition but due to some manufacturing flaws, the prototype is not able to produce the desired output.

The problem can be resolved by making some ground changes like: change in battery placement, better machining process, and lighter material for blade. It can be the best solution of the problem that world is facing nowadays. With further advancement in technology, it will play very significant role in reducing the overall loss of capital and components of a wind turbine.

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