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Design and Development of Vertical Axis Wind Turbine with Inverter

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ABSTRACT –

On the expanding cost of non-inexhaustible assets, sustainable assets are increasingly sought after. In this system, we make utilization of Vertical Axis Wind Turbine for creating energy, for the inverter. A Vertical Axis Wind Turbine is a kind of wind turbine where the principle rotor shaft is set transverse to the breeze while the fundamental parts are situated at the base of the turbine. This framework is controlled by ATmega 328 microcontroller, it comprises of a vertical axis windmill, DC motor, 12V battery, DC inverter, MOSFET switch, LCD and transformer. The windmill produces mechanical energy when wind courses through the turbine. This mechanical energy is changed over into electrical energy by dynamo, the power esteems are shown on LCD. The Vertical Axis Windmill converts the energy of wind into kinetic energy by means of blades, and charges the 12V battery. As the battery is switched on, the inverter changes over DC into AC and the step-up transformer expands the voltage, required to run the device. MOSFET is a transistor which manages the voltage and after that the load is powered.

Keywords – component, inverter, microcontroller, DC motor, battery, switch, LCD, transformer, transistor.

I. Introduction

Vertical axis wind turbines (VAWTs) represent a promising avenue in renewable energy technology, offering distinct advantages over their horizontal axis counterparts. Unlike traditional horizontal turbines, VAWTs harness wind energy from any direction, making them suitable for urban and confined spaces where wind patterns are unpredictable. This versatility extends their applicability beyond rural landscapes, potentially revolutionizing urban energy landscapes. Moreover, VAWTs often feature simpler designs with lower maintenance requirements, reducing operational costs and enhancing their economic viability.

The design of VAWTs holds considerable potential for innovation and optimization. Through advancements in materials science and aerodynamics, researchers are continually enhancing VAWT efficiency and scalability. Furthermore, the compact and aesthetically pleasing nature of VAWTs aligns with the growing demand for sustainable energy solutions that integrate seamlessly into urban environments. As such, exploring the design principles and performance characteristics of VAWTs is crucial for unlocking their full potential in the transition towards a cleaner, more sustainable energy future.

WIND TURBINES

Wind turbines have emerged as a pivotal technology in the global transition towards sustainable energy sources. These towering structures harness the kinetic energy of wind and convert it into electricity through the rotation of turbine blades connected to a generator. They come in various sizes and designs, but the most common distinction lies between horizontal axis and vertical axis configurations. Horizontal axis wind turbines (HAWTs) typically feature three blades mounted on a horizontal shaft and are predominant in large-scale wind farms. Conversely, vertical axis wind turbines (VAWTs) have blades arranged around a vertical axis and offer unique advantages, particularly in urban and decentralized settings.

VERTICAL AXIS WIND TURBINES

Vertical axis wind turbines (VAWTs) present a compelling alternative to traditional horizontal axis turbines, offering unique advantages in certain applications. Unlike their horizontal counterparts, which require a consistent wind direction to operate optimally, VAWTs are capable of capturing wind from any direction due to their omnidirectional design. This inherent feature makes VAWTs particularly well-suited for urban and densely populated areas where wind patterns are often erratic and complex. Additionally, VAWTs can be installed at lower heights compared to horizontal turbines, making them suitable for rooftop installations and other confined spaces where vertical clearance is limited.

The design simplicity of VAWTs contributes to their appeal, as they typically have fewer moving parts than horizontal turbines, leading to reduced maintenance requirements and lower operational costs. This advantage is especially significant in decentralized energy systems and off-grid applications, where reliability and ease of maintenance are critical considerations. Furthermore, VAWTs exhibit less sensitivity to turbulence and gusty winds, which can result in smoother and more consistent power generation. These attributes make VAWTs a viable option for micro grid integration and distributed energy generation, offering a decentralized and resilient energy infrastructure.

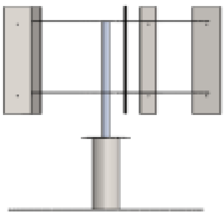
However, challenges remain in maximizing the efficiency and scalability of VAWTs. Aerodynamic design optimization, structural stability, and noise reduction are areas of ongoing research aimed at improving VAWT performance. Advancements in materials science, blade design, and control systems hold promise for enhancing the efficiency and competitiveness of VAWTs in the renewable energy landscape. Moreover, addressing concerns related to visual impact, wildlife interaction, and public acceptance is crucial for promoting the widespread adoption of VAWTs in various settings. Despite these challenges, the continued innovation and development of VAWT technology hold significant potential for expanding the reach of wind energy and accelerating the transition towards a sustainable future.


II. METHODOLOGY AND WORKING PRINCIPLE

The concept of our project is something like this, whenever wind will blow from any of the direction it will strikes to the turbine blades, which will rotate the turbine blades and in turn rotates the shaft of the turbine. Now this whole arrangement is connected to the DC generator, because of which we get DC voltage as output.

Now this DC voltage is then passed through the charge controller to charge the battery appropriately and to protect the reverse flow of current. After that we use the DC inverter circuit to convert DC voltage into AC voltage, since our load needs AC voltage to glow.

After that we have to step up the voltage to 230 Volt, so that our load gets appropriate voltage, because our load operates at 230 Volt, then we have used MOSFET switch to generate the frequency of 50Hz which is needed for it and thus we glow the load. Also we have the microcontroller here which is used to check the voltage generated by windmill and to display it continuously on LCD screen, this is how our entire system works[6].



Cad model

III. DESIGN CALCULATION

Conversion of kinetic energy into mechanical energy and further into electrical energy

KE= $1/2(mV^2)$..........(1)

Here we will equate mass (m) of wind molecules with mass flow rate i.e. ($\dot{m}$)

m= ρAV.................(2)

Substituting eq^n (2) in eq^n (1) , we will get the formula of mechanical power

required to rotate the wind turbine.

$P_{mech}=1/2(\rho AV^3)$........(3)

$P_{elec}=(P_{mech})(\eta_{turbine})(\eta_{alternator})$

Let us assume that we want 35W of electric power output .

Considering turbine efficiency ($\eta_{turbine}$) as 25% and alternator efficiency ($\eta_{alternator}$) as 85%

$P_{ele}=(P_{mech})\ (\eta_{turbine})\ (\eta_{alternator})$

$35 = P_{mech}\,(0.25)(0.85)$

$P_{mech} = 164.7W$

$P_{mech} =(1/2)(\rho AV^3)$

$164.7 = (1/2)(1.225\times A\times 6.5^3)$....[ρ_{air}=1.225kg/m^3 (constant)] , [V = 6.5m/s (assumed)]

$A = 0.99 = 1m^2$

IV. Conclusion

In this paper we have compared both the types of wind turbines, vertical axis wind turbines (VAWTs) offer unique advantages such as omnidirectional wind capture and simplified design, making them suitable for urban and decentralized energy applications. Despite challenges in efficiency optimization and public acceptance, ongoing research and technological advancements hold promise for enhancing VAWT performance and integration into diverse energy landscapes. With continued innovation and strategic deployment, VAWTs can contribute significantly to the transition towards a sustainable and resilient energy future.

V.FUTURE SCOPE

Future research on vertical axis wind turbines (VAWTs) could focus on enhancing aerodynamic efficiency, structural stability, and noise reduction through advanced materials and design optimization. Additionally, exploring innovative applications such as urban integration, floating platforms, and hybrid renewable energy systems could broaden the scope of VAWT deployment. Furthermore, addressing socio-economic factors, environmental impacts, and regulatory challenges is crucial for promoting widespread adoption. Overall, continued research and development efforts hold potential for expanding the role of VAWTs in the renewable energy landscape.

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