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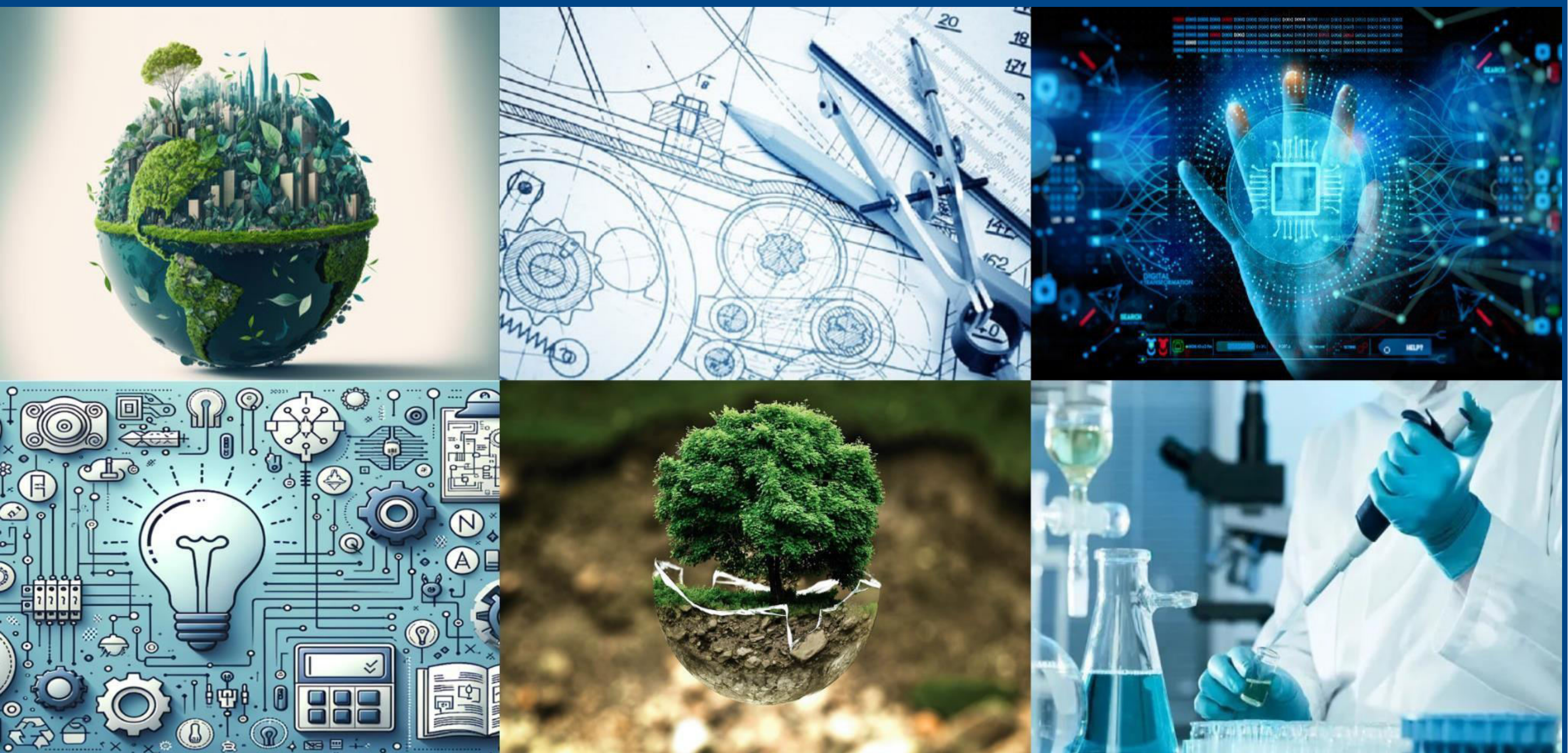

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Design and Development of a Spiral Vertical Axis Wind Turbine for Enhanced Energy Capture

Krushna Shirish Lamgunde[1], Salman Majnoddin Shaikh[2], Jay Yuvraj Gadekar[3], Tanuja Sanjay Bhosale[4], Krutika Sajjan Bhosale[5], Rajnandini Dnyaneshwar Patil[6], Riddhi Yogiraj Kurde[7], Sachin Parshuram Aiwale[8], Saurabh Bapurao Bobade[9], Siddharth Haridas Bobade[10]

UG Student, SVERI's College of Engineering, Pandharpur, Maharashtra, India[1]

UG Student, SVERI's College of Engineering, Pandharpur, Maharashtra, India[2]

UG Student, SVERI's College of Engineering, Pandharpur, Maharashtra, India[3]

UG Student, SVERI's College of Engineering, Pandharpur, Maharashtra, India[4]

UG Student, SVERI's College of Engineering, Pandharpur, Maharashtra, India[5]

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UG Student, SVERI's College of Engineering, Pandharpur, Maharashtra, India[9]

UG Student, SVERI's College of Engineering, Pandharpur, Maharashtra, India[10]

ABSTRACT: as the demand is increasing for the clean and decentralized power, the small-scale energy systems are becoming more important. In these systems, the vertical axis wind turbine is more efficient as it can operate on the low wind speed and does not need any alignment based on the wind direction. Here, we present the design and development of the spiral shaped vertical axis wind turbine for improvement of energy capture in such a low wind speed environment. The spiral blade design helps to guide the air more smoothly around the turbine, which improves its rotating ability on its own and minimize the fluctuations during operation. The work focuses on the design principles, aerodynamic considerations, and potential advantages of a spiral geometry of more enhanced performance. It is designed for applications such as rooftops, residential areas, and low wind regions.

KEYWORDS: vertical axis wind turbine, spiral blade design, renewable energy, aerodynamic efficiency, low wind speed turbine

I. INTRODUCTION

The global demand for clean and reliable energy has encouraged the development of technologies that can harness renewable resources more efficiently. Wind energy, in particular, has become one of the fastest-growing renewable sectors due to its sustainability and widespread availability. However, most large-scale wind systems rely on Horizontal Axis Wind Turbines (HAWTs), which require high wind speeds, open spaces, and constant alignment with wind direction. These limitations make HAWTs less suitable for crowded cities, rooftops, and regions where wind flow is inconsistent.

Vertical Axis Wind Turbines (VAWTs) offer an alternative that can overcome many of these challenges. Because they can capture wind from any direction and operate in turbulent, low-speed conditions, VAWTs are increasingly considered for decentralized and small-scale energy systems. Despite these advantages, traditional VAWT designs often struggle with issues such as low starting torque, aerodynamic losses, and unstable rotation.

To address these shortcomings, researchers have explored new blade shapes and geometries that can improve turbine performance. One promising approach is the use of **spiral or curved blade structures**, which are expected to guide

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airflow more smoothly and reduce sudden changes in torque during rotation. Such a design may help the turbine capture more energy from the wind, even when the available wind speed is relatively low.

This paper focuses on the conceptual design and analysis of a **Spiral Vertical Axis Wind Turbine (S-VAWT)** aimed at enhancing energy capture in low-wind environments. The study discusses the motivation behind choosing a spiral geometry, outlines the design features, and highlights the potential benefits of this approach. Although the turbine has not been fabricated or experimentally tested, the theoretical insights presented here serve as a stepping stone for future simulation, optimization, and prototype development.

II. LITERATURE REVIEW

Vertical Axis Wind Turbines (VAWTs) have been widely studied as an alternative to conventional horizontal axis turbines, particularly for applications involving low wind speeds and complex airflow conditions. Early research on VAWTs mainly focused on **Savonius** and **Darrieus** turbine configurations. Savonius turbines are drag-based and are known for their excellent self-starting capability; however, they generally exhibit low aerodynamic efficiency. In contrast, Darrieus turbines operate on lift-based principles and offer higher efficiency but often suffer from poor self-starting performance and structural complexity.

To overcome these limitations, several researchers have proposed modifications to blade geometry, including twisted, helical, and curved blade designs. Helical VAWTs have been shown to reduce torque ripple and improve rotational smoothness by distributing aerodynamic forces more evenly along the turbine axis. These designs also reduce vibration and mechanical stress, making them more suitable for continuous operation. However, efficiency gains from helical configurations are still limited under very low wind speed conditions.

Recent studies have explored the influence of blade curvature, overlap ratio, and aspect ratio on VAWT performance. Computational investigations indicate that curved blades can improve airflow attachment and reduce flow separation, leading to better torque generation during rotation. Some researchers have also highlighted that smooth blade transitions can minimize aerodynamic losses and enhance energy capture in turbulent wind environments, such as those commonly found in urban areas.

Spiral-shaped blade concepts represent a further evolution of curved blade designs. While limited research exists specifically on spiral VAWTs, related studies on twisted and helical turbines suggest that continuous geometric variation along the blade height can improve aerodynamic stability and reduce negative torque regions. These features are particularly important for turbines intended to operate at low wind speeds, where conventional designs struggle to maintain consistent rotation.

Overall, the existing literature indicates that blade geometry plays a crucial role in determining the performance of VAWTs. Although various modified designs have been proposed, there remains a gap in comprehensive theoretical studies focusing on spiral blade configurations. This research aims to address that gap by presenting a conceptual design and analysis of a spiral vertical axis wind turbine, providing insights that may support future simulation-based and experimental investigations.

III. METHODOLOGY OF PROPOSED SURVEY

The methodology adopted in this work is purely design-oriented and focuses on the conceptual development of a Spiral Vertical Axis Wind Turbine (S-VAWT). The objective of the proposed survey is to explore design considerations and geometric features that may support enhanced energy capture in low-wind environments. No experimental testing, simulation, or performance analysis has been carried out as part of this study.

A. Conceptual Design Approach

The proposed wind turbine is designed around a vertical rotational axis, incorporating a spiral-shaped blade configuration. The spiral form is selected to provide a continuous and smooth blade profile along the height of the turbine. This design approach is intended to conceptually improve airflow interaction while maintaining structural symmetry.

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The design process involved studying existing VAWT configurations and identifying limitations related to blade geometry and spatial utilization. Based on this understanding, a spiral blade layout was conceptualized to achieve a compact and visually continuous structure suitable for small-scale applications.

B. Geometric Configuration

The turbine design consists of multiple spiral blades mounted around a central vertical shaft. The geometry emphasizes uniform curvature and consistent spacing between blades to maintain balance during rotation. Parameters such as blade height, rotor diameter, and overall form factor were selected from a conceptual standpoint, without numerical optimization.

The vertical axis configuration eliminates the requirement for wind direction alignment mechanisms, making the design adaptable for locations with variable wind directions.

C. Structural Layout Considerations

From a design perspective, the spiral blade structure is arranged to ensure mechanical symmetry and structural continuity. The vertical layout allows even distribution of mass along the turbine height, which is an important consideration in reducing imbalance during operation. The design also allows compatibility with standard mechanical components such as shafts and generators, although integration was not implemented in this study.

D. Scope of the Proposed Survey

This work is limited to the conceptual design and structural representation of the spiral VAWT. The study does not include computational simulations, analytical calculations, prototype fabrication, or experimental validation. The purpose of the proposed survey is to present a novel design concept that can serve as a foundation for future research involving detailed analysis, optimization, and practical implementation.

IV. PROPOSED DESIGN

A. Front View

The front view illustrates the overall height and vertical alignment of the spiral blades mounted around the central axis, highlighting the continuous curvature of the turbine structure.

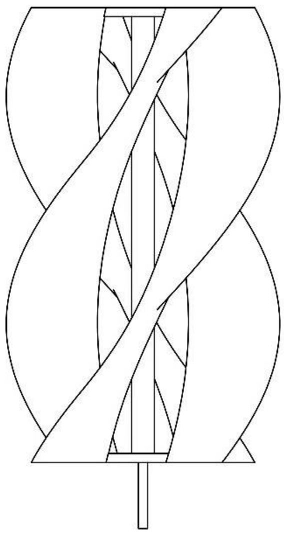

Fig. front view

B. Rear View

The rear view presents the symmetry of the spiral blade arrangement and confirms uniform spacing and balanced geometry along the vertical axis.

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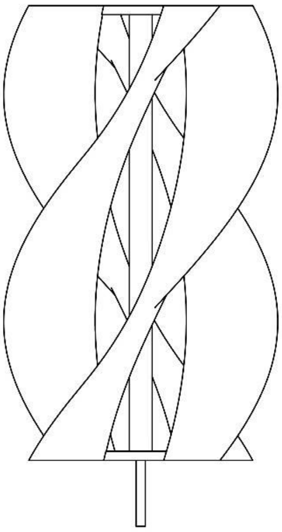

Fig. rear view

C. Right Side View

The right side view shows the lateral profile of the turbine, emphasizing the spiral blade orientation and the smooth transition of curvature along the height.

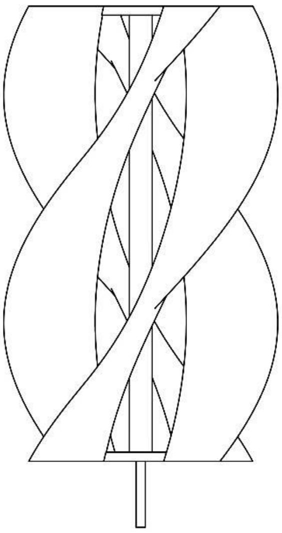

Fig. right side view

D. Left Side View

The left side view complements the right view by depicting the consistent blade geometry and structural continuity from an opposite direction.

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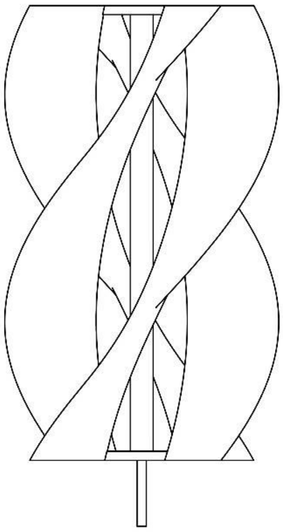

Fig. left side view

E. Top View

The top view illustrates the circular arrangement of the spiral blades around the central shaft, providing clarity on blade positioning and spatial distribution.

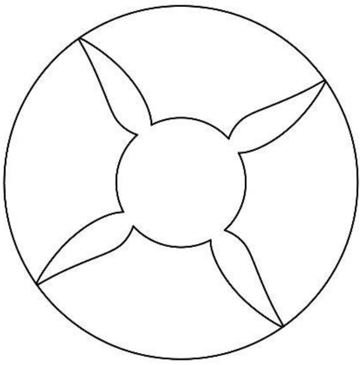

Fig. top view

F. Bottom View

The bottom view highlights the base geometry of the turbine, showing the blade termination and alignment with the vertical support structure.

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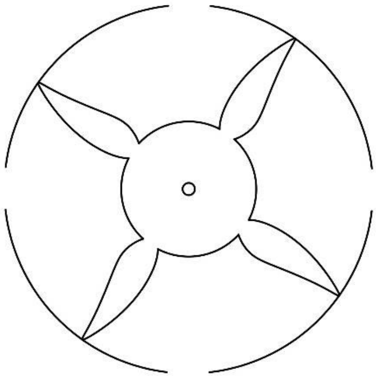

Fig. bottom view

G. Perspective View

The perspective view offers a three-dimensional representation of the turbine, clearly visualizing the spiral blade configuration and overall structural form.

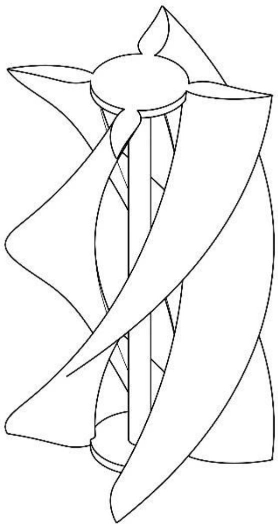

Fig. perspective view

V. CONCLUSION AND FUTURE WORK

This paper presented the conceptual design of a **Spiral Vertical Axis Wind Turbine (VAWT)** intended for small-scale and low-wind energy applications. The work focused exclusively on the geometric configuration and structural layout of the spiral blade design, highlighting its potential suitability for decentralized and urban wind energy systems. By adopting a vertical axis configuration with a spiral blade form, the proposed design aims to address some of the common limitations associated with conventional VAWTs, such as structural complexity and inefficient use of available space.

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The study was limited to the design stage and did not include analytical evaluation, computational simulations, or experimental validation. Nevertheless, the presented design offers a clear and structured foundation for further research and development in the field of vertical axis wind turbines.

Future Work

Future work can extend this research in several directions. Computational studies such as CFD simulations can be conducted to analyze airflow behavior and aerodynamic performance of the spiral blade geometry. Structural analysis may also be performed to assess mechanical stability and material suitability. Prototype fabrication followed by experimental testing under controlled and real-world wind conditions can provide practical insights into performance and efficiency. Additionally, optimization of blade dimensions and integration with electrical generators can further enhance the applicability of the proposed design for real-world renewable energy solutions.

REFERENCES

[1] Manwell, J. F., McGowan, J. G., & Rogers, A. L., *Wind Energy Explained: Theory, Design and Application*, 2nd ed., John Wiley & Sons, 2010.

[2] Hau, E., *Wind Turbines: Fundamentals, Technologies, Application, Economics*, 3rd ed., Springer, 2013.

[3] Paraschivoiu, I., *Wind Turbine Design: With Emphasis on Darrieus Concept*, Polytechnic International Press, 2002.

[4] Islam, M., Ting, D. S. K., & Fartaj, A., "Aerodynamic Models for Darrieus-Type Straight-Bladed Vertical Axis Wind Turbines," *Renewable and Sustainable Energy Reviews*, vol. 12, no. 4, pp. 1087–1109, 2008.

[5] Gupta, R., & Biswas, A., "Computational Fluid Dynamics Analysis of a Twisted Savonius Wind Turbine," *Renewable Energy*, vol. 86, pp. 721–732, 2016.

[6] Mohamed, M. H., "Performance Investigation of H-Rotor Darrieus Turbine with New Blade Shapes," *Energy*, vol. 47, no. 1, pp. 522–530, 2012.

[7] Pope, K., Dincer, I., & Naterer, G. F., "Energy and Exergy Efficiency Comparison of Horizontal and Vertical Axis Wind Turbines," *Renewable Energy*, vol. 35, no. 9, pp. 2102–2113, 2010.

[8] Saha, U. K., Thotla, S., & Maity, D., "Optimum Design Configuration of Savonius Rotor through Wind Tunnel Experiments," *Journal of Wind Engineering and Industrial Aerodynamics*, vol. 96, no. 8–9, pp. 1359–1375, 2008.

[9] Rezaeiha, A., Kalkman, I., & Blocken, B., "Effect of Pitch Angle on Power Performance and Aerodynamics of a Vertical Axis Wind Turbine," *Applied Energy*, vol. 197, pp. 132–150, 2017.

[10] Tjiu, W., Marnoto, T., Mat, S., Ruslan, M. H., & Sopian, K., "Darrieus Vertical Axis Wind Turbine for Power Generation I: Assessment of Darrieus VAWT Configurations," *Renewable Energy*, vol. 42, pp. 181–191, 2012.

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