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Design & development of a Nano Wind Turbine

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Abstract
In this paper, the design & development of a Nano Wind Turbine is presented. Small-scale wind turbines have received less attention compared to their large-scale counterparts, prompting the need for studies in this area. This research focuses on the dynamic properties of "Glass reinforced fiber composite" blades in a nano wind turbine, providing both experimental and analytical results. The study investigates crucial parameters such as the natural frequency and mode shapes of the turbine, which are necessary for determining its performance and lifespan. Additionally, the results are used to set safe blade rotation speeds. Using Creo Parametric software, a detailed ANSYS Workbench 14.0 model is developed for simulation, incorporating the material properties of Glass reinforced fibre composite. The mathematical and experimental results are compared, and the first four modes are found to be within acceptable limits, verifying the dynamic properties of the Glass reinforced fiber composite. The work done & presented in this paper is the result of the mini-project work that has been done by the first sem engineering students of the college and as such there is little novelty in it and the references are being taken from various sources from the internet, the paper is being written by the students to test their writing skills in the starting of their engineering career and also to test the presentation skills during their mini-project presentation. The work done & presented in this paper is the report of the assignment / alternate assessment tool as a part and parcel of the academic assignment of the first year subject on nanotechnology & IoT.
Keywords: Turbine, Wind, Power, Energy

Introduction
A small generator in a nano-wind turbine generates electricity using wind power. The electricity is conditioned by an inverter for compatibility with household devices and safe feeding into the grid [1]. Vibrations caused by high winds in isolated rural areas have prompted research into the dynamic analysis and assessment of high-power wind turbines. Small turbines for residential use generate 300 to 10,000 watts and measure 7 to 25 feet (2.1 to 7.6 m) in diameter. A paper outlines the process of identifying the dominant natural frequency and mode shapes of a turbine in a static condition [2]. The paper covers related work, geometrical modeling, finite element analysis, experimental analysis, and the results obtained from both methods. The study concludes with a summary of the dynamic features of a nano-wind turbine and its associated frequencies [3].

Overview
Design and development of a Nano Wind Turbine involves creating a small-scale wind turbine that can generate electricity for residential or small-scale use. The process involves various stages such as initial conceptualization, design, prototyping, and testing. The design needs to consider the size, shape, and blade material to ensure optimal performance [4]. The development stage involves creating a working prototype and testing it in various wind conditions to determine its power output and

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efficiency. The goal is to create a wind turbine that is cost-effective, efficient, and easy to install and maintain. The technology has the potential to provide renewable energy solutions for remote areas and reduce dependence on non-renewable sources of energy. It also offers opportunities for research and innovation in the field of wind energy [5]. CNT wind turbine blades is shown in Fig. 2, whereas the diagram of a typical wind turbine for generating power is graphically predicted in Fig. 1.

Objectives

Wind energy is a cost-free and environmentally friendly source of energy, making it a valuable resource for developing countries. With great potential for innovation and real-world applications, the field of wind energy offers significant economic opportunities [6] [16]. Wind farms are typically constructed to provide renewable energy to the electric power grid and their electricity production is determined by the average wind speed and number of turbines installed. Short-term and long-term objectives of wind farms are outlined below in the Fig. 1 respectively [7] [15].

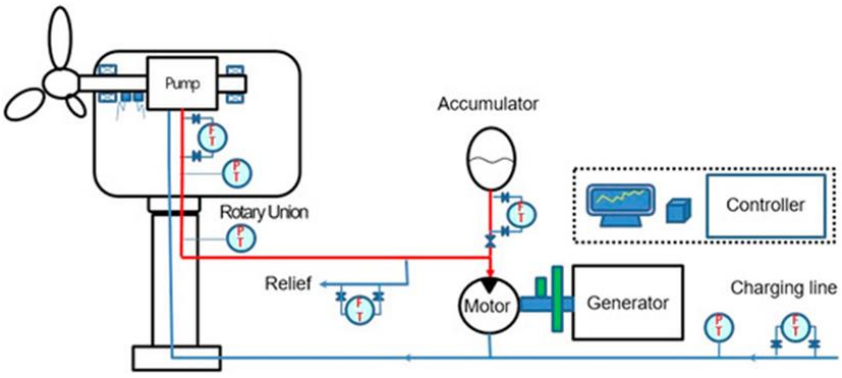

Fig. 1 : Diagram of a typical wind turbine for generating power

Advantages [8]

- Wind power creates good-paying jobs.
- Wind power is a domestic resource that enables U.S. economic growth.
- Wind power is a clean and renewable energy source.
- Wind power benefits local communities.
- Wind power is cost-effective.
- Wind turbines work in different settings.

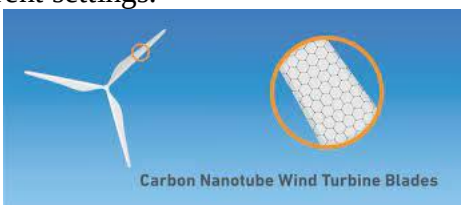

Fig. 2 : CNT wind turbine blades

Wind turbine generator system overview [9]

The wind turbine generator system in this study utilized wind force to rotate blades, producing mechanical energy that was converted into fluid energy by a hydraulic pump. The fluid energy then powered a hydraulic motor, generating mechanical energy that drove an electric motor and produced electricity [14]. The system schematic included a hydraulic pump, a hydraulic motor, a controller, and control valves. Safety and auxiliary circuits were present in the detailed circuit but were not considered in the study as they did not affect the system characteristics, although they could have impacted the speed of analysis results. The Fig. 3 gives the innovative wind turbine blades of the system.

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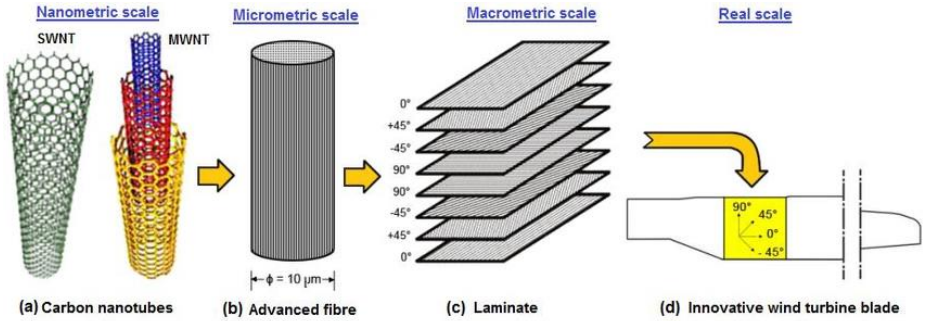

Fig. 3 : Innovative wind turbine nano blades

Conclusions

Wind turbines generate clean energy, reducing emissions of harmful pollutants like carbon dioxide, nitrogen oxide, and sulfur dioxide [11]. The use of wind energy can contribute to mitigating climate change, acid rain, and other environmental issues [13]. The energy balance of wind power is highly favorable, with the energy consumed during the entire lifecycle of wind plants being recovered in a few average operational months [12]. When compared with conventional technologies, wind energy offers significant environmental benefits [10].

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