Faculty of Electrical and Electronic Engineering Technology

DESIGN AND DEVELOPMENT OF SMALL-SCALE WIND GENERATOR AND MONITORING SYSTEM

KAUSHALYA NAIR A/P PERABAGARAN

Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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**A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology (Telecommunications) with Honours**

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

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Tajuk Projek : DESIGN AND DEVELOPMENT OF SMALL-SCALE WIND GENERATOR AND MONITORING SYSTEM

Sesi Pengajian : SEM 1 2022/2023

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I declare that this project report entitled DESIGN AND DEVELOPMENT OF SMALL-SCALE WIND GENERATOR AND MONITORING SYSTEM is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Date : 5 JANUARY 2023

APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology with Honours.

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Supervisor Name : TS. EFFENDY ONN SIAM

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DEDICATION

To my beloved mother, Mrs Shyamalla, and father, Mr Perabagaran,
and my siblings.

ABSTRACT

The most significant challenges in producing electrical energy using fossil-fuel resources are their expensive demands and limitations of the resources. Thus, renewable energy, which is achieved using natural resources, is one of the most major elements of the energy crisis' resolution. Solar, wind, geothermal and tidal energy are instances of renewable, clean and sustainable fuel resources that are unlikely to run out. Considering the number of wind turbines in use across the world is getting larger and the numerous projects are now being designed, wind energy is currently being the most advanced technology among those renewables. The major goal of this project is to produce electrical energy in a very efficient manner. Therefore in my thesis, I used Arduino Mega and Blynk app which collects the sensor values from the wind turbine to monitor the input and output data from the wind turbine.

ABSTRAK

Cabaran paling ketara dalam menghasilkan tenaga elektrik menggunakan sumber bahan api fosil ialah permintaan mahal dan had sumber tersebut. Oleh itu, tenaga boleh diperbaharui, yang dicapai menggunakan sumber semula jadi, adalah salah satu elemen paling utama dalam penyelesaian krisis tenaga. Tenaga suria, angin, geoterma dan pasang surut adalah contoh sumber bahan api yang boleh diperbaharui, bersih dan mampan yang tidak mungkin kehabisan. Memandangkan bilangan turbin angin yang digunakan di seluruh dunia semakin besar dan pelbagai projek kini sedang direka, tenaga angin kini menjadi teknologi paling maju di kalangan tenaga boleh diperbaharui tersebut. Matlamat utama projek ini adalah untuk menghasilkan tenaga elektrik dengan cara yang sangat cekap. Oleh itu dalam tesis saya, saya menggunakan aplikasi Arduino Mega dan Blynk yang mengumpul nilai sensor daripada turbin angin untuk memantau data input dan output daripada turbin angin.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, TS. Effendy Bin Onn Siam for his precious guidance, words of wisdom and patient throughout this project.

I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) and my parents for the financial support through the completion of my project which enables me to accomplish the project. Not forgetting my fellow colleague and friends for the willingness of sharing his thoughts and ideas regarding the project.

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CHAPTER 1

INTRODUCTION

1.1 Background

The research and application of renewable energy sources can effectively ease the problem of energy supply and climate change. Wind energy is recognised as a fresh source of energy with the greatest potential for development and use. The economic and environmental effects of technological advancements are becoming increasingly noticeable. Furthermore, the bulk of systems that have previously been implemented in power plants and the research content are too homogeneous. Due to the significant growth in power consumption, distribution feeders and transformers are becoming more widespread, covering larger geographic areas and running constantly with the expectation of being dependable, safe, and secure.

1.2 Problem Statement

Day by day, the development of renewable energy technologies has been aided by a limited supply of fossil fuels and better knowledge of clean energy supplies. For rural areas far from grid power and archipelago country, a small-scale wind turbine is the ideal alternative. As a result, it is necessary to comprehend the properties of small-scale wind turbines. Small-scale wind turbines, on the other hand, have a high initial cost, ineffective location, wind variation, wind direction shift, and aero-acoustic noise. As a result, small-scale wind turbines are projected to be costeffective. By providing the users a software to monitor the performance of the wind turbine will make things easier to observe and analyze.

1.3 Project Objective

This project’s primary goal is to present a method that can be used effectively and methodically to estimate the syrem wide TL of the MV distribution network with satisfactory accuracy. Specifically, the objectives are as follows:

a) Harvesting renewable energy (wind)

b) Monitoring the input, output and wind speed via Blynk app.

c) To reduce pollution on earth.

1.4 Scope of Project

The scope of this project are as follows:

a) Providing a clean fuel source to avoid pollution.

b) Leads to more energy efficient production.

c) Enhancing the ability to place turbines wherever necessary.

d) Making users to monitor the data easily through the blynk app.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Analyzing and incorporating information from earlier studies in the same topic is the focus of this chapter. The facts will be made public within a predetermined time frame and pertain to a particular issue or subjects. A literature review is an evaluation of the data present in publications, articles or books related to the subject of inquiry. In the review, this literature needs to be described, summed up, accessed, and clarified. It ought to serve as the research's theoretical underpinning and aid the athours in choosing the scope of thei investigation.

2.2 Condition Monitoring System for Wind Turbines

If bearings, gears, or other components fail and aren't identified until it's too late, problems can spread throughout the wind turbine. This could result in higher maintenance and labour expenditures, as well as more downtime. The Condition Monitoring System for Wind Turbines (CMS) from NTN may detect component failure circumstances early on, preventing damage from worsening. With this knowledge, advanced preparations can be made for replacement components and repairs can be carried out in a systematic manner. This not only helps to reduce maintenance expenses, but it also reduces wind turbine downtime.

2.3 Condition Monitoring of Wind Turbines: Challenges and Opportunities

In order to produce the wind power competitive with traditional power production technology, maintenance costs must be reduced and WT reliability and availability must be improved. Wind farm owners/operators can utilize condition monitoring (CM) technologies to help them achieve this goal. The goal is to gather information about the equipment' health that helps in the enhancement of the operating efficiency. Condition monitoring gives the instruments based on condition maintenance (CBM), rather than time-based periodic maintenance, which is performed at predetermined intervals regardless of machine health. Any problems that includes deagradation or incipient can be recognised in advance using condition-based maintenance techniques, before they result in costly failures, by adapting a condition-based maintenance system. Furthermore, healthy turbines can be left running, eliminating downtime caused by redundant time-based scheduled maintenance.

2.4 Wind Turbine Condition Monitoring System using NIMO

NIMO stands for Novel Integrated Condition Monitoring System for Wind Turbines, and It's a European initiative aimed at improving present state-of-the-art wind turbine health remote monitoring and finding better ways to prevent serious accidents and reduce unnecessary preventive maintenance costs. Acoustic emissions and high-frequency vibration analysis sensors will be used in the NIMO project to evaluate major primary elements such as turbine blades, towers, and foundations. These will be used in conjunction with oil temperature sensors, oil particle counters, current and pressure sensors, generator current sensors, and electric power output measurements to assess the general operational condition of the gearbox, braking mechanism, generator bearing, yaw and generator current sensors, and electric power output measurements, resulting in the entire state of the wind turbine health via the customizable application of a single monitoring system. Furthermore, by aggregating and evaluating the information gathered from the various sensing devices, the system's problems will be quantified and addressed, allowing wind farm operators to update their maintenance schedule.

2.5 Constructing Condition Monitoring Model of Wind Turbine Blades

This study suggests a way for detecting structural damage or weaknesses in wind turbine blades early on using a model to observe the sound of the blades, reducing the amount of labour required and the frequency of routine maintenance, and repairing the problem quickly in the future. The normal noises and pathological blades operated were used as the base in this investigation. The system utilised the discrete wavelet transform to make the sound to split into various frequency elements, feature extraction as an objective measurement, and outlier exposure to train a neural network architecture that could detect aberrant values that differed from the norm.

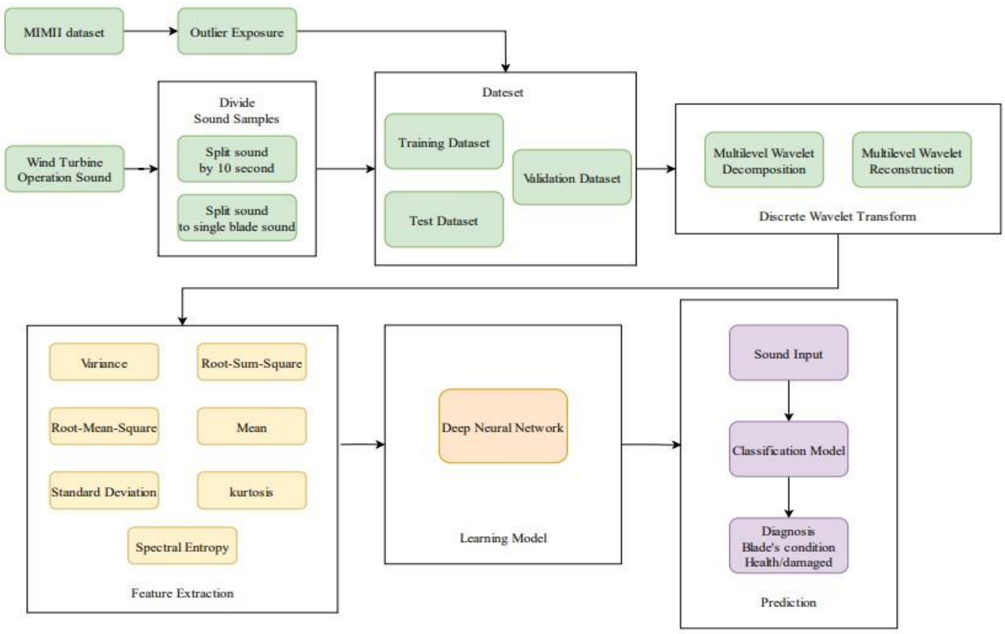

Figure 2.5 Monitoring Model Architecture

2.6 Design of a Condition Monitoring System for Wind Turbines

This research analyzed actual information to validate the effectiveness of a condition diagnosis model for the generator, main bearings, and pitching system that is essential for the management of wind turbines at off shore. The health diagnostic concept involves choosing the elements of the wind turbine to be analyzed, determining the data required for identification. This is to build a machine which is based on learning the condition prediction technique, and choosing the malfunction diagnosis specifications. Wind turbine elements are defined mainly on their system failure rate and availability. The generator, main bearing, pitching system, and yaw system were chosen after evaluating the risk of failure and availability of each equipment of the wind turbine, inspection will be carried out. The health diagnosing model analyses actual and forecasted wind turbine operating statistics, with actual data seeming to be utilized in the prognosis of wind turbine control system.

2.7 Wind Turbine Condition Monitoring using Multi-Sensor Data System

This research introduced a multi-sensor (i.e. vibrations, torque, voltage, and current) merging technology in order to enhance the sustainability of such systems. In the time domain, raising the speed of rotation of the blade, improved both wind turbine motions and power production. However, increasing the blade pitch angle lowers the total vibration intensity. This could be due to higher air resistance, as more of the blade's total surface area will be in contact with the air, acting as a damper. As a result of the increased air resistance, the blade's rotational speed decreased, and the generated current and voltage decreased. The electrical signals, on the other hand, have much clearer peaks and less noise than the vibrational signals.

2.8 The Monitoring System for Wind Power Generation (Wireless Sensor Network)

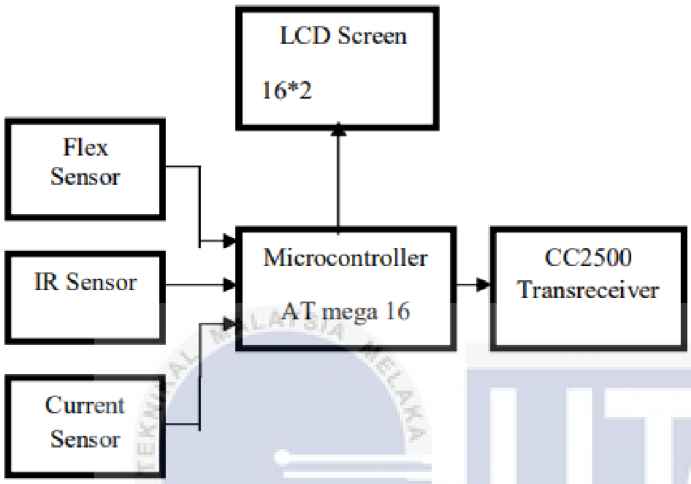

Figure 2.8(a): Block Diagram of Transmitter

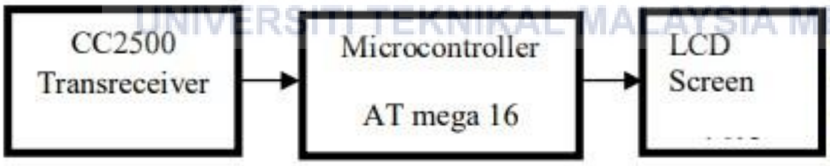

Figure 2.8(b): Block Diagram of Receiver

The project will be divided into two halves, as shown in the block diagram above. One is the transmitter, while the other is the receiver. Sensors like as flex, IR, and current will be used at the transmitter end.

Flex sensors are sensing devices that vary resistivity according to how far the sensor is bent, and the devices play the vital role. They require a 5-volt input and a 0 to 5 V output, with the resistivity altering with the degree of bend of the sensor and the voltage output changing appropriately.

An IR sensing device is an electrical appliance that detects and/or emits information about its surroundings using infrared radiation. Infrared sensors can both sense the vibration and detect an object's temperature. Most of them are classified as PIR sensors since they calculate the infrared radiation rather than emitting it.

The microcontroller will receive the signal from the signals, which will then transfer it wirelessly using the CC2500 transreceiver module, while the status of the windmill will be displayed on the screen.

2.9 Optimization of Computer Communication Monitoring System to Monitor Wind Turbine Speed

This article describes how to develop LabVIEW modules for system initialization, user login, parameter setting, acquisition and display, file I/O, database system module, temperature sytem, signal analysis system module and alarm system. This system is superior than traditional monitoring systems in terms of functionality. It utilizes TDMS files and SQL server mixed programming to centrally control system login, data storage, and data playback, allowing for real-time analysis of massive amounts of information. From a theoretical standpoint, because the CUSUM control chart evaluates information from previous monitoring sites, the detection effect of minuscule drift with a pattern is clearly better than that of the chart, which is the result of the control chart's subsequent evolution. This study proposes a method for monitoring wind turbine health based on the CUSUM control chart. To conduct a survey on the general status of wind turbines, the approach is first utilised to collect the unit's energy features, the output power is observered using the CUSUM control chart to achieve overall machine status monitoring. At the same time, virtual monitoring of the model is accomplished using the convergence of multiple technology of Data Socket and Remote Panels. Finally, as a monitoring object, the system employs a laboratory permanent magnet direct-drive wind turbine. The motor is controlled in real time according to PLC connectivity. The testing findings reveal that the monitoring system is a layout that is simple to utilise and flawless functionality, as well as significant applicability and precedent in the field of wind power supervision.

2.10 Detection and classification of faults in pitch-regulated wind turbine generators using normal behaviour models based on performance curves

The systematic performance of each WTG can be monitored utilising designs for health monitoring based on information and concepts and thorough analysis of the information provided by the SCADA system.

Data-mining-based methodologies and Normal Behaviour Models (NBM) have gained prominence in research methods seeking to provide early indication of flaws based on this database of information. According to the current operational and environmental conditions, the NBMs may forecast on-line reference condition parameters for each WTG component. An abnormal operational state is indicated by a deviation from the expected output. This research explored whether NBMs based on PCs could be a useful tool for quantifying WTG performance and detecting abnormal circumstances. It is critical to identify reference PCs with valid physical functions when employing PC-based NBMs. The goal of this study is to get a comprehensive grasping of WTG phases of function and to design a collection of enhanced NBMs for health monitoring systems (CMS) for WTGs based on PCs that use real-time SCADA data (1 s interval). The ability to recognise functional situations and pitching issues mechanisms is useful in developing PC-based fault prognosis models and criteria.

2.11A sample of figure

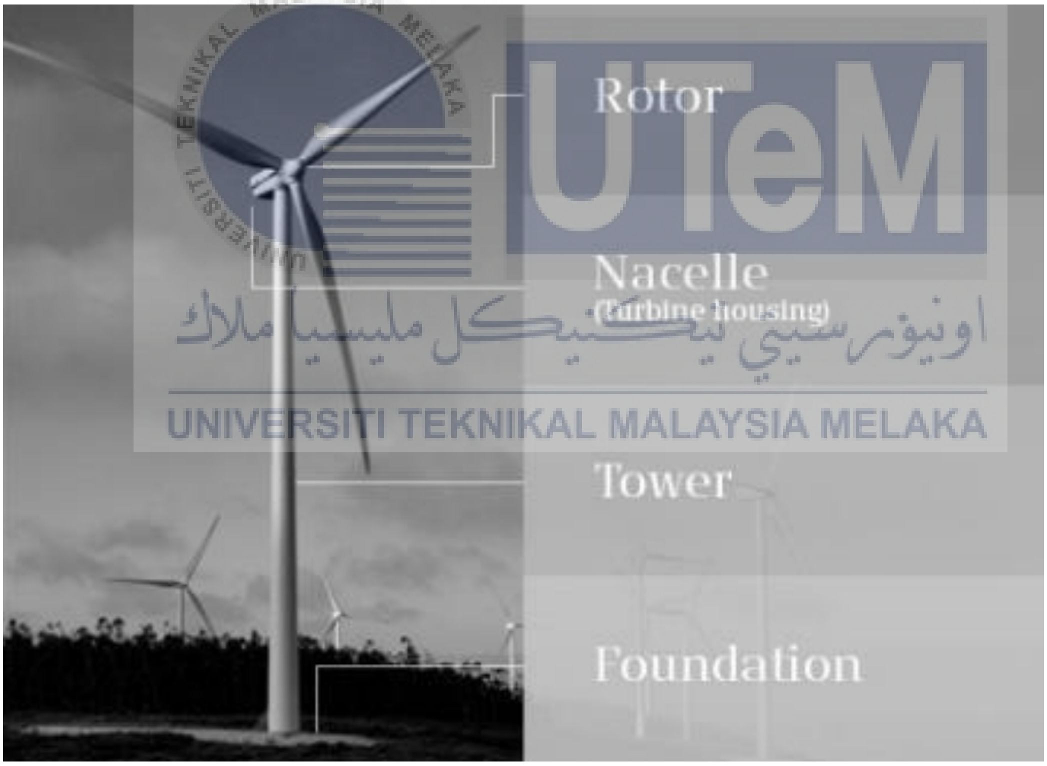

Figure 2.11 Wind Turbine