Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF STREET WIND TURBINE WITH EMERGENCY TRAFFIC LIGHT BACKUP SYSTEM FOR STREET LIGHT AND TRAFFIC LIGHT

MUHAMAD IKRAM HAKIMI BIN SAIFUL NIZAL
B081810482

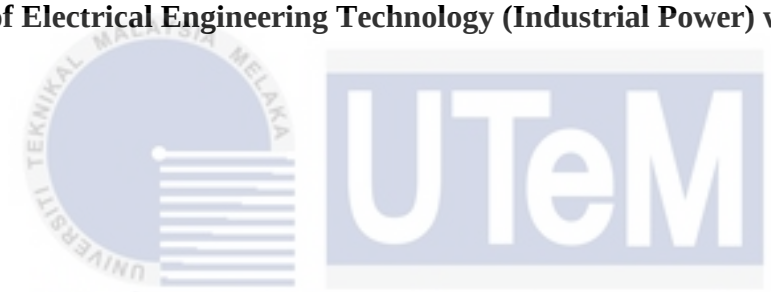
Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

2021

DEVELOPMENT OF STREET WIND TURBINE WITH EMERGENCY TRAFFIC LIGHT BACKUP SYSTEM FOR STREET LIGHT AND TRAFFIC LIGHT

MUHAMAD IKRAM HAKIMI BIN SAIFUL NIZAL
B081810482

A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electrical Engineering Technology (Industrial Power) with Honours



Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: DEVELOPMENT OF STREET WIND TURBINE WITH EMERGENCY TRAFFIC LIGHT BACKUP SYSTEM FOR STREET LIGHT AND TRAFFIC LIGHT

Sesi Pengajian: 2021

Saya **MUHAMAD IKRAM HAKIMI BIN SAIFUL NIZAL** mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinanuntuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaranantara institusi pengajian tinggi.
4. **Sila tandakan (X)

☐	SULIT*	Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTARAHSIA RASMI 1972.

☐ TERHAD* Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan.

☒ TIDAK TERHAD

Yang benar,

.....

MUHAMAD IKRAM HAKIMI BIN SIFUL NIZAL

Alamat Tetap:

PT 721,
KAMPUNG HUJUNG GALOK,
CHETOK, 17060,
PASIR MAS,
KELANTAN

Tarikh: 10 JANUARI 2022

Disahkan oleh penyelia:

.....

ARMAN HADI BIN AZAHAR

ARMAN HADI BIN AZAHAR
Pensyarah
Jabatan Teknologi Kejuruteraan Elektrik
Fakulti Teknologi Kejuruteraan Elektrik Dan Elektronik
Universiti Teknikal Malaysia Melaka

Tarikh: 17 MAC 2022

*Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini

DECLARATION

I declare that this project report entitled "Development of Street Wind Turbine with Emergency Traffic Light Backup System for Street Light And Traffic Light" 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.

Signature : 

Student Name : MUHAMAD IKRAM HAKIMI BIN SAIFUL NIZAL

Date :

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 (Industrial Power) with Honours.

Signature : 

Supervisor Name : ARMAN HADI BIN AZAHAR

Date : 17 MAC 2022

Signature :

Co-Supervisor :

Name (if any)

Date :

DEDICATION

This thesis is dedicated to my respective parents, lecturers and educators, and all of my dearest. They have given me the motivation and discipline to tackle tasks with zeal. This endeavour would not have been feasible without their love and support.

ABSTRACT

Street wind turbine is the other revolution of the wind turbine development, This small size wind turbine is suitable to place at the urban places that have limited of spaces and low speed of wind. This application is as to generate the backup power source that can be use when the loss of main power source to supply the street lights and traffic lights. So, the failure of street lights and traffic lights when the losing main supply power can be prevent. This act can make sure that the traffic flow is always smooth and free from the accidents. The wind source for generate this street wind turbine is come from the air turbulence that produces from the moving vehicles. This thesis has been written is to develop this prototype that can be used in Malaysia for the other way to generate the green energy to supplying the loads at the road. There are three stage of method to develop this project which is stage one is project research planning, stage two is development of the project system operation and stage three is project determination. In this thesis there are states the system for this prototype that will used the MPPT charger controller to control the generator and battery to store the power. In chapter four also will be discuss how the suitable design for the prototype.

ABSTRAK

Turbin angin jalanan adalah revolusi lain dari pengembangan turbin angin, Turbin angin bersaiz kecil ini sesuai ditempatkan di tempat-tempat bandar yang mempunyai ruang yang terhad dan kelajuan angin yang rendah. Aplikasi ini bertujuan untuk menghasilkan sumber tenaga sandaran yang dapat digunakan ketika kehilangan sumber kuasa utama untuk membekalkan lampu jalan dan lampu isyarat. Oleh itu, kegagalan lampu jalan dan lampu isyarat apabila kehilangan bekalan utama dapat dicegah. Tindakan ini dapat memastikan bahawa aliran lalu lintas sentiasa lancar dan bebas dari kemalangan. Sumber angin untuk menghasilkan turbin angin jalanan ini berasal dari pergolakan udara yang dihasilkan dari kenderaan bergerak. Tesis ini telah ditulis adalah untuk mengembangkan prototaip ini yang dapat digunakan di Malaysia untuk cara lain untuk menghasilkan tenaga hijau untuk membekalkan muatan di jalan raya. Dalam tesis ini ada menyatakan sistem untuk prototaip ini yang akan menggunakan pengawal pengecas MPPT untuk mengawal penjana dan bateri untuk menyimpan tenaga. Dalam bab empat juga akan dibincangkan bagaimana reka bentuk yang sesuai untuk prototaip.

ACKNOWLEDGEMENTS

In the name of Allah, the Almighty who guide us to the truth, the knowledge and with regards to Prophet Muhammad S.A.W for guiding us to the light.

First and importantly, I would like to thank my supervisor, Mr. Arman Hadi Bin Azahar for his invaluable assistance, wise words, and patience during this project.

I am also grateful to Universiti Teknikal Malaysia Melaka (UTeM) for organising this topic for students to make their technological development ideas a reality. Not to mention my mates' openness to share their opinions and suggestions upon this project.

My heartfelt gratitude goes to my parents and family members for their love and prayers through my studies. And also my lover, who has always been there for me and helped me get through my thesis.

Finally, I would like to thank all of the personnel at the technical support for completing the prototype, as well as fellow colleagues and classmates, Faculty members, and other persons who are not included here for their cooperation and assistance.

TABLE OF CONTENTS

PAGE

DECLARATION

APPROVAL

DEDICATIONS

ABSTRACT **i**

ABSTRAK **ii**

ACKNOWLEDGEMENTS **iii**

TABLE OF CONTENTS **i**

LIST OF TABLES **iii**

LIST OF FIGURES **iv**

LIST OF SYMBOLS **vii**

LIST OF ABBREVIATIONS **viii**

LIST OF APPENDICES **ix**

CHAPTER 1 INTRODUCTION **10**
1.1 Introduction 10
1.2 Background 10
1.3 Problem Statement 12
1.4 Project Objectives 13
1.5 Scope of Project 13

CHAPTER 2 LITERATURE REVIEW **14**
2.1 Introduction 14
2.2 Air Turbulence 15
2.3 Wind Turbine 17
2.3.1 Horizontal Axis Wind Turbine (HAWT) 18
2.3.2 Vertical Axis Wind Turbine (VAWT) 20
2.4 Control Techniques for Wind Turbine Systems 25
2.4.1 Power Control Techniques 25
2.4.2 MPPT Control Strategies 26
2.5 Summary 27

CHAPTER 3 METHODOLOGY **28**
3.1 Introduction 28

3.2 Flow Chart of Project 28
3.3 Project Methodology 31
3.3.1 Stage 1: Project Reasearch Planning 32
3.3.2 Stage 2: Development of the Project System Operation 32
3.3.3 Stage 3: Project Determination 33
3.3.4 Stage 4: Prototype Development 37
3.4 Prototype Design on AutoCAD Software 38
3.5 Method of Prototype Testing 39
3.5.1 Laboratory Testing Method 39
3.5.2 Real Situation Testing Method 39
3.6 Summary 41

CHAPTER 4 RESULTS AND DISCUSSION 42
4.1 Introduction 42
4.2 Simulation in MatLab Software 42
4.3 Calculation for Design of Wind Turbine 46
4.4 Design of Wind Turbine in AutoCAD software 51
4.5 Actual Result Based on Laboratory Test. 52
4.6 Result. 52
4.6.1 Data Analysis for 0cm Distance. 53
4.6.2 Data Analysis for 20cm Distance. 55
4.6.3 Data Analysis for 40cm Distance. 57
4.7 Discussion and Comparison of Data 59
4.7.1 Voltage 59
4.7.2 Current 59
4.7.3 Blade's Rotation Speed 60
4.7.4 Power 60
4.8 Actual Result Based on Real Situation Practical 61
4.9 Data Analysis for Actual Result Based on Real Situation Practical 62
4.10 Prototype Demonstration. 63
4.11 Summary 64

CHAPTER 5 CONCLUSION AND RECOMMENDATIONS 65
5.1 Introduction 65
5.2 Conclusion 65
5.3 Recommendation 66

REFERENCES 67

APPENDICES 71

LIST OF TABLES

TABLE	TITLE	PAGE
Table 2.1	Advantages and disadvantages of VAWT [14]	**Error! Bookmark not defined.**
Table 2.2	Comparison of Darrieus and Savonius	24
Table 4.1	Total of Force with Difference Angle of Blades	50
Table 4.2	Total of Force with Difference Number of Blades	50
Table 4.3	Total of Power with Difference Length of Blades	50
Table 4.4	Result for 0cm Distance Between Blower and Turbine	**Error! Bookmark not defined.**
Table 4.5	Result for 20cm Distance Between Blower and Turbine	**Error! Bookmark not defined.**
Table 4.6	Result for 40cm Distance Between Blower and Turbine	52
Table 4.7	Data for Practical Test on Real Situation	**Error! Bookmark not defined.**
Table 4.8	Graph of Voltage (mV) and Current (mA) in 120 second	62

LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 1.1	Illustration of air turbulent[1]	11
Figure 1.2	Example part of wind turbine[3]	12
Figure 2.1	K-chart of wind turbine for generate traffic light and street light	15
Figure 2.2	The transition of turbulent[5]	16
Figure 2.3	Illustration of air turbulent from car	16
Figure 2.4	Wind turbine[9]	17
Figure 2.5	American Farm Windmill[11]	18
Figure 2.6	Dutch windmill[11]	19
Figure 2.7	Modern Wind Turbine[8]	19
Figure 2.8	Savonius wind turbine[15]	22
Figure 2.9	VAWT Cup design[2]	22
Figure 2.10	Egg beater Darrieus wind turbine[16]	23
Figure 2.11	Straight bladed Darrieus wind turbine[17]	24
Figure 3.1	Flow chart of Project	30
Figure 3.2	Flow chart of project development	31
Figure 3.3	Block diagram for general system operation	32
Figure 3.4	Model of Turbine	33
Figure 3.5	DC Brushed Motor Generator	34
Figure 3.6	MPPT controller[21]	34
Figure 3.7	Lithium Polymer battery[21]	35
Figure 3.8	12V Adapter	35
Figure 3.9	XH-M350 Automatic Switching Device	36
Figure 3.10	ESP 8826[22]	36

Figure 3.11 Illustration of combination for system 37

Figure 3.12 Prototype System Construction 37

Figure 3.13 Design for Prototype 38

Figure 3.14 Flow of Traffic with The Level of Wind for One Cycle of Traffic Light System 40

Figure 3.15 Illustration for Dictance Between Car and Turbine 41

Figure 4.1 Simulation in Matlab 42

Figure 4.2 Variable of Base wind power (m/s) 43

Figure 4.3 Output parameter 44

Figure 4.4 Graph base wind speed (m/s) versus AC voltage (V) 45

Figure 4.5 Graph base wind speed (m/s) versus power (mW) 45

Figure 4.6 60° blade angle 46

Figure 4.7 90° blade angle 47

Figure 4.8 120° blade angle 47

Figure 4.9 Two blades 48

Figure 4.10 Three blades 48

Figure 4.11 Six blades 49

Figure 4.12 Wind Turbine model 51

Figure 4.13 Graph Level of Wind VS Voltage for 0cm Distance 53

Figure 4.14 Graph Level of Wind VS Current for 0cm Distance 53

Figure 4.15 Graph Level of Wind VS RPM for 0cm Distance 54

Figure 4.16 Graph Level of Wind VS Power for 0cm Distance 54

Figure 4.17 Graph Level of Wind VS Voltage for 20cm Distance 55

Figure 4.18 Graph Level of Wind VS Current for 20cm Distance 55

Figure 4.19 Graph of Wind VS RPM for 20cm Distance 56

Figure 4.20 Graph Level of Wind VS Power for 20cm Distance 56

Figure 4.21Graph Level of Wind VS Voltage for 40cm Distance 57

Figure 4.22 Graph Level of Wind VS Current for 40cm Distance 57

Figure 4.23 Graph Level of Wind VS RPM for 40cm Distance 58

Figure 4.24 Graph Level of Wind VS Power for 40cm Distance 58

Figure 4.25 Prototype Connecting to WiFi 63

Figure 4.26 Prototype Connected to WiFi and Run by Using Main Supply Power 63

Figure 4.27 Prototype Connect to WiFi and Run by Using Battery 64

LIST OF SYMBOLS

θ	-	Angle
τ	-	Torque
$^\circ$	-	Degree

LIST OF ABBREVIATIONS

HAWT	-	Horizontal Axis Wind Turbine
VAWT	-	Vertical Axis Wind Turbine
MPPT	-	Maximum Power Point Tracking
CPC	-	Collective Pitch Control
PID	-	Proportional Integral Derivative
IPC	-	Individual Pitch Control
DPC	-	Direct Power Control
IPC	-	Indirect Power Control
HCS	-	Hill Climb Search
OTC	-	Optimal Torque Control
AC	-	Alternating Current
DC	-	Direct Current
F	-	Force (N)
m	-	Mass (kg)
a	-	Acceleration (ms^{-2})
r	-	Radius (m)

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
Appendix A	Gentt Chart of Bachelor Degree Project 1	71
Appendix B	Gentt Chart of Bachelor Degree Project 2	72

CHAPTER 1

INTRODUCTION

1.1 Introduction

In chapter, I will come with one suggestion to undergo the problems of the backup power source for traffic lights and street lights to keep running well when blackout happens or when having the bad weather days by using the green energy.

1.2 Background

Traffic lights and street lights are getting the power supply from the same source which is if in Malaysia they used the sourcing from the Tenaga National Berhad (TNB). These organization are managing the electricity supply in Malaysia. For traffic lights, they are connected with the supply cable that travel underground same goes to the street light where these supplies are considered unmetered supplies. The supply power also come from the same source that supplying to our home.

For the traffic light, there are other source which is for backup power supply when the main supply turn off. So it let the traffic light still running when blackout. Opposite to the street light there are only provided with single power source. So, when blackout on that town happens, the street light also will turn off.

To solve the problems, the inventors was developed some solution such as using solar system for generate the street light and also some types of traffic light. But the solution is still having disadvantages on certain country. For example in Malaysia starting on late

November until late January, the states that locates at east coast of Malaysia are having the monsoon that prevent the solar system going well.

The moving object mostly will produce the air turbulent. The strength of the air is depending on the velocity of the moving object which is high velocity that object moving, the air turbulent also high. Besides, the size of object also affecting the strength of air turbulent.

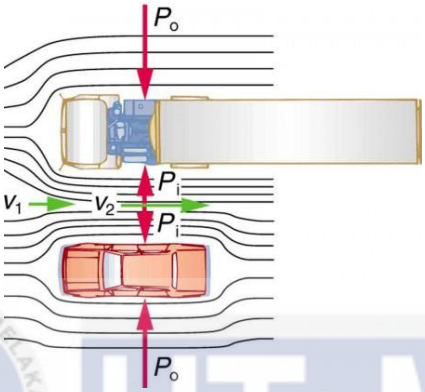


Figure 1.1 Illustration of air turbulent[1]

The presence the wind from the vehicle can make as the kinetic energy to move the turbine that place on the side road. From the turbine the mechanical energy produces than will changes by the generator to the electrical energy.

Design of the turbine is small scale with the Vertical Axis Wind Turbine will used in the project because of the low cost maintenance.[2] So, it is very suitable to place it on the limited space such as at the road divider.

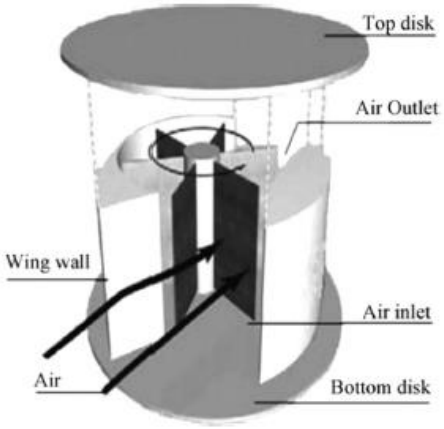


Figure 1.2 Example part of wind turbine[3]

The electric energy that produce from the generator will store in the battery than will use it when the blackout happen as the backup power source. To make the battery stay healthy, the charge controller will use in the connection of the system.

1.3 Problem Statement

Malfunction of the traffic light and street light when losing the main power supply and the solar system as backup source is not efficient. Traffic lights are an essential part of today's road infrastructure. Traffic lights are a set of three lights that signal whether one grouping of cars can go of if they need to stop. However, there still have the problem that cause from the malfunction of the system. In Malaysia, there are many cases of accidents cause from malfunctioning of traffic light. For example during the system lost power source to generate the signal, it causing the traffic movement become a mess and make the traffic flow become slow. If the driver that not being patient, it will cause an accident. The problem is not only from the traffic light but it also come from the malfunctioning of street lights. The malfunction of street light also can causing an accident to the road users. The problem also happened when a day having the bad weather which is the solar system as the backup power source cannot functionally well. Malaysia is the tropical climate which is they got the high rain rate. In the rainy day, the solar system will not functionally well due to lack of

sunlight. So, it is impossible to run their function as the backup power source for traffic lights and street lights.

1.4 Project Objectives

In order to make the improvement for solving the problems, there are the objectives of this project:

1. To design VAWT street wind turbine.
2. To develop the backup electric source to run the traffic light and street light when the main source going malfunction.

1.5 Scope of Project

There are scope of work for the project which is to make the backup supply for the traffic lights and street lights by generate from the street turbine. This project use the air turbulent from the moving vehicle on the highway canyon. There will have different strength of air turbulent due to the vehicle size and velocity. The turbine that places on the road side will spinning along with the generator shaft due to presence of kinetic energy from the air turbulent and generator will change to the electrical energy. This energy will store in the battery as the backup power source when blackout happen. To make the battery stay healthy, the charging controller will use.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review is the part where the information about the project was investigated. In this chapter, it will finding how the flow of the ideas on the design aspect, the comparison between the ideas for the project and theory of the project. Conducting this part is very important for project development.

Besides, this part also we will get the new knowledge about the topic. It is because we need to make some research for our topic based on the journals, articles, books, and source from internet. This chapter is written based on the information from the research that we have done.

In conclusion, this chapter is very important for project it is because we will determine what the best theory that will be apply on this project and also we can make some improvement based on the previous ideas.