UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF RIVER CURRENT OR TURBULANCE ENERGY HARVESTING SYSTEM : COMPARATIVE STUDY ON THE ENERGY GENERATING PERFORMANCE

This report is submitted in accordance with the requirement of Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

by

FAKHRUL FAIZ BIN HAMDAN

B071210496

910427-01-5395

FACULTY OF ENGINEERING TECHNOLOGY

2015

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Development of River Current or Turbulence Energy Harvesting Systems : Comparative Study On The Energy Generating Performance**

SESI PENGAJIAN: **2015/16 Semester 1**

Saya **FAKHRUL FAIZ BIN HAMDAN**

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 salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.

☐ SULIT	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☐ TERHAD	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
☑ TIDAK TERHAD	

Disahkan oleh:

Alamat Tetap:

NO 7, JALAN TU 23,

TAMAN TASIK UTAMA, 75450,

AYER KEROH, MELAKA.

Cop Rasmi:

ASRI BIN DIN
Pensyarah Kanan
Jabatan Teknologi Kejuruteraan Elektrik
Fakulti Teknologi Kejuruteraan
Universiti Teknikal Malaysia Melaka

b/p. Pn. Halyani

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

DECLARATION

"I hereby, declare this report entitled "Development of River Current or Turbulence Energy Harvesting Systems : Comparative study on the energy generating performance" is the result of my own research except as cited references.

Signature : 

Name : FAKHRUL FAIZ BIN HAMDAN

Date : 3rd JUNE 2015

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Power) with Honors. The member of the supervisory committee is as follow:

(Project Supervisor)

ASRI BIN DIN
Pensyarah Kanan
Jabatan Teknologi Kejuruteraan Elektrik
Fakulti Teknologi Kejuruteraan
Universiti Teknikal Malaysia Melaka

ABSTRAK

Air adalah peranan utama dalam kehidupan seharian kita sejak dahulu. Berdasarkan analisis tenaga boleh diperbaharui di Malaysia, air sungai merupakan salah satu potensi terbesar untuk menjana tenaga elektrik. Penyelidikan dan pembangunan mengenai sistem air sungai masih dijalankan dan dipertingkatkan kerana ia menelan kos yang tinggi serta kajian maklumat yang mendalam untuk membangunkan sistem berskala besar. Tujuan projek ini adalah untuk membina dan membangunkan suatu model prototaip sistem janaan elektrik dengan gelombang arus sungai mengikut skala tertentu, dimana memberikan tumpuan pada permukaan arus sungai. Komponen sistem yang akan dibangunkan ini diteliti dan dibuat kajian terlebih dahulu termasuk jenis turbin, penjana elektrik, kotak gear, pengawal, penukar, dan bank bateri. Antara kesemua jenis reka bentuk turbin jenis hydro yang sering diguna pakai, turbin aliran silang heliks (Gorlov's Turbine) dipilih, kerana keupayaan tork yang tinggi pada permulaan, keupayaan untuk menerima aliran masuk dari mana-mana arah, dan prestasi kuasa. Aspek keseluruhan projek adalah mengenai bagaimana potensi kedudukan turbin (kedudukan melintang dan menegak) berfungsi, prestasi 5 bilangan bilah turbin dan keupayaan reka bentuk turbin Gorlov itu sebagai satu sistem prestasi untuk menjana tenaga elektrik daripada arus air sungai. Selain itu, laporan kajian ini untuk mempromosikan tenaga boleh diperbaharui, memupuk sikap mesra alam dan mengkomersialkan air sungai sebagai sumber janaan elektrik. Simulasi dan reka bentuk yang dilakukan dan direkod adalah dengan menggunakan perisian seperti *MATLAB SIMULATION, AUTOCAD PSCAD,* dan *Cathia CAD.* Hasil jangkaan projek ini adalah untuk membangunkan dan membina sistem yang boleh menjana elektrik daripada arus air sungai atau sistem penuaian tenaga gelombang. Berdasarkan kajian perbandingan ke atas prestasi penjanaan tenaga, sistem ini boleh menjadi sandaran sebagai bekalan kuasa yang memberi faedah melalui penggunaan tenaga alam semula jadi. Projek kajian ini boleh dijadikan sumber rujukan kepada penyelidik lain untuk penambahbaikan kepada sistem sedia ada, atau membangunkan suatu sistem yang sama konsepnya untuk akan datang.

ABSTRACT

Water is a main role in our daily life since a long time ago. Based on the analysis of renewable energy in Malaysia, river water is one of potential to generate electrical energy. The research and development system of river water on progress because it highest cost and details information data to develop in big scale. The aimed of this project is to construct and develop the system by turbulence energy harvesting of river current with the available scale. The objective project focus on the potential surface area of river water. System components are reviewed and include turbine, electrical generator, gearbox, controller, converter, and battery bank. Among several turbine designs reviewed, a helical cross-flow turbine is selected, due to its self-start capability, ability to accept inflow from any direction, and power performance. The aspect of overall project present about how the potential of turbine position (either horizontal and vertical position) and the number of blades performance with their actual ability of Gorlov's turbine to fix as a performance system to generate electrical energy by current water river. Besides that, to promote the renewable energy, environmental friendly and commercialize water river as a sources of electricity generation. To describe the implementation result and discussion of the research, the simulation done with software such as SOLID WORKS SIMULATION, AUTOCAD PSCAD, MATLAB and CATHIA CAD and the data comparison recorded. The expected outcome of the project is to develop and construct the system that can generate electricity from river current or turbulence energy harvesting system. Based on the comparative study on the energy generating performance, the suitable system can applied to the real life and suitable for users. This system might become as generator to backup power for power supply to get the benefit from the energy of environment. This research project can be used as a reference to other researchers for improvements to existing systems, or develop a system that similar in concept for the next.

DEDICATION

I would like to dedicate this report to my beloved parents (Hamdan Hj Mis and Hidayu Hj Mansor) and my siblings (Faiqah, Razi, Faqiha, Razi), supervisor (Mr. Asri Bin Din and Mdm. Halyani Binti Mohd Yassim), lectures, my best friends (Razly Raffy & Amirah Muhammad Amin) and all my friends for giving assistant to complete this project successfully.

Thank for your endless love, sacrifices, prayers, supporters and advice.

ACKNOLEDGEMENT

Alhamdulillah, I would like to thank my beloved parents and my family for their support and motivating through my project.

I would like to express my gratitude to my supervisor, Mr. Asri Bin Din and co-supervisor Mdm. Halyani Binti Mohd Yassim with their support and help through my Degree Final Project is successfully.

I'm also appreciate to my friends, to all my classmates and club mates for their support and assistance in this project. Lastly, I also would like to thanks many people that have contributed and involved directly or indirectly to complete this project.

TABLE OF CONTENTS

LIST OF FIGURE

LIST OF TABLES

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

RPM	-	rotation per minute
kW	-	kilowatt
kWh	-	kilowatt hours
AC	-	alternating current
DC	-	direct current
Sg.	-	river (sungai)
Ω	-	resistance (ohm)
P	-	density of fluid
ω	-	angular velocity of turbine
Q	-	flow rate formula
σ	-	solidity
φ	-	helical angle
Gorlov's turbine	-	helical cross flow

CHAPTER 1

INTRODUCTION

1.0 Introduction

Nowadays, one of the main functions to generate electrical power called hydroelectric system. Hydroelectric is a way mankind harvest the energy of natural resources. The method of harvesting has become more complicated and efficient according the level of knowledge and studies. According on the analysis of renewable energy in Malaysia, river water has potential to generate electrical energy. Unfortunately, the records shown on 1999 just only 2% energy consumption of the source. This happened because of a few main factors, one of that is capital finance. The research and development system of river water still in progress but it going highly for cost and more details information data to develop the system in big scale. Based on that problem, several country develop a hydrokinetic turbine as a power source for monitoring equipment with the aim of significantly reducing the present power source system costs (Oliver Hammond, Shelby hunt, Emily Machlin, 2001),

Non-storage (run of river) hydroelectric is independent producer of clean, renewable energy and one of the most environmental friendly and commercially viable sources of electricity generation. It has been located on streams with natural river flow that act as barriers, thus greatly minimizing negative impacts on fish and wildlife habitat.

1.1 Project Background

The aimed of this research is to develop the model prototype system by turbulence energy harvesting of river current with the available scale. The objective project focus on the potential surface area of river water. The Run-Of-River systems have the same main component which is diversion and use the water. It will transport the water to move the turbine and generator, then convert the kinetic and potential energy from the water to generate electrical energy without dam. Based on that, this study required to construct and develop model prototype by methods that have potential to harvest energy from turbulence and make a comparative study on performance of the systems in generating energy.

This study will include the details of energy generating system in several aspects, which is power output, the performance of design, turbine parameter, and ability of blade. The method used is a potential & kinetic energy come out from the ones type of reaction turbine which is Gorlov's turbine also known as helical cross flow (free-flow type). The reaction turbine is generally suitable for low current velocity (about 0.5 m/s) and have high mechanical torque but at the same time depends on direction of water current. Moreover, the turbine is simple and no moving part, thus a reaction turbine develops power from the combined action of pressure and moving water. The runner is placed directly in the water stream flowing over the blades rather than striking each individually. Run of river power is hydro electric energy created when water is diverted from a stream through a mechanical part to spin a turbine, which creates electricity. The flow of river will free-cross or move over the mechanical part then the water river re-directed back onto the river further downstream.

Due this theory, the electrical energy produced by kinetic energy from the Gorlov's turbine will keep in batteries. The battery connected to the load such as lamp, fan, kittle and others electrical equipment with small load. The main purpose is to create the system with the concept of plug-and-play, portable and easy to control by people. Besides, can be emergency systems depend on some cases.

1.2 Problem Statement

The Malaysian's Government gives a serious attention in the need to find and utilize renewable resources to add to the energy supply. Apart from the apparent issues the country is looking for ways to diversify the current energy resource and promote the renewable energy at the same time environmental friendly. Although the implementation is going to be a long and tedious process, it is a worthwhile project to undertake in the long period time.

Conventional electricity generation produces carbon dioxide, which is released to the atmosphere, then contributes to the greenhouse effect and the phenomena of global warming. Renewable energy helps in reducing this, playing a role in making the world a healthier place for humans to live in.

Next, the current hydroelectric system that using the conventional dam destroys the environments which cause the rising in water level and will submerge the nearby forest thus not appropriate Malaysia as an environmentally friendly. Last but not least, most marine turbines, primarily water wheels, held the disadvantage of being quite large. That was necessary for them to produce sufficient amounts of power, plus the river current flow or speed not constantly and the location of river with high speed river current is difficult to know location so, it needs the suitable turbine and system for generate electrical power from the surface river current to get the good efficiency.

1.3 Objective

The objectives of this project study are summarized as follows:

1) To construct and develop methods those have potential to harvest energy from river current of turbulence

2) To investigate and analyze the output power from that method implemented.

3) To study the ability and functional of Gorlov's turbine for this system.

1.4 Scope of Study

The main scope of this study focuses on the availability of renewable energy in terms of energy and electricity generation. The geography scope of this study at Melaka's river in the Melaka Tengah area. The distance of Melaka river is 40.0km, starting from the Muara Sungai Melaka until Kg. Gadek (the junction of Sg, Batang Tampin with Sg. Batang Melaka). There are several main tributaries entering the Melaka river which is Sg. Putat, Sg. Cheng, Sg. Durian Tunggal and Sg. Alor Gajah. This system will be test on the current river at Sg.Putat and Sg. Durian Tunggal at depth of about 3-5 meter or below 10 feet in depth to get the actual result.

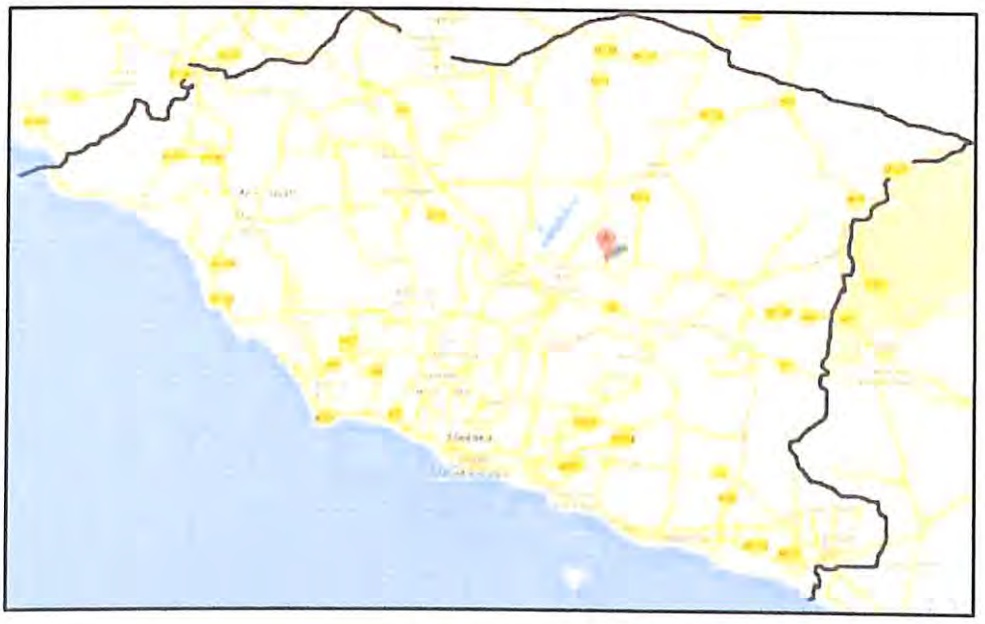

Figure 1.1 : Map of River in Melaka
(Source: http://www.damusyu.com/bpwg/lokasippwppg/images/melaka.jpg)

The preferred site may implement in rural area which is difficult for huge system to be delivered and install there. On the generation topic, the capacity of the energy generated should be taken into account, so that the suitable usage of application can be determined.

The main focus of this paper is to study the feasibility of the designed system, which is include the performance and the position (either horizontal and vertical) of turbine, the suitable generator, the efficiency of driver and actuator, and the type of floating system. These systems use the Helical Turbine or known as Gorlov's turbine as generate electricity. Furthermore, the number of blades also will give attention as the main focus about the performance of harvesting system. In addition, the system will have energy storage system to maximize the energy usability. Consequently, the output data were collected to determine the best configuration.

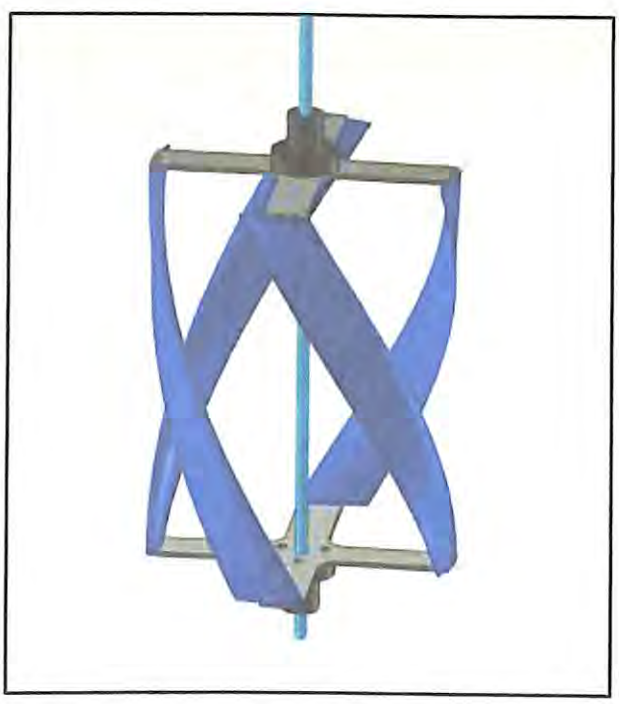

Figure 1.2 : Helical (Gorlov) Turbine
Diameter – 17.2cm, Length (Height) – 23.4cm.

According the limited availability details of published literature on about Gorlov turbine design, the scale model testing of the system was used 5 blades turbine with a, 0.3 solidity ratio for the helical turbine configuration and construct by aluminum alloy material. Based on the previous research, the Four-Bladed Turbine with a 60° helical pitch angle is more efficient than the other number of blades Turbine with 43.7° helical pitch

angle, despite the two turbines having the same blade profile, solidity ratio, and cross-sectional area Adam L. Niblick, (2012). However, the 5 blade of turbine will become research of this study to get the result and compare with four blades Gorlov's turbine.

1.5 Project Significant

The expected outcome of the project is to develop and construct the model prototype system that can generate electricity from river current or turbulence energy harvesting system. Based on the comparative study on the energy generating performance, the suitable system can applied to the real life and suitable to use. By using concept of plug-and-play, portable and easy to control by people, this system can be a generator as backup power for power supply, which is alternative way from natural environment energy to get the benefit from this system. So, this research will study the ability of turbine and the performance of position to construct and develop suitable system or device application. Although, this system design could be utilized in a way that it could benefits the society. At the same time user from rural area may use the designed system to power their farming tool, irrigation system, small home or anything as long as it within the range of power requirement that the system can supply. This study can be some research to other that can refer for develop the future technology or next study cases.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Chapter II describes literature review finding based on materials. The important part is literature review to get the project methodology includes of project requirement, milestone and schedule. The source of information details come from journals, reports, books, research, papers, internet and personal persons to achieved this proposed project. The journal that I have studied and picked based on interest and related with this paper is obtained through IEEE explore with the courtesy of UTeM digital library such as functional, benefit, constructing, maintaining, advantages and disadvantages of hydroelectric power generation. Even though, the information and subjected presented in the journal is not directly related to this research, but some important information and knowledge was able to extracted and applied to this research.

2.1 World's Energy Consumption

Renewable energy effectively using natural resources such as sun , wind , water and other To Produce energy. Since the type of resource is infinite in theory , it offers attractions for the widespread use and development. At this time , at least 8 % of primary energy for the world's consumption is sourced from renewable resources. Biomass is the highest percentage followed by hydropower . Modern technologies like wind, solar, geothermal and other technologies produce less than 1% of the world's demand (Kyairul Azmi Bin Bahafun, December 2007). Figure 2.1 and figure 2.2 highlights the present