UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Development of Speed Control for an Electric Bicycle by using Arduino

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree of Electronics Engineering Technology (Industrial) (Hons.)

by

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I hereby, declared this report entitled "Development of Speed Control for an Electric Bicycle by using Arduino." is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for Bachelor's Degree of Electronics Engineering Technology (Industrial) (Hons.). The member of the supervisory is as follow:

Signature : ……

Supervisor's Name : ENCIK SHAHRIZAL BIN SAAT

Date : ……

ABSTRAK

Melaka adalah salah satu tempat bersejarah di Malaysia yang mempunyai banyak pelancong dari dalam dan luar negara kerana mempunyai kepelbagaian tarikan pelancong. Salah satunya ialah keunikan becanya yang dihias dengan pelbagai aksesori bagi membuatkan ianya kelihatan menarik untuk digunakan sebagai kenderaan membawa pelancong mengililingi Bandar Melaka. Akan tetapi, kita dapat lihat kebanyakkan penarik beca adalah golongan tua. Tambahan pula, jumlah tenaga yang diperlukan akan meningkat apabila berat beban atau penumpang beca bertambah. Jadi, satu inisiatif telah diambil bagi membantu penarik beca mengurangkan jumlah tenaga diperlukan dengan membuat projek ini. Kita sedia maklum bahawa sebahagian dari beca adalah basikal. Jadi, untuk projek ini, basikal akan dipasang dengan sistem yang mempunyai Motor Arus Terus untuk mengawal putaran tayar belakang, Pengekod Putaran untuk memanipulasikan kelajuan yang dikehendaki dan kelajuan semasa, Arduino Mega ADK sebagai papan kawalan dan Pemacu Motor. Walaupun projek ini berkonsepkan basikal elektrik, tetapi konsep asal basikal akan tetap dikekalkan. Bagi projek ini, sistem operasinya bermula dengan kayuhan pada pengayuh, dari situ kelajuan putaran akan direkod oleh Pengekod Putaran lalu dihantar kepada papan kawalan iaitu Arduino Mega ADK bagi membandingkan kelajuan kayuhan dan tayar belakang yang juga direkod oleh Pengekod Putaran. Apabila kedua-dua data diperolehi, perbandingan akan dibuat. Jika kelajuan pada kayuhan lebih tinggi daripada kelajuan putaran tayar belakang, kelajuan Motor Arus Terus akan bertambah secepat mungkin sehingga mendekati kelajuan pada kayuhan, jika kelajuan kayuhan didapati kurang daripada kelajuan tayar, maka kelajuan Motor Arus Terus akan berkurang tetapi jika kelajuan kedua-dua pengayuh dan tayar belakang adalah sama, Motor Arus Terus akan mengekalkan kelajuan. Bagi melakukan perbandingan kelajuan tersebut, Terbitan Teras Berkadar digunakan bagi membolehkan kelajuan semasa dapat mengikut kelajuan dikehendaki secepat mungkin.

ABSTRACT

Malacca is one of the historical places in Malaysia that have a lot of tourist from inside and outside of the country and have a lot of tourist attraction. One of them is the unique trishaw that decorate with a lot of accessories to make it looked attractive which used to take the tourist around Malacca City. But we can see that that some of the trishaw rider is very old enough to rider the trishaw. In addition, the energy needed to cycle a trishaw is going to increase when the load or passenger weight is increase. So, we take some initiative to help the rider of trishaw to reduce their energy to cycle the trishaw by doing this project. We know that trishaw is made from part of bicycle. So, for this project the bicycle will be fabricated with a system which contain DC Motor to control the rotation of the rear wheel, Rotary Encoder to manipulate the desired speed and current speed, Arduino Mega ADK as a controller and Motor Driver. Even though this project is about an electric bicycle, but the original concept of bicycle is going to be maintain. For this project, the operation system will start by cycling the pedals, from there the speed will be collected by the Rotary Encoder and send to Arduino Mega ADK to compare the speed of pedals cycled and rotation of rear wheel which had been recorded by Rotary Encoder too. When both data collected, the comparation will be done. If the speed of pedals cycled is faster than the speed of rear wheel, the speed of DC Motor will increase until it reaches the speed of pedals cycled, if the speed of pedals cycled is slower than the speed of rear wheel, the DC Motor speed will be decrease. But if both speed of pedals cycled, and rear wheel are same, the speed of DC Motor will maintain the same. To do all those comparation of speed, Proportional Integral Derivative is used to ensure that the current speed can reached the desired speed as fast as possible.

DEDICATION

To my beloved parents

Azhar Bin Che Amat and Noor Azah Binti Ani @ Abd Ghani

To supervisor

Encik Shahrizal Bin Saat

To all friends that help me a lot towards completing this project.

ACKNOWLEDGEMENT

In the name of Allah, the Most Beneficent and Most Merciful.

Firstly, all praises to Allah, the Almighty God that has given me the strength and spirit to complete this project.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

DC	-	Direct Current
PID	-	Proportional Integral Derivative
PWM	-	Pulse Width Modulation
LiPO	-	Lithium Polymer
RPM	-	Revolutions Per Minute
km	-	Kilometre
A	-	Ampere
W	-	Watt
V	-	Volts
s	-	Seconds
GND	-	Ground
IN	-	Input
Min	-	Minimum
max	-	Maximum
T_R	-	Time Rising
LED	-	Light Emitting Diode
$\approx$	-	Approximately
$\pm$	-	Plus Minus

CHAPTER 1
INTRODUCTION

1.0 Background

Trishaw, one of the old generation transportation which is a bicycle with a sidecar and it is fully powered by the cyclist. The trishaw become the popular public transportation in the immediate years following the end of Japanese Occupation. But suddenly it started to suffer following a decline in popularity from mid of 1950. In the late of 1970, the trishaw riders were regarded as dying breed because many of them were involved for tourism trade.

Figure 1.01: Example of Trishaw

In the early of years, trishaw was a transport that evolved from the early concept which known as Rickshaw. It was known as “jinrikisha” in Japanese word which mean a man powered carriage as it is pulled by a man. (Bonny Tan)

Figure 1.02: Rickshaw

Basically, it is used human from one place to another place but sometimes it also been used to carry things. In Malaysia, we could see that trishaw were used mostly in historical city like Penang City and Malacca City as tourist’s attraction which will cost the tourist to pay the fee to enjoy the environment around the city on the trishaw.

1.1 Problem Statements

i) The energy needed for trishaw cyclists is the main problem that could be see as they cannot make much trip in a day as they consumed a lot of energy for a trip around the city when they carry heavy customer.
ii) The energy needed for trishaw cyclists need to climb up the slope and hilly road to reach the destination.
iii) Making electric bicycle without changing its own concept which it will fast when speed up the pedals and slow down when pedals cycled slow. The speed slowly decreases when the pedals release.

1.2 Objectives

i) To reduce the energy needed when cycling a bicycle.
ii) To fabricate a bicycle which designed with motor and its system.
iii) To design a suitable system used to control the speed of motor.
iv) To let motor generate the speed nearly same as the speed of pedals cycled.

1.3 Scope of Work

i) Fabricating a bicycle with motor and rotary encoder.
ii) Program the coding used to Arduino.
iii) Design the system that used to control the speed of DC motor.
iv) Produced the project that will help to reduce the energy needed.

1.4 Limitation

The limitations of the study are those characteristics of design or methodology that affected those researched and project from the findings. It was the problem in conducting the project as the time for the project is very limited and the scope become too big when it need to be done. So, for this phase of project only the scope which is stated in 1.3 Scope of Works will be done and the other phase maybe will be continue by another student from the next batch.

Some of those limitations are:

a) The battery recharging system
b) The exact speed of motor when pedals is cycled

1.5 Expected Result

At the end of this project, the expectation is to see the project result is at least passed accurate toward the objectives. From this project, it will give more advantages to those who want to make an electric bicycle and also when it goes to public, it could help the trishaw cyclists as we could see around Malacca City to reduce their energy needed when cycling a trishaw without changing the normal concept of bicycle. Besides that, I also expected to have a suitable system used to control the speed of DC Motor working with optimal performance.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

In this chapter, it will provide all about the understanding through the project development. It also will review the points of current knowledge from the information obtained that related to the concept of the project which will be used throughout the project development.

2.1 Trishaw

Trishaw is actually a transport that consist of three-wheel, seat, pedals and other equipment to make the passenger comfortable while enjoying the experience on the trishaw. It is made up of two parts which are bicycle and sidecar.

In the old generation, trishaw was so simple but in the new era especially in Malacca city, the trishaw was equipped with a lot of modern accessories like LED, Radio and a lot of decoration to make it look great and unique compared to trishaw in other places. This is because Malacca has put it as the tourist attraction that could attract all the tourist from domestic and also international tourist. [Norliza Mohamad Zakaria, Utusan Online, 2013]

The drivers line up in front of Christ Church on the main square and offer sightseeing excursions around town. Usually we're a bit uncomfortable being carried in human-powered transportation, wondering if it's fair to the driver. But we should know that it's better to support the drivers and the local economy than to not use their services. A one-hour tour costs about 40 Malaysian ringgits. For this sum of fee the rider gets transportation and a running commentary about Malacca and its history. It is definitely worth this journey into Malacca's past.

Figure 2.01: Trishaw in Malacca (Day view)

Figure 2.02: Trishaw in Malacca (Night view)

Type of Trishaw:

Front Ride

Front ride trishaw is a trishaw that put the cyclist in front of the passenger which mean that the bicycle is in front of the sidecar. This type of trishaw is rarely used in Malacca because it may block the view of the passenger.

Figure 2.03: Front Ride Trishaw

Side Ride

Side ride trishaw is a trishaw that put the cyclist beside of the passenger which mean that the bicycle is beside the sidecar. This type of trishaw is commonly used in Malacca because it put the cyclist near to the passenger and make it easy to the cyclist to communicate with their customer.

Figure 2.04: Side Ride Trishaw

Tail Ride

Tail ride trishaw is a trishaw that put the cyclist behind the passenger which mean that the bicycle is at the back of the sidecar. This type of trishaw is also rarely used in Malacca because it may block the view of the cyclist and the handling also will be a bit hard as the load is put in front of the cyclist.

Figure 2.05: Tail Ride Trishaw

2.2 Research Project

2.2.1 Pulse Width Modulation (PWM)

PWM is one of the way to manipulating signal width that's expressed with pulse in a period, to get different mean voltage. Some examples of PWM application are modulation data for telecommunication, power or voltage control, voltage regulator, audio effect and relay, also other applications that this time is trying to be applied in the process of electrolysis.

PWM signal commonly has constant basic amplitude and frequency, but it has variety pulse width. Pulse width directly proportional with pure signal amplitude that unmodulated which means PWM signal has constant wave frequency but variant duty cycle (between 0% and 100%). [R. Prayogo, Pengaturan PWM, 2012]

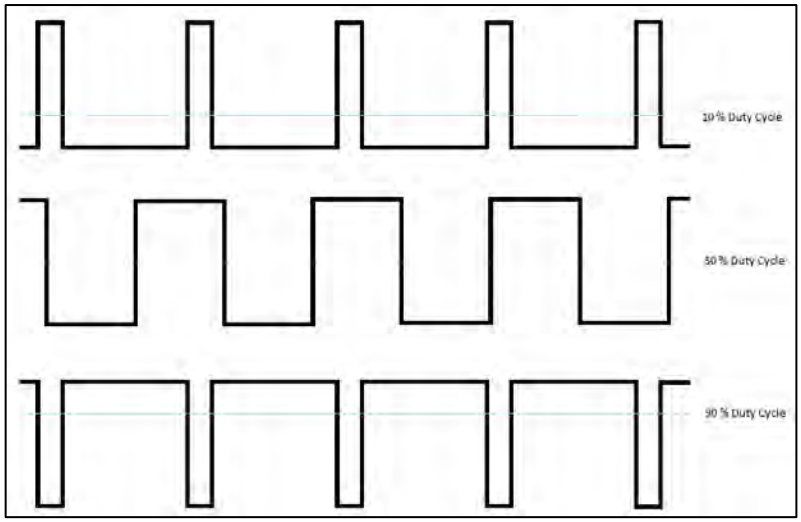

Figure 2.06: PWM

Duty cycle usually expressed in percentage. Example at duty cycle 50%, it means pulse width Ton amount 50% average voltage output is 50% from input voltage. By counting duty cycle that given, will be acquired the output voltage: