



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**POWER SOURCE MANAGEMENT SYSTEM OF ELECTRIC
VEHICLE RACING CAR**

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

by

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DECLARATION

I hereby, declared this report entitled “PSM Title” 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 the degree of Bachelor of Engineering Technology (Bachelor of Engineering Technology Automotive) (Hons.). The member of the supervisory is as follow:



.....

(Dr. Muhamad Zahir bin Hassan)

ABSTRACT

Electric car is an alternative power source to reduce pollution and to minimize the usage of mineral oil, and the system also release zero imitation. Moreover, the research of this technology have been started in early 1880s, and gaining popularity in the late 19th century. This technology are started forgotten when the advances technology in the internal combustion engine, and this technology provide a low cost and high efficient in that time. The basic of electric vehicles technology divide into three parts; power source (battery), controller and the motor. This technology become a trend nowadays following a rapid development and concernity to environment and health. There is two different technology widely used in automotive industry, there is the brushless and also the induction motor. Where the induction motor using a looping of copper coil, while the brushless motor using a permanent magnet as a rotor. In this study, the induction motor is used to drive the vehicle. Induction motor consist two main part which is stator and rotor. The rotor is supplied by an alternative current to induce a magnetic field, produce a torque that is required to drive a vehicles due to electromagnetic induction from a magnetic field produce by the stator winding. The strictly design has been made to mount and placement of all the equipment of the system to drive a car. After development of the induction motor has been made, a few analysis are made to ensure this technology are better compared brushless motor in order to win the race in Sepang International Circuit.

ABSTRAK

Kereta elektrik adalah sumber tenaga alternatif untuk mengurangkan pencemaran dan mengurangkan penggunaan minyak mineral, dan sistem juga melepaskan tiruan sifar. Selain itu, penyelidikan teknologi ini telah bermula pada tahun 1880-an awal, dan semakin popular pada abad ke-19. Teknologi ini sedang mula dilupakan apabila teknologi kemajuan dalam enjin pembakaran dalaman, dan teknologi ini menyediakan kos yang rendah dan kecekapan yang tinggi pada masa itu. Asas elektrik teknologi kenderaan terbahagi kepada tiga bahagian; sumber kuasa (bateri), pengawal dan motor. Teknologi ini menjadi satu trend pada masa kini berikutan pembangunan pesat dan kepekaan kepada alam sekitar dan kesihatan. Terdapat dua teknologi berbeza yang digunakan secara meluas dalam industri automotif, ada tanpa berus dan juga motor aruhan. Di mana motor aruhan dengan menggunakan gegelung gegelung tembaga, semasa motor tanpa berus menggunakan magnet kekal sebagai pemutar. Dalam kajian ini, motor aruhan yang digunakan untuk memandu kenderaan. Motor aruhan terdiri dua bahagian utama iaitu pemegun dan pemutar. Pemutar dibekalkan oleh arus alternatif untuk mendorong medan magnet, menghasilkan tork yang diperlukan untuk memandu kenderaan kerana induksi elektromagnetik dari medan hasil magnet oleh pemegun penggulangan. Ketat reka bentuk telah dibuat untuk melancarkan dan penempatan semua peralatan sistem untuk memandu kereta. Selepas pembangunan motor induksi telah dibuat, analisis

sedikit yang dibuat untuk memastikan teknologi ini adalah lebih baik berbanding brushless motor untuk memenangi perlumbaan di Litar Antarabangsa Sepang.

DEDICATIONS

This project is devote to the nest person I ever met, Dr. Zahir bin Hassan. To complete this project is an honour for me as a present for me to my family. This project also offers UTeM to improvise the electric racing car for the next tournament.

ACKNOWLEDGMENTS

Thanks to my parent and family because giving me a full support in every direction. From the beginning, this project needs a full dedication and focus to get it succeeds. Therefore, their support being a backbone to this project. Dr. Zahir is the most influences person in this project, his support, commitment and patience's during these project is conducted is such an impact to this project. To all my lecturer and my colleague helped me in ever single way is an honor for me and never be repay. Thanks to everyone for helped me to complete these projects and the report.

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CHAPTER ONE

INTRODUCTION

1.0 Overview

Electric vehicles become a trend nowadays because the concerned about the environment and health are increases, by joining the FV Malaysia 2015, shown that UTeM is one of the university in Malaysia concerning and support the green technologies to save the earth. To become a winner of this event become a main target because by winning this, it shown to the Malaysian that UTeM are the leading university in the green technology. The development of the electric racing car is and to choose the best technology to be use in the car become an headache for the team. Current technology wifely used in racing car in electric categories is brushless motor (BLDC), while the induction motor are keen to rises still developing. By referring to the most advancing electric car manufacturer, Tesla Motor. Inc. The company are using an induction motor to drive their vehicles (Lomas R., 1999). This proven an induction motor can be used to drive a racing car, and already been proven to be used in sedan car. To develop a racing car using this technology there is a few law must be obey, and the most important thing is the car should not exceed 7.5kw. The processing is quite complicated but the power produce by this technology are outrageous compared to BLDC motor. BLDC motor is quite simpler and also having a limited speed and lesser torque compared to the induction motor, this fact make the induction motor are even better (Covic G.A. *et al*, 2010).

Power source management system for an electric car is also can be called as a powertrain system. The system is from the power supply which is battery followed by the controller, motor and also differential. In the controller there is a few stage to converting a supply current (DC) to the output (3phase AC), the supply current is from the battery and the output current is to supply to the motor and transfer the energy to the wheel. The power draw from the motor is the most crucial things, to ensure the efficiency is high and the performance is optimum the power supply from the battery must be stable and consistence. More over the placement af all equipment must be consider to minimize the space of the power train system.

1.1 Research Background

In recent years electric vehicle is raising and the visibility on the road are increases. The alternated power to replace fuel are rises due to decreasing of crude oil sources. Moreover in a recent year the price of mineral oil are increase and become a burden to the customer and the technologies are refine to search and develop an alternate solution. The dependency on fossil fuel must be reduce and the energy storage capabilities should improve and would transform transportation (Rosengberg, 2011).

Most of the team entered in FV Malaysia 2015 for electric vehicle category using BLDC technology because the technology has been widely used and has been proven in many car but if the UTeM racing team taking a same principle and technology, the result and the speed are equal and to winning the race is unpredicted. To assure this team to winning the race, different technology with improved performance must be develop. Therefore an induction motor technology are choose. This technology a little

bit ancient compared to BLDC motor, although the technology are more backward but there is a few advantages to be prove this is the best technology to be choose for the race in Sepang.



Figure 0.1: Formula E 2015 Julius Baer Punta Del Este ePrix (FIA Formulae,2015)

1.2 Aim and Objective

FV Malaysia 2015 is the biggest UTeM even in the year therefore there is a few standard and aim should be completed, and for this study, the event as a preferred guide to develop an electric racing car.

1.2.1 Aim

The aim of this research is to develop a racing car by using an induction motor technology, the car performance must be improved, and should be faster and agile compared with the electric car using BLDC motor. Therefore this technology must be improved and continues research to develop a proper racing car to win the race. The other aim is by using this technology the power consume must not exceed the storage. Therefore a simple calculation must be made before this technology is used. Above all to win a title in the race is the best aim in this study.

1.2.2 Objective

The objective in this study are as follows:

- i. To identify the best and suitable capacitance for the battery storage for complete FV Malaysia 2015 (EV)
- ii. To develop a powertrain system of EV racing car.
- iii. To test the system and implement in UTeM electric racing car.

1.3 Organisation of Study

The remainder of this report is comprised of five further chapters as summarized below:

Chapter 2: A Review of literature relevant to the present study comprising the induction motor and available electric car technology in the market.

Chapter 3: The methodology, purposed to develop an electric powertrain system for UTeM electric racing car.

Chapter 4: Equipment there is require to drive the racing car and also the method are used to implement the technology to the car.

Chapter 5: The result required from calculation and also based on experimental the result is compared with the racing car drive by BLDC motor.

Chapter 6: Is the ending of the thesis that conclude the study either the objective is achieve or not.

1.4 Scope of Research

The scope of this research is limited to the following items so that the research could be focused to achieve the stated objectives.

- i. The motor technology selected
- ii. The battery capacitance required to complete the race
- iii. The process to implement the technology to the racing car.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

Electric vehicles is gaining popularity in the past two or three years and the technology are still developing. The power storage is the main concern about electric vehicle and the research about this technology become a priority among electronic company. "All the batteries we make now store less than 10minutes of all the energy usage in the world" (Gates, B. 2010). This statement show that the power storage technology are still a few step behind compared to what we achieve today. Therefore the research about this technology become priority and competed among the storage tycoon to produce a new technology to expand the storage capacity with the limited dimension. More over the greenhouse effect are increases, with developed electric vehicle technology can reduce carbon release to the environment.

This chapter begin with introduction to the basic powertrain to give an overview of electric car and their function. To be more specific about the function there is a few split part to narrow the scope. A review of electric car powertrain divide into two. Brushless Direct Current (BLDC) and induction motor. The basic of electric car powertrain is power storage, controller and a motor. In this study the technology about the induction motor are study and to implement to the actual racing car. All the equipment to drive this car using an induction motor technology are describe in detail and it function in this chapter finally the powertrain electric vehicle research review

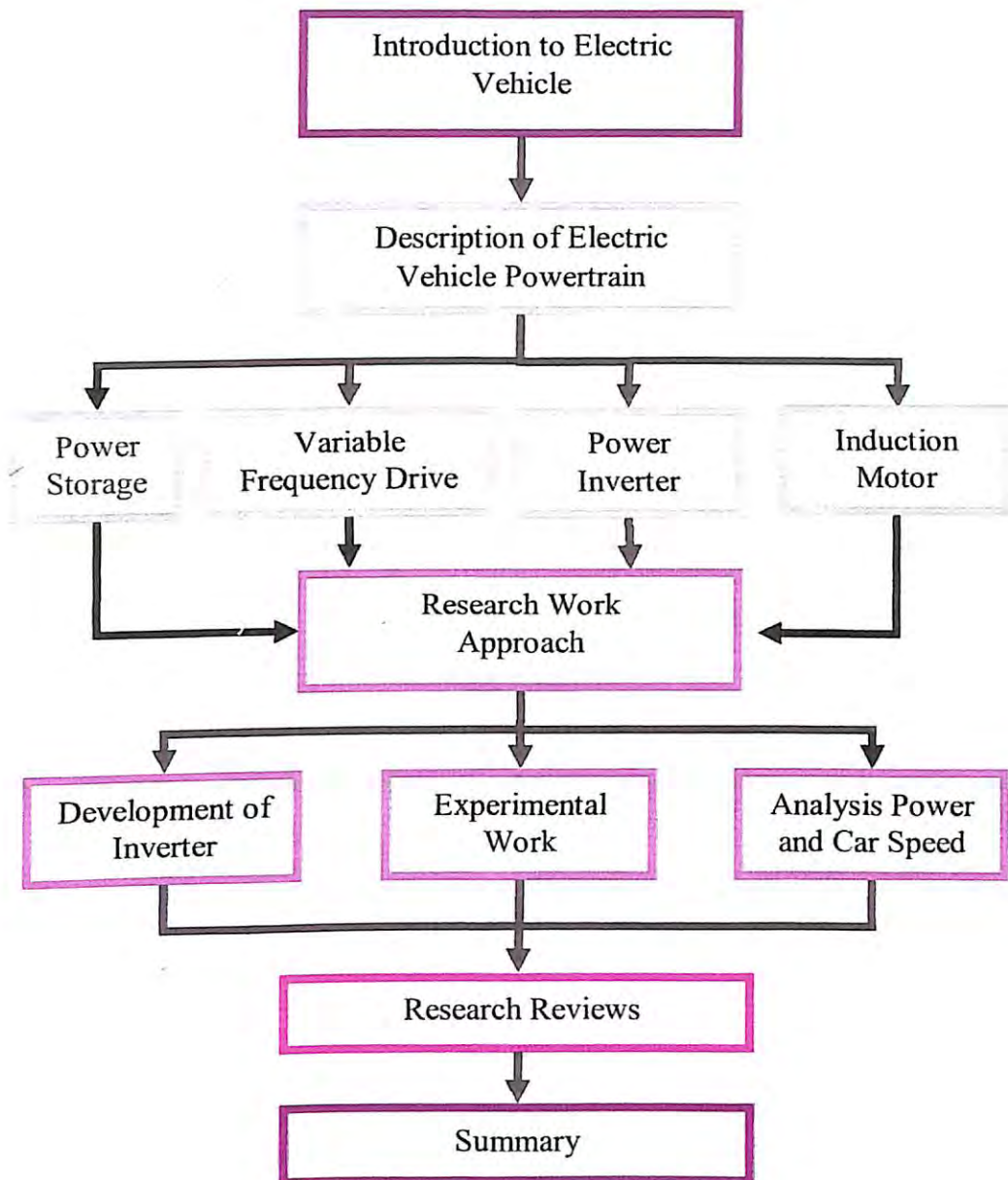


Figure 2-1: Overview of Literature Review

2.2 Electric Vehicles

2.2.1 Historical Background

Electric vehicle is a vehicle that uses an electricity to generate a move a vehicles. The technology is started when Slovak-Hungarian priest Anyos Jedlik invent the first crude but viable electric motor, with stator, rotor and commutator as it componem. He used to power a small car model a year later. After that Robert Anderson of Scotland build a

carriage using a crude electric in between 1832 to 1839. At the same time in the Holland, Professor Steatigh of Groningen is designing a small-scale electric car and build it by his assistance Christopher Becker in 1832. The exact year in Vermont, Thomas Davenport a blacksmith from Brandon invent the first DC electric motor build by American (M. Bellis, 2010). This shown that the technology of an electric cas is started a decade ago but due to cost and the advancing of internal combustion engine technology the Electric car become less popular and forgotten. In recent year due to pollution and awareness of the earth the technology to reduce an emission become important. Emission standard is introduce to control the emission, to protect human health and to achieve air quality standard. In the State, Environmental Protection Agency (EPA) is an agency that manage he emission standard but only in California using a different standard but the other state can follow either California or the nation standards. In Europe, all union using a same standard that new vehicles must be meet, standard is set for all road vehicles (EU Parliament, 1998) In Malaysia, United Nation Environmental Program (UNEP) is an agency to guides the Fuel Quality and Vehicles Emission Standard.

2.2.2 FV Malaysia 2015

FV Malaysia started by based on the previous event which is called Formula Varsity. The first event is held in the 2006 by Faculty of Mechanical Engineering, UTeM with only two participant which is UTeM itself an also from University Tun Hussien Onn. In 2008 this event once more been reorganized with five contestant from public Education Institute (PHEI), University Technical Malaysia Melaka(UTeM), University Putra Malaysia (UPM), University of Nottingham Malaysia (NU), Politeknik Kota Bahru (PKB), and the last contender is from Poiteknik Shah Alam (PSA). Next event is held in october 2010 the contents become more organized and having more contestant wich is 18 team from differ Higher Education Institute (HEI). The Formula Varsity become more popular and being a most privilege racing event in the HEI level, and in 2015 FV Malaysia is introduce to rebrand the previous event. This event challenges engineering student to design, build and race with formula style race machine. This event improve student capability and understanding about the engine

and the racing, it an opportunities for a student to sharpened their talent and improvise.
(FV Malaysia, 2014)



Figure 2-2: UTeM Formula Varsity 2012 (FV Malaysia 2015, 2015)

2.3 Electric Vehicles.

An electric vehicles must be consist of this three part which is the battery, electric motor and a controller (Leitman and Brant, 2009). The battery is functioning as a storage of a power, while a motor is a places to usage the power, and to control it power, the controller is invented. Figure below show a simple block diagram of an electric vehicles.



Figure 2.3: Simple block diagram of electric vehicle (Leitman and Brant, 2009)

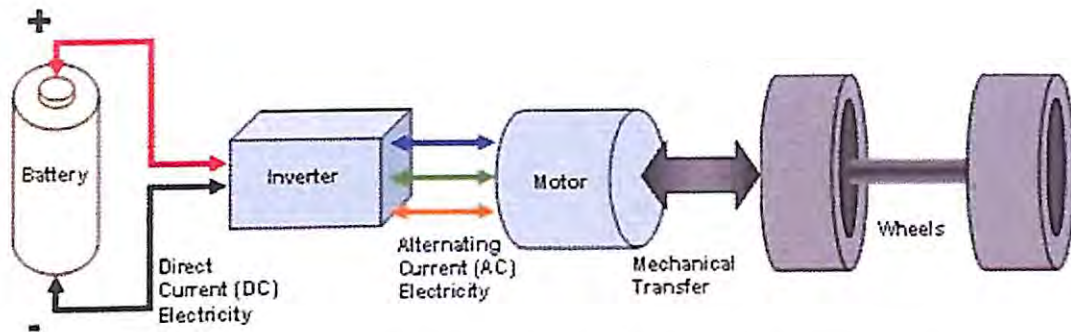


Figure 2.3.1: A complex diagram of HEV traction drive system

2.4 Electric Motor for EV

Motor is use to convert the energy from electrical energy to kinetic energy before transfer to the tire and move the vehicles. The propulsion of an EV is divided into two; commutator and commutatorless. BLDC and induction motor is the most popular electric motor used in the electric because the maintenance cost, both are brushless and don't need regular check compared to DC motor causes by the carbon connected to the rotor.

2.4.1 Brushless Direct Current Motor (BLDC)

Brushless DC motor has an advantages compared to the conventional brushed motor (B. Singh, 2009), the speed versus characteristics, high efficiency, high dynamic response, long operating life, noiseless operating at higher speed range and low maintenance is among the advantages of BLDC motor compared to brushed motor (H. Wang, 2012). All this advantages make the BLDC motor gain a popularity. Since this motor are introduce, it widely use in every sector including automotive and industrial medical, IT and more.

2.3.1.1 The Main Circuit Design and Implement of BLDC Motor Control System

The system is composed of multiple sub-circuits, mainly including: IR2130 drive circuit, the H drive Circuit Bridge, speed detection circuits, over current protection and the other peripheral circuits. Power circuits, keyboard circuit is the example for peripheral circuits. One uses STC89C52 single-chip microprocessor as controller (H. Wang). Now one gives elaboration for every main parts in detail.

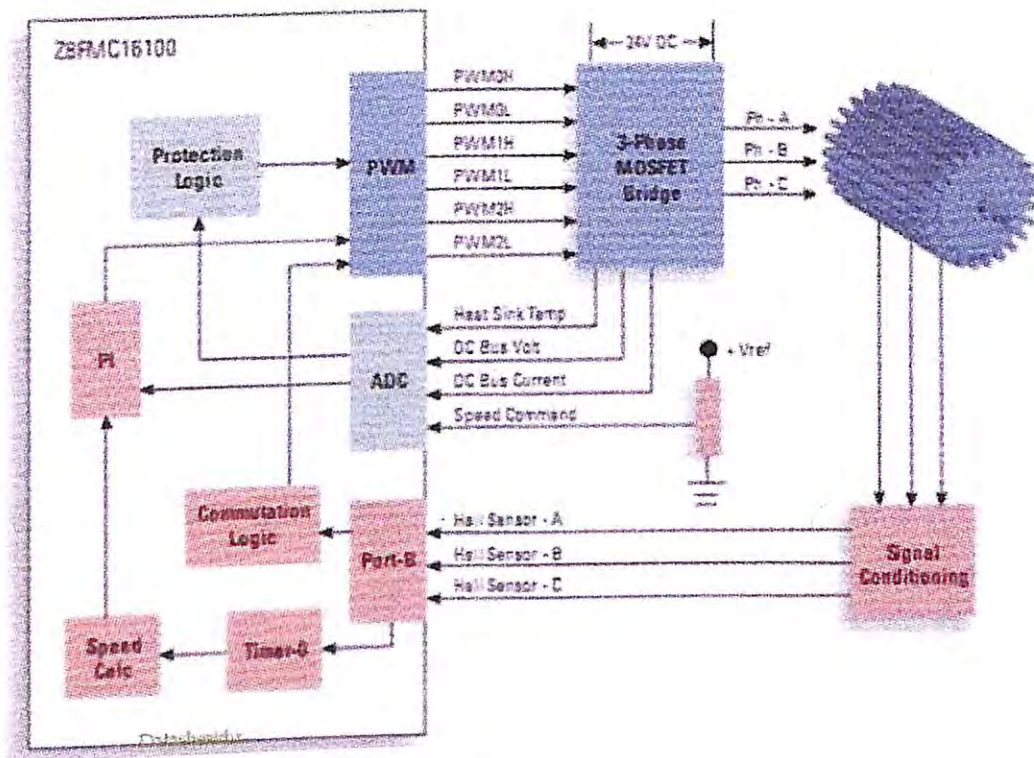


Figure 2.4.1.1: BLDC motor controller for scooter (Golden Motor, 2009)

2.4.1.2 IR2130 Drive Circuit

IR2130 belongs pre-drive chip, which has a bootstrap function. The external circuit design of IR2130 determines the performance of H-bridge drive circuit, so it is the key of the whole control system. In the design process, if the device selection is not appropriate, which may result in serious heat for the circuit. As a result this will cause the circuits burned. The circuit design shown in Figure 2.4.1.1, D1-D3 ultra-fast recovery diodes named uf4007, which avoid spike-wave of high frequency to break