SUPERVISOR DECLARATION

"I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for award of degree of Bachelor of Mechanical Engineering (Automotive)."

Signature :..............................

Supervisor :..............................

Date :..............................

DESIGN AND FABRICATE PROPULSION SYSTEM OF UTeM PERSONAL ELECTRIC VEHICLE (PEV)

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DECLARATION

"I hereby declare that the work in this report is my own except for summaries and quotation which have been acknowledged."

Signature :..............................

Author :..............................

Date :..............................

Dedicated to Rozani bin Che Jamaluddin, Norhanim binti Abd Ghani,

siblings and friends.

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ABSTRACT

Electric vehicle is widely used all over the world nowadays. It became a necessity in the present. Each time the energy crisis hit, especially the rise in oil prices, consumers" concern focused on fuel costs of vehicles. So, at this time, the developments in technology should be looked as a way to help this crisis. The increasing usage of oil and the increase in prices has seen the development of electric vehicle technology. These electric vehicles do not use oil as a primary fuel instead use the power of electricity. Therefore, it is a vehicle with zero emission. On top of these reasons, UTeM take the initiative to produce the first personal electric vehicles for daily use called UTeM-PEV. The main purpose of this project is to produce a personal electric vehicle for UTeM. In addition, this project is also to develop an optimized of *propulsion system* of PEV. This electric vehicle use electric bicycle motor as its main component to drive the wheels. In addition, batteries, controllers and throttle are also used to provide the energy and to control the energy flow to the motor. Through the literature review, this report introducing the electric vehicle and the major component of the systems. The methodology of this project is divided into three parts; design consideration, development of vehicle model and analysis. The results from the mathematical modelling been done to determine the performance of the PEV. The approach therefore can be used as a predictive tool to study the efficiency movement of the PEV using MATLAB software.

ABSTRAK

Kenderaan elektrik semakin meluas digunakan di seluruh dunia pada masa kini. Ianya menjadi suatu keperluan di masa sekarang. Setiap kali krisis tenaga melanda, khususnya kenaikan harga minyak, perhatian pengguna terarah kepada kos bahan bakar kenderaan. Ketika inilah perkembangan teknologi patut dilihat sebagai jalan dalam membantu kemelut ini. Penggunaan minyak yang begitu banyak dan peningkatan harganya telah memperlihatkan perkembangan teknologi kenderaan elektrik. Ianya tidak menggunakan minyak sebagai bahan api utama sebaliknya menggunakan kuasa elektrik. Oleh sebab itu, ianya merupakan kenderaan tanpa pencemaran. Atas sebab-sebab tersebut, UTeM mengambil inisiatif untuk menghasilkan sebuah kenderaan elektrik persendirian yang pertama untuk kegunaan harian yang dikenali sebagai UTeM-PEV. Tujuan utama projek ini adalah untuk menghasilkan sebuah kenderaan elektrik persendirian bagi UTeM. Selain itu, projek ini juga adalah untuk menghasilkan sistem penggerak yang optimum bagi kenderaan ini. Kenderaan elektrik ini menggunakan motor basikal elektrik sebagai komponen utamanya untuk menggerakkan tayar. Selain daripada itu, bateri, pengawal dan juga pendikit digunakan untuk menghasilkan tenaga dan mengawal aliran tenaga ke motor. Melalui kajian ilmiah, laporan ini menjelaskan tentang pengenalan kepada kenderaan elektrik dan komponen-komponen penting dalam system tersebut. Kaedah kajian untuk projek ini terbahagi kepada tiga iaitu pertimbangan rekabentuk, pembangunan model kenderaan dan analisis. Keputusan dari model matematik dilakukan bagi menentukan prestasi PEV. Lantarannya, pendekatan tersebut boleh digunakan sebagai alat ramalan untuk mengkaji pergerakan kecekapan PEV menggunakan perisian MATLAB.

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LIST OF ABBREVIATIONS

AC	Alternating Current
AGM	Absorbed Glass Matt
DC	Direct Current
EV	Electric Vehicle
HED	Hall Effect Device
IC	Internal Combustion
ICE	Internal Combustion Engine
PEV	Personal Electric Vehicle
PM	Permanent Magnet
PMS	Permanent Magnet Synchronous
PMBDC	Permanent Magnet Brushless DC
PMH	Permanent Magnet Hybrid
PWM	Pulse-Width Modulated
SR	Series Luctant
WOT	Wide Open Throttle
ZEV	Zero Emission Vehicle

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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

The environmental argument as well as economical issues for electric propulsion becomes more compelling to develop clean, efficient, and sustainable vehicle for urban transportation. Automobiles nowadays is very important in our daily life, and the exhaust emission produce by conventional internal combustion (IC) engine vehicles are to be blame for the major problem of air pollution that cause the greenhouse effect leading to global warming.

For the last 10 years, the number of automobiles on our planet doubled to about a billion or so (Husain, 2003). The increasing of new automobile being introduced on road by car makers only contributes more on pollution problem.

With an onboard generated power from IC engine fitted to vehicles, electric vehicle does not need to reduce the overall amount of energy used. This problem can be transferred to the power stations, which can use a wide variety of fuels and where the exhaust emissions can be handled responsibly. (Larminie and Lowry, 2003).

Electric vehicle have no emission and have potential to control the pollution problem in an efficient way. Therefore, EVs are the only zero-emission vehicles possible for nowadays and future.

1.2 PROBLEM STATEMENT

The technology of electric vehicles has appeared since nineteenth century but decrease as the gasoline powered engine take over the attention. Nowadays, the future of electric vehicles is very bright. Their impacts are very significant ranging from economic, to new technology that can be applied elsewhere and most importantly, to the environment. Here are the problem statements for this study:

i. Mobility device
ii. Green technology
iii. Efficiency
iv. Eco design
v. Affordability

1.3 OBJECTIVES

The objectives of this project are as follows:

i. To design and fabricate propulsion system of the first UTeM"s Personal Electric Vehicle (PEV).
ii. To provide an optimized propulsion system for UTeM"s PEV.
iii. To provide technical information in the fields of electrical vehicle propulsion.

1.4 SCOPES

The scopes of this project are:

i. To conduct feasibilities studies on motor performance.
ii. To study the efficiency movement of the PEV.
iii. To install and investigate the motor performance onto the UTeM-PEV.

1.5 EXPECTED RESULT

The project will result on development of the first UTeM"s Personal Electric Vehicle (PEV). This PEV use electric bicycle motors and batteries that available in market as the propulsion method. The outcome of the project let to the development of the electric vehicle propulsion system.

1.6 THESIS OUTLINE

This thesis consists of three chapters. Chapter 1 gives the introduction of electric vehicle, its background and brief history and the significance of the project, project objectives and its scopes. Chapter 2 describes the literature review of this project. It includes the current and previous research on the topic related to this project. Chapter 3 illustrates some ideas on how the project is carried out. It lists out the steps involved in each stage of the project. This methodology includes the software and hardware in the development of the electric vehicle. Chapter 4 includes the results taken after done some research based on certain factors. Chapter 5 explain about the discussion based on the results obtain. Chapter 6 includes the conclusion about this project and some recommendation that can be improved in future works.

CHAPTER 2

LITERATURE REVIEW

2.1 HISTORY OF ELECTRIC VEHICLE

Electric Vehicles (EV) are not a new phenomenon. In fact, EVs have a history of over 100 years. They enjoyed much popularity between the mid-19th century and early 20th century, when electricity was the preferred method for propulsion.

The EV was silent, clean, and simple to operate. However, its range was limited by the charge of its batteries. Thus, EVs were restricted to areas where they could easily return home to recharge or where recharging facilities were made available by a local electric power company.

Early EVs were slow compared to steam or gasoline-powered cars, with the normal cruising speed being less than 20 miles per hour. Higher than normal speeds cut down on the range that, in the early days, would only be about 25 to 40 miles. EVs enjoyed some success in the early years of the last century but ceased to be a viable commercial product by about 1920.

Subsequent advances in ICE technology and the invention of the electric starter negated this advantage; the greater range of gasoline cars, quicker refuelling times, and growing petroleum infrastructure, along with the mass production of gasoline vehicles by companies such as the Ford Motor Company (which reduced prices of gasoline cars to less than half that of equivalent electric cars), led to a decline in the use of electric propulsion, effectively removing it from the world‟s automotive market.

2.2 ELECTRIC VEHICLE

According to Leitman and Brant (2009), an electric vehicle consists of a battery that provides energy, an electric motor that drives the wheels, and a controller that sets the energy flow to the motor. Figure 2.1 shows the simple block diagram of electric vehicle.

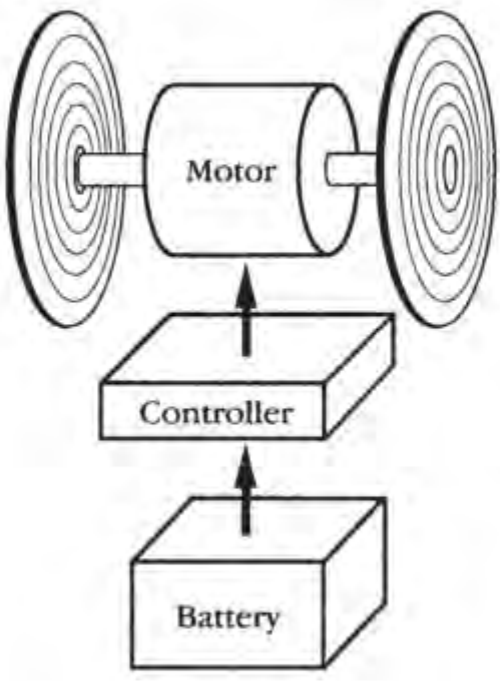

Figure 2.1: Simple block diagram of electric Vehicle (Source: Leitman and Brant, 2009)

EVs are known as zero emission vehicles (ZEVs) and are much environment friendly than gasoline or LPG-powered vehicles. EVs have fewer moving parts and therefore the maintenance is minimal. EVs are also very quiet in operation and far more energy efficient than gasoline engines. EVs don‟t have ICEs in them. Instead, electrical energy is stored in a storage battery, converted from chemical energy in a fuel cell. This electrical energy is used to power an electric motor, which then turns the wheels and provides propulsion for the vehicle. In EVs, it doesn‟t burn fuel, so they don‟t produce pollution as ICE vehicles do.

EVs propulsion system consists of three major deviations which are batteries, electric traction motor and last one is gear train. These major deviations are dispersing in many significance ways such as vehicles performance, vehicles specifications, and many things.

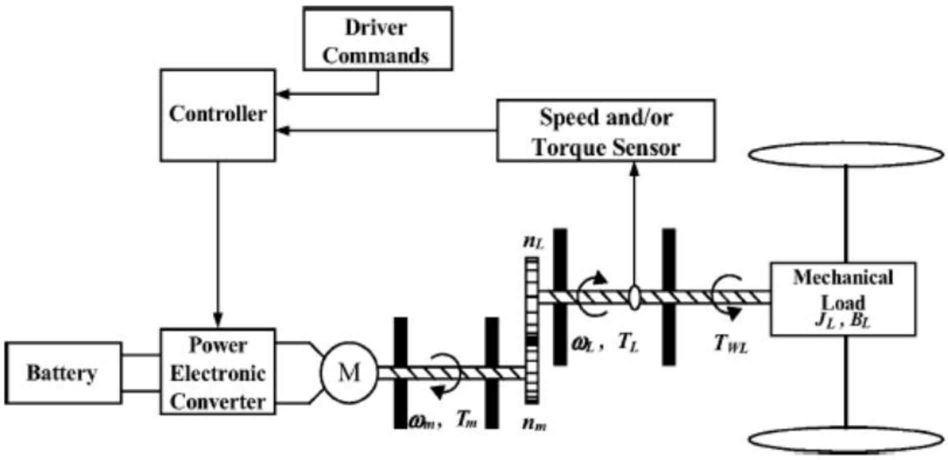

Figure 2.2: Electric Vehicle System (Source: Ahmad Faiz, 2008)

2.3 EV MOTORS

Motors in electric vehicle are the most important element in EV propulsion. There are many types of motor that have been developed for electric vehicle. A classification of these EV motors is shown in Figure 2.2, where there are two main groups, namely the commutator motors and the commutatorless motors.

Since the AC commutator motors have already been obsolete for EV propulsion, the DC commutator motors are loosely termed the commutator motors or simply the DC motors. The commutatorless motors can be further classified as two subgroups, namely the AC motors and the switched DC motors(Chau and Wang, 2005).

The AC motors include the induction motors, permanent magnet synchronous (PMS) motors, PM brushless DC (PMBDC) motors, and PM hybrid (PMH) motors, fed by sinusoidal, pulse-width modulated (PWM) or rectangular AC waveforms. The switched DC motors are mainly the switched reluctance (SR) motors which are fed by PWM or rectangular DC waveforms. Notice that the motor types encircled by round-corner boxes in Figure 1 have ever been used in EVs (Chau and Wang, 2005).

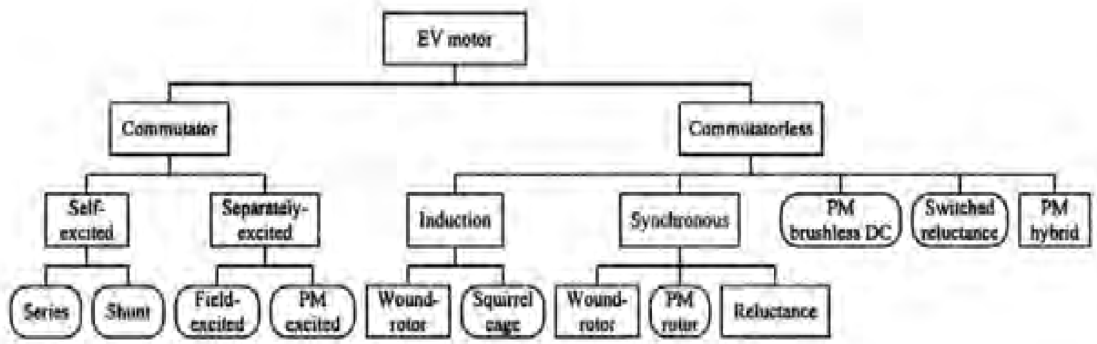

Figure 2.3: Classification of EV motors (Source: Chau and Wang, 2005)

2.3.1 DC Motor

Traditionally, DC commutator motors have been loosely named as DC motors. Their control principle is simple because of the orthogonal disposition of field and armature MMFs. By replacing the field winding of DC motors with PMs, PM DC motors permit a considerable reduction in stator diameter due to the efficient use of radial space. Owing to the low permeability of PMs, armature reaction is usually reduced and commutation is improved.

DC motors is less reliable and unsuitable for maintenance-free operation because of the major problem of DC motors, due to their commutators and brushes. Nevertheless, because of improvement in technology and simple control, DC motors have been well-known in electric propulsion (Chau and Wang, 2005).

Figure 2.3 shows a diagram of simple DC motor. It consists of a loop of wire, a stationary magnet and the commutator. When current is passed through the loop of wire, it will cause a magnetic field formed in the wire. The loop of wire will align up with the field of the stationary magnet. Then the commutator is flips on the field every half rotation and this cause the loop to continually spin.

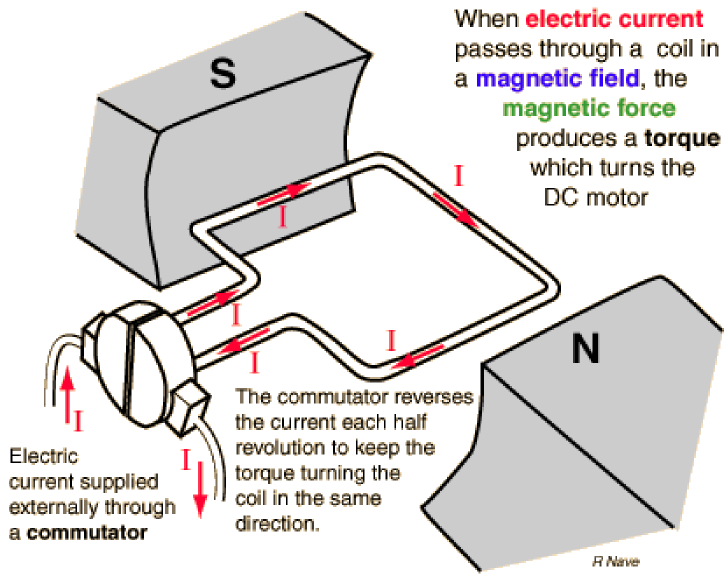

Figure 2.4: DC Motor (Source: diylive.net, 4 October 2010)

2.3.2 Series-wound motors

Series wound brushed DC motor which is the field winding and armature are connected in series, are the best for the road-going EVs today, as they have a high torque, cheap compared to the other types, have wide availability and required simple controllers compared to the other type of motors.

The series motor characteristic is particularly suitable for an electric vehicle as it gives excellent acceleration from rest combined with a controlled slowing down on hills and a constant high speed on the flat. Because of this reason and the fact that simple resistive and voltage controllers could be used, series-wound motors were widely used in electric vehicle from the early days onwards.

2.3.3 AC motors

Generally, there are three categories that the AC motor suitable for the use in electric vehicle: induction motors, synchronous motors and switched (or variable) reluctance motors (Westbrook, 2001). Induction and synchronous motors have been widely used for a long time in constant-speed industrial application. These types of motors become possible for electric vehicle use with the arrival of high power, high efficiency and variable frequency inverters.

All AC motors work on the same principle. A three-phase winding is distributed round a laminated stator and sets up the rotating magnetic field that the rotor „follows". The speed of this rotating field and hence the rotor can be calculated:

$$n = 60\,\frac{f}{p} \tag{2-1}$$

where n = speed in rev/min; f = frequency of the supply; and p = number of pole pair (Denton, 2004).

2.3.4 Brushless DC motors

A brushless motor operates much in the same way as a traditional brush motor. However, as the name implies there are no brushes (and no commutator). The mechanical switching function, implemented by the brush and commutator combination in a brush-type motor, is replaced by electronic switching in a brushless motor.

In a typical brushless motor the electromagnetic field, created by permanent magnets, is the rotating member of the motor and is called a rotor. The rotating magnetic field is generated with a number of electromagnets commutated with electronics switches (typically transistors or FETs) in a right order at right speed.

In a brushless motor, the trick becomes to know when to switch the electrical energy in the windings to perpetuate the rotating motion. This is typically accomplished in a brushless-type motor by some feedback means designed to provide an indication of the position of the magnet poles on the rotor relative to the windings. A Hall Effect Device (HED) is a commonly used means for providing this positional feedback.

In some applications brushless motors are commutated without sensors or with the use of an encoder for positional feedback. A brushless motor is often used when high reliability, long life and high speeds are required. The bearings in a brushless motor usually become the only parts to wear out.

In applications where high speeds are required (usually above 30,000 RPM) a brushless motor is considered a better choice because as motor speed increases so does the wear of the brushes on traditional motors.

A brushless motor's commutation control can easily be separated and integrated into other required electronics, thereby improving the effective power-to-weight and/or power-to-volume ratio. A brushless motor package (motor and commutation controller) will usually cost more than a brush-type, yet the cost can often be made up in other advantages (Mani, 2010).