ELECTRICAL VEHICLE CHARGING THROUGH INDUCTIVE POWER TRANSFER (IPT) SYSTEM

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PROJEK SARJANA MUDA II

Tajuk Projek : ELECTRICAL VEHICLE CHARGING THROUGH INDUCTIVE POWER TRANSFER (IPT) SYSTEM

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To my beloved parents, family, fellow friends and supervisor, thanks for all support in successfully producing this project.

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"In The Name of Allah, The Most Gracious and The Most Merciful"

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ABSTRACT

In the last 400 years, the electricity has been discovered, but this electricity is practically use and available at mid late 1800s. Due to the versatility of its function electrical vehicle has been invented. However, this electrical vehicle puts overwhelming demands on its battery specification such as the weight of battery, durability of battery and how fast it can recharge. So, to overcome this problem the wireless power transfer (WPT) has been implemented in this project. This project used inductive coil as the transmission medium from transmitter to receiver. For this project there are two approaches can be done which is static and dynamic. Where static, the electrical vehicle will be charge in motion without any physical contact between each other, but for this project will be focus on dynamic approaches, where the electrical vehicle will be supply directly from the track without any physical contact. For this project the small scale prototype has been implemented to capable in deliver the desired specification, which is 10W output power, 16 V input voltage and 1 MHz frequency and the load for this project is DC motor. At the end, this inductive power transfer has successfully implemented in this project.

ABSTRAK

Sejak 400 tahun yang lalu, elektrik telah berjaya ditemui tetapi ianya hanya diguna pakai pada pertengahan tahun 1800-an. Oleh kerana kepelbagaian fungsi elektrik, kenderaan elektrik dicipta. Walau bagaimanapun, permintaan spesifikasi bateri pada kenderaan elektrik sangat tinggi seperti berat bateri, ketahanan bateri dan berapa cepat ianya boleh dicas semula. Jadi, untuk mengatasi masalah ini pemindahan tenaga tanpa wayar (WPT) telah dilaksanakan dalam projek ini. Projek ini mengunakan gegelung induktif sebagai medium penghantaran dari pemancar ke penerima. Untuk melaksanakan projek ini, terdapat dua pendekatan yang boleh dilakukan iaitu statik dan dinamik. Untuk pendekatan secara statik, kenderaan ini boleh dicas tanpa sebarang sentuhan fizikal antara satu sama lain tetapi projek ini hanya menumpukan pada pendekatan secara dinamik, di mana kenderaan elektrik akan mendapat bekalan elektrik terus dari trek tanpa sebarang sentuhan fizikal. Untuk projek ini prototaip skala kecil telah dilaksanakan supaya ianya boleh mencapai spesifikasi yang dikehendaki , iaitu 10 W kuasa keluaran, 16 V voltan pemasukan dan 1 MHz kekerapan dan beban yang digunakan ialah DC motor. Diakhirnya, pemindahan kuasa induktif ini telah Berjaya dilaksanakan dalam projek ini.

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WPT	Wireless Power Transfer
IPT	Inductive Power Transfer
CPT	Capacitive Power Transfer
APT	Acoustic Power Transfer
ICEs	Internal Combustion Engines
EV	Electrical Vehicle
DC	Direct Current
AC	Alternating Current
PCB	Printed Circuit Board
PEVs	Plug-in Electrical Vehicle
HEV	Hybrid Electrical Vehicle
ZVS	Zero Voltage Switching
PWM	Pulse Width Modulation
UV	Ultra Violet

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CHAPTER I

INTRODUCTION

In this chapter, the introduction of project, objective of project, problem statement, scope of work, methodology and report structure will be introduced.

1.1 Background

In the last 400 years ago, the electricity was the most remarkable and novel disclosures, but it practically use and available since the mid late 1800s. The electricity was invented by Thomas Alva Edison, where he created numerous devices that significantly impact life around the world, including the motion camera, the phonograph and a durable, handy electric light [39]. Ever since then, electricity has been highlight due to the versatility of its function. The utilization of electric energy

has better improvements from year to years, where the battery is introduced. This battery has been found since 1936 near Baghdad, while constructing a railway. The labourers from that construction company have discovered the ancient battery known as Parthian Battery. This battery is believed to be 2000 years old. On the other hand, in 1800, Volta discovered when used a conductor, a certain fluid can generate a persistent stream of electrical power. Due to that the first voltaic cell is invented and it known as battery [1].

Initially, the battery that has been invented by Volta cannot deliver current for long periods of time, but from time to times, this device has been improve from disposal to rechargeable battery. This rechargeable battery has been invented by Raymond Gaston Plante in 1859 [1]. This rechargeable battery not only can charge and discharging but it has ability to increased supply current. The progressive changes in battery innovation encouraged major electrical advances, from telegraphs and telephones, and eventually driving to portable computers, mobile phones and especially to electric vehicle. Electrical vehicle puts overwhelming demands on its battery. The battery for electrical vehicle should have storing capacity as much as energy possible to achieve a long operating range. Besides that, it must have the most minimal weight to reduce the load on the drive system and can recharge rapidly and easily.

However, to achieve the battery specification for electrical vehicle is very difficult. In the present, the energy storing at full charged for electrical vehicle can reach from 100 to 200 km, although there are few models that can go 300 to 480 km, but it require bigger cell storage and larger battery pack and it is very expensive and it may need to replaced one or more times. At the point when a bigger battery pack is utilized, the opportunity to completely charging the battery might likewise being expanded, for the most part take around 4 to 8 hours. Other than has a battery-related problem, the price of electrical vehicle is more expensive compare to other vehicle with internal combustion engines (ICEs) [2] and this electrical vehicle has a limited charging station. Yet, this problem can be overcome by using wireless power transfer technology (WPT). This EV's can be charged through inductive power transfer (IPT), where it can transfer the power whether in static or in motion state. Even though this technology is still in the development stage, be that as it may, with

further change, the thought of IPT in electrical vehicle could be executed in high power application.

1.2 Objectives

1. To develop a small scale low power Electrical Vehicle prototype using Inductive Wireless Power Transfer method.
2. To improve the efficiency of proposed wireless power transfer by proposing class E and capacitor compensation method.
3. To analyse the performance of developed Inductive Power Transfer system for Electric Vehicle in terms of its output efficiency.

1.3 Problem Statement

These days, the interest on innovation item is high particularly in Electric Vehicle (EV) because of the lack of non-renewable vitality source, for example, petrol. Even though, this electrical vehicle has a lot of advantages such as environmental friendly but there is still one major problem regarding electrical vehicle such as battery related problem. In order to supply the electric sources, the user needs to charge whether in home or in certain charging station which is very limited for each country. Therefore, to fulfill the market demand, the Wireless Power Transfer (WPT) is used to overcome this problem.

Wireless power transfer technologies aim to transfer power without any physical contact. This could help to reduce the hassle wires. This work aims to provide a wireless power transfer technologies for Electrical Vehicle through inductive approach. Through this method, the EVs could be possible to be charged while moving. A small scale prototype will be developed to prove the concept of inductive wireless power transfer, where it can transfer the power whether in static or in motion state. Several experimental set ups need to be done to validate the proposed method.

1.4 Scope

The scope of work for this project has a few division of work to be performed. Firstly, the track for electrical vehicle is implemented. By referring to Figure 1.1 the track design is implemented.

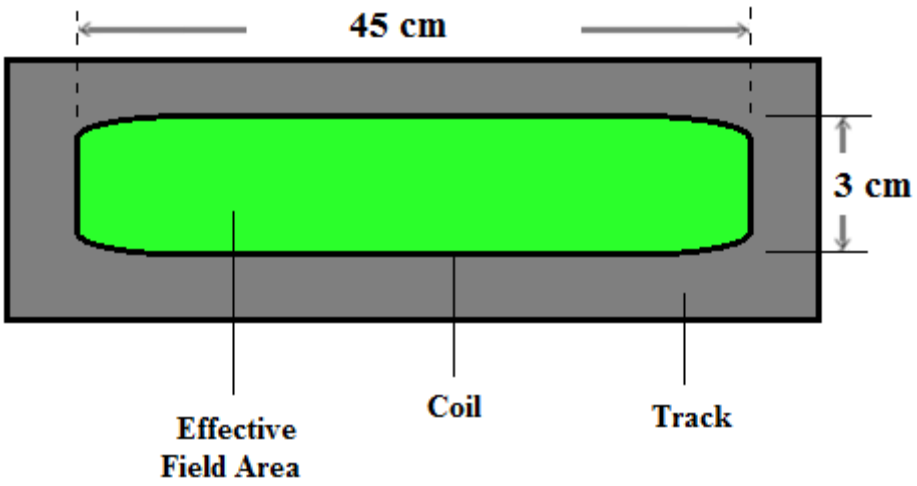

Figure 1.1: Track Design

The distance of effective field area is expected to have 100cm straight track, where this straight track represent one section. This section can be added depends on the desire distance for the user. The width of the track is depends on the width of the prototype, where for this case the 1/20 remote control car is used. The circular pad types are used at the transmitter as a medium to transfer power from track to the prototype electrical vehicle. The number of circular is depends on the size of circular pad itself. At receiver, a class-E is used and connected to coil that represent as power generator. In here, the class-E is supply with 16V DC supply and this DC supply will be converting into AC and transfer to transmitter coils simultaneously. The resonant frequency is set to 1 MHz for class-E inverter due to the small component used for this frequency. Secondly, the prototype part where the remote control car that acts as electrical vehicle.

Figure 1.2: Prototype Design

In Figure 1.2, the car itself represent the electrical vehicle that at the bottom of the car there is a coil that acts as receiver to receive power form the transmitter. At the transmitter, the compensator circuit and rectifier circuit is designed as a power losses compensator. The voltage regulator also needs to design to reach the desires output value for electrical vehicle prototype.

1.5 Methodology

This Electrical vehicle has a few division of system that should be accomplish, where is in programming and hardware. In software, the Multism, Proteus and LTspice software is used to analyses the prototype performance and for the hardware, a class-E inverter circuit is used to convert from DC to AC. Besides that, the MOSFET driver, rectifier circuit and compensator circuit need to be designed. In additional, a positive Printed Circuit Board (PCB) is used to build the circuit at transmitter and the receiver. For build PCB board circuit, there is some process that need to follows such as preparing the circuit artwork, exposing, developing, troubleshooting, etching, drilling and soldering. Other than that, the