Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF CAPACITIVE TYPE MOBILE PHONE CHARGER

NUR IMAN MAISARAH BINTI NOR HAIRI

Bachelor of Electrical Engineering Technology with Honours

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**A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electrical Engineering Technology with Honours**

Faculty of Electrical and Electronic Engineering Technology

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

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I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology with Honours.

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Supervisor Name : DR.AZHAN BIN AB RAHMAN

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Co-Supervisor :

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DEDICATION

To my beloved mother, Fadhilah Binti Othman, and my beloved father, Nor Hairi Bin Harun, thank you for all the continuous and never ending love and support from the very beginning I started my studies until the end of the semester. To my dearest siblings, Nur Aisyah Balqis and Nur Aina Mardhiah, I thank you for the emotional support and the motivation they have given me. A special thanks to my friends, who is always there for me and for always listened to my whines and whims.

ABSTRACT

In the recent years, Wireless Power Transfer (WPT) system is one of a groundbreaking technology that makes everyday life easier. This system allows power transfers from one plate of metal conductor to another without any physical touch. The WPT system is divided into their own category of fields and these category classified into acoustic power transfer (APT), microwave power transfer (MPT), inductive power transfer (IPT), and capacitive power transfer (CPT) and in this particular project the CPT system is chosen for its advantages compared to other system. Moreover, this technology will solve the problem with conventional electrical transmission. The objective of this project is to develop a capacitive type (CPT) mobile phone charger. The CPT system used a SMPS as a supply to the transmitter plate to convert AC supply into DC supply to transfer the electric field to the receiver plate. While, the receiver part will charge the mobile phone. The observation will be made by using a different size of transmitter and receiver plates, the type of material used and the position of the plates to compared the efficiency of the project. As the conclusion, this project is very user-friendly and the goal is to improve the conventional charging system into a wireless system.

ABSTRAK

Dalam beberapa tahun kebelakangan ini sistem Wireless Power Transfer (WPT) adalah salah satu teknologi yang dapat menjadikan kehidupan seharian lebih mudah. Sistem ini membolehkan pemindahan kuasa dari satu plate konduktor ke konduktor yang lain tanpa memerlukan sentuhan secara fizikal. Sistem WPT ini dibahagikan mengikut kategori bidang mereka dan kategori ini dekelaskan kepada *acoustic power transfer* (APT), *microwave power transfer* (MPT), *inductive power transfer* (IPT), and *capacitive power transfer* (CPT), dan projek ini telah mengkhususkan kepada sistem CPT oleh kerana kelebihan yang ada pada sistem itu berbanding dengan sistem WPT yang lain. Selain itu, teknologi ini diusulkan adalah untuk meyelesaikan masalah yang ada pada sistem electrik konvensional. Objective projek ini adalah untuk menghasilkan system Capacitive power transfer (CPT) untuk mengecas telefon bimbit. System CPT ini menggunakan SMPS sebagai bekalan untuk menukarkan sumber elektrik dari AC kepada DC untuk memberikan bekalan electric daripada plat pemancar kepada plat penerima. Seterusnya, bahagian plat penerima akan mengalirkan elektrik untuk mengecas telefon bimbit. Pemerhatian akan dibuat dengan menggunakan plat yang berukuran berlaian, menggunakan bahan logam yang berlainan dan posisi yang berbeza untuk membezakan kecekapan mereka. Sebagai konklusi, projek ini adalah mesra pengguna dan bertujuan untuk meningkatkan sistem pengecasan konvensional menjadi sistem tanpa wayar.

ACKNOWLEDGEMENTS

First and foremost, all praises to Allah (SWT) for the strength and blessing that have been given to me to complete this project. I would like to express my utmost gratitude and appreciation to my supervisor, Dr. Azhan Bin Ab Rahman for his precious guidance, word of wisdom and time in helping me successfully finished my Bachelor Degree Project. I believe without his support and encouragement I would not be able to finish this project victoriously.

I am also indebted to both of my parents, whom I most appreciated for the financial and emotional support throughout all this semester which empower me to finish the project.

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F	-	Farad
Q	-	Charge
V	-	Voltage
m^2	-	Area of conductive plate
m	-	Distance
F/m	-	Permittivity of dielectric material

LIST OF ABBREVIATIONS

WPT	-	Wireless Power Transfer
CPT	-	Capacitive Power Transfer
$SMPS$	-	Switch Mode Power Supply
EV	-	Electric Vehicle
LED	-	Light Emitting Diode
$CCWPT$	-	Capacitve Coupling Wireless Power Transfer
IPT	-	Inductive Power Transfer
DC	-	Direct Current
AC	-	Alternating Current

CHAPTER 1

INTRODUCTION

1.1 Background

The main components of power system are power generation, transmission, distribution and load. Electrical power transmission includes a bulk movement of electrical energy from power station for the power generation. From there it will go into a large substation for transmission. In transmission, the voltage will be transformed into a higher voltage 500kV, 275kV, 132kV, and 66kV. After that, for distribution the electrical power will be transformed into a lower voltage that is 33kV or 11kV to be distributed to small industries or factories. For the consumers load, the voltage will be further stepped down to 415V and 230V depending on their sector such as commercial or for residential use as shown in Figure 1.1. Types of conventional power transfer used to transmit electrical power are overhead lines, underground lines, submarine cables, HVAC and HVDC. But one of the major problems in conventional power transmission and distribution is that they have a significant loss during the operation. Furthermore, the downside of using the conventional system is that they used a huge amount of cables that sometimes interrupting the view and for underground line they have to dig into the ground so it will be harder to repair or to install the lines which makes it more expensive.

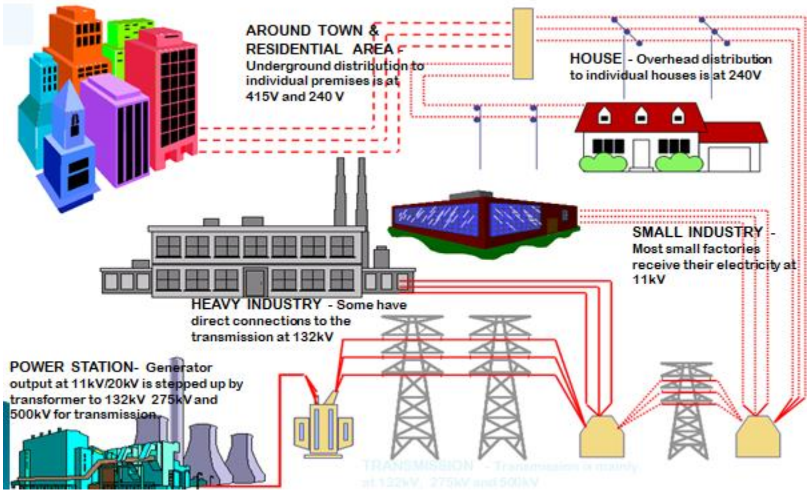

Figure 1.1 Power system components in Malaysia.

Which is why based on the problems stated above, wireless power transfer (WPT) is chosen as an alternative option to replace the conventional power transfer (Rozario, 2016). Wireless power transfer offers multiple benefits such as, WPT allows for charging of multiple devices and also they have universal compatibility (Lu et al., 2017). In addition, they reduce the use of wires. There is a various type of WPT technology shown in Figure 1.2 :

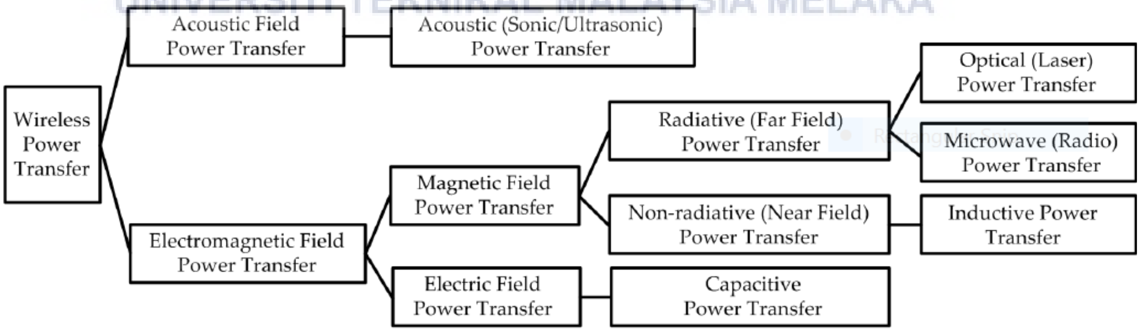

Figure 1.2 The categories of wireless power transfer system (Lu et al, 2017).

1.2 Problem Statement

Nowadays, everyone in the household use their own electronics devices and this will lead to an increase number of wires connected to the wall socket. This condition may be hazardous if the long wires got tangled up with each other and tripped someone in the household especially kids. The cables also can be damage because of rodent bites and manhandling (Rozario, 2016). For this reason, a solution must be made to reduce the usage of wires connecting to the power source.

Moreover, as of today, only a flagship smartphone uses the wireless power transfer technology. These smartphones often costs the most as it is the latest and more grandeur than the last smartphone that the brand releases so the price is usually very expensive.

With the development of capacitive phone charger we can also help to conserve earth from electronic pollution. Since, it is hard to dispose electronic waste (E-waste) and human health is at risks if it is done improperly.

These days having a phone is just like breathing where it is essential for everyone. Therefore, in this work, a capacitive wireless power transfer is used to charge the phone without using any electrical wire and in hope that this project may produce a capacitive power transfer charger that is cheaper than the wireless charger available in the market.

1.3 Project Objective

The main objectives that need to accomplish at the end of this project are:

a) To develop a capacitive wireless power transfer to power the load.

b) To transfer the electricity by using two plates of conductor.

c) To analyse the effectiveness of the system when using capacitive power transfer.

1.4 Scope of Project

The scope of this project are as follows:

a) Design a capacitive type mobile phone charger of wireless power transfer

b) Generate DC output

c) Produce the hardware so that electrical energy can be transmitted through and is connected to the plates to charge the load.

1.5 Thesis Organization

The outline of this thesis will explain all about the development of capacitive type phone charger project. This thesis have a total of five chapters, which consists of the project introduction, literature review, methodology, result and discussion and lastly the conclusion and future recommendation of the project. Firstly, chapter one will be about the introduction of the conventional system that is used today for transfer system. It also includes the problem statement, objectives and the scope of the project.

Then, in chapter two a more detailed research is conducted in order to write the literature review and background studies.

In chapter three, research methodology shows the method used to develop the project.

Next, for chapter four, the result of the experiments are presented and discussed in order to form an analysis.

Lastly, chapter five is the conclusion of the overall project. It will summarises the main points from chapter one until chapter four of the thesis. After that, a future recommendation is proposed for the betterment of the project for a future research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review is fundamentally an overview of the project and the objectives. It is also a comparison of the differences and the similarities of the perspectives of the work of multiple authors. The study is generally comes from books, dissertations, scholarly articles and other published material whether physically or electronically. The review produces a summary, advantages and limitation of the area of research and its application. The information gathered is to provide a deeper understanding for the project.

2.2 Wireless Power Transfer (WPT)

Wireless Power Transfer (WPT) is a system that allows electrical power to be supplied through air from one electrical network to another electrical network without the necessity of using the current-carrying wires (Lu et al., 2017). This process use the Faraday's law of electromagnetic induction. In order for the wireless power transfer to work the frequency of the transmitter and the receiver must be in resonance. Figure 2.1 depicts a transmitter coil powered by an electric source produces a magnetic field around it and then a second in which connected to the receiver is introduced in the same field with the same resonant frequency for the electric current to flow.

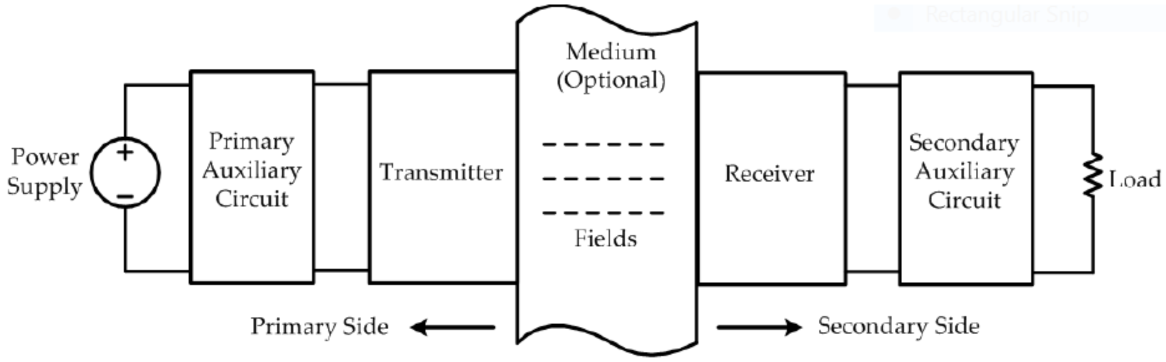

Figure 2.1 A common structure of Wireless Power Transfer (WPT) system (Lu et al., 2017).

Table 2.1 Comparison of the main Wireless Power Transfer (WPT) technologies

	Electric Field	**Magnetic Field**		**Electromagnetic Field**	
Technology	**Capacitive Coupling**	**Inductive Power Transfer**	**Resonant Inductive Coupling**	**Microwaves**	**Optical (laser) Radiation**
Range	Short	Short	Mid	Far	Far
Frequency	kHz-MHz	kHz-MHz	kHz-MHz	GHz	>THz
Propagation	Non-radiative	Non-radiative	Non-radiative	Radiative	Radiative
Strength	Very high	Very high	High	Low	High
Coupling Device	Metal plate electrodes	Wire coils	Turned wire coils	Phased arrays/	Lasers, photocells,

				parabolic dishes	lenses

Recently, WPT technology has been widely spread and garnered more attention due to its safety reasons, the cost, the high output power and more commercially successful. There are two main types of WPT that is capacitive power transfer (CPT) and inductive power transfer (IPT). Therefore, this project will only be focusing on capacitive power transfer (CPT).

2.2.1 A Brief History of Capacitive Power Transfer

In 18th century, for the near field applications, Nikola Tesla was the first person who started to experiment with it using capacitive power transfer (CPT). Figure 2.2 shows how Tesla attempted to transfer the electricity wirelessly by using capacitive power transfer coupling at Columbia College, New York. Tesla was aiming to transfer approximately 300kW of power by using a radio wave of 150 kHz but regrettably the experiment failed due to diffusion of the wireless power (Karabulut et al., 2018).

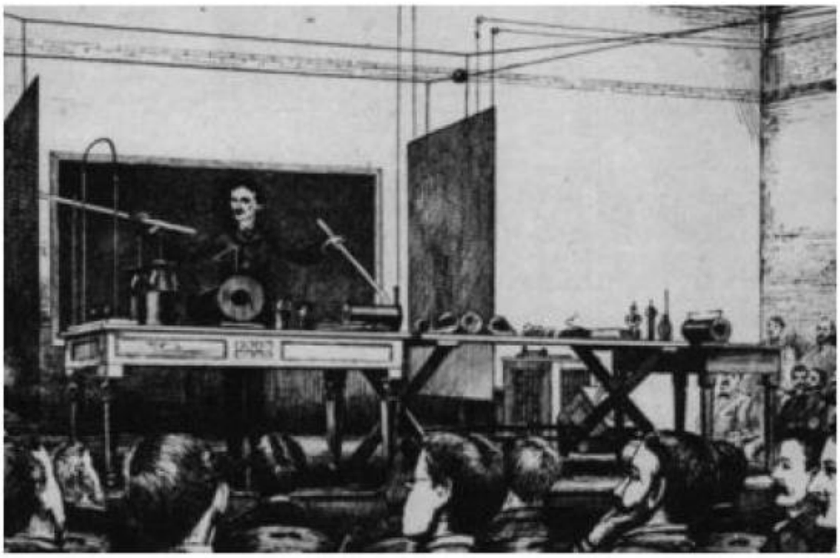

Figure 2.2 Nikola Tesla at Columbia College in 1891, demonstrating wireless transmission (Karabulut et al, 2018).

However, at the time electromagnetic induction (IPT) was more commercially used in wireless power transfer system. In the early 1900's, Tesla plays a pivotal part in developing several IPT methods such as radio based WPT. Nevertheless, in 1966, the first officially recorded CPT application potent was observed. In the study, 100 kHz of frequency was used on the transmitter and the receiver to transfer the electric as a design for underwater systems (Karabulut et al., 2018). Then, until the beginning of 2000's, because of the simple structure and confined radiation field finally the capacitive coupling started to garnered more attention in small consumer electronics (Lu, 2017). But at the time CPT system potential for higher power application have not been realize (Dai, 2017).