MULTIPLE WIRELESS POWER TRANSFER SYSTEM

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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This Report is Submitted in Partial Fulfillment of the Requirement for the Bachelor Degree in Electronic Engineering (Wireless Communication) With Honours

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer
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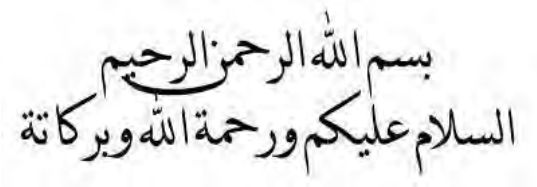
DEDICATION

Dedicated to my beloved supervisor, lecturer, my family and all my friends.

ACKNOWLEDGEMENT



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have become now. I cannot find the appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to achieve my dreams. Not to forget to all my supported siblings and my big family. I also would like to express special thanks to all my friends for their valuable information, various suggestions in improving the project and their cooperation towards the success of this project.

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ABSTRACT

Day by day new technologies are making our life simpler. This project describes the development of a multiple wireless power transfer for the purpose of demonstrating wireless power transfer. Wireless power transfer through resonant inductive coupling could be one of the next technologies that bring the future nearer. Wireless power transfer is a technique that converts energy from radio frequency (RF) electromagnetic (EM) waves into DC voltage, which has been used here for the purpose of providing a power supply to low power devices. In this project it has been shown that it is possible to charge low power devices wirelessly via resonant inductive coupling such as mobile phones without the need of wires and cables between the power source and the power destination. It minimizes the complexity that arises for the use of conventional wire system. In addition, the project also opens up new possibilities of wireless systems in our other daily life uses. The system will demonstrate wireless power transfer by charging a mobile phone. The project will discuss the performance of the system and explore how better power levels and efficiencies can be obtained.

ABSTRAK

Hari demi hari teknologi baru membuat kehidupan kita lebih mudah. Projek ini menerangkan perkembangan pemindahan tenaga secara wayarles bagi tujuan menunjukkan pemindahan tenaga secara wayarles. Pemindahan tenaga secara wayarles melalui gandingan induktif resonan boleh menjadi salah satu teknologi akan datang yang akan membawa masa depan lebih hampir. Pemindahan tenaga wayarles adalah satu teknik yang menukarkan tenaga daripada frekuensi radio (RF) elektromagnetik (EM) gelombang ke DC voltan, yang telah digunakan di sini untuk tujuan menyediakan bekalan kuasa untuk peranti-peranti kuasa rendah. Dalam projek ini, telah menunjukkan bahawa adalah mungkin untuk mengecas peranti kuasa rendah secara wayarles melalui gandingan induktif resonan seperti telefon bimbit tanpa memerlukan wayar dan kabel antara sumber kuasa dan destinasi kuasa. Ia mengurangkan kerumitan yang timbul bagi penggunaan sistem wayar konvensional. Di samping itu, projek ini juga membuka kemungkinan baru bahawasanya sistem wayarles boleh dingunakan di dalam kehidupan seharian. Sistem ini akan menunjukkan pemindahan tenaga secara wayarles dengan mengecas telefon mudah alih. Projek ini akan membincangkan prestasi sistem dan meneroka bagaimana tahap kuasa yang lebih baik dan kecekapan yang boleh diperolehi.

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CHAPTER 1

INTRODUCTION

New technologies emerge each and every day to make our life simpler. Despite all these, we still rely on the classical and conventional wire system to charge our everyday use low power devices such as mobile phones, digital camera etc. and even mid power devices such as laptops. The conventional wire system creates a mess when it comes to charging several devices simultaneously. It also takes up a lot of electric sockets and not to mention the fact that each device has its own design for the charging port. At this point a question might arise, "What if a single device can be used to charge these devices simultaneously without the use of wires and not creating a mess in the process?" The solution to all these dilemmas lies with inductive coupling, a simple and effective way of transferring power wirelessly

This chapter introduces the general overview and background of this project with the title "Multiple Wireless Power Transfer System". This project is expected to use a resonant inductive coupling technique. This chapter is divided into seven sections. In section one gives the general preview of this chapter. Section two gives a simple explanation of the background of the project and then continued with project motivation. Next, constructing the problem statement by summarizing with the current problem faced is being discussed in section four. Section five defines the objective of this project as a guideline to the solutions of the problems faced. The scope of the project is being described in section six. Finally, section seven will conclude the organization of the report. It is a summary of the report in developing this project. One

of the main purpose of this project is to compare different wireless power transfer development against each other's and do enhancement on the current WPT system.

1.1 Project Background

Wireless Power Transmission (WPT) is the efficient transmission of electric power from one point to another trough air without the use of wire or any other substance. This can be used for applications where either an instantaneous amount or a continuous delivery of energy is needed, but where conventional wires are unaffordable, inconvenient, expensive, hazardous, unwanted or impossible. The power can be transmitted using inductive coupling for short range, resonant induction for mid-range and electromagnetic wave power transfer for high range. This project will be developed by using near field or non-radiative method which is for mid-range. Charging low power devices and eventually mid power devices by means of inductive coupling could be the next big thing

Multiple wireless power transfer described in this project is motivated by the potential application of resonant inductive coupling as a means for wireless power transfer from a source coil to multiple receivers. Resonance inductive coupling technology has been implemented with biomedical and consumer electronics applications that demand higher power levels than previous wirelessly powered devices [1], [2], [3]. As the power levels increase, efficiency and range become important design considerations because these criteria determine the required amount of power transmitted to sufficiently power a load. Magnetic resonance coupling technology has been implemented with biomedical and consumer electronics applications that demand higher power levels than previous wirelessly powered devices. The industry realizes the demand for wireless power charging where mobile devices can be charged without the need for connecting wires.

WPT devices have been thought to be possible since Nikola Tesla's transmission model in 1897. The newest technologies rely on inductive coupling techniques to transmit power between transmitting and receiving coils. The most common and probably the oldest consumer application of wireless energy transfer can

be found in the electric toothbrush [4]. The frequency at which the device transfers power between the transmitter and receiver is dependent on the size of the coils. The higher the frequency at which the device is transmitting, the smaller the transmitting and receiving coils must be. Figure 1.1 shows the simplified drawing of condition for wireless power transfer to mobile devices where primary components in any WPT system are the coils.

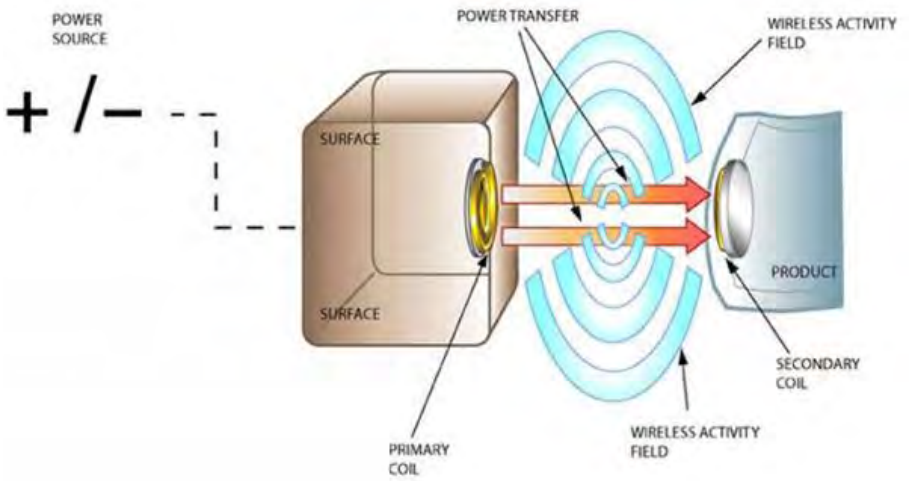

Figure 1.1: Simplified Drawing of Condition for Wireless Power Transfer to Mobile Devices

The system is broken into two parts, the transmitter circuit which provides power for wireless transfer and the receiver circuit, which is the mobile device that consumes the power. The power transmitter circuit contains the primary coil, the series resonant capacitor and a DC to AC inverter that inverters the DC power supply into the AC voltage needed to induce a magnetic field between the two coils. The power receiver circuit contains the secondary coil, a parallel resonant capacitor and an AC to DC converter. The primary and secondary coils form two halves of a resonant transformer. To demonstrate that power was successfully transferred wirelessly, a mobile phone was charged and there are multiple loads in wireless power transfer systems. The amount of power transmitted and effectively received will depend on how well the coils are designed.

Inductive coupling is an old and well-understood method of wireless power transfer. The source drives a primary coil, creating a sinusoidal varying magnetic field,

which induces a voltage across the terminals of a secondary coil, and thus transfers power to a load. This mechanism, responsible for power transfer in a transformer, where the magnetic field is typically confined to a high permeability core, also functions when the region between the primary and secondary coils is simply air. Inductive coupling without high permeability cores is used, for example, to power RFID tags and medical implants [5]. A common technique for increasing the voltage received by the device to be powered is to add a parallel capacitor to the secondary to form a resonant circuit at the operating frequency [6], [7].

1.2 Project Objectives

The main objective of this project is to build a multiple wireless power transfer. In order to make this project successful, the objectives have been declared these objectives must be achieved in completing this project. Objectives are a guidance of any project, so the objectives have been listed below.

i. To design and construct a method to transmit wireless electrical power through space.
ii. To design multiple port wireless power transfer system over range of few centimeters transmission distance using mid range technology.
iii. To develop a system of wireless power transfer for multiple small receivers
iv. To study a system that was capable of charging a mobile phone using the resonant inductive coupling technique.

1.3 Problem Statements

There are several problems based on recent way of wireless power transfer. Firstly, today most rechargeable, portable electronic devices comes with their own proprietary charger and cables. An average user of mobile electronic devices carries at least three different chargers and at least an equal number of cables for energy charging and data transfer functions. Cell phone consumer frustration encompasses not only the inability to make or receive a call because of a dead battery, but also addressing the added cost and inconvenience of juggling multiple chargers (at home, in the car, at the office, etc.). This has led to changing consumer expectations to charge mobile devices wirelessly, potentially eliminate the use of cables and chargers, and help mitigate the "inconvenience" associated with carrying external chargers and cables.

Next, current wireless power transfer is capable of transmitting current at distances of less than one inch. These distances allow for use in small consumer electronic devices such as electric toothbrushes and razors [4]. While these applications have proven to be profitable, the market still remains open for use in larger electronic devices. An aspect of WPT that has been largely unexplored is the ability to charge batteries and other electronic circuits.

Finally, wireless power technology is in high demand because of its convenience to consumer and industrial marketplaces. While wireless power devices have already been created by other companies and institutions, but they are still basic and not practical.