UNIVERSITI TEKNIKAL MALAYSIA MELAKA

INDUCTIVE WIRELESS POWER TRANSFER

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Power) with Honours.

by

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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: Inductive Wireless Power Transfer

Sesi Pengajian: 2020

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APPROVAL

This report is submitted to the Faculty of Electrical Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Power) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Penghantaran kuasa tanpa wayar (WPT) menggunakan projek pemindahan kuasa tanpa wayar untuk mengecas telefon pintar. Projek ini tidak menggunakan sebarang wayar dan ianya dapat mengatasi masalah teknologi pengecasan berwayar seperti wayar yang rosak, perlu menggunakan outlet kuasa untuk mengecas telefon pintar dan sebagainya. Objektif projek ini adalah untuk merancang dan membina kaedah untuk menghantar kuasa menggunakan pemindahan kuasa tanpa wayar induktif melalui udara dan mengecas peranti kuasa rendah dan lebih tertumpu untuk mengecas telefon pintar. Terdapat dua bahagian di dalam projek ini iaini pemancar dan penerima. Litar pemancar terdiri daripada bekalan AC 240V, penyearah, penyongsang atau dikenali sebagai pengayun dan gegelung. Litar penerima terdiri daripada gegelung penerima, penyearah dan akhirnya telefon bimbit yang digunakan sebagai beban. Perisian simulator NI digunakan untuk mensimulasikan prototaip projek sebelum ianya dilaksanakan dalam prototaip yang sebenar. Hasil kajian dan eksperimen teori membuktikan penghantaran tenaga dapat dilaksanakan dan akan menghasilkan aplikasi yang lebih cekap dan moden pada masa akan datang.

ABSTRACT

A wireless power transmission (WPT) using inductive wireless power transfer for charging a smartphone is a project that did not use any wire. This project help to decrease any inconvenience to users such as broken wire, need to find a power outlet when need to charge a phone, messy wire, and other problem. The objective of this project is to design and construct a method for transmitting electrical power through wireless atmospheric transmission and charging a designated low power device that mostly use for charging smart phone. The method consists of two part the transmitter and the receiver. At transmitter part consist 240V AC supply, rectifier, inverter or known as oscillator and primary coil. At receiver part consists of a secondary coil, rectifier and low power load. NI simulation was used to simulate the circuit before performing the hardware. Lastly, the background study and result proved the power transfer is applicable and willproduce more efficient and modern applications in the future.

DEDICATION

This research is dedicated to my beloved parents Mr. Jamaludin bin Hassan and Mrs. Rosilah binti Md Isa for their encouragement, motivation and endlessness. Special thanks to my supervisor also my co-supervisor, my lecturer and my friends for helping me to complete this project. I am thankful for the support and cooperation. I am also grateful to others for receiving advice and support in providing research and sources to expand my knowledge in this project.

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N	-	Number of coil turns
d Φ	-	Change in flux
dt	-	Change in time
H	-	Magnetic field
dL	-	Change in inductance
I_{enc}	-	Current flow in wire
r	-	Radius

CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, the world is full of technology usage. Every day the world will produce new technologies to make people life easier. Before the existing of all this technology, we still use the old way in our life. For the example, before the existence of wireless power transfer in our life we still use a wire to connect our electrical appliance. As the result, the usual wire usage creates inconvenience surrounding such as broken wire, messy wire and others. What if the people create something that will give a great opportunity to not create any mess by invent a life without wire but give the same result in our life? The solution to all this dilemma can be solve with wireless power transfer (WPT), easy and efficient way of transmitting power without wire.

It's been a decade since wireless power transfer was established in many applications. The applications mostly transfer small quantities of electricity. Recently, the wireless power transfer has become popular in industrial area because of the improvements for higher power products. From produce a little watt's power to numerous kilowatts power on medium distances. Most familiar wireless power transfer approach is inductivity coupled, invented more than a century ago by Nikola Tesla. From (Schmidt, 2013), innovator and scientist Nikola Tesla, regarded as the person who discovered wireless electricity in the twentieth century earlier in the 1890s. Nikola Tesla has also proved the theory by illuminating glass tubes with wireless transmitting energy.

From (Singh, 2012), back in Tesla's time, the innovation of the wireless power transfer could not go too far, as there is a specific amount of limitation, For example, funding and technology on its own. Thereby, the implementation of wireless power transfer technology has been decided to leave even without any in-depth research. Inductive wireless power transfer is the effective transfer of electrical power from any part to an alternative across the environment without the help of cable or another material. Power can remain transferred using a short-range inductive coupling. Wireless power transfer is a technology that can carry power to places that are infeasible or impossible to achieve. Filling up low-power equipment by inductive coupling could be the next big thing. Based on the research from (Teo, 2010), during 2007 a group of MIT researchers performed investigation on wireless power transfer and success to power up 60W bulb over distances of more than 2 metres, with an effectiveness for about 40%. This experiment completed Using a couple of resonators that were magnetically coupled. These pairs of resonators were also named a receiver and a transmitter, which will form a magnetic field coupling innovation. As a result, almost all people have started their studies on wireless power transfer.

1.2 Problem Statement

During the period of times, humans usually carry multiple cables to their devices in order to be able to charge them at other than few destinations, that will continue their internet-based usage life-style updates. However, smartphone charging wires might not have a long lifespan, especially when they are frequently used. It is either due to excessive usage or maybe just low quality manufactured by supplier because it can break easily, tear apart and maybe quit functioning on the spot. Furthermore, the use of cords often

causes mobile phone charging ports to suffer burnouts due to the constant charging through a wired link. It is because the USB port is still quite vulnerable and prone to forces that would easily destroy it, and that is why cords seem to be more burdensome throughout the era of using wireless charger.

The goal can be quite helpful and useful in this project to reduce such existing problem. Wireless power transfer devices or system can already be found in the market and they are safe to be used. Wireless technology solves many problems that often relate to wired charging capabilities. The wireless charging method is straightforward because it uses magnets that contain electromagnetic fields between one appliance so that the electrical energy is being converted into a metal coil in another appliance. One primary advantage of using the wireless charger is that many device types may use it. It makes the process less complex by not carrying multiple wire to charge a phone anymore.

1.3 Objective

This project has three main goals:

1) The goal of this project is to develop and create a method for transfer the power across an atmosphere using inductive wireless transmission and for loading a specified low power network.
2) To prove the electrical power transfer can be transfered wirelessly without any connection using cable or wire.
3) The develop convenient way to charging several mobile devices with a specific source to use a single power outlet simultaneously.

1.4 Scope of study

There are three main idea about scope study:

1) This project analysis will be emphasized only for inductive type of wireless power transfer.
2) This study shows the findings of a simulation in wireless transmission and various transmission distances of between 1 cm to 4 cm for electric and magnetic wave behaviour.
3) This project was being regulated over one appliance that can be achieved within the timeline and before designing the systems for multiple loads, it is vital to establish first the best parameters for efficient power transfers. This makes the project workable and feasible for the project for final year duration.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The aim of this section is to secure an understanding of the current capabilitiesof wireless power transfer as a whole and how these capabilities have evolved over the last decade via a survey of published experimental work. Within this survey, the attributes of inductive power transfer will be examined empirically to establish trends and operational or application spaces for inductive power transfer technology.

2.2 Background study

2.2.1 Inductive wireless power transfer

Using short or even long-range cords, wireless control, also known as inductive power transfer. Compared to previous technologies this technology provides powerful, quick, and low maintenance costs. It also allows portable electronics to charge themselves without ever plugging into omnipresent power wire. On the other hand, compared with wired electricity transmission, this technology's power loss is significantly less. The key feature of wireless power transfer stays enables continuous charging of electrical devices, and to lose a power cord's restriction. From (Mohammad Shidujaman, Hooman Samani, Mohammad Arif, 2014), WPT uses three main systems, microwaves solar and resonant compartments, for example. Microwaves can be used to transfer electromagnetic waves in an electrical system via an energy source to the receiver.

To send power between two items, the inductive charging that using a magnetic wave is used. Based on (Kweku, 2017), the charging point sends energy to the electrical appliance through an inductive coupling that gathers the power throughout the batteries. Since there is a slight difference between two wires, inductive charging is a small distance wireless transmission of power.

Inductive chargers commonly will use induction coil to generate an electromagnetic alternating field inside of the charging base, whereas the next induction coil also in portable device absorbs electromagnetic electric power mostly from system and transforms it into the applied voltage to charge the battery. The electrical transformer consists two adjacent induction coils. Lower electric shock risk due to the absence of exposed conductors induced loading compared with conductive charge. The potential to enclose the charging connection completely also makes the approach attractive where water permeability is necessary. Inductive charging as the model applied for Implanted medical appliances that need intermission also permanent external power and electrical toileting appliances such as toothbrushes and razors being used close and sometimes in water. Inductive charging makes it more convenient to charge mobile devices and electric vehicles instead of requiring to attach the power cord, the component can be located on or near the charging pad (Kweku, 2017).

The wireless charging moves quickly from a new device to a common part on smart devices , especially on mobile phones with a long-term power hunger which need to be filled regularly. Wireless transmission systems generally have resonant or inductive characteristics. The converter and receptor act as a close-coupling transformer with an inductive wireless charging device to provide energy with low separate areas. Resonant wireless power transmission iteratively evolve the principle to freely linked coil pairs by

electrical resonance to improve power transmission performance, although when coupling is weak based on (Riehl, P.S. , Satyamoorthy, A. , Akram, H. , Yen, Y. C. , Yang, J. C. , Juan, B., 2015) research.

2.2.2 Faraday's law of magnetic induction

Faraday's law of electromagnetic induction is the basic law of electromagnetism that predicts how a magnetic field interacts with an electrical circuit to produce an electromotive force (Anon., 2019).

The Faraday Magnetic Induction Law equation is described as:

$$emf = -N\frac{d\phi}{dt} \quad \text{.....} \quad (2.1)$$

Equation (2.1) demonstrates the electromotive force is significantly related to flux adjustments, dϕ, whereas the time change, dt was inversely proportional. N is strongly related to the number of turns and the increasing the spindle turns, the increased the force.

The (-) sign is known as the law of Lenz because he claims that the flow changes, dϕ are referred by the current and the magnetic field (V V Mayer, E I Varaksina, 2017).

Figure 2.1 shows the diagram for wireless charging pad for smart phone and Figure 2.2 indicates a process of the inductive wireless for the lighting a bulb. The electromagnetic fields are produced by the current produce from the battery. Whenever the primary closed-circuit wire remains close the electromagnetic field, the output is triggered.

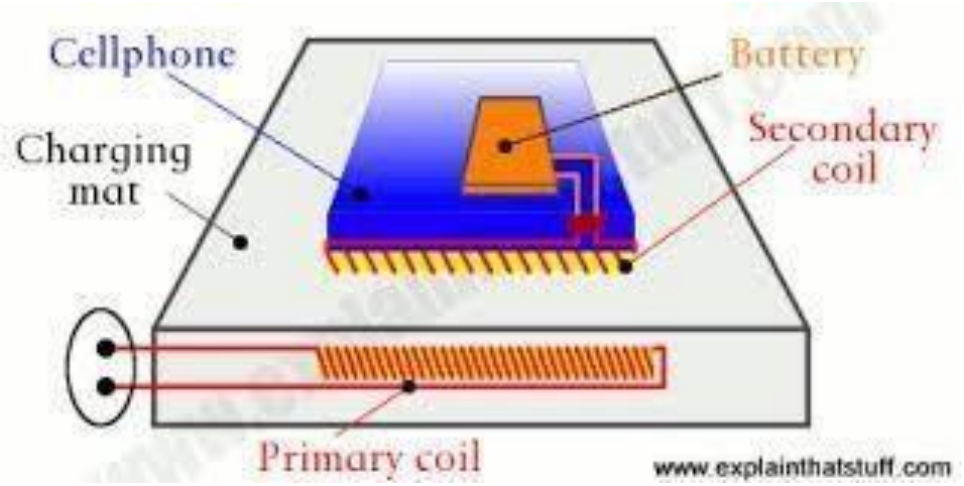

Figure 2.1: wireless charging pad for smart phone (Mearian, 2018)

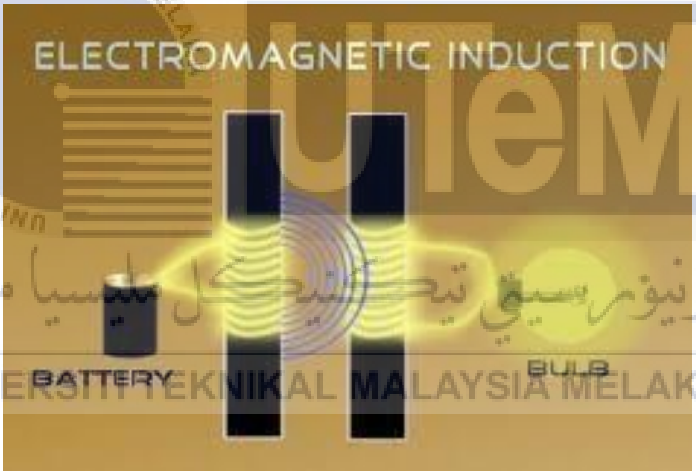

Figure 2.2: wireless electromagnetic induction for lighting the bulb (Toppr, 2020)

2.2.3 Ampere's law

In classical electromagnetism, the law of Ampere, which Andre-Marie Ampere discovered in 1826, refers to the distributed magnetic field in a closed loop (IEEE, 2011)