DESIGNING AND IMPLEMENTATION OF WI-TRICITY SYSTEM CONTROL

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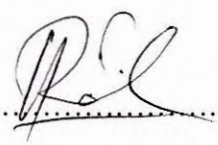
Tandatangan : 

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ABSTRACT

Effective electrical power transfer is the foundation of the modern civilization. However, the traditional ways by electric power cables and electric batteries are often not satisfactory for mobile devices, such as cell-phones, notebooks and robots. Use of plugs and wires limits the mobility. There are various situations in which electrical energy is desired but cannot by conveniently supply. Today, wireless power transfer has only been commercially demonstrated at small distances through use of induction. To address these problems, researchers have been studying wireless power transfer technology or Wi-tricity technology. Wireless energy transfer based on coupled magnetic resonances is a new technology which energy can be transferred via coupled magnetic resonances in the non-radiative near-field. This thesis demonstrated the transfer of wireless power at relatively large distances through radio frequencies in the development of a prototype for a commercial product. A simple energy transfer system structure was proposed in this project. The impact on the voltage and current of receiver coil caused by different transfer distance is investigated and shows that the longer is the distance between the two coils, the lower the voltage and the current of the receiving coil is. The strength of magnetic field is depends on the number of turn of the copper wire at the transmitter coil and receiver coil and the input current to the transmitter coil. Furthermore, this system has been successfully embedded with the IR module and PIC microcontroller to overcome the limitation of the previous Wi-tricity system where the previous system does not have the control system to control the current source supply. For future recommendation, the strength of the magnetic field can be improved by better quality of copper wire. Besides that, the number of turn of coil and the input current source can be increased to improve the strength of the magnetic field.

ABSTRAK

Pemindahan kuasa elektrik yang berkesan adalah asas untuk tamadun moden. Walaubagaimanapin, cara tradisional menggunakan kabel dan bateri tidak memuaskan peranti mudah alih seperti telefon bimbit, komputer riba dan robot. Menggunakan plug dan wayar menghadkan mobiliti. Terdapat berberapa situasi dimana elektrik tidak dapat diguna dan dibekalkan secara berkesan. Untuk menangani masalah ini, penyelidik telah mengkaji teknology kuasa pemindahan tanpa wayer atau disebut sebagai teknologi Wi-tricity. Pemindahan tenaga tanpa wayar berdasarkan resonans serta magnet adalah teknology baru yang membolehkan tenaga dipindah melalui resonans magnet. Pada hari ini, kuasa pemindahan tanpa wayar telah dikomersial dan menunjukkan pemindahan kuasa jarak kecil melalui induksi. Tesis ini menujukkan pembinaan prototaip pemindahan kuasa tanpa wayar pada jarak kecil melalui frekuensi radio. Sebuah structur sistem pemindahan tenaga mudah telah dicadangankan dalam projeck ini. Impak ke atas voltan dan arus gegelung penerimaan yang disebabkan oleh jarak pemindahan berbeza dikaji. Keputusan menunjukkan voltan di bahagian penerima menurun apabila jarak antara gegelung meningkat. Kekuatan medan magnet bergantung kepada bilangan gegulung pemancar dan penerima dan arus masuk kepada gegulung. Selain daripada itu, system ini berjaya terbenam dengan modul IR dan mikropengawal PIC untuk mengawal bekalan arus punca. Kekuatan medan magnet boleh diperbaiki dengan wayar kuprum yang lebih berkualiti. Selian itu, bilangan pusingan gegelung dan arus masuk boleh ditingkatkan untuk menambah kekuatan medan magnet.

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LIST OF ABBREVIATIONS

RFID	-	Radio Frequency Identification
MIT	-	Massachusetts Institute of Technology
LCD	-	Liquid crystal display
AC	-	Alternating Current
IR	-	Infrared
CCS	-	Custom Computer Service Compiler
DC	-	Direct Current
PCB	-	Printed Circuit Board

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CHAPTER I

INTRODUCTION

1.1 Background

Electricity is today a necessity of today modern life. It is difficult live or passing a day without electricity. The conventional use of electricity is made possible through the use of wires. Today, Wi-tricity or also referred to with the name of wireless electricity or wireless power transfer has been attracting a great deal of attention. Wi-tricity will enable advances in the use of electronic devices such as mobile phones, portable computers and etc.

Wi-tricity is the short form of wireless electricity. It is the transmission of electrical energy from a power source to an electrical load without interconnecting wires. It is used to power on the electrical devices without the exits of wire. Besides that, because of the Wi-tricity, some of the devices will not require the battery to operate. Although functional, wireless power transfer through induction is constrained to very small distances; the transfer efficiencies get increasingly worse as the distance between transmitter and receiver increases.

Many of the contactless feed systems are based on the electromagnetic induction's principle. Small distance wireless energy transfer is demonstrated through used of induction. Knowledge of electric circuit logic and electromagnetic theory is important to realize the practical design. The concept of Wireless electricity began with the experiments of Heinrich Hertz and Nikola Tesla at around the 1890s and it still under the research until today. It has been attempted many times throughout the last century [1].

The advantage of inductive wireless power transfer is that it is a low cost and highly efficient method of transferring power. The design of an induction link is fairly straight forward and surprisingly efficient at small distances.

This thesis provides a literature review of the history of Wi-tricity throughout the last century. All of the methods that have been used to achieve Wi-tricity will be reviewed along with the advantages and disadvantages of each method. This thesis will conclude with a small discussion on issues with Wi-tricity. In order to detailed investigate the principle of the electrical energy transmission; building the model of this scheme is important for the research on transferred power, efficiency, optimizing the structure and parameters, and determining the controlling method.

1.2 History of Wi-tricity

Magnetic fields and inductive coupling have been studied since the discovery of transformer by Hans Oersted and Michael Faraday. In 1886, Westinghouse Company developed first commercial AC transformer. A complete mathematical understanding of the coupled circuits used to make the transmitter and receiver was first published by Frederick Terman in 1935 [2].

Idea of using microwave power transmission was put forward by William C. Brown in 1961. In 1973, world first passive RFID system demonstrated at Los-Alamos National Lab [2].

In 1988, a power electronics group led by Prof. John Boys at The University of Auckland in New Zealand, developed an inverter using novel engineering materials and power electronics and concludes that inductive power transmission should be achievable. A first prototype for a contact-less power supply is built [2].

In 2007, a physics research group, led by Prof. Marin Soljačić, at MIT confirm the earlier (1980's) work of Prof. Boys by wireless powering of a 60W light bulb with 40% efficiency at a 2 meters distance using two 60 cm-diameter coils [2].

In 2010, Haier Group debuts the world's first completely wireless LCD television at CES 2010 based on Prof. Marin Soljacic's research on wireless energy transfer and Wireless Home Digital Interface (WHDI) [2].

1.3 Problem Statement

In general, the battery technology is the major approach to supply the power of these systems. The advantage of the approach is technically simple. However, unacceptable problems such as the hidden danger of battery and the low capacity that can not satisfy the high power consumption requirement of system， limit its development.

Besides that, standard wired charging device also experiences wasted power in that a charger left plugged into an electrical outlet while the device is not attached wastes as much as 93% of the power it pulls over its entire lifetime. Also, the manufacturing and disposal processes of zinc-carbon, alkaline, and lithium-ion batteries entail significant carbon emissions. If Wi-tricity technology can replace 2% of battery powered devices in one year, 11,600 metric tons of CO_2 can be saved. Wi-tricity can improve energy efficiency, reduce mercury waste, and preserve clean air by diminishing a reliance on battery power and the subsequent carbon emissions [1].

Not only that, conventional power transfer provide unacceptable problems such as the tripping hazard. Tripping hazard is difficult to prevent unless we think about them as we work with the things that can create them. The only way to avoid the tripping hazard is to reduce the use of wire or it can be improve by Wi-tricity product.

Furthermore, another serious unacceptable problem occurred with current wire power transfer system is people might get electrical shock during flood. There are too many incident happen ill electric shock victims during flood. Wi-tricity can prevent this incident happen because no wire is required and it's transfer energy in electromagnetic form. So that, people will not get electrical shock in this kind of energy transfer.

1.4 Objective

The main objective of this final year project is:

i. To design the Wi-tricity power based.
ii. To design and implement of Wi-tricity system control.
iii. To investigate the energy transfer efficiency.

1.5 Scope of work

Hardware and software are covered in this project. The hardware consists of transmitter, receiver coil and PIC micro-controller circuit and IR module. The transmitter coil is the resonant antenna driven by AC generator to transmit energy while the receiver coil is grounded resonant antenna that received energy from transmitter and directly powering the output load. The PIC micro-controller circuit is used to trigger the transmitter coil to transmitter power to the receiver coil when there is object detected by the IR module. The software consists of programming by using software CSS (Custom Computer Service) compiler to generate system ON and OFF control coding and Protues to design the PCB layout.

1.6 Methodology

In order to design the Wi-tricity power based and to design and implement of Wi-tricity system control and investigate the energy transfer efficiency, I came up with an idea of developing and implementing Wi-tricity system control. Two approaches were used in collecting primary data to gain information, ideas and suggestions in further developing this system. Firstly, in the theoretical approach, researching the selected topic is selected to seek the information towards this system. Besides that, reading journal, books, magazines, as well as articles from the library will also help me in completing this study. Secondly, I have used the experimental approach to test the hypothesis underlying my study. This experiment was conducted in order to investigate the energy transfer efficiency of Wi-tricity system. After that, designing the project circuit is important to make sure the efficiency of the system. Last but not least, I will make the troubleshooting to detect the problems that arise in order complete the research.

1.7 Thesis Outline

The remainder of this thesis is organized as follows:

Chapter 2, *Theoretical Review*, the concept of the Wi-tricity system control is studied to understand the concept of wireless energy transfer in order to design the appropriate circuit.

Chapter 3, *Literature Review*, history of wireless energy transfer is analyzed and the propose project is compared with the current technology. Besides that, the others method of transferring energy is also analyzed.

Chapter 4, *Research Methodology*, the proper procedure in designing and manufacturing of the system is discussed.

Chapter 5, *Result and Discussion,* the result of the experiment is presented. The experimental result is discussed and analyzed for future improvement.

Chapter 5, *Conclusions and Recommendations,* conclusions from the results is drawn and a future area for research is recommended.

1.8 Summaries of Chapters

Introduction was included to briefly explain some important parts of whole project, objective of project, problem statement of project, scope of work and the methodology of the project.

Theoretical review shows the detail concept of the wireless energy transfer and the working concept of the whole project. This chapter includes electromagnet induction, resonance frequency of the system, quality factor of the system and detail concept of inductor.

Literature review shows the details in different designs of Wi-tricity system control circuit construction and different functions which were used to be discussed, compared to the current Wi-tricity system.

In methodology, a brief flow of project from discussing the project with supervisor, until the end of presentation and technical report was described. Besides that, the flow in manufacturing the transmitter and receiving coil is discussed in detail. Furthermore, the uses of Protues and CSS compiler to design the PIC 16F6770 microcontroller circuit also included in the methodology.

Expected results and discussion shows the expected results of this project, the range of the wireless energy transmission, the relationship between the source frequency

and the resonance frequency and the functionality of the CCS programming is discussed in this chapter.

Finally, results and discussion, related to objective; benefits on Designing and Implementation of Wi-tricity System Control and the whole project were concluded in conclusion.

CHAPTER II

THEORETICAL REVIEW

2.1 Concept of Electromagnetic Inductive Coupling

This chapter will discuss the detail concept of how the energy can be transferred wirelessly and the theory or the equation that involved in the wireless energy transfer model.

2.2 Concept of Electromagnetism

The term electromagnetism is defined as the production of a magnetic field by current flowing in a conductor. Understand electromagnetism in greater detail is needed to understand how it can be used to do work.

Magnetism is a basic force of nature that causes certain types of material to attract or repel each other. Permanent magnet is an example of objects having stable magnetic fields. Oscillating magnetic fields diverge with time, and can be supplied by alternating current flowing on a wire.

Electromagnetism is the strength that causes the interaction between charged particles. The area in which this happens is called electromagnetic fields. How are these two things related? The moving electric charges in a conductor create magnetic fields where the moving magnet in a conductor creates magnetic fields. This effect is called electromagnetic induction and is the starting point of operation for wireless energy transfer or Wi-tricity System.

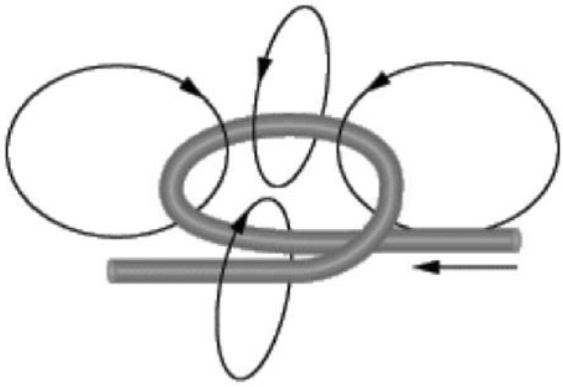

Figure 2.2.1 Magnetic field around wire

The form of the magnetic field around the wire is shown in Figure 2.1.1. The magnetic field in circular form is developed around the wire. The field generated is perpendicular to the wire and that the field's direction depends on which direction the current is flowing in the wire. The easy way to increase magnetic field is to coil the wire because the magnetic field around a wire is circular and perpendicular to the wire.

2.3 Electromagnetic Induction

Electromagnetic induction is the creation of an electrical voltage or potential difference across a conductor within a changing magnetic field.