RESEARCH ARTICLE OPEN ACCESS

Wireless Power Transmission Using Resonance Inductive Coupling

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ABSTRACT
In this paper, we present the concept of transmitting power without using wires i.e.transmitting power as Magnetic waves from one place to another is in order to reduce the transmission and distribution losses. This concept is known as **Resonance Inductive Coupling (RIC)**. We also discussed the technological developments in Wireless Power Transmission (WPT). The advantages, disadvantages, biological impacts and applications of WPT are also presented.
Wireless power or wireless energy transmission is the transmission of electrical energy from a power source to an electrical load without man-made conductors. Wireless transmission is useful in cases where interconnecting wires are inconvenient, hazardous, or impossible. the proportion of energy received becomes critical only if it is too low for the signal to be distinguished from the background noise. With wireless power, efficiency is the more significant parameter. A large part of the energy sent out by the generating plant must arrive at the receiver or receivers to make the system economical.The most common form of wireless power transmission is carried out using direct induction followed by resonant magnetic induction. Other methods under consideration are electromagnetic radiation in the form of microwaves or lasers and electrical conduction through natural media
Keyword: Wireless Power Transmission (WPT), Resonance Inductive Coupling (RIC)

a. INTRODUCTION

The idea of wireless power transfer originated from the inconvenience of having too many wires sharing a limited amount of power sockets. We believe that many people have the same experience of lacking enough sockets for their electronic devices. Thus by creating a wireless power transfer system, it would help clean up the clutter of wires around power sockets making the space more tidy and organized.
The technology for wireless power transmission or wireless power transfer (WPT) is in the forefront of electronic development. Applications involving microwaves, solar cells, lasers, and resonance of electromagnetic waves have had the most recent success with WPT. The main function of wireless power transfer is to allow electrical devices to be continuously charged and lose the constraint of a power cord. Although the idea is only a theory and not widely implemented yet, extensive research dating back to the 1850's has led to the conclusion that WPT is possible. Wireless Power Transmission, Transfer the three main systems used for WPT are microwaves, resonance, and solar cells. Microwaves would be used to send electromagnetic radiation from a power source to a in an electrical device.

The concept of resonance causes electromagnetic radiation at certain frequencies to cause an object to vibrateReceiver.This vibration can allow energy to be

transmitted between the two vibrating sources. Solar cells, ideally, would use a satellite in space to capture the suns energy and send the energy back to Earth. This concept would help to solve the major energy crisis currently concerning most of the world. These ideas would work perfectly in theory, but converting the radio frequencies into electrical power and electrical power to radio frequencies are two main problems that are withholding this idea to become reality. This paper will explore the technological applications of microwaves, resonance, and solar cells in WPT and explain the basic technique of transmitting power wirelessly. It will also include problems encountered during experimentation and recent advances in the field. The paper will also include the futuristic applications of WPT and its ability to solve the energy crisis.

1.2. NEED OF PROJECT

The need of this project is to produce a platform which can detect the battery level of an electronic device, such as a cell phone, then be able to automatically charge the device when the battery level of the device drops below a certain threshold. Our project will use resonant induction charging which can charge multiple devices at the same time as long as they have the same resonant frequency.

1.3 TECHNOLOGY

- **Inductive Coupling**

Two devices are said to be mutually inductively coupled or magnetically coupled when they are configured such that change in current though one wire induces a voltage across the ends of the other wire by electromagnetic induction. This is due to the mutual inductance.

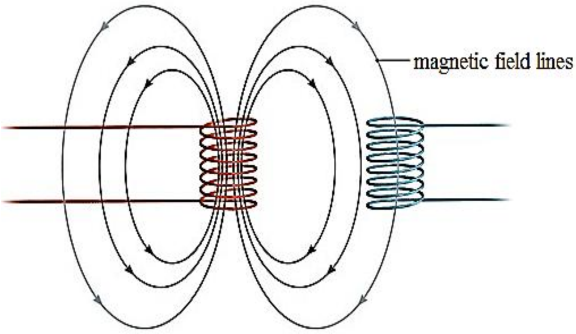


Fig. Inductive coupling

Transformer is an example of inductive coupling. Inductive coupling is preferred because of its comfortable, less use of wires and shock proof.

1. **Resonance Inductive Coupling (RIC)**

RIC is the combination of both inductive coupling and resonance. Using the concept of resonance it makes the two objects to interact each other very strongly.

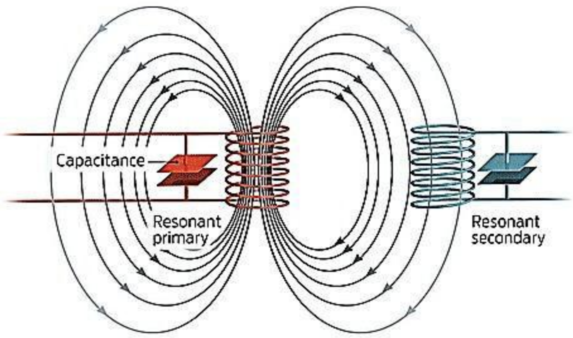


Fig. Resonance Inductive Coupling

Inductance induces current in the circuit. As seen in the figure 7, the coil provides the inductance. The capacitor is connected in parallel to the coil. Energy will be shifting back and forth between magnetic field surrounding the coil and electric field around the capacitor. Here the radiation loss will be negligible.

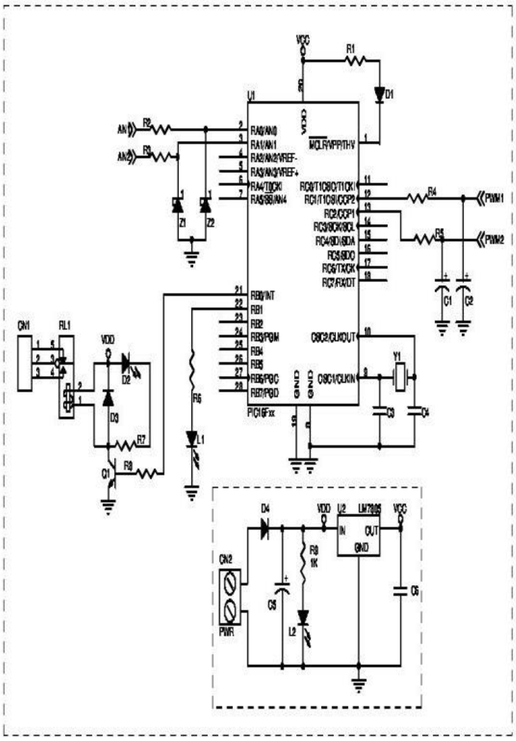
II. LITERATURE SURVEY

Electricity by today's standards is considered an essential to life. Electricity has been the fuel for technological development since its first applications dating back to the late 16th century. This marvellous phenomenon, however, comes with a price. The cost of making electricity is harmful to the environment. The Energy Information Administration's records show that nearly 50% of all electrical plants are high polluting coal plants. Major changes in the environment have occurred over the last 30 years that are detrimental to the future of this planet. If this path is left unchanged, scientists have predicted that certain parts of the world could be uninhabitable by 2050. The solution is to reduce greenhouse gas emissions into earth's atmosphere through alternative power generation. One sustainable technology leading this charge is wireless power transfer (WPT).

The concept of wireless power transmission has been around since the mid 17th century. WPT is exactly what the name states; to transfer electrical power from a source to a device without the aid of wires. The founder of AC electricity, Nikola Tesla, was first to conduct experiments dealing with WPT. His initial experiment of lighting gas discharge lamps from over 25 miles away, wirelessly, was a success. His idea came from the notion that earth itself is a conductor that can carry a charge throughout the entire surface. Although his idea of a world system of WPT could never be properly funded, his initial research sparked the scientific world into a whole new theory of power generation. While Tesla's experiments were not creating electricity, but just transferring it, his ideas can be applied to solve our energy crisis. His experiments sparked new ideas such as applications involving microwaves, lasers, resonance and solar cells. Each application has its respective drawbacks but also has the potential to aid this planet in its dying need for an alternative to creating power.

Today, portable technology is a part of everyday life. Most commonly used devices no longer need to draw power from the supply continuously. But from portability emerges another challengeenergy. Almost all portable devices are battery powered, meaning that eventually, they all must be recharged–using the wired chargers currently being used. Now instead of plugging in a cell phone, PDA, digital camera, voice recorder, mp3 player or laptop to recharge it, it could receive its power wirelessly–quite literally, "out of thin air".

2. HARDWARE



2.1 PULSE-WIDTH MODULATION

Pulse-width modulation is a digital technique for varying the amount of power delivered to an electronic component. By adjusting the amount of power delivered to a motor or LED, the speed or brightness (respectively) can be controlled. the simplest and most flexible PWM is generated by a microcontroller.Pulse-width modulation (PWM), or pulse-duration modulation (PDM), is a commonly used technique for controlling power to inertial electrical devices, made practical by modern electronic power switches.

The average value of voltage (and current) fed to the load is controlled by turning the switch between supply and load on and off at a fast pace. The longer the switch is on compared to the off periods, the higher the power supplied to the load is.

The PWM switching frequency has to be much faster than what would affect the load, which is to say the device that uses the power. Typically switching have to be done several times a minute in an electric stove, 120 Hz in a lamp dimmer, from few kilohertz (kHz) to tens of kHz for a motor drive and well into the tens or hundreds of kHz in audio amplifiers and computer power supplies.

The term duty cycle describes the proportion of 'on' time to the regular interval or 'period' of time; a low duty cycle corresponds to low power, because the power is off for most of the time. Duty cycle is expressed in percent, 100% being fully on.

The main advantage of PWM is that power loss in the switching devices is very low. When a switch is off there is practically no current, and when it is on, there is almost no voltage drop across the switch. Power loss, being the product of voltage and current, is thus in both cases close to zero. PWM also works well with digital controls, which, because of their on/off nature, can easily set the needed duty cycle.PWM has also been used in certain communication systems where its duty cycle has been used to convey information over a communications channel.

2.2 MOSFET BASED RF AMPLIFIER

A wireless power transmission is possible to achieve near-field resonant coupling using high alternating voltages and strong electric fields, an analog should be possible with parallelresonance, high currents and strong magnetic fields as well. Tesla coils utilize a high impedance resonant circuit to produce extreme voltages required for capacitive coupling, and this high voltage creates a problem for small scale applications like indoor battery charging (corona and arcing caused by strong electric fields can even cause fires)

Magnetic coupling is attractive because it allows fairly large amounts of power to be transmitted without need for high voltages. The basic idea is again to have two high-Q resonant circuit, which are now coupled magnetically and are preferred to have as low characteristic impedance as possible. The only question that remained was how to feed RF power at an appropriate frequency into the transmitting tank circuit – and some sort of a self-resonant oscillator looked like a good choice.

A self-oscillator circuit based push and pull MOSFET and the concept is very similar to the RF oscillator Converter shown below. As far as I know that two MOSFETs need to generate square waveforms (PWM) which come from the current within the centered tap transformer or two inductors when powering at DC voltage.The diodes allow the cross-coupled FET's to pull the opposing FET's gate voltage down to shut it off. The resistors bias BOTH the FETs in the ON state, which is an unstable condition- they cannot both be ON because this would turn them both OFF... it becomes bi-stable, the resonance of the LC tank sets the pace. When the resonant cycle reaches a point where the drain voltage of the OFF state FET begins to drop, it sucks the bias voltage of the opposite FET away through the diode, turning it off.

2.3 CURRENT SENSOR (SHUNT)

In electronics, a shunt is a device which allows electric current to pass around another point in the circuit. the current to be measured must be first converted into voltage so that it could me measurable too with the ADC channels. The current to voltage conversion can be done by placing a small value resistance (shunt) in series with the current path. The voltage drop across the resistance will then vary linearly with the current.

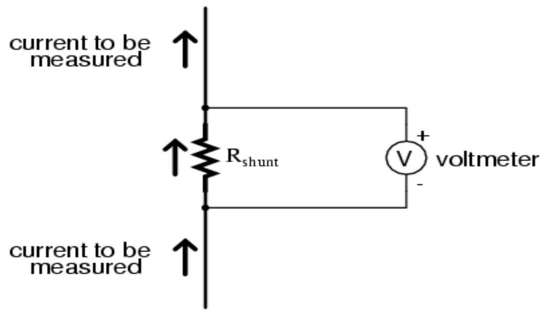


Fig. Diagram of Current Sensor

Current sensor (shunt) resistance is so small in value, the voltage drop across won't be very high for small currents. Even for 1 A of current, the voltage drop across it would be only 0.286 V. To improve the resolution (and hence accuracy) of current measurement, this voltage must be amplified before the AD conversion process. An operational amplifier with a suitable gain can do this task. The figure below shows how this whole technique works.
In the circuit, R15 (Shunt) is the low value current sensing resistor which is connected in series with the load. Our objective is to derive the load current (I). The low voltage drop across Shunt (R15) is amplified by the non-inverting amplifier. The gain of the amplifier is set by R16 and PR1 resistors. For PR1 = 10K, and R16 = 1K, the gain of the amplifier would be about 8.7. This is enough to linearly scale Vs (0-0.57V) to Vo (0- ≈ 5V). Now you have 0-5 V voltage signal that corresponds to 0-2 A current through R15. This voltage signal is now more appropriate for ADC conversion with Vref = 5 V. within the safe limit (0-5 V) of the microcontroller's ADC channel. An additional zener diode (ZD1) at the output ensures that the Input voltage at PIC's ADC channel won't be greater than 5.1 V. The scaled output is connected to AN0 channel (pin 2) of PIC MCU.

2.4 ANALOG TO DIGITAL CONVERTER (ADC)

An ADC is an electronic device that converts an input analog voltage or current to a digital number proportional to the magnitude of the voltage or current.
We need to do some maths related to AD conversion. You know that any application that uses analog-to-digital converters (ADCs), requires a fixed reference voltage to provide accurate digital count for input analog signal. If the reference voltage is not stable, the ADC output is meaningless. In this project, the reference voltage for ADC operation is selected to be VCC (= +5 V). Therefore, the ADC will convert any input voltage between 0-5 V in to a digital count between 0-1023. ADC, doing some math with ADC conversion. This number can be converted to the actual measured current. The measured current is displayed on a four digit seven segment LED display.

2.5 MCU CLOCK

A 8 MHz crystal provides accurate timing and an easily divisible clock source for the internal hardware timers. This high frequency clock source is used to control the sequencing of CPU instruction

2.6 RELAY INTERFACE

A single pole dabble throw (SPDT) relay is connected to port RC6 (pin 17) of the micro controller through a driver transistor (Q2). The relay requires 12 volts at a current of around 100 ma, which cannot provided by the micro controller. So the driver transistor is added. The relay is used to operate external electronic lock, or any other electrical device ETC. Normally the relay
remains off. As soon as pin of the micro controller goes high, the relay operates. When the relay operates and releases. Diode D6 is the standard diode on a mechanical relay to prevent back EMF from damaging Q2 when the relay releases. LED L2 indicates relay is operated.
LED has a current limiting resistor in series. The LED / resistor combination is simply in parallel with the relay

2.7 POWER SUPPLY

The power supply circuit. It's based on 3 terminal voltage regulators, which provide the required regulated +5V and unregulated +12V.
Power is deliver initially from standard 12V AC/DC adapter or 12V_1000ma Transformer. This is fed tobridge rectifier (Diode D2 ~ 4) the output of which is then filtered using 1000uf electrolytic capacitor (C1) and fed to U2 (voltage regulator). U2 +5V output powers the micro controller and other logic circuitry. LED L1 and its associate 1K current limiting resistors provide power indication. The unregulated voltage of approximately 12V is required for relay, and RF Amplifier-driving circuit.

RESULT:

Distance	Voltage V(dc)	Current (mA)	Application
6 Inch	4.5 to 5	100	MOBILE CHARGING
8 Inch	4.5	500	FILAMENT BULB
1 feet	7 to 8	50	LED

III. FUTURE SCOPE

WPT, if successful will definitely change the way we live. Imagine cell phones, laptops, digital camera's getting self charged! Wow! Let's hope the researchers will be able to come up with the commercial system soon.

IV. CONCLUSION

In this paper, the concept of **Resonance Inductive Coupling** it explicitily studied. The Wireless Power Transmission would replace the conventional inefficient technology. It will further reduce the dependence on the fossil fuel and other petroleum products that directly leads to the Global Warming.

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