Wireless Power Transmission Techniques

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Abstract: Wireless Power Transmission (WPT) is the transmission of electricity without wires as a physical link. In this method, we have studied different methods of wireless power transmission. The methods applied for wireless power transmissions like electromagnetic induction, electrostatic induction, electromagnetic radiation, laser method, electrical conduction, and microwave method are considered. This study also focuses on the merits, demerits, and recent technologies of this field. This paper also includes a brief introduction to the WiTricity technique.

Keywords: Wireless power transmission (WPT), methods of WPT, WiTricity.

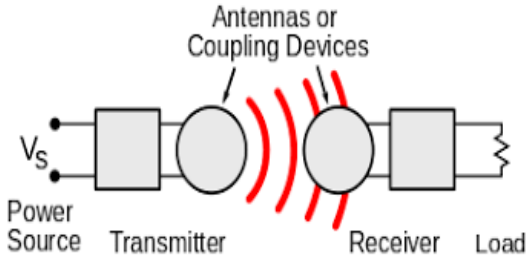
I Introduction

Wireless power transfer (WPT or wireless charging) is a technology that allows the transmission of energy through an air gap to a load without any interconnecting cables.Electricity, often shortened to “electric power”, is a form of energy that can be transmitted without the need for physical connections using a concept called magnetic resonance. Wireless transmission of electricity is useful when it’s inconvenient, dangerous, or impossible to use traditional wired connections. This method has been used in various applications, such as charging smartphones and electric vehicles, with power levels ranging from very low (microwatts) to high (kilowatts). Other methods include using electromagnetic radiation in the form of microwaves or lasers, as well as electric wires through natural media. When power is transmitted and distributed, approximately 26% of it is lost. Therefore, knowledge in the field of WPT is increasingly important for the modern power electronics engineer.

II Literature survey

In this paper, we have studied in detail the concept of wireless power transmission. The goal of this research is to provide a summary of the most recent advancements and progress made in the area of transmitting power wirelessly. In this paper, we have reviewed the techniques of wireless power transmission. Also in this paper, we have explored the basic concept of WiTricity.

III System architecture



IV Techniques of WPT

There are two techniques for WPT i.e. Near- field and Far-field techniques.

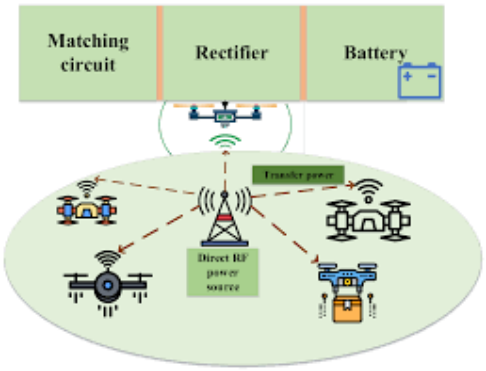
A. Near-field techniques

Near-field techniques are methods used to transfer power over short distances. This is done by using either magnetic fields through coils of wire or electric fields through metal electrodes that are close to each other. It is also known as the non-radiative technique. It is classified into three types:

1. Electromagnetic (EM) radiation.
2. Inductive coupling.
3. Capacitive coupling.

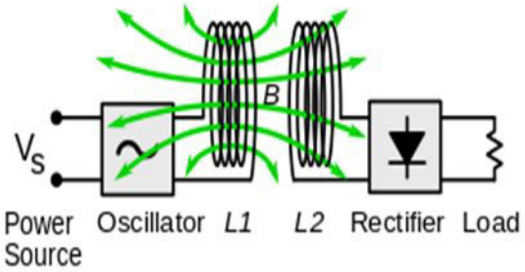
1. Electromagnetic (EM) radiation:
In this method,the power is transferred by the

process of emission of EM radiation from the transmitting antenna to the receiving antenna. Omnidirectional radiation and unidirectional radiation are the two categories that classify the direction in which energy is emitted.



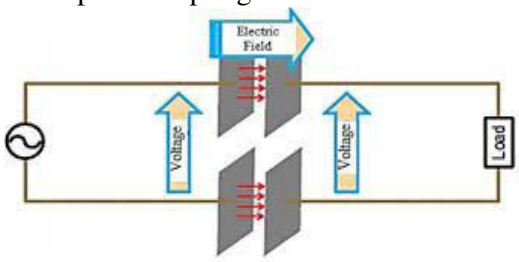
2. Inductive coupling:

In this method, power is transferred between wire coils through the use of magnetic field. The receiver coil (L2) and transmitter coil (L1) form a transformer shown in the dig below. An alternating current flowing through the transmitted coil (L1) creates an oscillating magnetic fled (B) by Ampere's law which passes through the receiving coil (L2). Then by Faraday's law of induction AC is generated in the receiver. This AC can be rectified by a rectifier for suitable applications. Inductive coupling is widely used in applications such as electric toothbrushes and shavers, biomedical
pesticides, etc.



3. Capacitive coupling:

It is also known as electric coupling. It uses electric fields for power transmission between two electrodes (anode and cathode) which form a capacitance for the transfer of power.
In capacitive coupling, which is a type of electrostatic induction, energy is transferred between electrodes using electric fields. An AC voltage is applied to the transmitting plate, and by electrostatic induction, an alternating potential is induced on the receiver plate which generates an alternating current to flow in the load circuit. Capacitive coupling is used in very few power applications, because of the large voltage requirement. Capacitive coupling is used for charging battery-powered portable devices, in biomedical implants, and integrated circuits.
There are two types of capacitive coupling:
i. Bipolar coupling
ii. Unipolar coupling

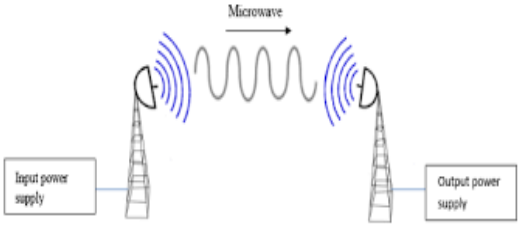


B. Far-field techniques:

In far-field techniques, power is transferred over long distances, often multiple kilometers with the help of high-directivity antennas or laser light. This technique aims at high-power transmission. It is classified into two categories, microwave power transmission, and laser power transmission.

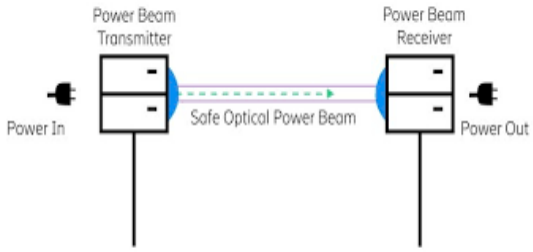
1. Microwave power transmission (MPT):

This technique transfers high power from the base station to the receiving station or mobile devices with two places being in the line of sight. In recent trends of WPT, microwaves are used as the frequency range of choice for transmission. It provides an efficiency of approx. 76% but this is possible only if the transmission waves are focused properly on the wave collection device. The most common transmitters for microwaves are the traveling wave tube (TWT), klystron, and magnetron. Magnetron is more widely used than klystron and TWT
as it is less expensive.



2. Laser power transmission:

This technology is a bit different from MPT (Wireless Power Transfer) because it used a mirror to concentrate power in a small area. In simpler terms, it focuses the power in one spot using a mirror. This technology also produces high powers that are more efficient. It gets attenuated when transmitted through the air. This technique uses the concept of photovoltaic effect. This technique is known as "power beaming" as the power is beamed at the receiver that can convert it intoelectrical energy.



VRecent technologies

1. WiTricity

In simple words, WiTricity means Wireless Electricity. This new technique WiTricity is based on the principle of magnetic resonance. When two objects have the same resonant frequency, they can easily transfer energy between each other while not being affected much by other objects that have different frequencies.
A company named WiTricity is an Australian company that is working on this technique of WPT making our life easier. The technique of wireless power transfer is quite old as we know we can charge our smartphones or laptops wirelessly by keeping them on a magnetic surface or the device used for wireless charging. But that is not truly wireless, we need to keep the device to be charged on the charging device. WiTricity is working to make the charging truly wireless. This is based on magnetic resonance.
As we know electricity and magnetism are linked with each other i.e. if there is a magnetic field there is electricity and vice versa. This technique consists of a source and a receiver. The main source emits the magnetic field and the receiver receives the magnetic field and passes the current. In this, the current is in the alternating form but the medium between the source and the receiver is in the form of magnetic.
WiTricity is working on a project to charge EV vehicles wirelessly. In a recent survey 96% were interested in wireless charging and 70% are more likely to buy EV vehicles.

2. Internet of Things (IoT) Wireless Power

As the number of IoT devices continues to grow, there is a need for wireless power solutions that can charge and power multiple low-power devices simultaneously. Technologies like RF energy harvesting and near-field communication (NFC) wireless charging are being explored for IoT applications.

3. Qi Wireless Charging Technology

Qi (pronounced "chee") is a wireless charging standard that enables devices to be charged without the need for physical cables or connectors. It uses inductive charging, where power is transferred between a charging pad or surface and a compatible device through electromagnetic fields. Qi technology is widely adopted and supported by many smartphones, tablets, and other electronic devices. By simply placing a Qi-enabled device on a compatible charging pad, the device can recharge its battery wirelessly, providing convenience and eliminating the hassle of dealing with cords and plugs.

VI Merits and demerits

A. Merits:

WPT system can lower consumer electricity costs and eliminate the need of wires, cables and transmission towers. The electricity can be transferred to long distances without wires and cables, due to this there will be no transmission and distribution loss. Practically there are no losses and the efficiency can be as high as 96% or 97%.

B. Demerits:

The main drawback is high power loss and lack of directionality, making it insufficient for long distances.

VII Applications of WPT

1. Field of electronics.
2. Medical devices.
3. Electric vehicles.
4. Led lightning.
5. Defense system.
6. Solar power satellites.

VIII Conclusion

In this paper, we have focused on the wireless transmission system and its applications, and using this technology we can transfer energy using the basic concept of WiTricity.

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