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Power Transmission Technology Using Wireless Network

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Abstract
In this paper, we have presented the concept of wireless transmission i.e. power transmission without using any type of the electrical conductor and/or wires. We have presented an idea that is discussed here about how electrical energy can be transmitted as microwaves so that to reduce the transmission, allocation and other types of losses. Such technique is known as Microwave Power Transmission (MPT). We have also presented and correlated several aspects with the currently available Power transmission systems to the related history of wireless power transmission systems and also the related developmental changes. The basic design, merits and demerits, applications of Wireless Power Transmission are also discussed . The paper describes the various types of WPT technologies; Inductive Coupling, Magnetic Resonance and Radio Frequency (RF) technology. It also discusses the advantages and shortfalls of each type. An extensive survey of past works was discussed. Results from the research findings showed that distance and conversion efficiency were limiting factors in implementing wireless transfer technology.

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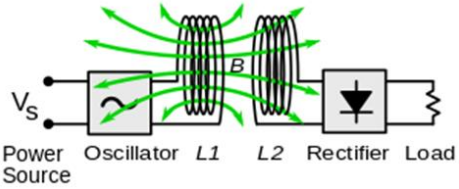
I. Introduction

The development of social modernization and the deepening of electrification, the methods of transmitting electrical energy include traditional contact transmission and modern wireless transmission. The former has a relatively long development time and mature technology, but its disadvantages are difficult to solve. Electricity is transmitted through the contact of metal wires. First, sparks will be generated at the contacts due to friction, which will reduce the insulation and shorten the life[1-3]. Finally, it will threaten the safety and stability of the power system. In addition, it is not applicable in some cases, such as working in mines and oil fields. Electric sparks may increase the possibility of explosion and pose a threat to personal safety. In order to improve the convenience of people's lives, various portable electronic devices are widely popularized, followed by safety problems caused by frequent use of power plugs, waste of resources caused by different specifications and different types of charging cables. Considering a series of problems in "wired" transmission, a power supply mode without wires and contact points is urgently needed to solve. Wireless transmission emerged at the historic moment, and with the maturity of power electronics technology and the development of electromagnetic field theory, this transmission mode was changed from impossible to possible. The development of wireless transmission will diversify the power system in the transmission and distribution link. It uses inductive coupling, magnetic resonance coupling, microwave and other forms of energy transmission. It is a safe, reliable and convenient new transmission method.



Generic block diagram of an inductive wireless power system

II. Wireless Power Transfer

Wireless power transfer, also known as wireless energy transmission or wireless charging, is a technology that allows electrical energy to be transmitted from a power source to an electrical device without the need for physical connectors or wires. This technology eliminates the need for traditional power cables and can provide a convenient and efficient way to charge or power various devices.

There are different methods of wireless power transfer, but two of the most common approaches are:

- Inductive Coupling: Inductive wireless charging uses electromagnetic fields to transfer power between two coils – a transmitter coil in the charging pad or base station and a receiver coil in the device being charged. When the coils are closely aligned, electrical current flows through the receiver coil, which can then be used to charge a battery or power the device.
- Resonant Inductive Coupling: This is an extension of inductive charging that uses resonance to improve power transfer efficiency. It involves tuning the transmitter and receiver coils to the same resonant frequency, allowing for more efficient power transfer over a greater distance.

Wireless power transfer is commonly used for charging mobile devices, such as smartphones and electric toothbrushes, as well as for electric vehicles (EVs) and some medical devices. There are also ongoing research and development efforts to extend wireless power transfer capabilities to other applications, such as powering IoT devices, industrial machinery, and even transferring power over longer distances for applications like wireless power transmission for space-based solar power systems.

The efficiency and range of wireless power transfer systems can vary depending on the technology used. Still, the goal is to provide a convenient and reliable means of supplying electrical power without the need for physical connections.

III. Wireless Power Transfer Data

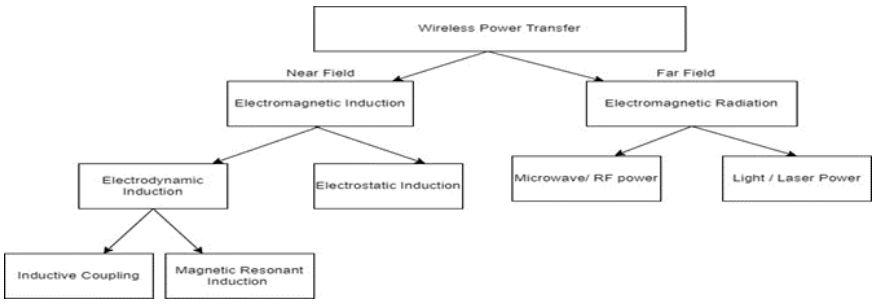
Wireless power transfer primarily focuses on transmitting electrical power from a source to a device without physical connections. It is not designed for transmitting data. However, there are some technologies and wireless communication methods that can coexist or be integrated with wireless power transfer in certain applications:

- Near Field Communication (NFC): NFC technology allows short-range wireless communication between devices. It is often used for data transfer, such as sharing information between smartphones or enabling contactless payments. While NFC primarily deals with data transfer, some wireless charging systems incorporate NFC for communication and authentication.
- RFID (Radio-Frequency Identification): RFID is a technology used for identifying and tracking objects using radio waves. It doesn't transfer data in the traditional sense but is used for purposes like inventory management and access control.
- Qi Wireless Charging and Data Transfer: The Qi wireless charging standard, which is commonly used for wireless charging of smart phones, has a feature called "Qi Data over Wireless Power" that enables the transfer of small amounts of data (such as authentication or device identification) alongside the wireless charging process. This can be used for simple data exchange between devices.
- Resonant Coupling and Data: Some wireless power transfer technologies, like resonant inductive coupling, can, in theory, be used to transfer data alongside power. However, this application is rare and requires more advanced engineering and design.

It's important to note that while these technologies can support some form of data transfer in conjunction with wireless power, they are not suitable for high-speed data transmission. Wireless communication methods such as Wi-Fi, Bluetooth, and cellular networks are used for most data communication needs. If a wireless power transfer device does support data transfer, it will be regulated as an intentional radiator.

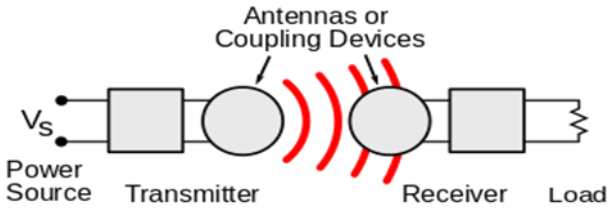
IV. Wireless Power Transfer Work

Wireless power transfer works by using electromagnetic fields to transfer electrical energy from a power source to an electrical device without the need for physical connectors or wires. There are a few different methods for wireless power transfer, but one of the most common approaches is inductive coupling. Here's a simplified explanation of how it works:



Wireless Power Transmission

- Transmitter Coil: In a wireless charging system, you have a charging pad or base station. This pad contains a coil of wire. When electricity flows through this coil, it generates an electromagnetic field around it. Think of it like a magic ring of energy.
- Receiver Coil: In the device you want to charge, such as a Smartphone, there's another coil of wire. This is called the receiver coil. It's designed to pick up the energy from the electromagnetic field created by the transmitter coil.
- Alignment: For wireless charging to work efficiently, the transmitter coil and receiver coil need to be close to each other and aligned properly. This is why you must properly place your device on the charging pad.
- Energy Transfer: When the coils are close and aligned, the electromagnetic field created by the transmitter coil induces a flow of electrical current in the receiver coil. This current can charge the device's battery or power it directly.
- Charging: As the electrical current flows into the device's battery, it charges it as if you were plugging in a charger with a cable.



Generic block diagram of a wireless power system

- The Advantages of Wireless Power Transfer:

Wireless power transfer offers several advantages, which make it a compelling technology for various applications. Here are some of the key advantages:

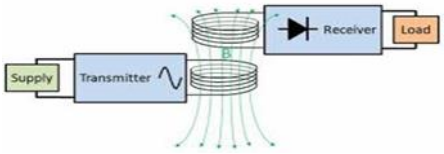
- Convenience: One of the most significant advantages of wireless power transfer is its convenience. Users can charge their devices without the need for physical cords or connectors simply by placing them on a charging pad or within a certain range of the power source.
- Reduced Wear and Tear: Since there are no physical connectors, there is less wear and tear on charging ports and cables. This can extend the lifespan of devices, especially those with delicate or frequently used charging ports.
- Safety: Wireless power transfer systems are designed with safety in mind. They often include temperature monitoring and foreign object detection to prevent overheating or damage. This can reduce the risk of electrical accidents or fires.
- Flexibility in Design: Wireless charging can work through various materials, such as wood, plastic, and glass. This allows for more flexibility in the design and placement of charging pads. It can be integrated into furniture, vehicles, and various consumer electronics without disrupting the visual aesthetics.
- Aesthetics: Wireless charging pads can be integrated seamlessly into the design of furniture, vehicles, and consumer electronics, enhancing aesthetics and reducing clutter caused by cords and cables.
- Mobility and Portability: Wireless charging is particularly useful for mobile and handheld devices, like smart phones and wearable's. It allows for convenient and hassle-free charging on the go.
- Healthcare Applications: In healthcare settings, wireless power transfer can be used to charge medical devices like pacemakers, eliminating the need for surgery to replace batteries.
- Electric Vehicles (EVs): Wireless charging for electric vehicles offers a more convenient and hands-free way to charge electric cars, especially for autonomous vehicles that can park and charge on their own.

- Space Applications: In space, wireless power transfer can be used for transmitting power from solar panels on satellites to the spacecraft's systems, eliminating the need for physical wires that can be damaged or compromised in the harsh space environment.
- IoT Devices: Wireless power transfer can be used to power and charge a variety of Internet of Things (IoT) devices, eliminating the need for frequent battery replacements.
- Harsh Environments: In applications where wires or connectors are exposed to harsh environments, such as underwater or extreme temperatures, wireless power transfer can be a more reliable and durable solution.
- User Experience: The simplicity of wireless charging enhances the overall user experience, making it easier for people to keep their devices charged and ready for use.
- the Disadvantages of Wireless Power Transfer

While wireless power transfer offers several advantages, it also has some disadvantages and limitations that should be considered:

- Lower Efficiency: Wireless power transfer is generally less efficient than traditional wired charging. Some energy is lost as heat during the transfer process, which can result in slower charging and wasted energy.
- Limited Range: The range of effective wireless power transfer is limited. Most systems require the device to be placed very close to the charging pad or source. This means that devices must be accurately aligned and can't be moved too far from the power source during charging.
- Slower Charging: Wireless charging, in most cases, is slower than wired charging. This can be a drawback when you need a quick charge for your device.
- Device Specificity : Different devices may require different wireless charging standards or technologies. For example, not all wireless chargers are compatible with all smartphones or devices, which can be confusing for consumers.
- Higher Cost: Wireless charging technology often costs more than traditional charging methods. The charging pads and associated components can be more expensive to produce and purchase.
- Heat Generation: Wireless charging can generate heat, both in the charging pad and the device being charged. Excessive heat can affect the lifespan and performance of batteries.
- Compatibility and Standardization: There are multiple wireless charging standards, like Qi, PMA, and others. This lack of standardization can lead to confusion and incompatibility issues, as not all devices work with all wireless chargers.
- Energy Loss: In some wireless power transfer methods, such as resonant inductive coupling, there can be energy loss as radio waves propagate between the transmitter and receiver coils, reducing overall efficiency.
- Bulkiness: Some wireless charging solutions, like charging pads or stands, can be bulkier than simple charging cables, making them less portable.
- Security and Privacy: In some applications, like wireless charging kiosks in public places, there may be concerns about security and privacy, as there's a potential for data interception or malware injection through the charging process.
- Environmental Impact: Wireless charging systems still rely on electricity generated from various sources, including fossil fuels. If the energy source is not clean and sustainable, the environmental benefits of wireless charging can be limited.
- Limited Use in High-Power Applications: Wireless power transfer is less efficient and practical for high-power applications, like charging electric vehicles, requiring high energy transfer rates.

It's important to weigh these disadvantages against the advantages and consider the specific needs of the application or device when deciding whether to use wireless power transfer.



Wireless Power Transfer Circuit Working

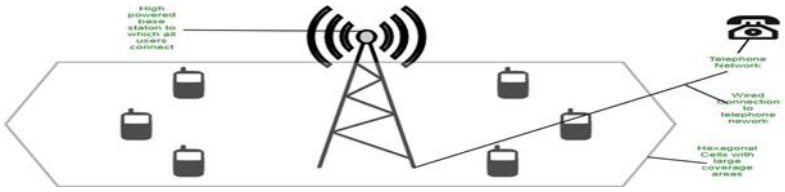
Microwave Transmission

alludes to the innovation of transmitting data or vitality by the utilization of electromagnetic waves whose wavelengths are advantageously measured in little quantities of centimeter; they are called microwaves. The remote vitality exchange with microwaves requires a wellspring of electromagnetic radiation, and a microwave recipient with a DC rectifier to change the microwave vitality into DC electrical power [10] . The transmitting and getting units must be in viewable pathway. Viewable pathway (LoS) is a sort of proliferation that can transmit and get information just where transmit and get stations are in perspective of each other with no kind of a hindrance

between them. The electrical vitality is first changed over into microwave energy in the transmitter which is transmitted over separation to beneficiary which has rectenna that changes over these microwaves back into electrical vitality. Air conditioning can't be changed over specifically to microwave in a transmitter. To start with it must be changed over to DC utilizing oscillator. In the beneficiary, the output DC from rectenna is changed over to AC for utilize. Power radiating by microwaves has the trouble that for most space applications the required gap sizes are extensive because of diffraction constraining radio wire directionality. Remote high power transmission utilizing microwaves is well demonstrated. Investigations in the many kilowatts have been performed at Goldstone in California in 1975 and all the more as of late (1997) at Grand Bassin on Reunion Island. These strategies accomplish removes on the request of a kilometre. Under exploratory conditions, microwave transformation proficiency was measured to be around 54%.

Laser Transmission

A laser is a gadget that produces light through a procedure of optical enhancement in view of the invigorated outflow of electromagnetic radiation. A laser varies from different wellsprings of light since it radiates light rationally. Spatial rationality enables a laser to be engaged to a tight spot. The instrument of creating radiation in a laser depends on invigorated discharge, where vitality is extricated from a progress in a particle or atom. Power can be transmitted by changing over power into a laser bar that is then pointed at a photovoltaic cell [12 . This component is mostly known as "control radiating" since the power is channeled at a collector that can change over it to electrical energy. There are parcel of favorable circumstances in this framework It permits limit bar traverse huge separations; Compact size; No radiofrequency obstruction to existing radio correspondence [13] . There are different drawbacks too. Laser radiation is unsafe. Change amongst power and light is wasteful. Photovoltaic cells accomplish just 40%—half productivity. Barometrical ingestion, and retention and dissipating by mists, mist, rain, and so on [14] . It requires an immediate viewable pathway with the objective. This technique has been utilized as a part of military and aviation applications



Wireless Power Transmission through Solar Power Satellites:

V. Conclusion

The idea of remote power transmission offers more noteworthy potential outcomes for transmitting power with immaterial misfortunes. In the long run, this could lessen our general public's reliance on batteries, which are at present substantial and costly. As remote innovation is getting mainstream now a day, the request of battery is likewise diminishing. For the long range control transmission power can be sent from source to collectors quickly without wires, lessening the cost. Batteries should be revived or changed in the long run, henceforth the requirement for this sort of work.

and improving transmission efficiency is a subject worthy of study. With the continuous development of human science and technology, there will definitely be a qualitative improvement in transmission efficiency and cost control. Once wireless power transmission technology matures, human life will change dramatically. In short, in the long run, wireless power transmission technology has great potential application value.

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