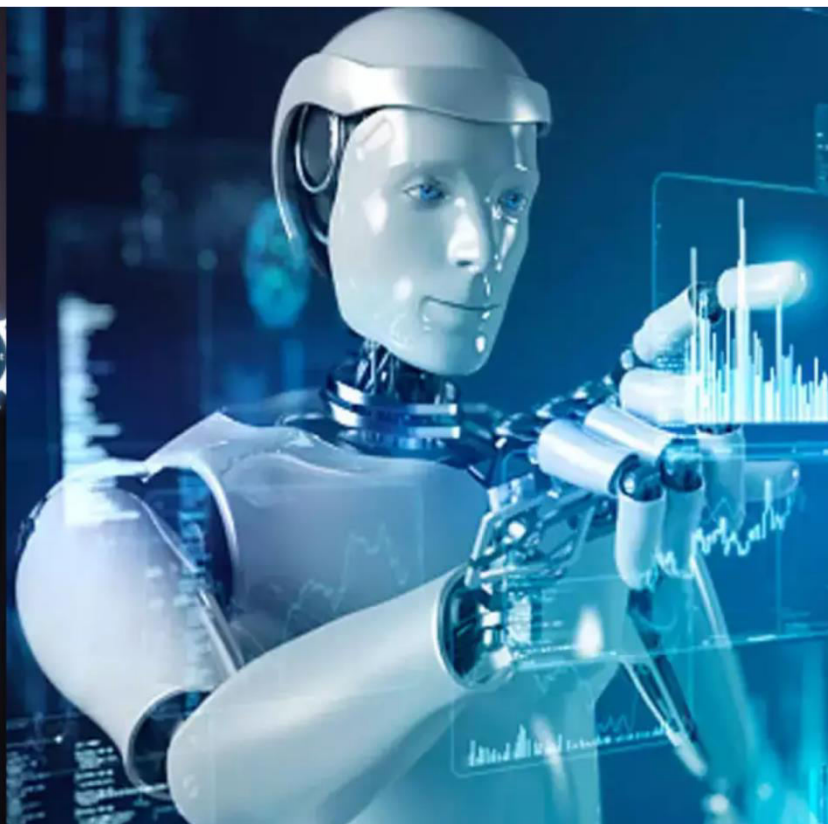




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# Air Charging Technology

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**ABSTRACT:** With the progress of time and knowledge, the living standard of people increases, and more and more individuals utilize travel resources, such that these resources are being used increasingly without appreciation. However, the world is making efforts actively to promote the construction of new energy to mitigate the domestic oil issue; electricity is the most widely used energy resource. This is due to the limitation of fuel resources in the world and the vast amount of environmental degradation caused by fuel resource usage. Electric vehicle wireless charging technology can be achieved by companies using power resources that are available. Current developments in wireless charging methods and the advancement of commercial products have posed a possible alternative method to resolving the energy bottleneck of typically beneficial battery-governed devices. However, adding Wireless charging to the current Wireless communication network introduces an onslaught of daunting issues dealing with efficiency, strategy, and force management. This paper provides an extensive analysis of wireless charging techniques, including recent advances in air charging, along with the advancement in some parameters and system applications. In this paper, we provide an overview of global developments in air charging technology.

**KEYWORDS:** Air charging, Wireless charging, Wireless power transfer, EV Vehicles, Inductive charging, magnetic resonance, resonant charging, UAV.

## I. INTRODUCTION

The extensive application of big data networks in recent years has significantly informationalized domestic development, and core technologies such as wireless power transfer remain the focus of intense research and optimization. With the improvement of people's living standards, their demand for more convenient transportation also increases. In addition, the energy used to drive today's domestic vehicles is quite scarce, thus the world is perpetually on the brink of an energy disaster [1].

Wireless charging or wireless power transfer is a technological innovation whereby a source of power can wirelessly deliver electromagnetic energy to an electrical load through an air gap, without the need for cables. Due to the ease and added user experience it offers, this technology is being integrated into a vast array of applications, ranging from low-force dental devices to high-power transportation. Today, this development is rapidly moving from theory to the routine part of a business problem, especially if there is to be an instance of advanced devices. Wireless charging-enabled mobile phones have recently hit the market from industry giants such as Samsung, Apple, and Huawei. Today, there is fast movement from theory to application, and this is quite common in the instance of advanced devices. A number of large corporations, such as Samsung, Apple, and Huawei, have launched new-generation smartphones with integrated wireless charging ability. Based on IMS's projection, the wireless charging device market would expand to \$4.5 billion by 2016, higher than the study's highest estimated Wireless point. Pike Research estimated that by 2020, the market for wirelessly controlled objects would expand to 20 billion dollars [2].

The wireless character of wireless power transfer (WPT) technology has seen it applied across an extensive range of applications, ranging from charging electric vehicles (EVs), mobile phones, and biomedical implants, to solar-powered satellites, space rovers, and others. This revolutionary method provides a new, easy means of charging without the use of any wires or other intermediaries to transfer.

Security, long-distance transmission, etc. are just a few of the numerous hurdles that the WPT still needs to overcome. These challenges advance the development of WPT into new areas. WPT technology can potentially offset the e-limited UAV's flight time endurance. The e-UAV has existed as long as aircrafts have, and it has been widely used in numerous environments. However, one of the disadvantages of e-UAV is its short flight time. There are usually two main ways to increase the amount of time an e-UAV can remain in the air. The two options are to construct a charging



station and to make the battery have a larger capacity so that it would have to be recharged less often. In this research, we present a wireless power transfer (WPT) system for electric vehicle charging, one that is able to charge a vehicle's battery without human intervention.

## II. LITERATURE REVIEW

Mi states that its Air Charge technology enables you to wirelessly charge your electronic devices, without charging mats or wires. In this section, we are going to address history, advancements and principle of air charge technology in charging the electric vehicles.

### History of wireless charging technology

Nikolai Tesla, who pioneered the study of wireless power transmission in the 19th century, is credited with defining the technology's operating principle as wireless charging. Nikola Tesla spent much of the 19th century researching and experimenting with methods for achieving practical wireless power transmission. Ultimately, Nikolai Tesla employed electromagnetic induction to power an electric bulb wirelessly in 1889. Since the study started, this is the first time wireless power transmission has been fully employed. The researchers further researched electromagnetic waves in depth, founded on the concept of electromagnetic induction, and proved that electromagnetic waves theoretically can achieve wireless energy transmission [3].

During the succeeding years, a team of Japanese researchers toiled day and night in creating a new means of wireless power transmission with the help of a carrier-microwave transmission wire that mostly converts electric power into microwave so that it can travel quickly in the air. Time and an increase in scientific and technological ability made it possible for the United States to turn the first theoretical microwave wireless transmission into a reality for the first time in the early 1960s.

A company that operated on behalf of the United States' Department of Defense started working on wireless power transmission in 1960. After years of research and development based on ongoing experimental trials, the firm developed an antenna composed of semiconductor diodes that transforms microwaves into direct current, which makes its charging possible. Concrete evidence now exists that the technology makes it possible to transmit electrical energy wirelessly through the air [4].

### Wireless Charging Principle

A wireless force transfer is a method very much akin to the standard correspondence system functionality. Just like how various modification schemes are utilized to effectively transfer the message signal in an essential communication system, force must be transferred from sender to receiver with the aid of different innovations or schemes (i.e., coupling technique, RF approach). In short, wireless charging technology is similar to balance charts in correspondence systems.

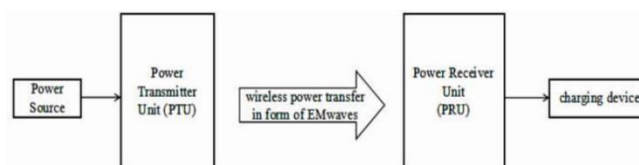


Figure – 1: Diagram of basic wireless charging device [5]

The core Wireless charging technology is depicted by the diagram in figure 1. The source of the electrical force is discussed in the central square, which is something everyone is aware of. The Power Transmitting Unit (PTU) is seen in the next square; it consists of a resonator (primary) or transmitter, a matching circuit, an energy amplifier, an analog-to-digital converter, a correspondence module, and an A-D converter. Through the air gap between the two pieces, electrical energy is transferred in the form of electromagnetic (EM) waves. This PTU square is comparable to a modulator in terms of its value in the alphabet. Power Receiving Units (PRUs) consist of components like resonators (secondary or beneficiary), rectifiers, DC-DC converters, and corresponding modules, and are located close to the Power Transfer Unit (PTU). In this case, DC-DC converters, as opposed to DCAC converters, are used, with batteries

serving as the primary power source. Batteries store DC energy, which means they may accept DC input from any source and use it to power themselves [5].

### **Wireless Charging Technologies**

There are three typical categorizations of wireless charging systems. The first two are non-radiative coupling based, while the third is radio frequency (RF) radiation based.

**Non-Radiative Charging:** Transmitter-side elements of a typical non-radiative wireless charging setup are: i) A rectifier to transform alternating current (AC) to direct current (DC); ii) a DC/DC converter to step down the voltage of a DC source from a high to a low level; and iii) an inverter to transform direct current (DC) to alternating current (AC). An alternating current (AC) to direct current (DC) rectifier, a direct current (DC) to direct current (DC) converter, and a charging heap constitute the benefactor side. **Inductive coupling:** In this method, a magnetic field is employed to pass electrical energy between two loops.

When the main coil is excited by a source that mainly produces a magnetic field of a frequency that is not exactly the same as that of the field, inductive power transfer (IPT) takes place in the secondary coil of the energy receiver within the field. The auxiliary coil of the in-field energy receiver gets current or voltage from the nearby handle. Storage devices and wireless units can be charged using the voltage that is induced when a wireless connection is formed. The method can function up to a frequency of 1 kilohertz. To ensure maximum charging, the optional loop should be tuned at working recurrence. In practice, the quality parameters for such circuits are drawn with minimal concern because of the precipitous fall in power that occurs as a consequence of trading rich quality characteristics for a limited amount of power. The useful charge distance has decreased by a matter of centimeters as a consequence of underestimating high-quality products [6].

**Magnetic Resonance coupling:** In this method, electrical energy is produced and transferred between the resonating loops through magnetic fields that change or affect each other, owing to the coupling-based transient wave coupling. Although the two complete loops are at the same thunderous recurrence, they are tightly coupled, leading to high energy move efficiency with minimal spillage to non-resounding externalities. Magnetic reverberation coupling is a good example of resistance to the area and identifiable pathway trade required because of the property of reverberation. The effectiveness of magnetically coupled resonators was discovered to be higher than that of inductively coupled resonators when it relates to the transfer of forces over long distances. Additionally, a number of receiver resonators can be connected to a single transmitter resonator. Because this is the case, a number of devices can be charged simultaneously [7].

**Radiative Charging:** As a part of this innovation, radio waves and microwaves are diffused to convey the massive power of RF radiation. Generally, radio frequency waves travel through space at the same speed as light. Normal microwave frequencies are between 300MHz and 300GHz. In contrast to microwaves, infrared and X-ray electromagnetic waves are highly dangerous to living tissue, so they are not a suitable option for energy transmission. The force transmission side on the transmitter starts with a conversion of alternating current (AC) to direct current (DC), and then there is a transformation of radio frequency (RF) using a magnetron. Once created in the air, the microwave (microwave) or radio frequency (RF) energy picked up by the receiving antenna is transformed into direct current (DC) electricity. Received power by the receiving equipment, accuracy of impedance matching between voltage multiplier and radio cable, and ability of the voltage multiplier to change AC to DC voltage are all essential to the RF-to-DC conversion efficiency.

**Acoustic Power Transfer:** Ultrasonic, being sound waves, are utilized to transfer energy through the air's dielectric medium in this new innovation. This new technology, based on a Wireless force move process in bio-clinical implantation, is relatively recent. The main reference is "Ultrasonic resonance," an industry standard. Excitation of ultrasonic waves is much less than electromagnetic waves in acceptance coupling or radiative innovation. Efficient planning and proposal enable a short frequency with reasonably low activity recurrence in the ultrasonic Wireless force transmission device. Therefore, ultrasonic waves can be employed to deliver power over long distances while maintaining the overall size of the device relatively small in comparison to electromagnetic wave devices.

### **III. AIR CHARGING TECHNOLOGY**

It should be noted that there are three different wireless charging techniques [8]:

#### **Radio Charging**

This charging system is based on a set of very tiny batteries and has a negligible effect on the grid. This technology is extensively applied in many consumer devices, such as wireless keyboards and mice, medical tools, hearing aids, wristwatches, and music players. These equipment utilize radio waves for wireless data transmitting and receiving.

By this method, radio waves are produced by connecting the transmitter to an electrical outlet. By tuning the receiver to the same frequency as the transmitter, you may charge the battery.

#### **Inductive Charging or Near Field Charging**

This charging process utilizes electromagnetic induction as its scientific principle. When an electric current is flowed through a wound coil or cable plugged into a charging station or pad, it produces a magnetic field. The magnetic field then induces another electric current to be produced in the induction coil of a portable device nearby.

Some of the devices that utilize this type of charging include smartphones, smart watches, and kitchen appliances that support the Qi wireless charging standard or the Ki kitchen cordless standard. These standards are utilized to wirelessly charge the devices.

#### **Resonance Charging**

Much power-consuming devices employ a different type of charging mechanism known as resonance charging. Such technologies exist on cars, vacuums, robots, and even big laptops. Specifically, a copper coil attached to the charger is inductively linked to a second copper coil, which is directly attached to the power source.

When the copper coils are tuned to the same electromagnetic frequency, wireless charging can occur. The mobile device battery can be recharged rapidly by being plugged into the outlet. Due to resonance effects, wireless charging only works over relatively short distances.

#### **Wireless Charging Standards**

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#### **Wireless Charging Standards Based on Applications**

##### **Qi standard**

The most commonly used wireless charging protocol is the Qi standard. The Qi charge standard, designed by the Wireless Power Consortium (WPC), supports inductive charging at 40mm distance. Samsung, Sony, Apple, HTC, LG, Huawei, Motorola, Nokia (HMD), and Blackberry are some of the primary smartphone brands that support the Qi wireless charging standard. Power consumption is below 100W, and its frequency range to operate is 110 to 22 kHz. This standard is used by most car chargers, phone chargers, infrastructure charges, home robotics, laptops, and speakers.

##### **Ki cordless kitchen standard**

In 2019, the Ki cordless kitchen standard was published by the Wireless Power Consortium (WPC). The standard applies to low-voltage juicers, kettles, and other battery-operated heating appliances that consume up to 2.2 kilowatts of power but are otherwise cordless. The appliances are charged wirelessly via inductive charging technology. This specification is applied to equipment running at 13.56MHz 50-60 kHz and consuming up to 2200W.

##### **SAE standard**

The Society of Automotive Engineers (SAE) has developed a WPT standard for electric vehicles known as SAE (SAE). Inductive resonant coupling is used to charge the system in question. According to Forbes, the SAE discovered wireless charging to be efficient over a 10-inch air gap with an efficiency of up to 94%. The Vehicle Assembly (VA) is

an on-vehicle device on the other side of the vehicle from the Ground Assembly (GA), which connects the charging equipment to the grid [10].

#### IV. CONCLUSION

It is possible that air charging technology, also known as wireless power transfer, will significantly alter the way in which electric vehicles are charged in the future. Using this system, energy may be transferred from a charging station to a vehicle's battery using radio waves.

The ease of use is one of the most notable benefits of air charging technology. Those who live in flat buildings or densely populated regions may appreciate not having to take the time to plug their automobiles in to charge them. Another benefit of air charging is that it may be done automatically while the vehicle is parked, freeing drivers from the burden of overseeing the charging process. While promising, air charging technology is still in its infancy and not widely available. Yet it does have drawbacks, such as a reduced efficiency compared to standard plug-in charging and more costs related to installing charging stations.

The overall state of air charging technology is promising, but it will likely be some time before it becomes a common way to charge electric vehicles. For the time being, however, the most common mode of charging will be the standard plug-in type.

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