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Innovative Wireless Charging Solutions for Electric Vehicles

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Abstract

As the automotive industry's the future arise, electric vehicles (EVs) are at the forefront of zero-emission transportation technology. Although conventional plug-in charging stations are widely utilized, Wireless Power Transfer (WPT) is an alternate alternative. WPT may be used as either dynamic charging equipment for moving cars or static charging systems for parked cars. This study addresses the distinction between plug-in and wireless charging, the mechanics of wireless charging, various kinds of charging systems, and the potential uses of dynamic charged. Because of the advantages that electric cars (EVs) provide for the environment and new advances in battery technology, EV adoption is increasing around the world. Nonetheless, one of the main barriers preventing broad adoption is the accessibility and convenience of use of the infrastructure needed for charging. This article describes the planning and building of a wireless charging station with the goal of increasing accessibility for users and promoting the adoption of electric cars. The indicated wireless charging method effectively transfers power between a vehicle-mounted receiver and a ground-based generating pad using resonant inductive coupling. Adaptive power governance, automated alignment detection, and safety measures that guard against electromagnetic interference and foreign object recognition are important characteristics. Both simulation and real-world testing are used to determine the system's performance, proving that it is practical for daily usage. There is also discussion of the potential rewards of wireless charging, including its simplicity, ability to integrate with autonomous car systems, and less impact on bodily connections. By offering a workable solution that can be implemented in public, business, and residential contexts, this study advances EV infrastructure and enables a wider use of electric transportation.

Keywords: Electric vehicle, wireless charging, wireless power transfer, inductive power transfer, capacitive power transfer. Dynamic wireless charging

INTRODUCTION

An electric motor fuels an electric vehicle (EV), which runs on electricity rather than internal combustion engines. A need for cleaner cities, resource depletion, and environmental concerns have all propelled the development of EVs. EVs are often charged via plug-in techniques. Wireless charging devices, however, provide a practical and effective alternatives.

Conventional wired or plug-in charging solutions are also included under the broad term "conductive charging system". The solutions that are connected have a few problems. For instance, they require secure connections and charging cords. Further, the product that has to be charged and the power supply need to be physically attached to the charger.

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Additionally undesirable to both consumers and the environment is the connected charging a system [1]. Electric shock might occur from a shorted charging line or deteriorating insulation due to several variables including temperature, ground contact, or self-charging equipment.

They can be used with many batteries, or, in order to reduce risk and decrease charging times, a non-capacity battery may be changed on a single charge as needed. For instance, if a car with certain batteries can go a specific distance on a single charge. As an alternative, you may swap out your automobile battery and charge it while you're on the road. However, batteries also have certain drawbacks [2].

BLOCK DIAGRAM

Batteries have a long lifespan, are heavy, and they can cost a lot at first. The weight of the batteries eventually keeps it from holding any more after a certain point. Future upgrades for electronic storage devices will fix these problems. Another technique for overcoming battery issues is WPT. A method to lower the initial cost is to use a wireless charging system instead of big, heavy batteries [3]. The WPT approach is productive and efficient since it does away with the disarray of wires and connectors that manual add-on payment systems have (Figure 1).

We outline and look at the many components of EV wireless charging systems in this study, as well as their working theories, approaches, materials, and methodologies, after carefully reviewing the pertinent research literature.

The key findings of this investigation are listed in the following order:

- Provide your thoughts and observations on pertinent queries [4].

An overview of the WPT methodology is provided before delving into specifics about EV wireless charging systems and the many ways employed for this objective.

- Finished reading DWCS and SWCS and gave a summary of the design procedure.
- The design and development of the IPT-based DWCS have been reviewed.
- Communication with wireless charging systems, power management controls, and system connectivity.

Mutual induction is used to move power between two coils (Figure 2). The primary coil takes up the sending antenna, while the secondary coil brings up the receiving antenna.

Working Principle of Tesla Coil

High-voltage transformers called Nicholas coils are frequently employed as transmitters for wireless power transfer. The Tesla coil serves as a resonant transformer, and the primary and secondary LC circuits are only loosely connected [5].

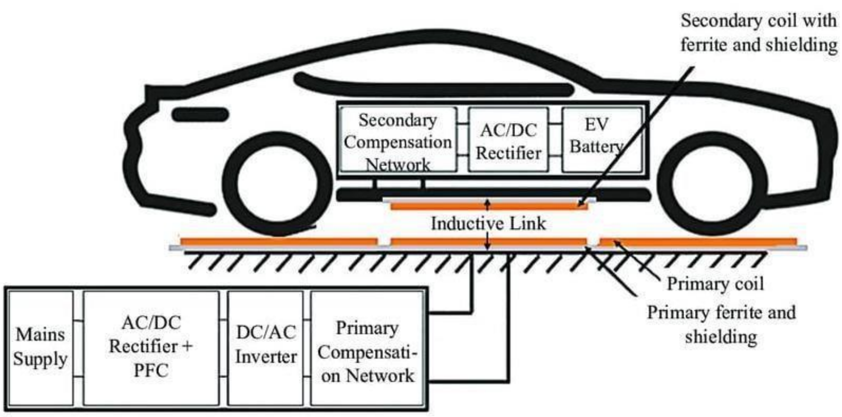

Figure 1. Bock diagram of project.

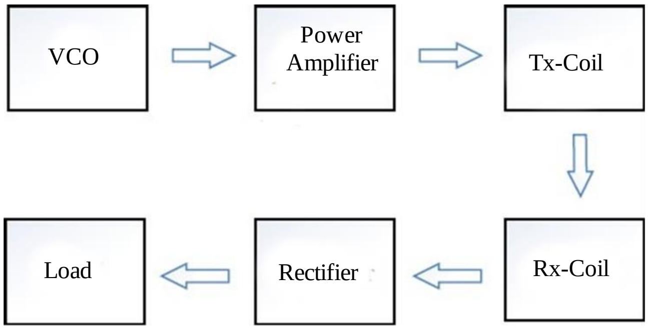

Figure 2. Inductive coupling can be utilized to transfer electricity wirelessly over a short distance.

It is a transformer, which is why we use it as a transmitter, but it performs differently from a typical transformer in that it presents us with a high-frequency output that increases induction on the load side and a lot of power. A capacitor known as the main capacitor is charged by a high-voltage generator in a Tesla coil, and the charge is then momentarily stored. Electricity is generated when the capacitor is totally charged and linked to a unique switch known as a gap, which ionizes the air around the electrodes [6].

The first battery and the primary coil are separated by and, and a capacitor's other end is connected to the high-voltage generator. It is possible to couple primary transistors in either series or parallel configurations. The first coil's opposite end is the radio frequency ground (Figure 3).

High-voltage transformers nicknamed Tesla coils are frequently employed as transmitters for wireless power transfer. Rough coupling exists between the primary and secondary LC circuits, while the Tesla coil serves as a resonant transformer. Because it functions differently from a typical transformer and can offer higher power and frequency output, which has a stronger effect on the cargo, we employ it as a transmitter. A capacitor known as the main capacitor gets powered by a high-voltage generator in a Tesla coil, and the charge is then momentarily stored. Electricity is created when the capacitor is completely charged and linked to a unique switch known as a gap, which ionizes the air between the electrodes to create electricity.

The high-voltage generator is connected to the other end of the capsules, which has a gap between the primary coil and capacitor within. It is possible to attach primary capacitors in parallel or series. The first coil's opposite end is the radio frequency grounds [7].

AC to DC Conversion Circuit

All electrical and electronic devices require proper powering. Although Tesla coils function at several frequencies, the majority of the everyday electronics run at 50 or 60 Hertz. The Tesla coil produces and operates at greater levels in order to maintain a consistent LC resonant frequency. The electricity from a Tesla coil must be transformed into a form that other devices may use so that it cannot be used directly by any device. Energy can change forms, yet it always exists, according to the rule of conservation of electricity [8].

This idea also holds true in this case. The high frequency voltage is captured by the load coils and is transmitted to the whole power plant, which converts AC to DC.

Every bridge rectifier's detail is presented with clarity and vibrancy. Figure 4 depicts the circuit layout of the whole bridge rectifier; Figure 5 is a schematic design of the rectifier bridge in its whole form, converting AC voltage to DC voltage. In our project, we used this AC-DC converter twice: first to supply DC power to the load LED at its receiving point and again in the oscillator circuit [9].

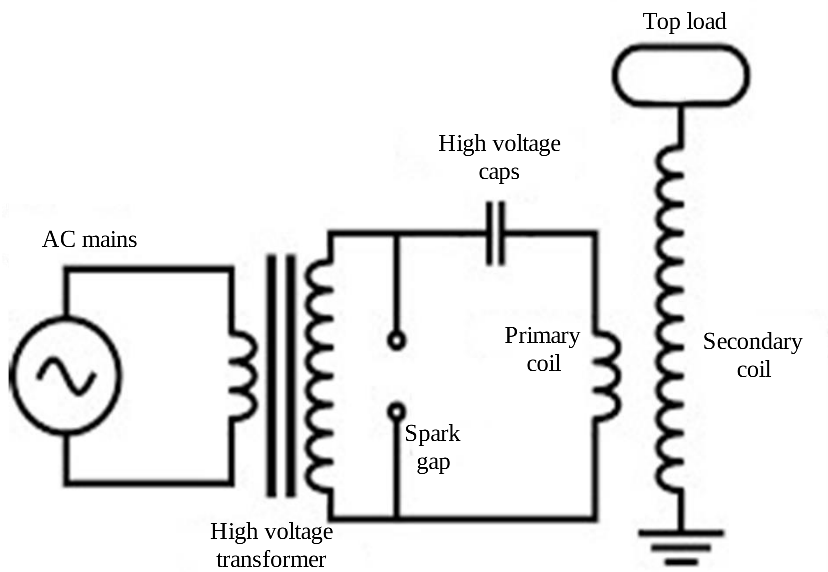

Figure 3. Tesla Coil Operation.

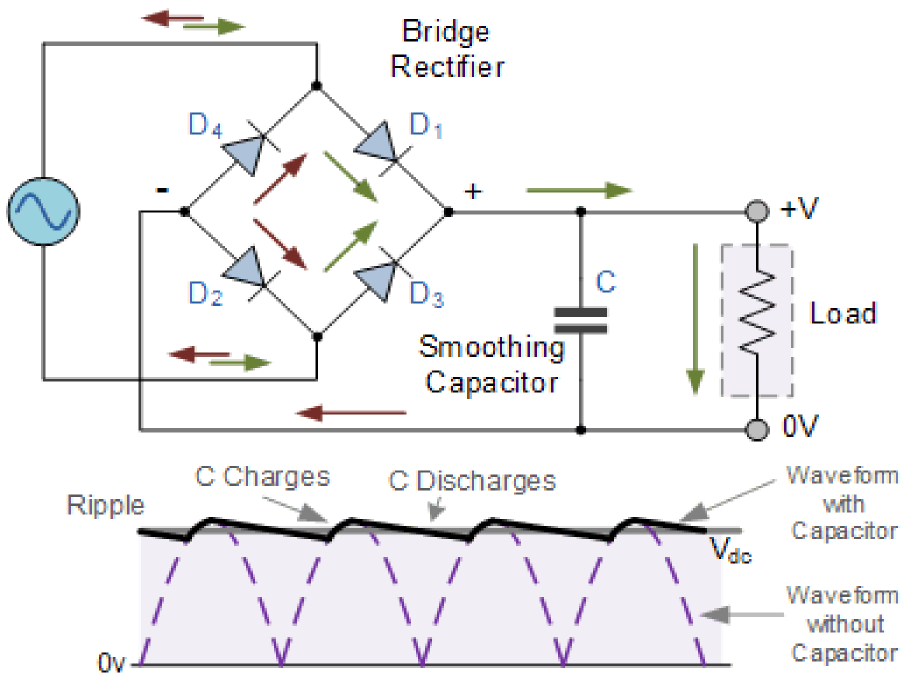

Figure 4. Full bridge rectifier and its O/P waveform.

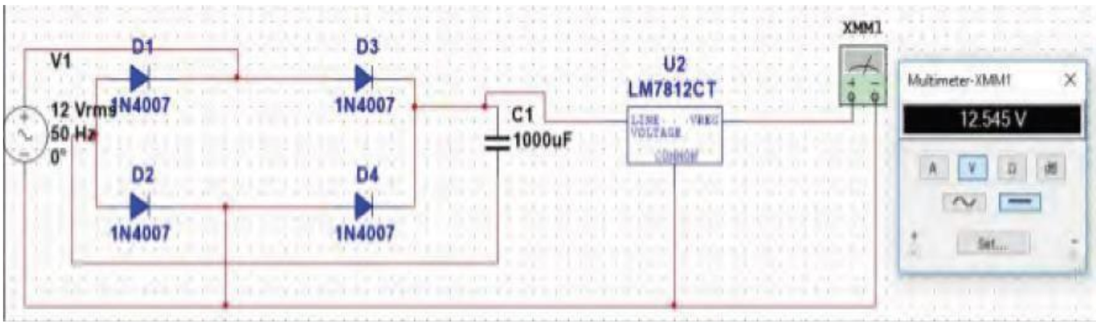

Figure 5. Schematic arrangement of full bridge rectifier.

Basic Working Principle

Wireless charging and transformer running are same. Both wire coils and receiver coils are used in wireless charging. The electrical grid's 220V 50HZ alternating power is transformed into high-frequency signals alternating current via AC/DC and DC/AC converters before being sent to the transmitting coil. Disconnect the receiving spiral, provide alternating magnetic flux, and allow the receive coil to combine the AC output. Good wireless charging depends on the communicate with and receive coils' resonance frequencies being maintained, which is why both sides have balance to do this. A battery management system (BMS) or battery pack gives voltage to the particular battery, and the receiving interface converts AC power onto DC power.

Development of Wireless Charging

By using wireless charging instead of the required cable, wire losses can be reduced. It might be risky for someone to plug in and unplug for charging while holding wrong cords. Wireless payments have numerous drawbacks while being effective and time-saving. Designed to charge electric vehicles (EVs) in parking lots or when the vehicle is close to a power outlet, the stationary electric vehicle is a system. This is in alongside plug-in parking. Electric car charging while driving is a highly popular capability.

When an electric car charges while it is being driven, this is known as dynamic wireless powering.

WEVCS is separated into two categories:

1. Wireless charging that is static.
2. Dynamic wireless charging system

Static Wireless Electric Vehicle Charging System

It charges while the car is fixed; as the name implies, making it possible to quickly and easily change plugs without the driver having to get out of the car. Put another way, we can stop the motor vehicle and charge the battery because it has a wireless charge mechanism. The receiver is positioned beneath the vehicle, and the transmitter is fitted.

Before we start charging the car, we must plug in the transmitter and the receiver. Charging time is influenced by the size of the pad, the power supply's power level, and the amount of space between the two devices. Where cars are typically parked for extended periods of time, SWCS is advised [10]. There should be 150–300 mm of space between traffic signals. Parking lots, business buildings, homes, retail centers, and other locations can all have SWCS implanted (Figure 6).

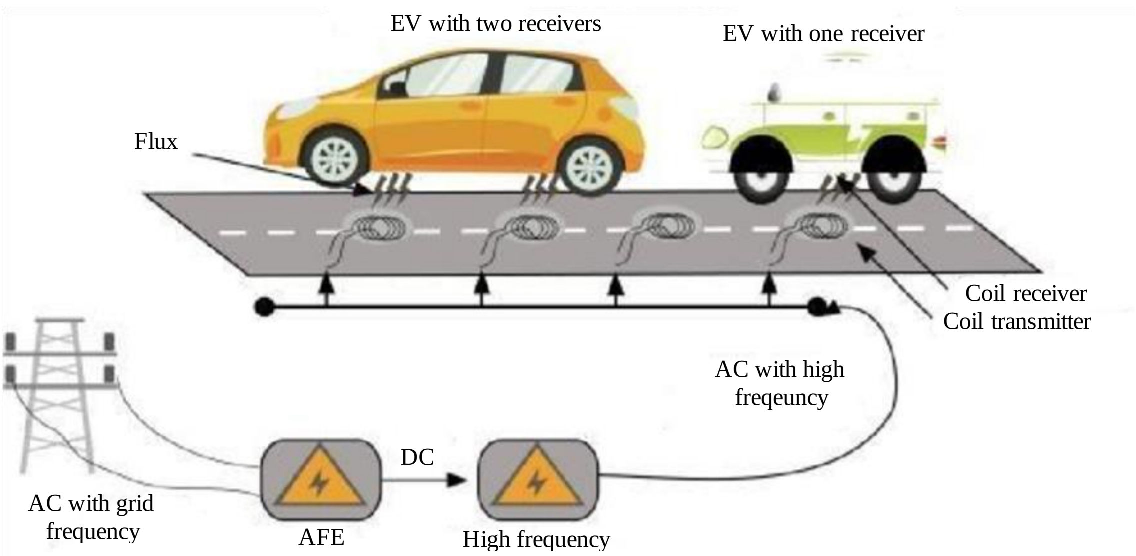

Figure 6. Static wireless electric vehicle charging system.

Dynamic Wireless Charging System [DWCS]

Wireless charging, a solution for on-the-go auto charging, is the ultimate in electric car technology. Regarding wireless charging technology, it has demonstrated efficacy. The priority is on the electric vehicle's power and range. When driving on and off the highway, dynamic wireless charging will assist in maintaining and increase the vehicle's battery charge. It also lessens the requirement for a sizable power reserve and helps the car weigh less overall. Energy is transferred through the air between the sending station and a receiving coil.

ADVANTAGES AND DISADVANTAGES

Advantages

- Ecologically Friendly
- Compared to a similar gas-powered vehicle, operating costs are lowered by 80%.
- There are no fuel costs.
- Less maintenance is required than for a gas-powered vehicle.
- Pollution-free and lightweight vehicles
- Electronically Secure
- Charging is practical
- Infinite range and instantaneous charging.
- Multiple EVs can be charged simultaneously.
- Quieter than standard automobiles in nature

Disadvantages

- Limited range and power
- It's expensive

RESULTS

Many techniques, such as inductive transmission or resonance coupling using an ic555 circuit, may be used to send power wirelessly to an electric automobile utilizing an ATmega328 microprocessor. A power MOSFET circuit with a main and secondary coil also functions well. Specific usage and design options, together with aspects like efficiency, range, and power transmission capability, will determine the project's outcome. It is critical to consider the safety, EMI, and overall performance of the system. The successful firmware programming, hardware integration, energy storage for the EV battery on both sides where the coils are triggered, and the fact that this solar-powered vehicle retains both wireless and solar energy are all factors that will determine the final result.

The project's power consumption is another way to explain it. The ATmega328 microcontroller will be employed for carrying out this procedure.

FUTURE SCOPE

- The nation and city should get set up for the day when they get power. It is predicated on both the most recent technological developments and official directives. Since battery-powered automobiles offer the finest economy, safety, and power to consumers, they have the possibility to completely transform the field of transportation.
- Dynamic electric vehicle charging is significant; this technology has the potential to power biomedical implants, permit hyperloop travel at supersonic speeds, and build robots that mirror humans. Business difficulties provide countless chances to succeed.
- The market for electrically powered cars is expanding dramatically these days. Innovative technology and technological advancements could make WEVC a more formidable rival.

Advanced equipment can also be good for power electronics. Switching losses are yet another considerable energy waste in WEVC systems, in addition to leakage currents. After clearing the job from the ledger, Static WEVC is able to discharge employees, but the salary remains same.

CONCLUSION

- The investigation of wireless recharge for electric cars was done in this work. The best technology for electric car charging is a wireless charger.
- Compared to wireless charging, Bluetooth wireless charging offers several benefits. because of his vast travels. It shortens the time needed to charge the motorbike and even enables EV charging while going.
- Medical treatment will eventually become more affordable, even with the substantial upfront costs. Because of its advantages over conventional cable systems, it is utilized more frequently. By deploying WCEV, power loss and impact of power may be minimised.
- It is projected that in the future, things will be wireless. Comparing wireless charging to other methods, there are several benefits.
- As technology develops more about it, wireless charging for electric cars may become possible. Inverter topology, design control, and human safety still require immediate inquiry.

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