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Static Wireless Electric Vehicle Charging System

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ABSTRACT: Wireless power transmission is the way to transfer power without using wire. Everyone can get clean and green wireless power. Wireless power transmission (WPT) is popular and gaining technology finding its application in various fields. The power is transferred from a source to an electrical load without the need of interconnections. WPT is useful to power electrical devices where physical wiring is not possible or inconvenient. The technology uses the principle of mutual inductance. This project deals with research and development of wireless charging systems for electric vehicles using wireless transmission. The main goal is to transmit power using resonance coupling and to build the charging systems. The systems deal with an AC source, transmission coil, reception coil, converter and electric load which are battery. This project introduces a groundbreaking stationary wireless electric vehicle (EV) charging system employing Tesla coil technology. Addressing the limitations of traditional EV charging methods, the system utilizes electromagnetic resonance for wireless energy transfer.

KEYWORDS: Mutual induction, Electric vehicles, Static wireless charging, coil, Arduino Uno

1. INTRODUCTION

Now a days world is shifting towards electrified mobility to reduce the pollutant emissions caused by nonrenewable fossil fueled vehicles and to provide the alternative to pricey fuel for transportation. But for electric vehicles, traveling range and charging process are the two major issues affecting it's adoption over conventional vehicles. With the introduction of Wire charging technology, no more waiting at charging stations for hours, now get your vehicle charged by just parking it on parking spot or by parking at your garage or even while driving you can charge your electric vehicle. As of now, we are very much familiar with wireless transmission of data, audio and video signals so why can't we transfer power over the Air. Wireless Power Transfer (WPT) is a futuristic technology with the advantage of flexibility, convenience, safety, and the capability of becoming fully automated. (i)Elimination of Cables: Stationary wireless charging eliminates the need for cumbersome cables and connectors, offering a cleaner and more streamlined charging experience. This not only enhances user convenience but also reduces wear and tear on both the charging infrastructure and the electric vehicle. (ii)Charging Pad Technology: At the core of this system lies the charging pad, strategically positioned on the ground or embedded in designated parking spaces. The pad incorporates a coil of wires connected to a power supply, serving as the source of the electromagnetic field required for power transfer. (iii)Vehicle Integration: Electric vehicles equipped with compatible wireless charging receivers feature coils positioned strategically on their undersides. These coils align with the charging pad's coil, establishing a connection through electromagnetic induction when the vehicle is parked over the charging station. (iv)Electromagnetic Induction Process: The charging process hinges on the principle of electromagnetic induction, where an electric current is induced in the coil of the vehicle by the magnetic field generated between the charging pad and the vehicle's receiver. This induced current is then harnessed to charge the electric vehicle's battery. Stationary Wireless Electric Vehicles Charging System. (v)Communication for Efficiency: To ensure optimal efficiency and safety during the charging process, there is a communication system between the charging station and the electric vehicle. This system regulates the power transfer, aligns the coils accurately, and facilitates a smooth exchange of information between the charging infrastructure and the EV. Wireless EV charging offers advantages such as increased convenience, reduced wear

and tear, and improved efficiency. However, challenges like standardization, alignment precision, and potential energy losses are areas where ongoing research and development aim to refine and enhance the technology. As the automotive industry continues its shift towards electrification, stationary wireless electric vehicle charging systems emerge as a promising and innovative solution to enhance the EV charging experience, ultimately contributing to a more sustainable and accessible transportation future.

II.RELATED WORK

Static wireless charging, also known as wireless power transfer (WPT) or inductive power transfer (IPT), is a technology that enables the charging of electric vehicles (EVs) without the need for physical electrical connections. In this approach, the energy is transferred wirelessly from a charging pad on the ground to a receiver coil mounted on the underside of the EV. The following is a detailed overview of related work in the field of static wireless charging of electric vehicles:

- 1) Inductive Power Transfer Fundamentals: Researchers like Karalis et al. (2008) and Kurs et al. (2007) have contributed to the theoretical understanding of resonant inductive coupling, which forms the basis for efficient wireless power transfer over longer distances. Studies have been conducted on the design and optimization of magnetic coupler geometries, coil configurations, and compensation topologies to improve power transfer efficiency and reduce electromagnetic emissions.
- 2) Coil and Pad Design: Researchers have explored various coil designs, including circular, rectangular, and solenoid-based configurations, to achieve high coupling coefficients and efficient power transfer (Miller et al., 2014; Deng et al., 2017). The impact of coil misalignment, airgap variation, and ferrite shielding on power transfer performance has been investigated (Budhia et al., 2013; Zaheer et al., 2017).

Pad designs, including overlapped and non-overlapped configurations, have been proposed to accommodate different vehicle sizes and parking scenarios (Bosshard et al., 2015; Zhang et al., 2016).

- 3) Power Electronics and Control Systems: Researchers have developed high-frequency inverter topologies and control strategies for efficient power conversion and regulation in wireless charging systems (Li et al., 2015; Duan et al., 2016). Techniques for foreign object detection, misalignment compensation, and dynamic power control have been explored to ensure safe and efficient operation (Beh et al., 2014; Yin et al., 2017).

- 4) Electromagnetic Compatibility and Safety: Studies have been conducted on the electromagnetic compatibility (EMC) of wireless charging systems, addressing issues such as electromagnetic interference (EMI) and human exposure to electromagnetic fields (EMFs) (Campi et al., 2017; Xu et al., 2018). Shielding techniques, magnetic field cancellation, and exposure assessment methodologies have been proposed to mitigate EMC and safety concerns (Rozaanov et al., 2013; Guo et al., 2017).

- 5) System Integration and Standardization: Researchers have investigated the integration of wireless charging systems into electric vehicles, considering factors such as packaging, thermal management, and interoperability (Lukic and Pantic, 2013; Chatterjee et al., 2017). Standardization efforts, such as those by the Society of Automotive Engineers (SAE) and the International Electrotechnical Commission (IEC), have been undertaken to ensure interoperability and facilitate the widespread adoption of wireless charging technology (SAE J2954, IEC 61980).

The field of static wireless charging for electric vehicles continues to evolve, with ongoing research efforts aimed at improving power transfer efficiency, reducing costs, addressing safety concerns, and facilitating widespread deployment in public and private charging infrastructures.

III.METHODOLOGY

Static wireless electric vehicle charging, also known as stationary wireless charging, is a method of charging electric vehicles (EVs) without the need for physical cables or plugs. Here's a simplified explanation of the methodology:

Inductive Charging Principle: Static wireless charging relies on electromagnetic induction. It involves transferring energy between two coils – one in the ground (transmitter) and the other on the vehicle (receiver) – through a process of electromagnetic induction.

Ground-Based Charging Unit: A charging unit is installed in the ground, typically in parking spaces or designated charging areas. This unit consists of a coil connected to a power source.

Vehicle-Based Receiver: The electric vehicle is equipped with a receiver coil usually installed underneath the vehicle. This coil is designed to pick up energy from the ground-based charging unit.

Alignment and Proximity: Proper alignment and close proximity between the ground-based charging unit and the vehicle's receiver are essential for efficient energy transfer. Alignment can be facilitated through guiding lines or sensors.

Energy Transfer: When the vehicle is parked over the ground-based charging unit, an alternating current is passed through the coil, creating an oscillating magnetic field. This induces a current in the receiver coil of the vehicle, which is then converted into electricity to charge the vehicle's battery.

Efficiency and Safety: Static wireless charging systems aim for high efficiency in energy transfer while ensuring safety for both the vehicle and nearby objects or individuals. This includes features such as automatic shutoff mechanisms to prevent overheating and electromagnetic interference.

Integration with Smart Grids: Some static wireless charging systems are designed to integrate with smart grids, allowing for optimized charging schedules based on grid demand and renewable energy availability.

Overall, static wireless electric vehicle charging offers convenience and eliminates the need for manual plugging and unplugging, making it a promising technology for widespread adoption of electric vehicles.

IV.IMPLEMENTATION

Working: The A static wireless electric vehicle (EV) charging system typically involves a few key components:

Charging Pad: This is installed on or embedded in the ground where the vehicle parks. It contains coils of wire that create an electromagnetic field.

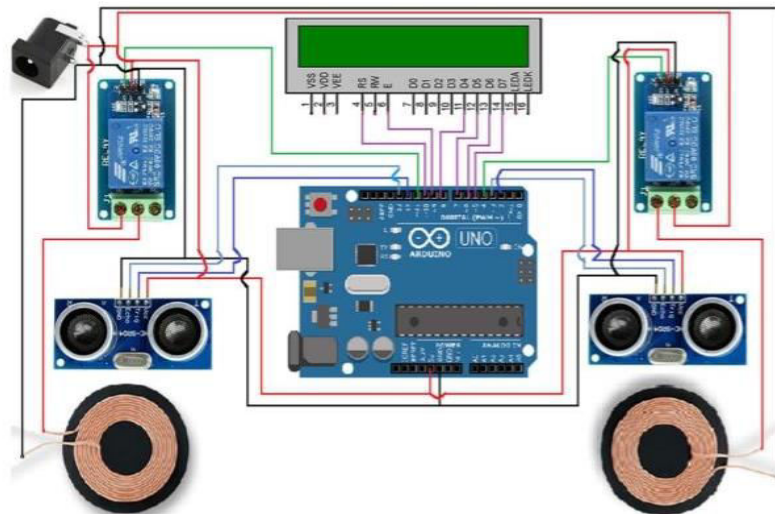


Fig. (a) Connection diagram of Static Wireless electric vehicle charging system

Receiver Coil: Fitted on the vehicle's underside, the receiver coil picks up the electromagnetic field generated by the charging pad.

Power Electronics: These components manage the flow of electricity from the charging pad to the vehicle's battery. They include rectifiers, inverters, and control circuits.

Communication System: Some systems incorporate communication between the charging pad and the vehicle to optimize charging efficiency and safety. This could involve protocols like RFID, Wi-Fi, or Bluetooth.

Here's how the system typically works:

Alignment: The driver parks the EV over the charging pad. The system may have alignment aids, like visual or auditory cues, to assist in proper positioning.

Power Transfer Initiation: Once the vehicle is properly aligned, the charging pad activates the electromagnetic field. This field induces an electric current in the receiver coil on the vehicle.

Conversion and Regulation: The induced current is converted and regulated by the vehicle's power electronics to match the requirements of the battery. This involves converting AC current induced by the pad into DC current usable by the vehicle's battery.

Charging: The regulated current is then used to charge the vehicle's battery. The charging process continues until the battery reaches its predetermined state of charge or until manually stopped by the user.

V. EXPERIMENTAL RESULTS

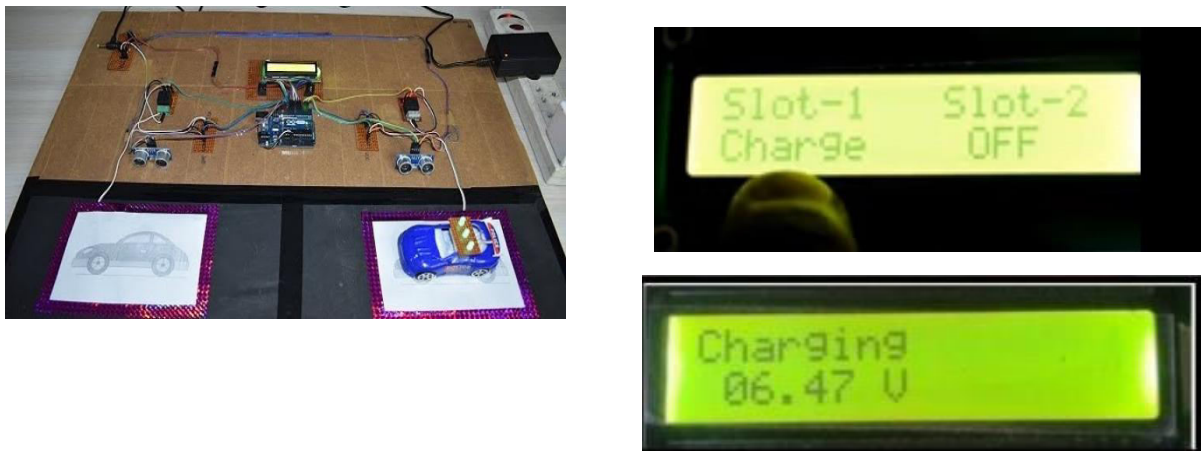


Fig. (b) Overall Hardware Setup

VI. CONCLUSION

In conclusion, the development and implementation of stationary wireless electric vehicle (EV) charging systems represent a significant leap forward in the evolution of sustainable transportation. The innovative technology addresses several challenges associated with traditional EV charging methods and offers a range of benefits, contributing to the broader adoption of electric vehicles. The elimination of physical connections, improved user convenience, and reduced wear and tear on infrastructure and vehicles are key advantages. Safety enhancements, standardization efforts, and compatibility improvements further solidify the viability of wireless charging in diverse applications. As advancements continue, with ongoing research and technological innovations, the wireless charging landscape is poised for continued growth. The positive environmental impact, coupled with scalability and future-proofing through standardized approaches, positions wireless EV charging as a crucial element in the transition towards clean and efficient transportation systems.

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