Wireless Power Transmission for Electrical Vehicle

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***Abstract* — Electric vehicles (EVs) are a substitute for fossil fuels in the road transportation system and can aid in lowering fossil fuel use. However, the battery's low capacity limits how often EVs may be used. WPT, or wireless power transfer, can by charging EVs while they are moving along a wireless charging lane embedded in a road, you may extend the operating range of electric vehicles. A charging lane can only provide a certain amount of electricity at once. One issue here is how to effectively divide the power among the various EV penetration levels when a lot of EVs pass a charging lane? Nevertheless, no prior studies have been conducted to address this problem. In order to address this issue, we suggest a method to balance the The fog computing center plans the power distribution and gathers data from EVs. Instead of using clouds closer to cars, we employ fog to lessen the lag in communication. The power allotted to each EV is scheduled by the power scheduling model. To mitigate network congestion caused by EVs and fog, we let vehicles to select their preferred communication channel for interacting with local controllers.**

Keywords- electric vehicle; charging system; reliability; bibliometric analysis.

I. INTRODUCTION

The wireless solution is increasingly spreading as a method of battery charging for Electric Vehicles (EVs). The standard technology of wireless EV battery charging is based on the Inductive Power Transfer (IPT) between two coupled coils, one connected to the electrical grid and the other connected to the rechargeable battery. The IPT provides benefits in terms of safety and comfort due to the absence of a plug-in operation: through IPT, the electrocution risk typically arising from power cords is avoided, and the battery charging operation can automatically start. According to the state of the EV, there are mainly two types of IPT for wireless charging: static IPT, when the vehicle is stationary and nobody is inside it (e.g., in a parking area); dynamic or quasi-dynamic IPT, when the vehicle is being used (e.g., while in motion or during a traffic red light). The wireless power transfer obviously represents the only solution for dynamic charging, since a wired connection would be impossible during motion. We know that for a journey from one place to another, we use vehicles. For the motion of vehicles, we need fuel like petrol or diesel. The use of such fuels creates pollution, and due to this, we face the problem of global warming. Additionally, importing these fuels requires foreign currency, which negatively impacts economic growth. The cost of fuel increases every few months, which is not economical for us. Considering this, many people now prefer battery-operated vehicles. But the main drawback of these vehicles is the problem of battery charging. To address this, an idea named “Wireless Power Transmission for Electric Vehicles” has been developed.

For this, a battery-operated vehicle is made using a gear motor. A coil is placed on the vehicle to convert electromagnetic waves into electrical energy. A bridge rectifier circuit is used to convert AC signals into DC signals, and this DC signal is fed to the battery for charging. On the road, an optics module is used to detect the vehicle. A coil is used to transmit electromagnetic waves obtained from the electronic circuit. Arduino Uno is used to interface the battery with a 2*16 LCD. A software program is installed in Arduino Uno, enabling the charging voltage to be displayed on the LCD. In this system, there is no wire connection between the power transmitter and receiver system.

II. LITERATURE REVIEW

[1] Qiang wang and Hong Li, This work examines and develops a type of coupled magnetic resonance-based wireless power transfer system. The technology for wireless power transmission is introduced, and the advantages of coupled magnetic resonant wireless power transmission are explained. Subsequently, it examines the impact of associated variables, such as the transmission distance (d) and the load resistance (R L) of the emitting and receiving resonant coils, on the system's transfer power and efficiency.

The experiment evaluates the suggested wireless power transmission system, and the findings indicate that, in order to optimize the design of the transmission power or efficiency, all of the aforementioned pertinent elements should be carefully taken into account. The experiment's outcomes further demonstrate the soundness of the theoretical reasoning.

[2] Q. Zhao and F. C. Lee -High step-up DC-DC converters that don't need isolation are needed for a lot of applications. High step-up voltage gain can be achieved by certain DC-DC converters, but at the expense of either an excessive duty ratio or a significant quantity of circulating energy. High voltage gains are possible with coupled inductors in DC-DC converters, but the losses incurred by leakage inductors reduce their efficiency. Active clamp converters recover leakage energy at the expense of higher topological complexity. This work proposes a family of high step-up, high efficiency DC-DC converters with simple topologies. The suggested converters outperform their active-clamp equivalents by realizing active-clamp-like features using linked windings and diodes rather than active switches. High productivity is attained as a result of The output rectifier reverse-recovery issue is resolved and the leakage energy is recycled.

[3] R. J. Wai, C. Y. Lin, R. Y. Duan, -This research proposes a high voltage gain, low switch stress, high efficiency dc-dc converter. In general, increasing the step-up ratio of the traditional boost converter can be accomplished by using a linked inductor. However, the leaking inductor may be the source of the switch surge voltage, necessitating the adoption of high-voltage-rated devices. A three-winding linked inductor is employed in the suggested architecture to increase the magnetic core's utility rate and provide a high voltage gain without using an excessively high switch duty cycle. Additionally, the leaking inductor releases its energy straight to the output terminal, preventing the circulating current phenomenon and the formation of of the switch's surge voltage. Furthermore, the output diode's reverse-recovery current is reduced by adjusting the delay time created by the linked inductor's primary and secondary current crossing. The goal of high-efficiency power conversion can be accomplished. Additionally, the suggested scheme makes use of the closed-loop control methodology to address the power source's voltage drift issue when loads vary. To show the efficacy of the suggested power conversion approach, some experimental findings using a proton exchange membrane fuel cell power source with a 250-W nominal rating are provided.

III. OBJECTIVES

1) The main objective of our project is to design and develop a wireless power transfer system suitable for electric vehicles using resonant magnetic coupling technology.
2) The main aim of our project is to design and develop an antenna system suitable for vehicles using resonant magnetic coupled wireless power transfer technology to electric vehicle charging systems.

3) At the core of the wireless power charging systems are primary and secondary coils. In order to transfer the rated power, both sides have to be tuned by resonant capacitors.

IV. PROBLEM STATEMENT

The current dependence of electric vehicles (EVs) on wired charging infrastructure presents significant limitations, hindering their widespread adoption. These limitations include limited charging availability, long charging times, and the inconvenience of physically connecting a charging cable. Wireless power transfer (WPT) technology offers a promising solution to these challenges by enabling EVs to be charged automatically and seamlessly while parked or even in motion. However, further research and development are needed to overcome technical challenges such as efficiency losses, safety concerns, and cost reduction to make WPT systems universally available and economically viable for mass EV adoption. By addressing these challenges, WPT can revolutionize the EV industry, leading to a more convenient, efficient, and sustainable transportation future.

V. PROPOSED SYSTEMS

In the proposed system aims to develop an antenna and wireless power transfer system suitable for electric vehicles (EVs).Using resonant magnetic coupling principle, the wireless power transfer technology to the electric vehicle is designed. When the vehicle's power receiver's frequency is tuned in exact with the resonance frequency of the transmitter unit below the road, the electrical power will flow from the transmitter coil inside the platform to the receiving coil inside the bottom of the electric vehicle. This project describes the design and implementation of a wireless power transfer system for moving electric vehicles of any type like e-cars or e-bikes.

VI. METHODOLOGY

The idea of electric vehicles that are powered by the roads has been put up in an effort to solve battery issues. This technique enables wireless power charging while the electric vehicle is in motion, allowing for battery downsizing and the elimination of waiting periods for charging. Designing and developing an antenna and WPT system suited for moving vehicles is the primary goal of our research (EVs). The technology for wireless power transmission to electric vehicles is created using the resonant magnetic coupling concept.

When the resonant frequency of the emitter unit below the road is correctly synchronized with the automobile's power receiver, electricity will be transmitted between the coil that transmits inside the base to the receiver coil inside the bottom. When the frequency of the electric vehicle's power receiver is exactly matched to the resonance frequency of its transmitter unit below the road, current will be transmitted from the coil that transmits below the road's surface to the receiving coil within the lowest part of the electric car. In this project, the design and execution of a wireless power transfer system for moving electric automobiles utilizing the model EV system is addressed.

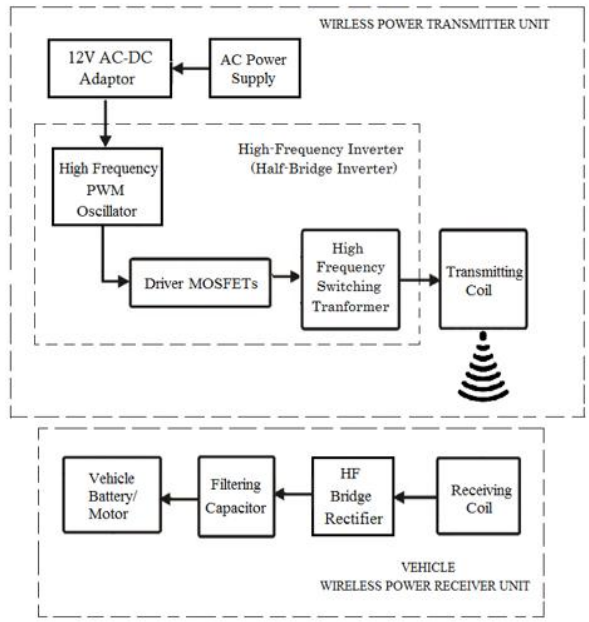

Figure 1: Block Diagram

6.1 AC Power Supply

The wireless power transmitter requires an AC power supply, which is obtained from an AC220v source.

6.2 AC-DC Adapter (SMPS)

To convert the AC power supply to DC, a Switching Mode Power Supply (SMPS) is used. The input of the SMPS is 220v AC, and the output is 12v DC.

6.3 High Frequency PWM Oscillator

The KA3525 IC circuit is used for building Very High Frequency PWM Oscillators. This oscillating device creates a pulse width modulation (PWM) wavelength in the range of 65 KHz and generates PWM switching pulses for controlling the MOSFETs. The two MOSFET gates receive PWM1 and PWM2, two distinct PWM pulses produced by the oscillator. Because of the 90-degree phase difference between each PWM pulse, each MOSFET turns on and off alternatively.

6.4 Driver MOSFETs

Here, an extremely high frequency transformer is switched by two driver MOSFETs. The "Drain" pins of the two MOSFETs are joined by both ends of the transformer's primary. Current passes through the transformer's primary winding when a MOSFET is switched ON. One MOSFET turns on half of the primary, while another MOSFET turns on the other half. A square AC wave is created in the transformer primary as a result of the alternate switching of both MOSFETs.

6.5 High Frequency Transformer

Two driver MOSFETs are used to switch a very high frequency transformer in this instance. The primary terminals of the transformer's transformer connect the "Drain" pins of each of the MOSFETs. When a MOSFET is turned ON, current flows via the primary winding of the transformer. A half of the core is illuminated by one MOSFET, and the other half is illuminated by a different MOSFET. The alternating switching of the two MOSFETs results in a square AC wave in the transformer primary.

6.6 Half bridge Inverter

An HF flipping transformer and a couple MOSFETs make up the Half Bridge Inverters circuit driver. Two MOSFETs are linked to the switching transformer's primary, and the transmitting coil is connected to the secondary. The higher frequencies AC voltage is produced by the 1⁄2 Bridge
Inverter from a DC input voltage.

6.7 Transmitting Coil

The copper coil windings of the source coil are intended to transform the higher-frequency oscillating power supply into electromagnetic signals that echo at a certain frequency.

6.8 Receiving Coil

From the sender's antenna, the receiver coil receives electromagnetic frequencies and transforms them into high energy electrical power.

6.9 HF Bridge Rectifier

Rapidly switching with the objective to transform the HF current from the coil of copper in which it is received into a DC (direct current) source voltage, rectifying diodes are employed in HF bridge rectifiers.

6.10 Filtering Capacitor

The filtering effect of the capacitor eliminates ripple that is created at the rectifier & generates a steady and smooth DC voltage output that may be utilized to power a vehicle's motor or charge batteries.

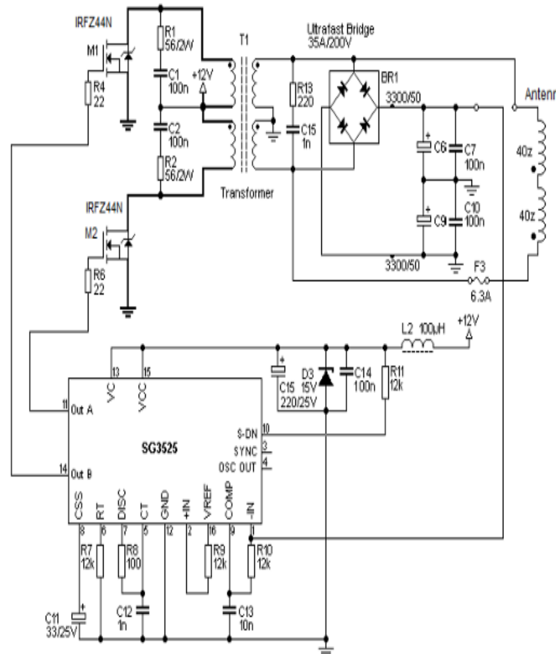

Figure 2: Transmitting circuit diagram

As shown in fig 2, Transmitter circuit diagram AC-DC Converter or Switching Mode Power Supply (SMPS) converts 220V 50Hz AC supply into 24V DC output. The converted DC is then converted into a High frequency AC using a high frequency resonant half- bridge PWM inverter. The HF inverter used here is a half bridge push-pull type inverter. It is operated using a PWM switching controller which produces 45 to 120KHzoscillator Frequency. The HF converter converts Dc to HF ac. The HF ac current is fed to a switching transformer, which drives the HF Ac power to the transmitting coil. Transmitting coils convert HF electrical current into electromagnetic waves. The transmitting coil is operated at its resonant frequency so that maximum power will be transmitted with higher output efficiency.

As shown in fig. 3, The receiver consists of a receiving coil which is tuned to the frequency of the transmitting coil. So when coils are within the coupling range, the power is received in the receiving coil. The receiving coil converts the electromagnetic waves back to HF AC output. High frequency AC current is converted into a DC current using a fast switching bridge rectifier. A capacitor filter is used, which stabilizes the Dc voltage and produces a constant Dc output. Then the output of the filtering circuit provides a constant charging current to batterie of the vehicle.

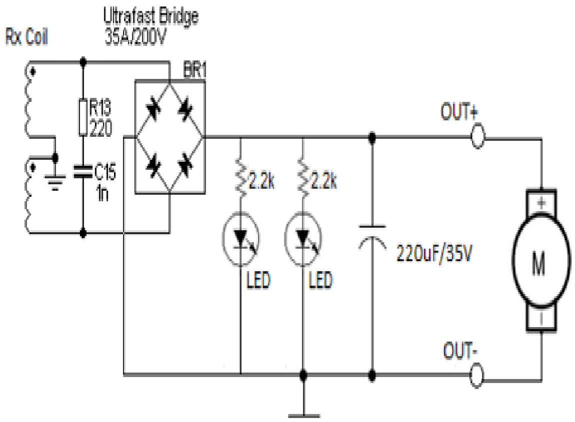

Figure 3: Vehicle Receiver Circuit Diagram

MOSFET stands for Metal-Oxide-Semiconductor Field Effect Transistor. There are two main types of MOSFETs: n channel and p-channel. In an n-channel MOSFET, the source and drain are doped with n-type material (which has an excess of electrons), and the gate is separated from the channel by an insulating layer of oxide. When a voltage is applied to the gate, it creates an electric field that allows current to flow between the source and drain. In a p-channel MOSFET, the source and drain are doped with p-type material (which has a deficiency of electrons), and the gate is negatively biased with respect to the source and drain.

VII. MERITS AND DEMERITS

7.1 Merits

1. No line of sight required: Wireless power transmission does not require a clear line of sight between the transmitter and receiver. Even if there are physical barriers like wood, metal, or other devices between the source and the load, electricity transmission is still possible.

2. Interference-free: Unlike radio waves, wireless power transmission does not interfere with other electromagnetic waves, making it suitable for sensitive applications.

3. Safe: Wireless power transmission using resonant coupling produces significantly reduced wavelengths, making it safe for human use.

4. More efficient: Compared to electromagnetic induction, wireless power transfer through resonance induction is more effective in transferring energy over greater distances.

7.2 Demerits

1. Limited range: Wireless power transfer is only practical over short distances, typically a few meters.

2. Efficiency: The efficiency of wireless power transfer decreases with increasing distance, with efficiency rates of around 40% for long distances and up to 85% for short distances.

3. Development stage: While wireless power technology is rapidly evolving, it is still in the early stages of development. Further research and development are needed to improve its effectiveness and distance capabilities.

VIII. CONCLUSION

Wireless Power Transfer (WPT) technology is a promising solution to address the challenges associated with EV charging. The WPT system's components include a power transmitter and power receiver, with various modules such as inverter, energy lines, regulators, rectifying devices, and pickup modules. The resonating frequencies used in the WPT system affect the constant voltage and constant current management. The electricity lines are set up alongside and below the road, with the transmitted energy powering the EV motors and recharging the batteries. WPT technology has the potential to offer a more convenient, efficient, and safe charging solution for EVs, and further research is required to improve its performance and reduce its cost.

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