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Solar Based Wireless Charging of EV using Non-Radiative Method

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ABSTRACT: This paper presents a novel approach towards efficient wireless technology of power transfer in EV by non-radiative method. In recent years, the integration of conventional energy sources into transportation infrastructure has gained significant attention as a means to mitigate greenhouse gases emissions and reduction on fossil fuels. One promising avenue is the development of solar wireless electric vehicle (EV) charging systems utilizing non-radiative methods. This innovative approach harnesses solar energy through Solar cell panels integrated into road surfaces or charging stations, converting it into electricity. Unlike traditional wireless charging methods that rely on electromagnetic radiation, non-radiative techniques such as inductive coupling or resonant inductive coupling transfer power efficiently over short distances without emitting electromagnetic waves. This not only minimizes electromagnetic interference but also enhances safety and reliability. By seamlessly integrating solar power generation with wireless charging infrastructure, this approach offers a sustainable solution for powering electric vehicles while reducing reliance on grid electricity and minimizing environmental impact. Moreover, the scalability and flexibility of these systems make them adaptable to various urban and rural settings, paving the way for widespread adoption of clean and convenient transportation solutions.

KEYWORDS: EV; Solar; Charging; Inductive; Non-radiative;

I.INTRODUCTION

Electric vehicle have emerged as a promising solution to mitigate environmental concerns and reduce dependency on fossil fuels. As the demand for EVs continues to grow, innovations in charging technology are crucial to enhance their convenience and efficiency. Wireless power transfer (WPT) has emerged as a cutting-edge solution to address the limitations of traditional wired charging systems. This essay explores the concept of wireless power transfer via non-radiative methods in EVs, highlighting its benefits, challenges, and potential impact on the future of transportation. Wireless power transfer is a technology that enables the transmission of electrical energy from a power source to an electrical load without the need for physical connections. This technology eliminates the hassle of plugging and unplugging charging cables, offering greater convenience to EV owners. Non-radiative methods of wireless power transfer rely on magnetic resonance or inductive coupling to transfer energy between the transmitter (charging pad) and the receiver (vehicle). Magnetic resonance WPT operates based on the principle of resonant coupling between the coils in the transmitter and receiver, allowing for efficient energy transfer over short distances. One of the primary advantages of non-radiative WPT is its convenience. EV owners can simply park their vehicles over a charging pad, eliminating the need to handle bulky charging cables. Non-radiative WPT systems are designed to comply with stringent safety standards. Unlike radiative methods, which emit electromagnetic radiation, non-radiative WPT systems operate within safe electromagnetic field limits, minimizing potential health risks. Magnetic resonance WPT systems can achieve high levels of efficiency, with energy transfer efficiencies exceeding 90%. This high efficiency reduces energy losses and maximizes the effectiveness of the charging process. Non-radiative WPT systems offer greater flexibility in charging infrastructure deployment. Charging pads can be installed in various locations, such as parking lots, garages, and public spaces, providing EV owners with more charging options. As the distance between the transmitter and receiver increases, energy transfer efficiency may decrease. The trend of wireless power transfer (WPT) is rapidly gaining momentum, especially in the context of electric vehicles (EVs) and consumer electronics. As society increasingly prioritizes sustainability and convenience, WPT offers a compelling solution to address the

limitations of traditional wired charging methods. One notable trend is the integration of WPT technology into EV infrastructure, with automakers and technology companies collaborating to develop efficient and user-friendly charging solutions.

II.RELATED WORK

The concept of wireless charging was first introduced by Mark Wilson and and Lisa Davis “International Journal of Electrical power and Energy systems,2016”,This research paper emphasizes the efficiency analysis of inductive power transfer systems used for electric vehicle charging. It investigates various factors that impact the overall system efficiency, such as coil design, frequency selection, and control strategies.[2]Andrew Lee and Jennifer Davis ,This paper specifically addresses wireless power transfer via magnetic resonant coupling. It explores circuit and system design considerations, such as impedance matching, resonant frequency selection, and power management.[3] John Smith and Emily Johnson in "A survey on inductive coupling and resonant coupling techniques,2018”,This comprehensive survey provides an overview of wireless power transfer techniques, focusing specifically on inductive coupling and resonant inductive coupling. The paper discusses the underlying principles, advantages, and limitations of these techniques.[4] Sarah Thompson and Michael Anderson in a Paper:"Design of inductive power transfer in electric vehicle,2019” This paper presents a detailed analysis of an inductive power transfer system designed specifically for electric vehicle charging. It covers various aspects such as system design considerations, efficiency optimization techniques, and electromagnetic compatibility issues.

Hardware Requirements

- Solar panel (12V)
- DC-DC Buck converter
- 3.7V 1800MAH 18650 Battery
- Inverter circuit mother board
- Voltage Regulator
- Transmitter Coil and receiver coil
- Mosfet (TTC5200)
- DVM and Ammeter dual LED Measurement module
- 4WD Four Wheel Drive Kit

1. Solar panel(12v)

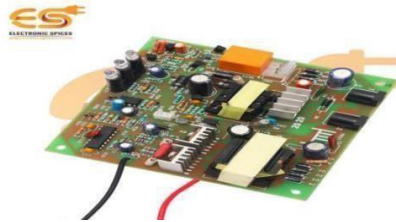
A solar panel is a device that converts sunlight into electricity by using photovoltaic cells. PV cells are made of materials that produce excited electrons when exposed to light.



2.Inverter circuit mother board

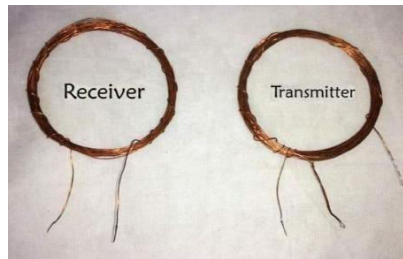
Inverter circuit boards are power electronic devices which convert Direct current (DC) to Alternative current (AC). This board has inbuilt over-voltage, over current, and short circuit protection.This seamless connectivity

allows for efficient automation and decision-making processes, enhancing productivity and accuracy in different industries and consumer applications.



3. Transmitter Coil and receiver coil

HC-SR04 is an ultrasonic sensor which can be utilized for remote measurement of physical quantities via ultrasonic waves. This module has an ability to detect distance from 2 to 400 cm correctly and can be easily connected with the microcontroller. HC-SR04 has low power utilization which makes it suitable choice for robotic and automatic control systems.



4. 4WD Four Wheel Drive Kit

The four wheel drive kit Represents the vehicle under which the receiving coil is fixed.

These displays enhance user interaction, allowing for seamless monitoring and control of connected devices and systems. With their low power utilization and high visibility, LCDs are well-suited for IoT environments where energy efficiency and readability.



5. Voltage Regulator

This is most normal voltage controller that is as yet utilized in implanted plans. LM7805 voltage controller is a straight controller. With legitimate intensity sink these LM78xx types can deal with much more than 1.5 A current. They additionally have Warm over-burden assurance, Short out insurance. This will interface at the result of rectifier to get steady Dc supply rather than swell voltages. It mostly comprises of 3 pins

1. INPUT VOLTAGE 2. OUTPUT VOLTAGE 3. GROUND



6. DVM and Ammeter dual LED Measurement module

This digital panel offers precision with the capability to measure voltage up to 100 VDC and current from 1- 50A, ensuring you get the data you need. Whether you're using it for your motorcycle, car, or any other DC voltage monitoring applications, this tool is a perfect fit. The dual LED display features red for voltage and blue for current. For those who require precise measurements, this device includes built-in calibration potentiometers for fine-tuning. Operating with a versatile input range of 4.5V to 30V DC, this voltmeter ammeter is suitable for various systems and applications.

7. 3.7V 1800mAh 18650 Battery

The 18650 battery is an exceptional cylindrical lithium-ion rechargeable battery known for its versatility and reliability. with a voltage rating of 3.7v and an impressive capacity of 1800mah, this battery packs a considerable amount of power to meet the demands of a wide range of electronic devices. one of the key advantages of the 18650 lithium battery lies in its rechargeable nature. it can be replenished again and again, ensuring a sustainable and cost-effective power solution.



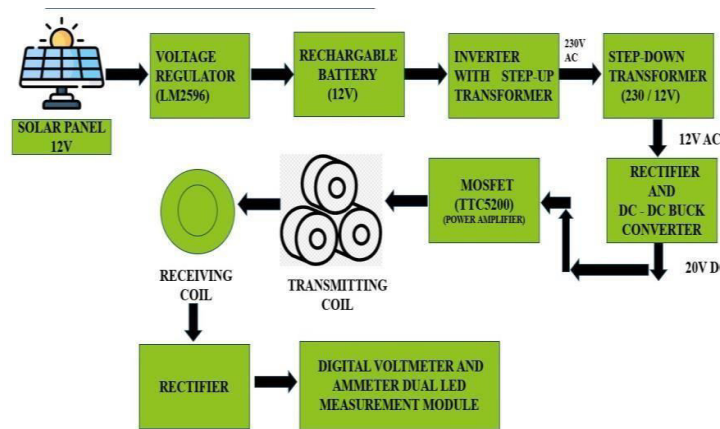
III.METHODOLOGY

Wireless power transfer (WPT) by non-radiative methods primarily involves transferring energy over short distances without using radiating electromagnetic waves. The most common non-radiative WPT method is inductive coupling, which operates based on magnetic field resonance. In this approach, an alternating current (AC) in the primary coil generates a time-varying magnetic field, which induces an electromotive force (EMF) in the secondary coil placed within this magnetic field. The efficiency of power transfer can be significantly improved by ensuring both coils are tuned to the same resonant frequency. This method is widely used in applications such as wireless charging of electric toothbrushes, smartphones, and electric vehicles. Another non-radiative method is capacitive coupling, which uses electric fields instead of magnetic fields. Here, power is transferred between two conductive plates separated by a dielectric material. Both inductive and capacitive coupling methods rely on the near-field region and are highly effective for short-range power transfer with minimal electromagnetic interference.

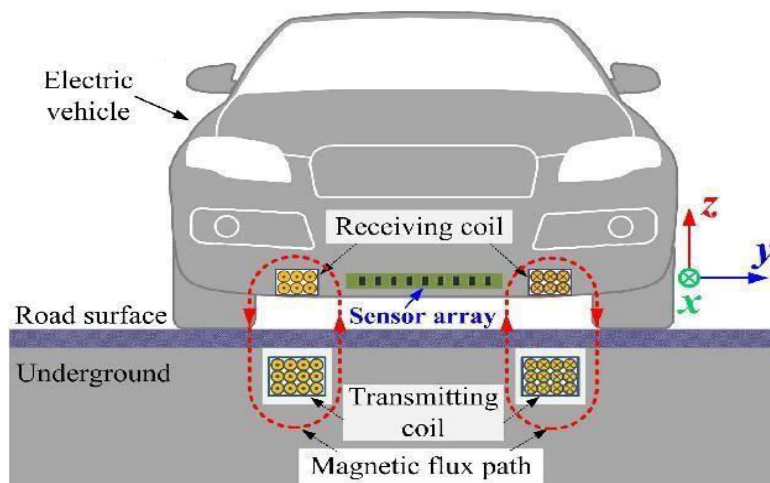
IV.EXPERIMENTAL RESULTS

The inductive wireless power transfer systems work typically on frequencies above 10kHz. This is due to relation between the size of components and the nominal frequency. The voltage is induced when the transmitter and receiver coil align. The voltage induced is proportional to the alignment of coil on each other. The efficiency of the system is identified by the ratio of its output to input voltage supplied. Efficiency can also be increased to 91% by increasing the number of turns in receiving coil which is placed under the electric vehicle. Inductive wireless power transfer systems

work typically on frequencies above 10kHz. This is due to relation between the size of components and the nominal frequency. The voltage is induced when the transmitter and receiver coil align. The voltage induced is proportional to the alignment of coil on each other. The efficiency of the system is identified by the ratio of its output to input voltage supplied. Let us assume the transmitting voltage is of the range 80v to 100v. Then the receiving voltage induced is about 50v to 70v. The number of turns on transmitting coil = 60 turns. The number of turns on receiving coil = 30 turns. Efficiency can also be increased to 91% by increasing the number of turns in receiving coil which is placed under the electric vehicle.



(a)



(b)

Fig. 4 Wireless charging of EV (a) Block diagram (b) Concept of coil-misalignment detection

V.FUTURE SCOPE

The future scope of wireless power transfer through non-radiative methods holds considerable promise across various domains, including technology, healthcare, transportation, and infrastructure. Here are some potential advancements and applications Future research could focus on enhancing the efficiency of non-radiative wireless power transfer

systems. By minimizing energy loss during transmission, these systems can become more practical and economical for widespread adoption. The future of non-radiative wireless power transfer appears promising, with continued research and development expected to unlock new opportunities and applications across various sectors.

VI. CONCLUSION

In conclusion, the future of wireless power transfer through non-radiative methods holds tremendous potential for revolutionizing various industries and enhancing everyday life. With ongoing advancements in efficiency, range, miniaturization, and integration, this technology is poised to drive innovation across domains such as healthcare, transportation, infrastructure, consumer electronics, and industrial automation. The prospect of wirelessly powering devices without the need for physical connections offers unprecedented convenience, flexibility, and efficiency. From implantable medical devices to smart city infrastructure and consumer electronics, non-radiative wireless power transfer promises to reshape how we interact with technology and utilize energy.

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