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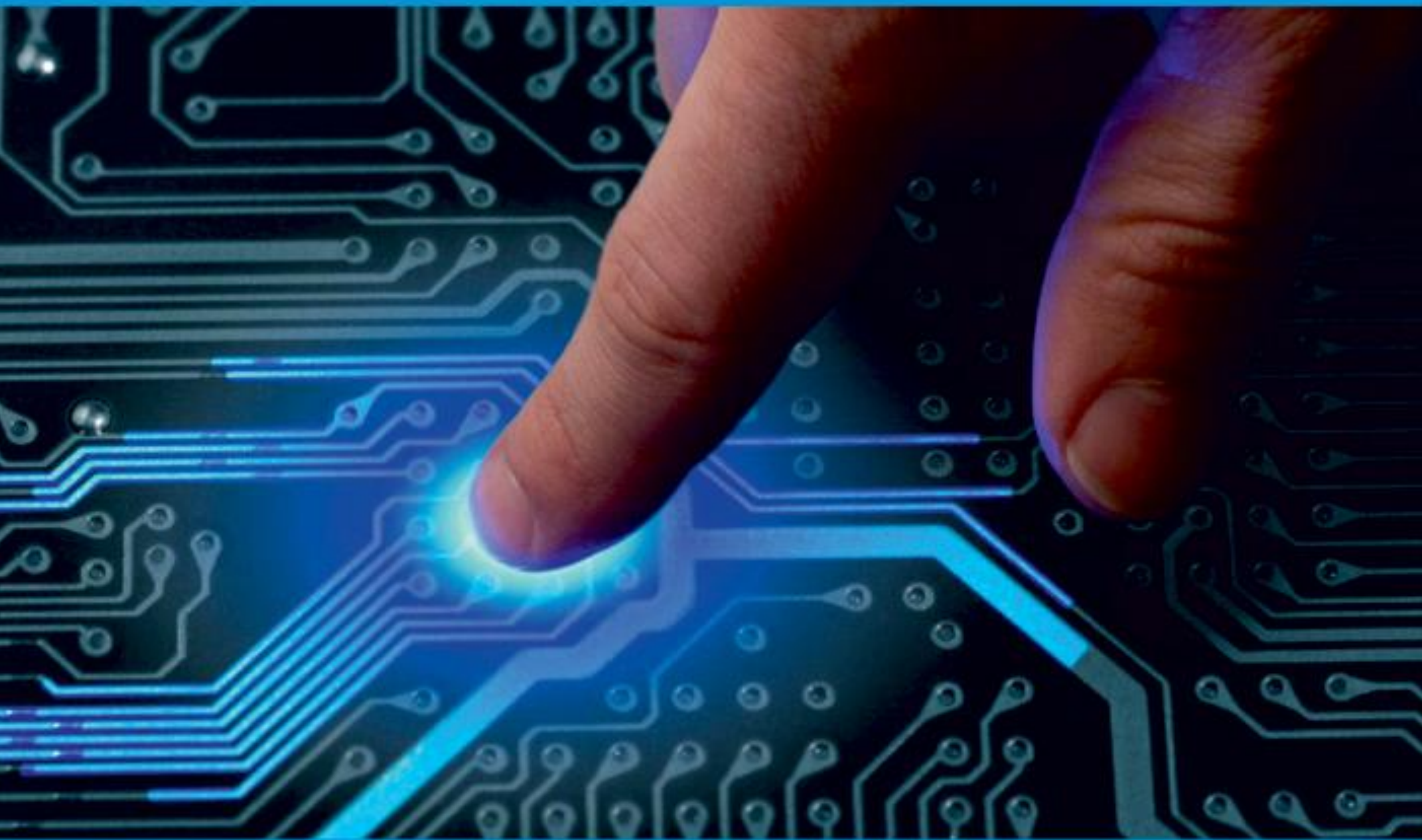

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Wireless Charging for Electric Vehicles Towards Sustainable Transportation

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ABSTRACT: Electric vehicles (EVs) are instrumental in shaping sustainable transportation, offering a pathway to mitigate emissions and reduce reliance on fossil fuels. However, their widespread adoption faces challenges, particularly in developing robust charging infrastructure. Wireless charging (WPT) emerges as a promising solution, providing convenience and potentially enhancing efficiency. This abstract delves into the potential of WPT for EVs, examining its role in sustainable transportation. Key advantages include user convenience, cable clutter elimination, and integration with renewable energy sources like solar power. Technical aspects encompass different WPT technologies, such as inductive and far-field charging, alongside discussions on efficiency and power transfer limitations. The sustainability impact is emphasized, highlighting increased EV adoption, reduced reliance on fossil fuels, and the importance of clean energy sources for WPT systems. Ongoing research efforts to refine WPT technology and its contribution to a sustainable transportation future are also discussed.

KEYWORDS: Electric vehicle, Misalignment, Power pads, V2G, Wireless Charging, wireless power transmission, EV charging, photovoltaic system, AI, solar energy.

I. INTRODUCTION

Wireless charging represents a groundbreaking technology poised to revolutionize the way electric vehicles (EVs) are powered, eliminating the need for physical cables. By harnessing electromagnetic fields, wireless charging enables energy transfer between a ground-based transmitter pad and a corresponding receiver pad on the EV. As the global demand for electricity escalates, driven by factors like rising natural gas prices and regulatory pressures to curb greenhouse gas emissions, alternative energy sources such as solar power have gained prominence. EVs play a crucial role in combating air pollution, despite their limited range on a single charge. While traditional grid-connected wired charging stations remain prevalent, this article focuses on leveraging renewable energy sources, notably solar power, for wireless power transfer (WPT) technology to mitigate reliance on cables.

II. BACKGROUND STUDY

1. Background Study

The concept of wireless charging for electric vehicles (EVs) using solar power represents an innovative fusion of two pivotal advancements in sustainable transportation. Here's a comprehensive breakdown of the key aspects crucial for understanding this transformative technology.

2. Concept:

Wireless Charging: The primary principle relies on inductive coupling, where a charging pad, either embedded in the road or designated charging area, contains a coil. Another coil is affixed to the underside of the EV. When the EV aligns over the charging pad, an alternating current (AC) passes through the pad's coil, generating a magnetic field. This magnetic field induces an electric current in the EV's coil, thereby charging the battery. Solar Power Integration: Solar panels play a central role by converting sunlight into direct current (DC) electricity. This DC power can be utilized directly for charging batteries or converted to alternating current (AC) for wireless transmission through an inverter. The AC power can then be regulated and directed to the charging pad's coil for wireless charging

3. Benefits:

Reduced Reliance on Fossil Fuels: Solar power emerges as a clean and renewable energy source, eliminating greenhouse gas emissions inherent in traditional electricity generation methods. Moreover, wireless charging obviates the need for physically plugging in the vehicle, providing a more user-friendly charging experience. Potential for

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Dynamic Charging: Theoretically, the integration of coils into roadways holds promise for enabling EVs to charge while in motion, utilizing designated lanes for dynamic charging.

4. Challenges:

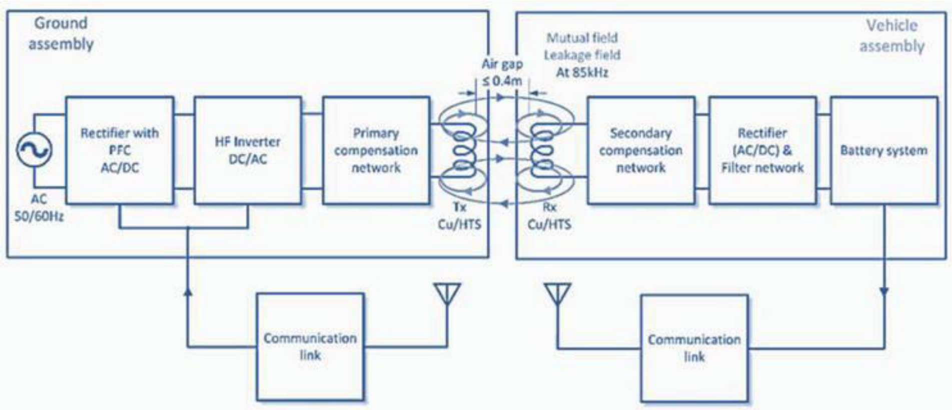
Efficiency: Presently, wireless charging exhibits lower efficiency compared to plug-in charging due to energy losses during the conversion of magnetic fields. Infrastructure Cost: The installation of solar panels and embedding charging coils in roads necessitates a substantial upfront investment, presenting a notable challenge for widespread adoption. Power Transfer Distance: The efficiency of wireless charging diminishes significantly with increased distance between the coils, posing a technical challenge for long-range charging. Foreign Object Detection: Systems must be adept at detecting and preventing accidental charging or damage caused by metallic objects on the road surface**.**

III. CURRENT RESEARCH

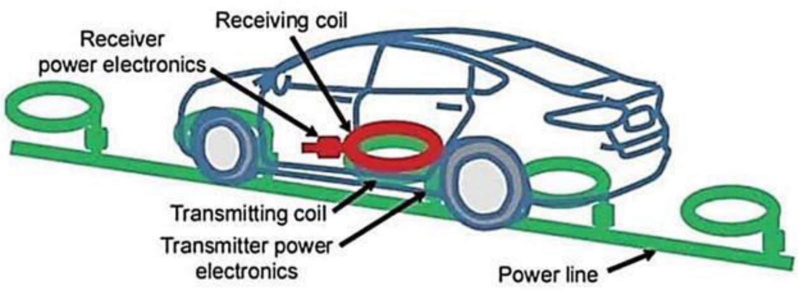
Ongoing research endeavors focus on enhancing the efficiency, expanding the power transfer range, and improving the affordability of wireless charging systems for EVs. Additionally, exploration into concepts for dynamic in-road charging is underway, showcasing a commitment to continual innovation in the field.

IV. RESOURCES FOR FURTHER STUDY

https://ijirt.org/master/publishedpaper/IJIRT150995_PAPER.pdf "[PDF] SOLAR WIRELESS ELECTRIC VEHICLE CHARGING SYSTEM https://www.researchgate.net/publication/372174778_SOLAR_WIRELESS_ELECTRIC_VEHICLE_CHARGING_SYST EM" "https://nevonprojects.com/solar-wireless-electric-vehicle-charging-system/"This background study provides a starting point for understanding wireless charging for EVs using solar power. As research progresses, this technology has the potential to revolutionize electric transportation by offering a convenient, sustainable, and efficient charging solution**.**



(a)



(b)

Fig1: Wireless Charging for Electric Vehicles

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V. METHODOLOGY

Wireless Charging for Electric Vehicles (EVs) using solar energy involves several steps: 1. Solar Panels Installation: Install solar panels on rooftops, carports, or dedicated solar structures in areas with ample sunlight exposure. 2. Solar Energy Conversion: Solar panels capture sunlight and convert it into electricity through the photovoltaic effect. 3. Power Regulation and Storage: Use power regulators and batteries to regulate and store the solar energy generated. This ensures a consistent and reliable power supply for charging. 4. Wireless Charging Infrastructure: Install wireless charging pads or coils embedded in the ground at designated parking spots or charging stations. 5. Receiver Coil Integration: Equip EVs with receiver coils, typically located underneath the vehicle, which can pick up the electromagnetic energy emitted by the charging pads. 6. Alignment and Efficiency Optimization: Ensure proper alignment between the charging pads and the receiver coils to maximize energy transfer efficiency. 7. Charging Process: When an EV parks over a wireless charging pad, the receiver coil in the vehicle detects the electromagnetic field and converts it back into electricity to charge the vehicle's battery. 8. Monitoring and Maintenance: Regularly monitor the system's performance, including solar panel efficiency, charging pad functionality, and battery health. Perform necessary maintenance to keep the system operating optimally. By integrating solar energy with wireless charging technology, EVs can be charged conveniently and sustainably, reducing reliance on grid electricity and fossil fuels.

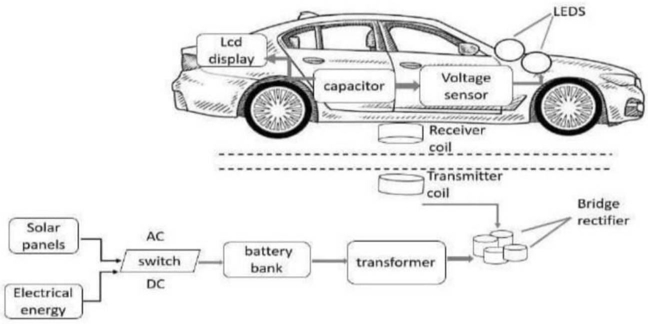

Figure 2: Methodology of Wireless Charging for Electric Vehicles using solar power

The concept of Wireless Charging for Electric Vehicles (EVs) using solar power is an exciting development that combines renewable energy with convenient charging. Here's a breakdown of the method: The Infrastructure - Solar Panels: Solar panels convert sunlight into DC electricity. These panels would likely be installed alongside the charging lanes or at designated solar farms. The infrastructure - Power Conditioning Unit: The DC electricity from the solar panels needs conversion to AC for efficient wireless transmission. This unit regulates and manages the power flow. In-Road Charging Coils: Copper coils embedded in the road beneath the designated charging lanes. These coils produce a magnetic field when supplied with alternating current (AC). The Vehicle - Receiver Coil: Positioned beneath the electric vehicle (EV), the receiver coil interacts with the magnetic field generated by the in-road coils, thereby inducing electric current into the EV's battery.

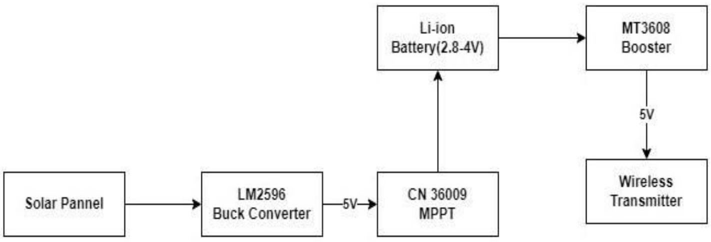

Fig. 3 Wireless Transmitter

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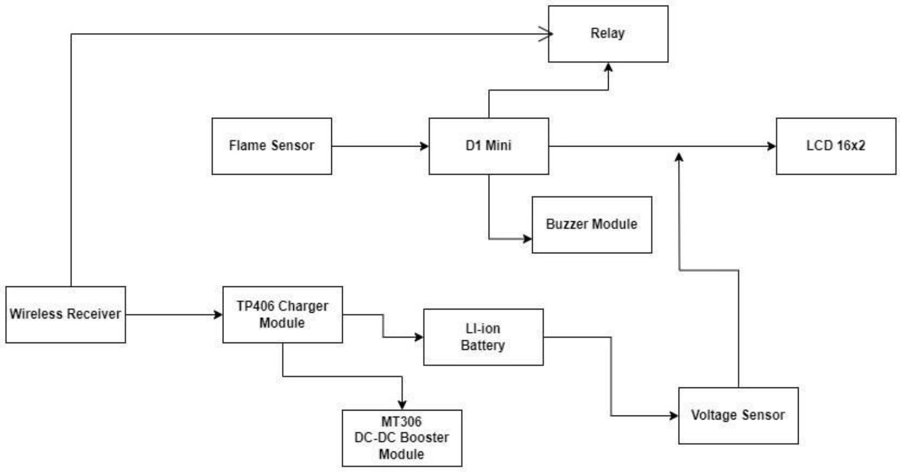

Fig. 4 Wireless Receiver

Charging Process: Solar panels generate direct current (DC) electricity, which is then converted to AC and regulated for transmission by the power conditioning unit. The AC current powers the in-road coils, generating a magnetic field. This magnetic field interacts with the receiver coil on the EV, inducing electric current, which subsequently charges the EV's battery. The DC power generated by the solar panels is stored in the battery via a charge controller. To enable wireless charging, the DC power is converted into high-frequency AC using an inverter, which is mounted on the transmitter coil. In situations where sunlight is unavailable or during cloudy weather, the electric vehicle can still be charged using domestic AC power supply (AC 220V, 50Hz). This AC power is first converted into DC and then supplied to the transmitter coil. The transmitter coil contains an inverter that converts DC to high-frequency AC. This high-frequency AC is wirelessly transmitted from the transmitter coil to the receiver coil. Upon reception, the high-frequency AC is converted back to DC and stored in the receiver battery via a battery charger module. The stored power is utilized to operate the electric vehicle. In the event of fire or smoke detection by the fire sensor, the relay module automatically halts power transmission, ceasing the charging process. Coils embedded in the road beneath designated charging lanes facilitate this charging mechanism by generating a magnetic field when energized with AC current. AC current.

VI. IMPLEMENTATION

Implementing wireless charging for electric vehicles (EVs) using solar power involves a series of critical steps. Firstly, it requires designing both the ground-based wireless charging pads and the receiver pads integrated into EVs, ensuring efficient power transfer without significant losses. Solar power generation is integral, necessitating the installation of solar panels to generate electricity, with the size of the solar array tailored to the charging system's power requirements and available installation space. Energy storage solutions, such as batteries, are incorporated to store excess solar energy for use during periods of low sunlight or high demand. The next step involves the installation of wireless charging infrastructure, including the placement of charging pads at designated parking spots or along roadways, all interconnected with the solar panels and energy storage system. EVs must be equipped with compatible wireless charging receivers, enabling them to charge when parked over the wireless charging pads. Safety and efficiency considerations are paramount, ensuring the system is safe for users and vehicles while optimizing efficiency to minimize energy losses during charging. Compliance with relevant regulations and standards for wireless charging and solar power systems is essential, varying depending on deployment location. Finally, establishing a system for monitoring charging infrastructure performance and conducting regular maintenance ensures optimal operation. At the receiver end, necessary components are acquired, including NodeMCU ESP8266, wireless transmitter and receiver coil, flame sensor, relay module, solar panel, TP4056 lithium battery charger, 16x2 LCD display, and a lithium-ion battery. A wireless charging system is developed utilizing the transmitter and receiver coil for efficient power transfer, with the NodeMCU ESP8266 integrated for communication and control between the charging system and the electric vehicle**.**

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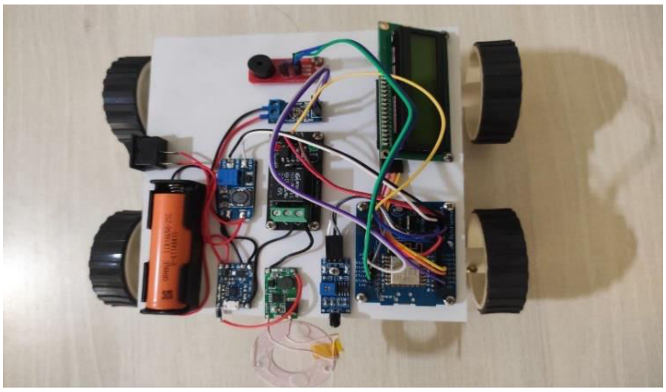

Figure 5: Receiver end of the model

Incorporated a flame sensor to detect any potential fire hazards during the charging process, ensuring user safety. Integrated relay module for controlling power flow and safety shutdown mechanisms. Utilized the 16x2 LCD display for real-time monitoring of charging status, battery levels, and system alerts. Integrated a 12V, 10W solar panel to provide renewable energy for charging, enhancing sustainability and reducing reliance on grid power. Implemented TP4056 lithium battery charger for efficient and safe charging of the lithium-ion battery used in the system. Ensured compatibility and proper charging protocols to maintain battery health and longevity. Constructed a model of an electric vehicle incorporating the developed wireless charging system. Tested the functionality and performance of the prototype to ensure seamless integration and operation.

Figure 5: Transmitter end of the model

Transmitter end: Design and construct the transmitter model housing for accommodating the components securely and efficiently. Integrate the 12V, 10W solar panel into the transmitter model to harness renewable energy for charging purposes. Install the TP4056 lithium battery charger within the transmitter model to facilitate charging of the lithium battery. Develop the necessary code for the transmitter model to regulate power transfer, monitor charging status, and ensure safety features. Integrate the code into the NodeMCU ESP8266 microcontroller for controlling the transmitter model's operation. Conduct comprehensive testing of the transmitter model to verify functionality, efficiency, and reliability. Optimize the system for improved performance, ensuring compatibility with the wireless receiver coil and electric vehicle charging requirements.

VII. RESULTS

Wireless charging for electric vehicles using solar power presents numerous advantages. By leveraging renewable energy sources, it promotes sustainability while reducing reliance on grid electricity, thereby contributing to environmental conservation efforts. Moreover, the convenience it offers, allowing vehicles to charge without the need

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for cables, enhances user experience and facilitates seamless integration into daily routines. However, the efficiency of solar panels and wireless charging systems, as well as the availability of sunlight, impact overall effectiveness. Despite these challenges, technological advancements are continuously improving the efficiency and practicality of these systems, thereby fostering the growth of eco-friendly transportation solutions. In practical terms, wireless charging for electric vehicles using solar power holds significant promise. Its advantages include environmental friendliness, as solar power is a clean and sustainable energy source that reduces reliance on fossil fuels for both electricity generation and EV charging. Additionally, the convenience it offers is unparalleled – envision continuously charging your EV while driving on designated lanes embedded with charging coils, eliminating the need for frequent stops at charging stations and potentially alleviating range anxiety. Furthermore, wireless charging eliminates the wear and tear associated with traditional charging connectors, offering a more durable and user-friendly alternative. From a technical standpoint, the feasibility of wireless charging is well-established, utilizing inductive coupling, although ongoing research is focused on enhancing efficiency and power transfer over distance. In summary, wireless charging for EVs using solar power represents a promising technology with substantial environmental and convenience benefits, yet overcoming technical challenges and addressing cost considerations are imperative.

Figure 6: Wireless Charging for Electric Vehicles towards Sustainable Transportation

VIII. CONCLUSION

Transportation plays a pivotal role in the development of any nation, and the future of the transportation industry lies in electric vehicles (EVs). Through our project, we have successfully implemented a wireless charging system. Additionally, we have designed a battery management unit that displays battery voltage on a 16x2 LCD. This measurement is facilitated by the microcontroller. Leveraging the built-in Wi-Fi module of the NodeMCU, users can conveniently monitor vehicle data from any location using the Blynk application.

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