Wireless Charging System For Electrical Vehicles On Road

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ABSTRACT

This project introduces a wireless charging system for electric vehicles (EVs) that utilizes electromagnetic induction to transfer power from coils embedded in the road to a receiver coil on the vehicle, eliminating the need for direct wired connections. The system consists of transmitter coils, a microcontroller-based monitoring system, and a battery management system (BMS) to optimize energy use and ensure real-time monitoring. It allows dynamic charging while the vehicle is in motion, reducing downtime and enhancing vehicle range, and is designed to minimize energy loss for economic efficiency. The Arduino-based control system regulates power transfer for safety and optimal performance. This wireless charging technology aims to revolutionize the EV industry by providing a seamless, contactless solution, particularly beneficial for public transport systems, fleet vehicles, and highways. It contributes to the development of sustainable, smart transportation, supporting the transition to a greener, more efficient future in the context of growing interest in renewable energy and smart cities.

Keywords: EV, BMS, Gain voltage, plug in, 12V battery, copper coils.

I INTRODUCTION

The rapid adoption of electric vehicles (EVs) has become a key strategy in addressing the global need for sustainable transportation solutions. As EVs gain popularity, the need for efficient, accessible, and widespread charging infrastructure has become more critical. Traditional charging methods typically require drivers to plug their vehicles into charging stations, which can be time-consuming and may create inconvenience, especially on long journeys. To overcome these challenges, this project proposes a wireless charging system that eliminates the need for direct wired connections, enabling a more seamless, efficient, and convenient way to charge EVs. At the heart of the proposed system is the use of electromagnetic induction to transfer energy from a stationary transmitter coil, embedded in the road, to a receiver coil mounted on the vehicle. When the vehicle moves over the transmitter coils, the alternating magnetic field generated by the coils induces power in the receiver coil, which is then converted into usable electrical energy to charge the EV's onboard battery. This process eliminates the need for physical connections, thus enabling continuous, dynamic charging while the vehicle is in motion, which addresses the limitations of stationary charging stations.

The system is designed to optimize energy transfer and ensure safety through the integration of a microcontroller-based monitoring system and a battery management system (BMS). The monitoring system continuously tracks power levels, voltage, and current, preventing power fluctuations that could harm the vehicle's battery or other components. This real-time monitoring also allows for the regulation of the power transfer, ensuring efficient and stable operation. The BMS ensures that the vehicle's battery is charged optimally, helping to extend its lifespan and improve overall system performance.

One of the key advantages of this wireless charging system is its ability to charge vehicles while they are in motion. This reduces the need for drivers to stop and plug in their vehicles, significantly decreasing downtime and increasing the range of EVs. Moreover, the system is designed to minimize energy loss, making it a cost-effective and energy-efficient solution. This is particularly valuable for public transport systems, fleet vehicles, and highways, where seamless energy supply is essential to maintaining operational efficiency. Incorporating this wireless charging technology into urban and highway infrastructure can play a pivotal role in the future of smart cities and sustainable transportation. With the growing interest in renewable energy and the need to reduce carbon emissions, the system offers a practical solution to meet the increasing demand for electric mobility. By eliminating the need for stationary charging stops and optimizing energy transfer, the proposed system has the potential to revolutionize the EV industry and significantly contribute to a greener, more efficient future.

II LITERATURE SURVEY

[1] T. K. Ghosal, M. A. H. A. Mamun, and S. M. Islam, "A Review on Wireless Power Transfer for Electric Vehicle Charging," 2019.

This paper presents a comprehensive review of wireless power transfer (WPT) techniques for electric vehicle (EV) charging, focusing on the principles of electromagnetic induction and resonant inductive coupling. The authors discuss various WPT systems, including their efficiency, charging distance, and application challenges. The study highlights the potential of dynamic wireless charging systems, where EVs can be charged while in motion, similar to the system proposed in the project. The review concludes that although significant progress has been made, further research is needed to improve energy transfer efficiency and reduce system costs.

[2] A. S. Tiwari, P. K. Jain, and S. S. Gupta, "Design and Development of Wireless Charging for Electric Vehicles," 2020.

This paper examines the development of wireless charging technologies for electric vehicles, focusing on the design of transmitter and receiver coils. The authors review electromagnetic induction-based charging systems and compare them with conventional plug-in methods. Their findings suggest that wireless charging offers increased convenience and efficiency for users, eliminating the need for physical connections. The authors also explore the integration of advanced control systems to ensure efficient energy transfer, which aligns with the system proposed in the project for dynamic charging while the vehicle is in motion.

[3] J. R. S. S. L. Prabhu, "Electromagnetic Induction-Based Wireless Charging for Electric Vehicles: A Review," 2021.

This review article explores the use of electromagnetic induction for wireless charging of electric vehicles, highlighting both stationary and dynamic charging methods. The author discusses the technological advancements, challenges, and safety considerations in the development of such systems. One of the key aspects of the paper is the emphasis on improving the power transfer efficiency and minimizing losses, which is central to the design of the wireless charging system outlined in the project. The author also highlights the potential for integrating these systems into existing infrastructure.

[4] H. A. M. A. Mamun, T. K. Ghosal, and M. R. Islam, "Dynamic Wireless Charging System for Electric Vehicles: Challenges and Opportunities," 2020.

This paper investigates the challenges and opportunities associated with dynamic wireless charging systems for electric vehicles. The authors analyze the potential benefits of charging EVs while in motion, including extended driving range and reduced charging downtime. They also discuss the technical obstacles, such as maintaining stable power transfer and ensuring vehicle safety during charging. The findings support the feasibility of the proposed system, emphasizing the importance of real-time monitoring and efficient energy management to achieve optimal performance, as reflected in the project's design.

[5] L. G. A. W. B. Chien, "Smart City Integration with Wireless EV Charging Systems: A Review," 2021.

This paper explores the integration of wireless charging systems for electric vehicles in smart city infrastructure. The authors discuss the benefits of implementing wireless charging on public roads and highways, enhancing the operational efficiency of public transport and fleet vehicles. The paper emphasizes the role of control systems in regulating energy transfer, a concept central to the proposed project's design using an Arduino-based monitoring system. The study highlights the growing importance of dynamic wireless charging in fostering sustainable urban mobility.

[6] P. S. R. K. Reddy and D. S. S. B. D. R. Rajendra, "Battery Management System for Electric Vehicle Wireless Charging," 2022.

This study focuses on the integration of battery management systems (BMS) with wireless charging systems for electric vehicles. The authors explain how a BMS can optimize energy storage and distribution during wireless charging, ensuring that the EV's battery operates efficiently. The paper also discusses the importance of monitoring systems to prevent overcharging and undercharging. The concepts presented in the paper are in line with the proposed project, which integrates a BMS to regulate energy use and improve the overall performance and lifespan of EV batteries during wireless charging.

III WORKING METHODOLOGY

The working methodology of the proposed wireless charging system for electric vehicles (EVs) revolves around the principles of electromagnetic induction. The system consists of a transmitter coil embedded in the road, a receiver coil installed on the vehicle, and a control system to ensure efficient power transfer. The transmitter coil, connected to an external power source, generates an alternating magnetic field. When an EV moves over this coil, the receiver coil mounted on the vehicle captures the magnetic field and converts it into electrical energy to charge the vehicle's battery.

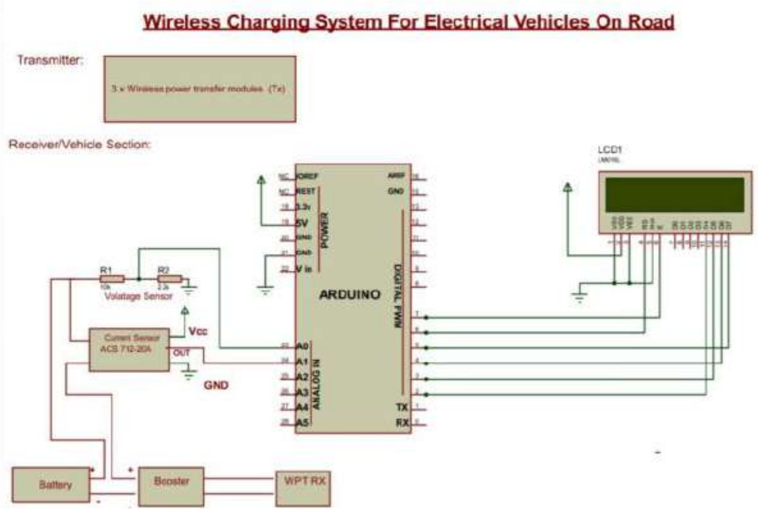

Fig.1. System model diagram.

The receiver coil captures the alternating magnetic field produced by the transmitter coil and induces a current within the coil. This induced current is then converted into usable electrical energy using a power conversion system, which feeds the energy to the vehicle's battery. The energy conversion process is optimized to minimize energy loss, ensuring that the maximum possible power is transferred to the vehicle's battery as it moves over the transmitter coils, enabling continuous charging without the need for the vehicle to stop.

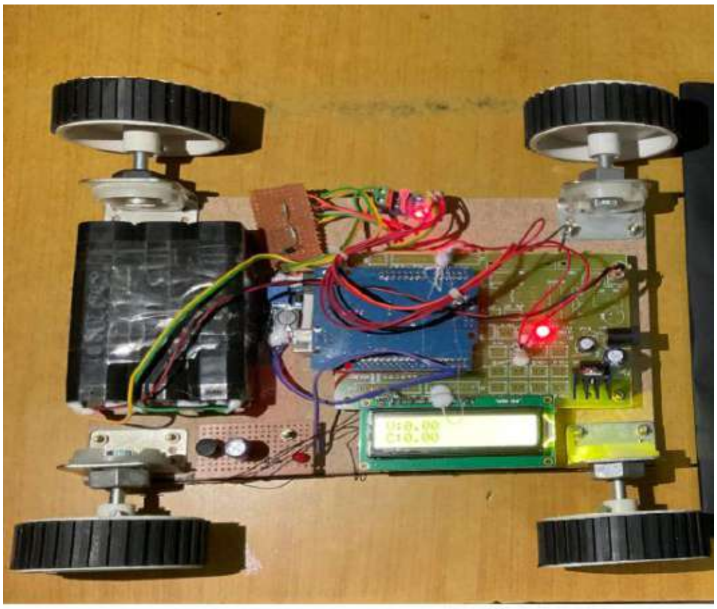

Fig.2. Vehicle setup image.

A crucial part of the system is the integration of a Battery Management System (BMS) that regulates the flow of energy to the EV's battery. The BMS ensures the battery is charged efficiently by controlling the voltage and current provided to it. It also monitors the battery's state of charge (SOC), preventing issues like overcharging or undercharging, which could potentially damage the battery. This optimization extends the lifespan of the battery and ensures that the vehicle's charging process is both safe and effective. The power transfer process is regulated by an Arduino-based microcontroller-based control system that continuously monitors and adjusts the power flow. The system is equipped with sensors that measure voltage, current, and other key parameters in real-time. The control system uses this data to regulate the power transfer and ensure that the vehicle receives a consistent, stable charge as it moves over the transmitter coils. In case of any fluctuation or power disruption, the system can quickly respond to ensure optimal and safe energy transfer.

One of the standout features of this wireless charging system is the dynamic charging capability, which allows the EV to charge while it is in motion. As the vehicle moves over the transmitter coils, the receiver coil captures power continuously, enabling charging without stopping. This dynamic charging significantly enhances the vehicle's range, reduces charging downtime, and optimizes the usage of road infrastructure. Furthermore, the system is designed to be energy-efficient with minimal power loss, ensuring that the wireless charging process is both practical and economically viable for large-scale deployment.

IV IMPLEMENTATION

The implementation of the wireless charging system for electric vehicles (EVs) involves integrating multiple components to create a seamless power transfer mechanism. First, the transmitter coils are embedded in the road surface at strategic locations such as highways or urban roads, powered by an external source. These coils generate an alternating magnetic field when energized, which propagates above the surface. The vehicle, equipped with a receiver coil, moves over these transmitter coils, capturing the magnetic field and converting it into electrical energy. This energy is then transferred to the vehicle's battery for charging. Next, the receiver coil, which is mounted on the vehicle, uses electromagnetic induction to capture the magnetic field from the transmitter coils. The induced current is then processed by a power conversion system that converts the AC (alternating current) into DC (direct current) suitable for charging the vehicle's battery. To ensure that the energy transfer is efficient and stable, a microcontroller-based control system, equipped with voltage and current sensors, continuously monitors the charging parameters. The system adjusts the power transfer rate to maintain a consistent charge, ensuring that the battery is charged safely and efficiently during operation.

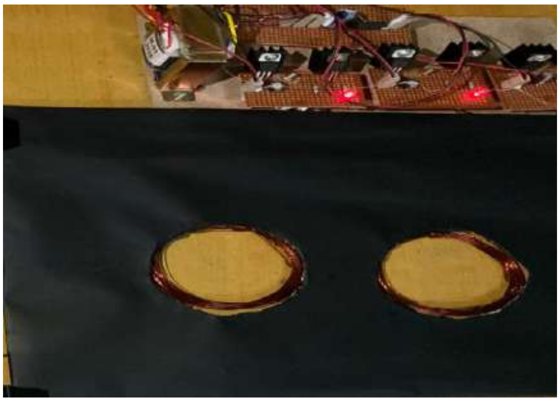

Fig.3. Road setup of TX side

The final stage of the implementation involves the integration of a Battery Management System (BMS) within the vehicle. The BMS regulates the charging process by managing the voltage and current to prevent overcharging or undercharging, which could damage the battery. The system is also responsible for monitoring the state of charge (SOC) and ensuring optimal energy utilization. This control ensures that the vehicle's battery is charged efficiently, maximizing its lifespan. Furthermore, the system can detect any fluctuations in power supply and immediately adjust the charging process, ensuring smooth and uninterrupted power transfer as the vehicle moves over the charging coils. This implementation creates a dynamic and reliable wireless charging solution for electric vehicles.

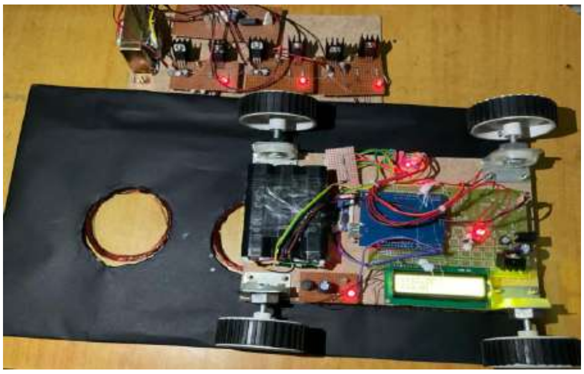

Fig.4. Output of charging EV vehicle

CONCLUSION

In conclusion, the proposed wireless charging system for electric vehicles offers a transformative solution to enhance the convenience and efficiency of EV charging. By leveraging electromagnetic induction and integrating a dynamic charging mechanism, the system allows vehicles to charge while in motion, eliminating the need for frequent stops at charging stations. The use of a microcontroller-based control system and a Battery Management System ensures optimal power transfer, energy efficiency, and safety. This innovative approach not only improves vehicle range and reduces downtime but also represents a significant step toward the development of smart, sustainable transportation infrastructure, contributing to the widespread adoption of electric vehicles and the realization of a greener future.

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