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Smart Wireless Charging System For Electric Vehicles

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ABSTRACT

In this project, we seek to investigate the viability and potential of wireless charging for electric vehicles (EVs). Our initial step is to research the different wireless charging technologies that are available today, with an emphasis on determining the most efficient, practical, and effective approach for actual application. Once we have thoroughly assessed the alternatives, we will choose the technology that provides the optimal combination of performance, safety, and cost-effectiveness. After determining the most appropriate method, we intend to create and construct a functional prototype that illustrates how wireless charging can be used in EVs. This prototype will not only indicate the operation of the system but also enable us to conduct experiments to evaluate its performance under varying conditions. We will contrast the operation and efficiency of the prototype with conventional wired charging techniques to learn the real differences between the two methods. Along with technical assessment, we will evaluate the financial implications of implementing wireless charging technology. We also consider the cost of implementation for this technology and analyse the outcome of it over the cost of investment.

Keywords: Wireless Charging, Electrical Vehicles (EV's), Technology, Prototype, Cost of Investment.

I. INTRODUCTION

With the increasing momentum towards sustainable and eco-friendly solutions globally, electric vehicles (EVs) have become an essential component of transportation in the future. EVs provide a cleaner substitute for conventional internal combustion engine vehicles, with lower greenhouse gas emissions and fossil fuel dependency. Nevertheless, with all their popularity, there remain issues with convenience, safety, and efficiency in charging infrastructure to prevent greater uptake. Today, EVs are mainly charged using wired charging stations, where users need to plug in heavy cables themselves. Although functional, this has some disadvantages such as cable deterioration, safety concerns in inclement weather, and user inconvenience to those with limited mobility or who occupy public places.

To overcome these constraints, wireless charging technologies have been of particular interest. Wireless charging, specifically via inductive coupling, does away with physical connectors because it transfers energy from a transmitting coil in the charging pad to a receiving coil in the vehicle through an electromagnetic field. This process is safer, more resilient, and user-friendly, allowing drivers to merely drive over a charging pad to charge without having to intervene manually.

This study aims to design and implement a prototype wireless charging system for electric vehicles based on inductive coupling. The system proposed incorporates major components such as transmitting and receiving coils, control circuit, distance sensor, and microcontroller that manages the charging process. Through the detection of the vehicle's presence and alignment, the system ensures that charging is only initiated in ideal conditions, enhancing safety and energy efficiency. An LCD screen gives real-time charging status and battery level feedback.

With this project, we hope to prove the viability of wireless charging for EVs and investigate its potential for use in contemporary transportation infrastructure, furthering the ultimate vision of sustainable and convenient mobility.

II. LITERATURE SURVEY

[1] Wireless charging technologies for electric vehicles: Inductive, capacitive, and magnetic gear. The authors are Ahmed A. S. Mohamed, Ahmed A.

Shaier, Hamid Metwally, Sameh I. Selem. This paper discusses various wireless charging technologies for electric vehicles and highlights the most promising ones: IPT, CPT, MWPT, and MGWPT. It discusses how these systems operate, their configurations, and their advantages and disadvantages. Through comparison of such factors as cost, efficiency, power and frequency, the research assists in determining the best solutions for EV charging. Overall, it demonstrates that wireless charging has the potential to contribute significantly to making electric vehicles more convenient and might even enable future innovations such as self-charging

and autonomous vehicles, bringing us closer to a cleaner, more intelligent transportation system.

[2] Wireless Fast Charging Solutions for Electric Vehicles: Future Trends and Technological Challenges. The authors are V. Mokshayini, P. Sindhuri, K. Vivek, P.A. Mohanarao, Aakula Swathi, Vasupalli Manoj. This paper discusses wireless rapid charging technologies for electric vehicles have enormous prospects but face severe challenges. Magnetic Resonance has the best speed and flexibilit and is well suited for high-power, fast-charging applications, but its premium price tag and low efficiency preclude its wider use. Inductive charging strikes the middle ground with a happy balance between performance and cost and provides a suitable solution to public and domestic charging facilities. Capacitive Coupling, though cheaper, lags behind in speed and charging range, limiting its use to certain applications. Efficiency continues to be the greatest challenge to wireless charging systems, with wire alternatives still outcompeting wireless in energy consumption. Interference, safety concerns, an infrastructure investments are also primary barriers to implementation[2]. New innovation is necessary to unlock the maximum potential of wireless fast charging through increased efficiency, reduced cost, and assurance of safety. As technology evolves, wireless charging could become a crucial element in the EV ecosystem, facilitating the global transition to sustainable mobility.

III. PROBLEM STATEMENT

The increasing adoption of electrical vehicles (EV's) necessities efficient and convenient charging solutions. Traditional wired charging systems pose limitations in terms of accessibility, safety, and maintenance. This project aims to develop a smart wireless charging system.

IV. METHODOLOGY

The procedure for research on wireless fast charging technologies for electric vehicles (EVs) involves a number of key steps. To start with, there will be a thorough literature review to gather information regarding available technologies, efficiency measures, and issues with wireless charging. This review will provide a foundation for grasping current advancements and identifying areas of technology gaps.

Next, we plan to design and build an experimental prototype of a wireless charging system using inductive coupling technology [2]. This prototype will go through thorough testing to check how efficiently it transfers power. We'll measure things like energy loss and how long it takes to charge under different conditions.

We'll also focus on safety by testing for issues like electromagnetic interference, overheating, and overall system safety. Alongside this, we'll review current standards and protocols for wireless charging to see where improvements are needed and suggest ideas for creating universal standards, so different EV models and chargers can work together.

A cost-benefit analysis will help us understand whether it's financially practical to use wireless charging, considering installation and long-term maintenance costs. We'll also use simulations and models to predict how well the system would perform with different types of vehicles and in various weather conditions. Lastly, we'll study real-world examples of existing wireless charging systems to learn about their performance, challenges, and potential for wider use in the future.

V. RESULTS

We have worked on a Smart Wireless Charging System for Electric Vehicles using magnetic induction technology. The setup includes a transmitter coil powered by a 9V battery regulated through a buck converter to supply safe 5V DC, preventing damage. When an EV approaches the station, an ultrasonic sensor detects it within 20cm, prompting the LCD to display **"Ready to charge, park vehicle."** If not aligned properly, the LCD shows **"Checking, adjusting car."** At 3cm, charging begins with the message **"EV charging, please wait."** If misaligned, it displays **"Too far, move backward"** or **"Too close, move forward."** On the vehicle side, a receiver coil transfers energy to a TP4056 module, which charges the battery. A microcontroller monitors voltage, charging, and discharging, and sends real-time updates to an LCD and cloud, viewable via phone or laptop. Once charging is complete, the system displays **"Thank you, visit again."** This smart, contactless system enhances user convenience and charging safety.

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Fig.1: Ready to charge Park Vehicle

Fig.2: Checking Adjusting Car

Fig.3: – EV-Charging… Please wait…

VI. CONCLUSION

Electric vehicle charging was shown to be effective and user-friendly with the inductive coupling technology-based wireless charging system. Our project has contributed to the advancement of wireless charging technology for electric vehicles, particularly in the area of inductive coupling. By developing a smart and efficient system, we have demonstrated the potential for wireless charging to become a viable and convenient option for electric vehicle owners. However, there are still limitations and challenges to be addressed in terms of cost, standardization, and widespread implementation. Further research and development in these areas will be necessary to fully realize the potential of wireless charging for electric vehicles.

VII. FUTURE SCOPE

• **Optimization of the power transmission efficiency:**

Further optimization of the power transmission efficiency to reduce energy losses during wireless charging. This can be achieved through improvements in the design of the coils and the control circuitry.

• **Integration of renewable energy sources:**

The integration of renewable energy sources, such as solar panels, to power the wireless charging

system. This would not only reduce the dependency on the grid but also make the system more sustainable and eco-friendly.

• **Creation of a control system that is more reliable and effective:**

The development of a more robust and efficient control system that can detect and mitigate any interference or obstacles that may affect the charging process. Advanced sensors and algorithms can be used to accomplish this.

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