WIRELESS POWER TRANSFER SYSTEM FOR ELECTRIC VEHICLE APPLICATION

Shweta Gadgay[1], Premkumar[2], Vishwabasava[2], Toran Vivek[2]

ABSTRACT

A Wireless Power Transfer (WPT) system for electric vehicle applications enables efficient, contactless energy transmission between a charging pad and the vehicle. This project focuses on designing a resonant inductive coupling system to improve power transfer efficiency, safety, and convenience. The system eliminates physical connectors, reducing wear and maintenance while enhancing user comfort. Key components include a transmitter coil, receiver coil, power electronics, and control circuitry. The proposed solution aims to achieve high efficiency over short distances, making it suitable for stationary and dynamic EV charging, supporting the future of sustainable and smart transportation.

KEYWORDS: Wireless Power Transfer (WPT), Electric Vehicles (EVs), Resonant Inductive Coupling, Contactless Charging, Power Electronics, Charging Efficiency, Dynamic Charging

Access Online

Article DOI:
10.5281/zenodo.21374151

[1] Professor, Department of Electronics and Communication Engineering, Guru Nanak Dev Engineering College, Bidar, Karnataka, India
[2] UG Student, Department of Electronics and Communication Engineering, Guru Nanak Dev Engineering College, Bidar, Karnataka, India

How to Cite:
Shweta Gadgay, Premkumar, Vishwabasava & Toran Vivek (2026), Wireless Power Transfer System for Electric Vehicle Application, International Educational Journal of Science & Engineering (IEJSE),Vol: 9, Special Issue, May 2026 94-99

Research Paper

I. INTRODUCTION

The increasing adoption of electric vehicles (EVs) has highlighted the need for efficient, safe, and convenient charging technologies. Traditional wired charging systems, while effective, suffer from drawbacks such as mechanical wear, safety risks, and user inconvenience. Wireless Power Transfer (WPT) offers a modern solution by enabling contactless energy transfer between a ground-based transmitter and a vehicle-mounted receiver. This system operates primarily on resonant inductive coupling, which allows efficient power transfer over short distances.

In this project, a wireless charging system is designed to enhance energy efficiency, reliability, and ease of use. It incorporates power electronic circuits, compensation techniques, and control mechanisms to maintain stable power flow. The system also supports both stationary and dynamic charging, reducing dependency on frequent plug-in charging. Overall, WPT technology plays a significant role in advancing sustainable and intelligent transportation systems.

II.LITRATURE SURVEY

Recent studies on Wireless Power Transfer (WPT) for electric vehicle (EV) applications focus on improving efficiency, reliability, and usability. Early research established that WPT can transfer energy through electromagnetic fields using techniques such as inductive, capacitive, and resonant inductive coupling. Among these, resonant inductive coupling is widely preferred due to its higher efficiency and ability to transfer power over moderate distances.

Several researchers have significantly contributed to the development of Wireless Power Transfer (WPT) systems for electric vehicle applications. Emrullah Aydin, Mehmet Timur Aydemir, and Ahmet Aksoz, along with Mohamed El Baghdadi and Omar Hegazy, have worked extensively on inductive power transfer systems and EV charging technologies. Their studies mainly focus on improving system efficiency, coil design, and overall performance of wireless charging systems.

In addition, Iman Okasili, Ahmad Elkhateb, and Timothy Littler have contributed to the design and analysis of WPT systems, particularly in the areas of compensation techniques and power converter topologies. Their research highlights methods to enhance power transfer efficiency and maintain stable operation under varying conditions.

Furthermore, Alicia Triviño-Cabrera, José M. González-González, and José A. Aguado have explored different wireless charging methods, including inductive and resonant techniques, focusing on practical EV applications. Researchers such as Xi Zhang, Chong Zhu, and Haitao Song have also worked on advanced WPT technologies, optimizing system design and improving performance for real-world implementation.

Finally, authors like Prince, Dr. Vipin Kumar, and Weijian Jin have studied system optimization, efficiency analysis, and design improvements, contributing to the ongoing development of reliable and efficient wireless EV charging systems.

III.EXISTING SYSTEM

The existing system for wireless communication in electric vehicle (EV) environments primarily relies on the Dedicated Short Range Communication (DSRC) protocol, which utilizes the Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) technique. Although widely adopted, this approach exhibits significant limitations in high-density traffic scenarios, particularly in vehicle-to-fog communication frameworks. The inefficiency of CSMA/CA under heavy network loads leads to increased contention, latency, and packet collisions, thereby reducing overall communication reliability. Furthermore, current channel allocation techniques demonstrate a higher average packet drop rate as the number of EVs increases, adversely affecting data transmission performance and system scalability. Existing technologies also present several research challenges, including limited bandwidth utilization, lack of adaptive resource management, and vulnerability to dynamic network conditions. These challenges highlight the need for improved communication protocols and more efficient channel allocation strategies. Addressing these issues is essential to ensure robust, low-latency, and scalable communication systems for next-generation EV applications and intelligent transportation systems.

IV.PROPOSED SYSTEM

The proposed system employs an advanced BSoC-based power scheduling method to balance EV battery charge, improving efficiency and lifespan. It also integrates passive and active shielding techniques to reduce electromagnetic leakage in wireless power transfer systems, enhancing safety, reliability, and overall performance for next-generation electric vehicle charging applications.

The system consists of the following main components:

- Arduino uno
- Wireless power transfer
- IR sensor
- Voltage sensor
- Relay

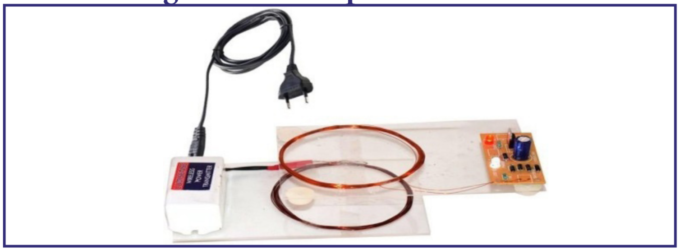
A. ARDUINO UNO:

Fig. 1: Arduino uno

The Arduino Uno serves as the central control unit of the system, coordinating sensing, control, and communication tasks. It processes inputs from voltage and ultrasonic sensors and manages relay switching operations. Its microcontroller enables real-time decision-making, ensuring efficient wireless power transfer and safe operation of the electric vehicle charging process.

B.WIRELESS POWER TRANSFER:

Fig. 2: Wireless power transfer



Wireless Power Transfer enables contactless energy transmission between transmitter and receiver coils using electromagnetic induction. In EV applications, it eliminates physical connectors, enhancing convenience and safety. The WPT module ensures efficient power delivery while minimizing losses, supporting dynamic or stationary charging and contributing to improved user experience and system reliability.

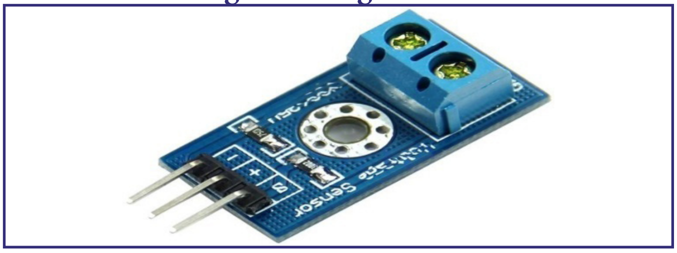
C . LCD DISPLAY:

Fig. 3: LCD display:

The 16x2 LCD Display is used to provide real-time system information such as voltage levels, charging status, and sensor outputs. It improves user interaction and monitoring by displaying essential parameters, ensuring better control, system transparency, and effective management of the wireless power transfer process.

D. VOLTAGE SENSOR

Fig. 4: Voltage sensor



The voltage sensor monitors the electrical parameters of the system, particularly battery voltage levels during charging. It provides real-time feedback to the controller for regulating power flow and preventing overcharging or undervoltage conditions. This ensures battery protection, system stability, and efficient energy management in the wireless charging process.

E. RELAY

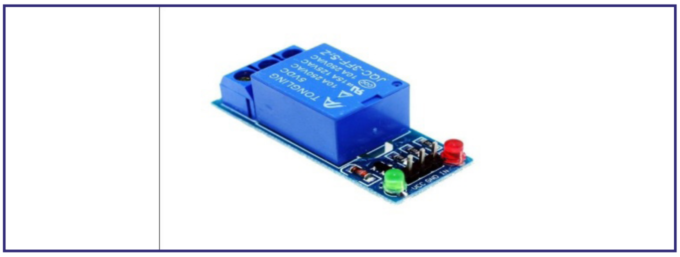
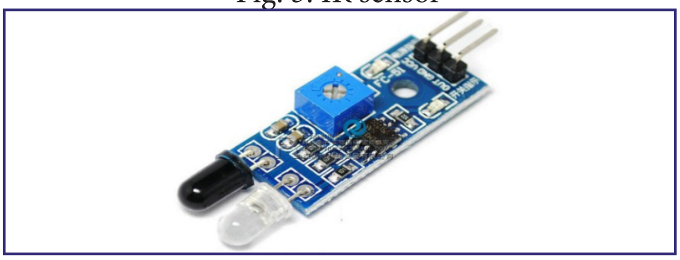


Fig 5: Relay

The relay acts as an electrically operated switch controlled by the microcontroller to regulate power flow in the system. It enables safe connection and disconnection of the charging circuit based on system conditions. This component ensures protection against faults, enhances control flexibility, and supports automated operation of the wireless charging system.

F. IR SENSOR

Fig. 5: IR sensor

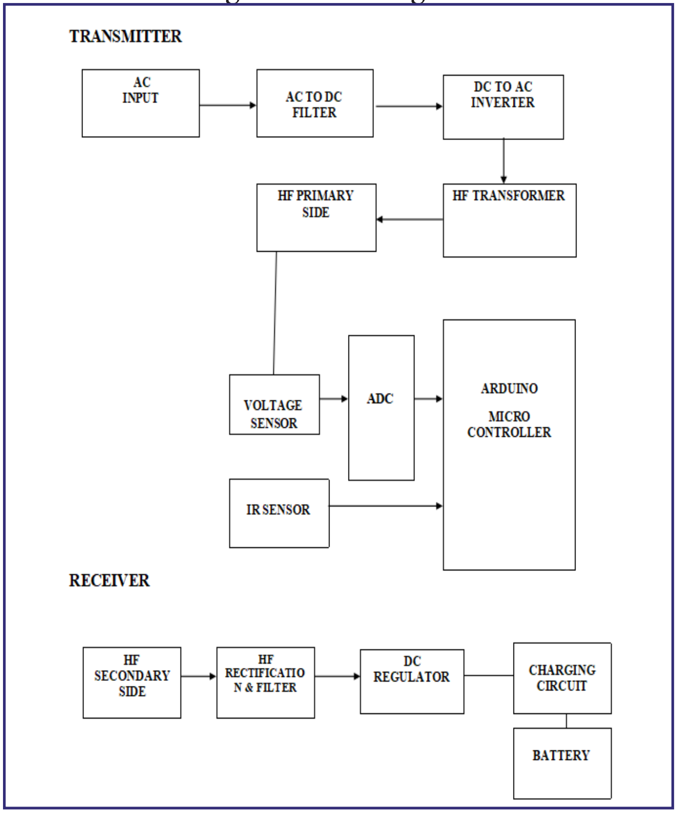


The IR sensor detects the presence and alignment of the electric vehicle over the wireless charging pad using infrared radiation. It enables automatic system activation when a vehicle is positioned correctly.

This enhances efficiency, reduces energy loss, and supports safe, contactless operation in the wireless power transfer system.

V. METHODOLOGY

Fig. 6: Block Diagram



The proposed Wireless Power Transfer (WPT) system for electric vehicle (EV) applications is designed to enable efficient, contactless energy transfer using high-frequency electromagnetic coupling. The transmitter section begins with an AC input, which is converted to DC using an AC–DC rectifier and filter. This DC is then inverted back to high-frequency AC through a DC–AC inverter, which drives the high-frequency (HF) primary coil. The HF transformer facilitates wireless energy transfer to the receiver side.

The system incorporates a voltage sensor and IR sensor interfaced with an ADC and a microcontroller (Arduino) to ensure intelligent control. The voltage sensor monitors system parameters, while the IR sensor detects vehicle presence and alignment. The microcontroller processes these inputs to regulate operation and improve efficiency and safety.

On the receiver side, the HF secondary coil captures the transmitted energy, which is then rectified and filtered to obtain DC output. A DC regulator stabilizes the voltage before supplying it to the charging circuit, which charges the EV battery. This architecture ensures efficient power transfer, reduced losses, and safe operation. Overall, the system enhances convenience, automation, and reliability in EV charging applications.

VI. CIRCUIT DIAGRAM

Fig. 7: Circuit Diagram

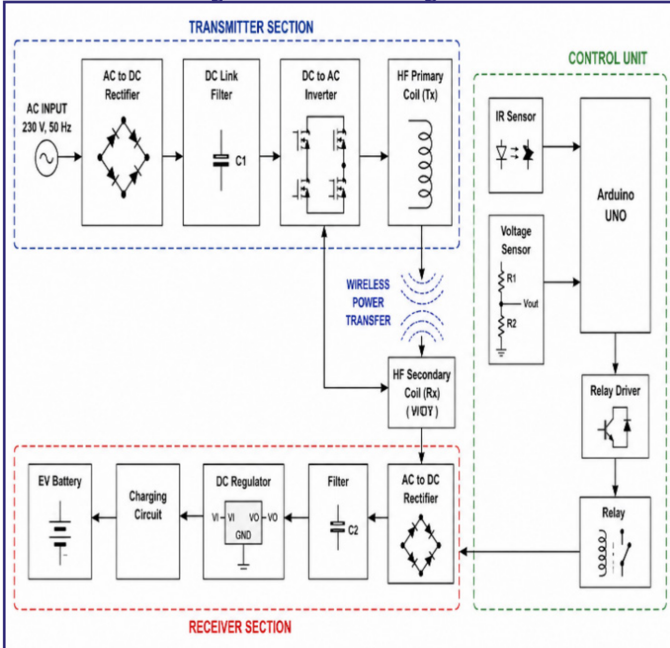


Fig. 1. Simplified circuit diagram of Wireless Power Transfer system for EV application.

The proposed Wireless Power Transfer (WPT) system for electric vehicle (EV) applications is designed to achieve efficient, contactless energy transfer using high-frequency electromagnetic coupling. The system is divided into three main sections: transmitter, receiver, and control unit. In the transmitter section, an AC input supply is first converted into DC using a rectifier, followed by filtering through a DC link capacitor to remove ripples. The filtered DC is then converted into high-frequency AC using a DC–AC inverter, which energizes the high-frequency (HF) primary coil, enabling wireless transmission of power.

The receiver section consists of an HF secondary coil that captures the transmitted energy through magnetic coupling. The induced AC voltage is converted into DC using a rectifier and further smoothed by a filter capacitor. A DC regulator is employed to maintain a stable output voltage suitable for the charging circuit, which is used to charge the EV battery efficiently and safely.

The control unit, implemented using an Arduino Uno, plays a crucial role in system automation and protection. It receives input from an IR sensor for vehicle detection and a voltage sensor for monitoring system parameters. Based on these inputs, the controller manages the relay operation to enable or disable power transfer. This integrated approach ensures improved efficiency, safety, and reliability, making the system suitable for modern EV charging applications.

VII. RESULT

The experimental results of the proposed Wireless Power Transfer (WPT) system demonstrate efficient and reliable performance for electric vehicle (EV) charging applications. The system successfully achieves contactless energy transfer between the transmitter and receiver coils using high-frequency electromagnetic coupling. The output obtained at the receiver side is stable and suitable for battery charging after rectification, filtering, and voltage regulation.

The integration of the Arduino Uno enhances system automation by effectively controlling the charging process based on sensor inputs. The IR sensor accurately detects vehicle presence and alignment, ensuring that power transfer occurs only under proper conditions. Additionally, the voltage sensor continuously monitors system parameters, preventing overcharging and maintaining battery safety.

The use of a regulated DC output ensures consistent charging performance with minimal energy loss. The relay mechanism provides reliable switching, improving overall system protection. Experimental observations indicate reduced power loss, improved efficiency, and stable operation under varying conditions. Overall, the proposed system proves to be a safe, efficient, and practical solution for wireless EV charging, contributing to the advancement of intelligent transportation systems.

VIII. CONCLUSION

In conclusion, the Wireless Power Transfer (WPT) system for electric vehicle applications presents a promising advancement in modern energy transmission technology. By enabling contactless power delivery through electromagnetic coupling, the system enhances convenience, reduces wear and tear associated with physical connectors, and improves overall safety. The integration of efficient power electronic components ensures stable and reliable energy transfer with minimal losses. Furthermore, the system supports sustainable transportation by facilitating efficient EV charging infrastructure. Despite challenges such as alignment sensitivity and efficiency optimization, the proposed design demonstrates strong potential for real-world implementation, contributing to the development of smarter and more user-friendly electric mobility solutions.

IX. FUTURE SCOPE

The future scope of the proposed Wireless Power Transfer (WPT) system focuses on enhancing efficiency, scalability, and real-time adaptability for electric vehicle (EV) applications. Advanced control algorithms integrated with the Arduino Uno or higher-performance controllers can enable dynamic charging and intelligent energy management. Incorporating IoT-based monitoring and communication technologies can improve system automation and remote diagnostics. Further research can explore high-power transfer capabilities, improved coil design, and better shielding techniques to minimize electromagnetic interference. Additionally, integration with renewable energy sources and smart grid infrastructure can promote sustainable and eco-friendly EV charging solutions.

REFERENCES

1. L. Cheng, Y. Chang, Q. Wu, W. Lin and C. Singh, “Evaluating charging service reliability for plug-in EVs from the distribution network aspect,” IEEE Transactions on Sustainable Energy. IEEE, vol. 5, pp.1287-1296, 2014.
2. N. Xu and Y. Chung, “Reliability evaluation of distribution systems including vehicle-to-home and vehicle-to-grid,” IEEE Transactions on Power Systems. IEEE, vol. 31, pp.759-768, 2016.
3. A. Alahyari, M. Fotuhi-Firuzabad and M. Rastegar, “Incorporating customer reliability cost in PEV charge scheduling schemes considering vehicle-to-home capability,” IEEE Transactions

on Vehicular Technology. IEEE, vol.64, pp. 2783-2791, 2015.
4. S. Habib, M. Kamran and U. Rashid, "Impact analysis of vehicle-to-grid technology and charging strategies of electric vehicles on distribution networks--a review," Journal of Power Sources. Elsevier, vol. 277, pp.205- 214, 2015.
5. M. Ansari, A. Al. Awami, E. Sortomme and M. Abido, "Coordinated bidding of ancillary services for vehicleto-grid using fuzzy optimization," IEEE Transactions on Smart Grid. IEEE, vol. 6, pp. 261-270, 2015.
6. L. Hua, J. Wang and C. Zhou, "Adaptive electric vehicle charging coordination on distribution network," IEEE Transactions on Smart Grid. IEEE, vol.5, pp.2666- 2675, 2014.
7. N. Xu and Y. Chung, "Well-being analysis of generating systems considering electric vehicle charging," IEEE Transactions on Power Systems. IEEE, vol. 29, pp. 2311-2320, 2014.
8. W. Suand M. Chow, "Performance evaluation of a PHEV parking station using particle swarm optimization," Power and Energy Society General Meeting, 2011 IEEE., pp. 1-6, 2011.