2026 Volume: 02 Issue: 07 www.ijrpa.com ISSN 2456-9995 Research Article

International Journal Research Publication Analysis

Page: 01-14

SMART WIRELESS EV CHARGING SYSTEM

***Rachna Krishndev Shelke, Prof. S. A. Bhosale**

Electronics and Telecommunication Engineering, AMGOI,Vathar Kolhapur, Maharshtra.

Article Received: 11 June 2026
Article Revised: 01 July 2026
Published on: 21 July 2026

***Corresponding Author: Rachna Krishndev Shelke**
Electronics and Telecommunication Engineering, AMGOI,Vathar Kolhapur, Maharshtra.

DOI: https://doi-doi.org/101555/ijrpa.7742

ABSTRACT

The increasing adoption of electric vehicles (EVs) has accelerated the demand for advanced charging technologies that offer greater convenience, safety, and operational efficiency. Although conventional plug-in charging systems are widely used, they suffer from several limitations, including connector degradation, electrical safety concerns, frequent maintenance, and reduced user convenience. Wireless Power Transfer (WPT) technology provides a promising solution by enabling contactless energy transmission through electromagnetic induction. However, existing wireless charging systems continue to face challenges such as coil misalignment, reduced power transfer efficiency, limited real-time monitoring, and the absence of intelligent charging control.This paper proposes a smart wireless electric vehicle charging system designed to improve charging reliability while maintaining user safety and energy efficiency. The proposed architecture integrates an inductive power transfer mechanism with a microcontroller-based control unit, battery management system (BMS), RFID-based vehicle authentication, voltage and temperature sensing, and automatic charging control. The system continuously monitors charging conditions and regulates power delivery to prevent overcharging, overheating, and unnecessary energy consumption. Furthermore, the modular design provides a flexible platform for future integration of adaptive resonance control, IoT-enabled remote monitoring, and intelligent battery health prediction.

KEYWORDS: Electric Vehicle, Wireless Power Transfer, Inductive Charging, Battery Management System, Smart Charging, RFID Authentication, Electromagnetic Induction, Embedded Control, Energy Efficiency, IoT.

I. INTRODUCTION

The rapid growth of electric vehicle (EV) technology has become one of the most significant developments in sustainable transportation. Increasing environmental concerns, stringent emission regulations, and the depletion of fossil fuel resources have accelerated the transition from conventional internal combustion engine vehicles to electric mobility. Although EVs provide an environmentally friendly transportation solution, the availability of efficient, safe, and user-friendly charging infrastructure remains a major challenge for their widespread adoption. Conventional wired charging systems have been extensively deployed because of their relatively high charging efficiency and mature infrastructure. However, these systems require direct physical connections between the charging station and the vehicle, resulting in several practical limitations such as connector wear, cable damage, electrical safety concerns, regular maintenance, and reduced user convenience. These issues become more significant in public charging stations and high-frequency charging environments where charging connectors are subjected to repeated mechanical stress.

Wireless Power Transfer (WPT) technology has emerged as an attractive alternative by enabling contactless charging through electromagnetic induction. In this approach, electrical energy is transferred from a transmitter coil installed in the charging station to a receiver coil integrated within the electric vehicle without requiring any physical electrical connection. This technology improves user convenience, enhances operational safety, and reduces maintenance associated with conventional charging connectors. Consequently, wireless charging has attracted considerable attention from researchers, automobile manufacturers, and power electronics industries.contains a formal set of editorial guidelines for IEEE Transactions, Journals, and Letters, including:Despite recent advancements, several technical challenges continue to limit the practical implementation of wireless EV charging systems. Power transfer efficiency is highly dependent on the alignment between transmitter and receiver coils. Even minor positional deviations can significantly reduce charging efficiency and increase energy losses. In addition, thermal management, electromagnetic interference (EMI), charging safety, battery protection, and system cost remain important research issues. Most existing low-cost prototype systems also provide limited monitoring capabilities and lack adaptive control strategies for improving charging performance under varying operating conditions.To address these challenges, this research presents a smart wireless electric vehicle charging system based on inductive wireless power transfer integrated with embedded control and battery protection mechanisms. The proposed system incorporates RFID-based vehicle authentication, voltage and temperature monitoring, automatic charging control, and a Battery Management System (BMS) to ensure reliable and safe charging operation. The developed prototype continuously supervises charging parameters and automatically controls the charging process to prevent overcharging, overheating, and unnecessary power consumption while improving operational reliability.The primary objective of this work is to develop a practical, economical, and scalable wireless charging solution suitable for light electric vehicles. The proposed architecture establishes a foundation for future enhancement through intelligent charging algorithms, adaptive resonance tuning, IoT-enabled remote monitoring, and battery health prediction techniques. The outcomes of this research are expected to contribute to the development of efficient and intelligent wireless charging infrastructure for future smart transportation systems.

2.LITRATURE REVIEW

1] Ramakrishnan et al. (2024) developed a high misalignment-tolerant wireless charging system for electric vehicles using an improved inductive power transfer architecture with constant current and constant voltage (CC–CV) charging control. Their experimental results demonstrated improved charging stability under coil displacement. However, the proposed system mainly focused on hardware optimization and did not include intelligent monitoring or adaptive control techniques for further efficiency enhancement.

[2] Elymany et al. (2024) investigated the influence of coil misalignment on wireless power transfer performance using advanced transmitter and receiver pad configurations. Their study analyzed the impact of lateral displacement on magnetic coupling and charging efficiency, providing improved interoperability between different charging pad structures. Nevertheless, real-time alignment correction and intelligent decision-making were not incorporated.

[3] Nejad et al. (2024) proposed a vision-based foreign object detection system for wireless EV charging. The system employed image processing techniques to identify metallic or unwanted objects near the charging pad, thereby improving operational safety. Although the proposed method enhanced charging reliability, it was primarily focused on safety rather than improving power transfer efficiency or charging optimization.

[4] Latha et al. (2025) presented a comprehensive review of modern wireless power transfer compensation topologies for electric vehicle charging. The study compared different resonant compensation techniques in terms of efficiency, power capability, and circuit complexity. The authors highlighted that further research is required in adaptive compensation methods and intelligent control strategies to improve overall charging performance.

[5] Manivannan et al. (2025) introduced a bipolar coil arrangement to improve anti-

misalignment capability in wireless EV charging systems. The proposed coil configuration enhanced magnetic coupling and reduced efficiency degradation caused by positional errors. However, the system did not integrate battery condition monitoring or IoT-based charging supervision.

[6]R ahman and Ali (2025) proposed an Adaptive Neuro-Fuzzy Inference System (ANFIS) for dynamic wireless charging applications. Their intelligent controller minimized power loss caused by coil misalignment and significantly improved charging stability. Despite the promising results, the computational complexity of the controller may increase implementation cost for low-cost charging systems.

[7] Li et al. (2025) reviewed the application of intelligent algorithms in wireless EV charging, including machine learning, fuzzy logic, and optimization techniques. The study concluded that artificial intelligence has significant potential to improve charging efficiency, adaptive control, and battery management. However, practical low-cost implementations of these intelligent algorithms remain limited.

[8]J ournal of Power Sources Review (2025) presented a comprehensive review of wireless EV charging technologies, standards, infrastructure, and technical challenges. The authors emphasized the importance of high-efficiency power electronics, charging interoperability, and standardization for commercial deployment.

[9] The authors discussed the influence of magnetic coupler geometry on charging efficiency and demonstrated that optimized coil structures significantly improve magnetic coupling while reducing leakage flux. However, further work is required to reduce sensitivity to coil misalignment.

[10] Recent studies on battery management integration highlighted the importance of continuous monitoring of battery voltage, current, and temperature during wireless charging. Intelligent battery management was identified as an essential requirement for improving battery lifetime and charging safety.

[11]Several researchers investigated electromagnetic shielding techniques to minimize electromagnetic interference (EMI) generated during wireless charging. Their findings showed that appropriate shielding materials improve safety and reduce unwanted magnetic field leakage without significantly affecting transfer efficiency.

[12] Recent investigations on adaptive control strategies demonstrated that intelligent controllers can improve wireless charging performance under varying air gaps and loading conditions. Nevertheless, many practical prototypes still rely on fixed-frequency operation.

[13] Researchers also emphasized the growing role of IoT-enabled monitoring in wireless EV

charging systems. Remote monitoring enables continuous observation of charging status, fault diagnosis, and predictive maintenance, although its implementation in low-cost prototypes remains limited.

[14] Recent research on dynamic wireless charging suggested that in-motion charging can significantly reduce range anxiety and battery size requirements. However, infrastructure cost, alignment accuracy, and standardization continue to be major challenges before large-scale deployment becomes practical.

3. METHODOLOGY

The proposed gadget introduces a smart Wi-Fi electric vehicle (EV) charging solution especially tailored for two-wheelers. This technique outlines the entire layout—from the sensing mechanisms and power transfer structure to protection protocols and feedback systems. The key emphasis lies in automation, efficiency, and safe wireless power transfer through the use of an incorporated microcontroller-based intelligent decision system. The device is extensively divided into the following main **Subsystems:** The system consists of two main subsystems: the transmitter unit, mounted on the charging station, and the receiver unit, integrated into the electric vehicle (EV). At the core of the transmitter unit lies the STM32 Nucleo-F103RB microcontroller, which acts as the main controller for sensing and relay switching. The charging process is initiated when the system first verifies the presence and identity of the EV using a two-level detection mechanism. First, an RFID module checks for an authorized RFID tag. Second, an IR sensor detects the physical presence of the vehicle by monitoring its proximity. Only when both conditions are satisfied does the STM32 microcontroller activate a relay module that powers the wireless power transmitter coil. The transmitter coil is powered by a 12 V lithium battery and is capable of transmitting power wirelessly at 5 V/2 A using the principle of electromagnetic induction..Charging Station (Transmitter Side):This includes the primary coil connected to a high-frequency oscillator and MOSFET-based amplifier, which generates the alternating current required to produce a magnetic field. A microcontroller (Arduino) monitors input parameters and displays system status on an LCD screen. Sensors are used to track temperature and current at the station, while tuning capacitors are added to achieve resonance with the receiver coil. Vehicle Unit (Receiver Side): This has the secondary coil that receives the magnetic flux and converts it to AC voltage. A bridge rectifier converts AC to DC, and the output is regulated before reaching the vehicle's battery. An onboard microcontroller checks the battery voltage, temperature, and triggers alerts or automatic cut-offs to prevent overcharging or overheating. It also manages user authentication before allowing power flow.A comprehensive overview of the architecture is illustrated in the block diagram (Figure 1), which presents the complete interconnection of components across both the transmitter and receiver units. Power transmitted by the coil is received by the receiver coil embedded within the vehicle. This coil is connected to a rectifier circuit which converts the AC induction signal into DC. The output then flows through a boost converter (XL6319E1) to amplify the voltage to suitable levels for charging the onboard 3.7V lithium-ion battery. This output is then passed through a Battery Management System (BMS), which regulates the charging current, prevents overvoltage, and ensures the battery operates within safe thermal and electrical limits.

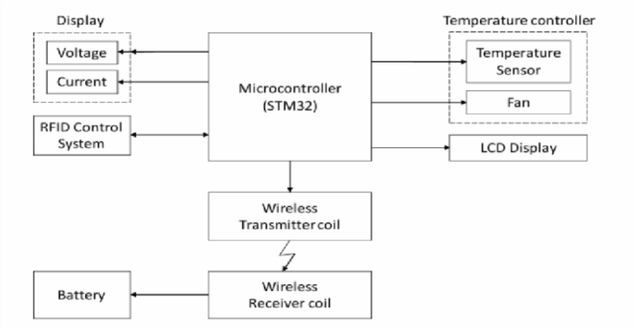

Fig 1. Block Diagram.

The output from the BMS is directly connected to the battery. To allow real-time monitoring of battery health, a voltage sensor (ZMPT101B) is connected to the positive terminal of the battery and a current display module is connected to the negative motor pin to estimate load current. Data from these sensors is displayed on a 16x2 I2C LCD display, which is placed on the transmitter side for user reference. This helps users easily observe charging voltage and current during operation.

Further safety and monitoring are enabled through a parallel control unit using an Arduino Nano. This microcontroller receives temperature input from a DHT11 sensor and battery voltage via an analog pin. It then controls two relays: one for voltage-based protection and another for temperature regulation. If the voltage exceeds 4.10V, or the ambient temperature rises above 35°C, the respective relay is deactivated, stopping the charging process. Once the voltage drops below 3.90V or temperature falls to under 34°C, the relays reactivate to resume charging. This setup introduces a hysteresis-based safety mechanism to avoid frequent toggling and ensures charging stops under potentially hazardous conditions.

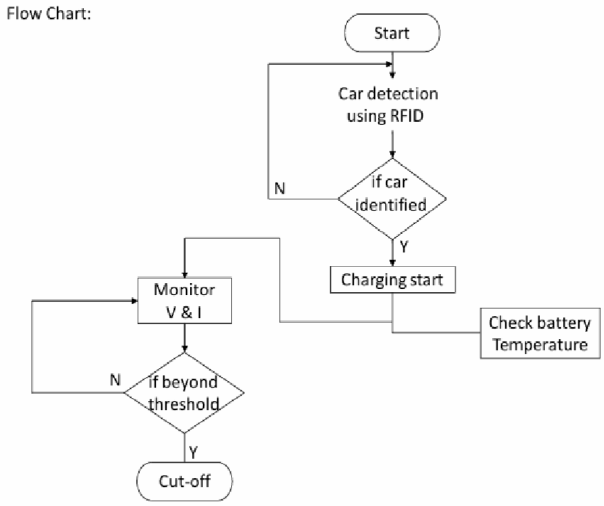

Fig 2. Flow Chart.

The sequential logic and decision-making process are illustrated in the flowchart (Figure 2). The process begins with idle monitoring through the IR sensor. Once an EV is detected, the system waits for RFID verification. Upon successful authentication, the STM32 microcontroller enables the relay and activates the wireless power transmitter coil. Simultaneously, the Arduino continuously monitors the battery voltage and temperature conditions. If either parameter exceeds its predefined threshold, the corresponding relay is switched OFF, thereby interrupting the charging process. Charging resumes only when the monitored values return to safe operating limits. This multi-layered protection mechanism ensures safe operation by preventing battery overcharging and overheating. The power transfer efficiency of the proposed system is represented by Equation (1), while Equation (2) describes the voltage regulation mechanism during the battery charging process.

The efficiency (η) of the wireless power transfer is given by the formula:

$$\eta = \frac{P_{received}}{P_{transmitted}} \times 100 \quad (1)$$

The output voltage V_{out} from the rectifier and boost converter is regulated to ensure safe charging of the battery, using the following relation:

$$V_{out} = V_{in}\left(1 + \frac{D}{1-D}\right) \quad (2)$$

Asshownagainindetermine1, Each component is carefully selected and positioned to ensure modularity, reliability, and efficient system performance. The use of the I²C communication protocol for the display simplifies wiring and reduces GPIO pin utilization, while the analog and digital input/output pins interface with the sensors and relay modules. Power isolation and switching are achieved using electromechanical relays, providing robust protection during fault conditions. Wireless power transfer occurs across an air gap of approximately 2–10 mm between the transmitter and receiver coils. The receiver coil generates a 5 V DC output after rectification and voltage regulation using a 7805 voltage regulator, ensuring a stable and reliable power supply for battery charging. Although compact, the wireless charging module is optimized for this application and supports power transfer up to 5 V, 2 A, which is sufficient for charging a lithium-ion battery from approximately 3.7 V to 4.2 V within about 20 minutes, depending on battery capacity and operating conditions.

The control flow illustrated in Figure 2 presents the system operation in clearly defined stages, making the control strategy easy to understand and implement. This modular architecture not only improves system reliability but also facilitates troubleshooting, maintenance, and future expansion. The dual-microcontroller architecture effectively separates system responsibilities: the STM32 microcontroller manages authentication and relay control, while the Arduino continuously monitors battery voltage and temperature to provide protection against overcharging and overheating. This division of tasks enhances the robustness, flexibility, and overall efficiency of the proposed wireless EV charging system. Collectively, Figure 1 and Figure 2 provide a comprehensive representation of the hardware architecture and decision-making process, clearly illustrating the system's physical interconnections and intelligent control strategy.

IV. RESULTS AND DISCUSSION

The developed wireless electric vehicle (EV) charging system was successfully tested and evaluated, demonstrating reliable performance, efficient power transfer, and enhanced safety features. The system was powered by a 12 V lithium-ion battery, which supplied energy to the transmitter coil. The receiver coil, positioned in close proximity to the transmitter coil, generated an AC voltage that was subsequently rectified into DC. A 7805 voltage regulator in the rectifier circuit regulated the output voltage to a stable 5 V DC, which was used to charge a 3.7 V lithium-ion battery.

The charging process was initiated only after successful vehicle authentication using the RFID-based access control module. Charging commenced when the battery voltage was approximately 4.0 V and gradually increased to about 4.2–4.5 V within approximately 20 minutes, depending on the battery condition. Throughout the charging process, the system maintained stable charging conditions without significant voltage fluctuations or overheating. The battery voltage, charging current, and temperature were continuously monitored to ensure safe and efficient operation.

A digital voltage and current monitoring module was used to measure the receiver coil output voltage and provide real-time feedback on the electrical parameters of the system. The measured values were simultaneously displayed on the LCD screen, enabling users to monitor the charging status and system parameters in real time. To prevent thermal buildup, a cooling fan was automatically activated when the battery temperature reached 45°C. Furthermore, the charging process was automatically terminated if the battery voltage exceeded 5.2 V or the temperature rose above 50°C, thereby protecting the battery from overcharging and thermal damage.

The experimental results confirmed that the proposed system is capable of controlling and monitoring the wireless charging process efficiently, reliably, and safely. Figure 1 illustrates the hardware prototype and LCD display showing the charging status along with real-time system parameters, while Figure 2 presents the measured performance characteristics of the proposed system. The key experimental observations include an input voltage of 12 V, a regulated output voltage of 5 V, a charging duration of approximately 20 minutes, and an increase in battery voltage from approximately 4.0 V to 4.2–4.5 V. These results demonstrate the feasibility and effectiveness of the proposed RFID-enabled wireless EV charging system, highlighting its safety, reliability, and suitability for electric two-wheeler charging applications.

TABLE 1: Charging Parameters and Operational Status.

Parameter	**Value**
VoltageCut-off	5.2V(ChargingStop)
TemperatureCut-off	50degreeC(ChargingStop)
ChargingStatus	ActiveDuringcharging
Batteryvoltage(Start)	3.7V(NorminalVoltage)
BatteryVoltage(End)	.2V(FullyCharged)
ChargingTime	20minutes4

InputVoltage	12V
RegulatedOutputVoltage	5V
VoltageatReceiverCoil	DisplayonLCD(fig2)
TemperatureatBattery	Below45degreeCbeforechargingFanactivatesafter45degreeC

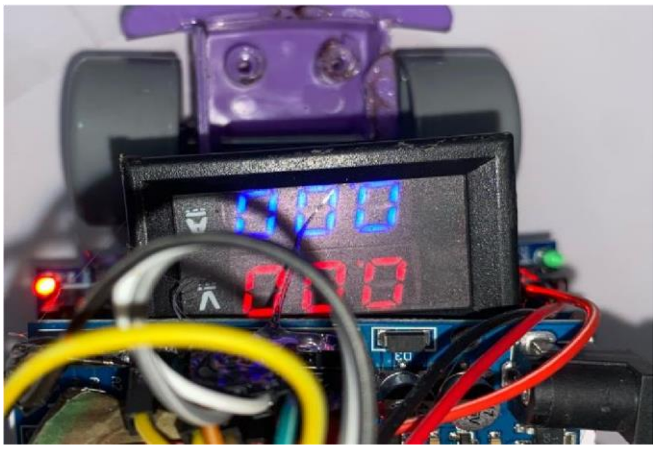

Fig2: Voltage and Current Display.

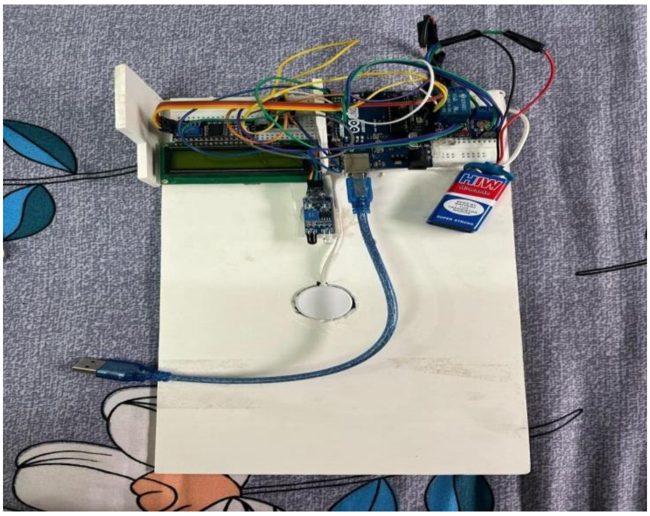

Fig3. Setup.

V.CONCLUSION

The proposed wireless electric vehicle (EV) charging system using a coil-based power transfer mechanism demonstrates a sustainable and convenient alternative to conventional plug-in charging methods. By utilizing the principle of electromagnetic induction, the system efficiently transfers power wirelessly from the transmitter coil to the receiver coil, making the charging process simpler, safer, and more user-friendly. The proposed design reduces dependence on physical connectors, minimizes mechanical wear and tear, and enhances safety by eliminating risks associated with exposed electrical contacts, such as electric shock and connector damage.

In addition, the integration of RFID-based authentication, voltage and temperature monitoring, and automatic protection mechanisms ensures secure and reliable charging operation. The dual-microcontroller architecture further improves system robustness by separating authentication and relay control from protection monitoring functions. Experimental results demonstrated stable power transfer, regulated 5 V output, efficient charging performance, and effective protection against overvoltage and overheating conditions.

REFERENCES

1. A. M. Ahmed and O. O. Khalifa, "Wireless power transfer for electric vehicle charging," *AIP Conference Proceedings*, vol. 2306, no. 1, Art. no. 020026, Dec. 2020. DOI: 10.1063/5.0032383.
2. C. Riekerk, F. Grazian, T. B. Soeiro, J. Dong, and P. Bauer, "Study on Soft Start-Up and Shut-Down Methods for Wireless Power Transfer Systems for the Charging of Electric Vehicles," in *2021 IEEE PELS Workshop on Emerging Technologies: Wireless Power Transfer (WoW)*, San Diego, CA, USA, Jun. 2021, pp. 1–6. DOI: 10.1109/WoW51332.2021.9462867.
3. C. Panchal, S. Stegen, and J. Lu, "Review of Static and Dynamic Wireless Electric Vehicle Charging System," *Engineering Science and Technology, an International Journal*, vol. 21, no. 5, pp. 922–937, Oct. 2018. DOI: 10.1016/j.jestch.2018.06.015.
4. A. A. S. Mohamed, A. A. Shaier, H. Metwally, and S. I. Selem, "Wireless charging technologies for electric vehicles: Inductive, capacitive, and magnetic gear," *IET Power Electronics*, 2024. DOI: 10.1049/pel2.12624.
5. A. Zaheer, H. Hao, G. A. Covic, and D. Kacprzak, "Investigation of Multiple Decoupled Coil Primary Pad Topologies in Lumped IPT Systems for Interoperable Electric Vehicle Charging," *IEEE Transactions on Power Electronics*, vol. 30, no. 4, pp. 1937–1955, Apr. 2015. DOI: 10.1109/TPEL.2014.2329693.
6. M. Budhia, G. A. Covic, and J. T. Boys, "Development and Evaluation of Single-Sided Flux Couplers for Contactless Electric Vehicle Charging," in *2011 IEEE Energy Conversion Congress and Exposition (ECCE)*, Phoenix, AZ, USA, Sep. 2011, pp. 614–621. DOI: 10.1109/ECCE.2011.6063826.
7. A. Shaier, A. A. S. Mohamed, H. Metwally, and S. I. Selem, "A New Hollow Solenoid Receiver Compatible with the Global Double-D Transmitter for EV Inductive Charging," *Scientific Reports*, vol. 13, Art. no. 11925, 2023. DOI: 10.1038/s41598-023-38645-1.

8. A. Ahmad, M. S. Alam, and A. A. S. Mohamed, "Design and Interoperability Analysis of Quadruple Pad Structure for Electric Vehicle Wireless Charging Application," *IEEE Transactions on Transportation Electrification*, vol. 5, pp. 934–945, 2019. DOI: 10.1109/TTE.2019.2929443.
9. Z. Zhang and K. T. Chau, "Homogeneous Wireless Power Transfer for Move-and-Charge," *IEEE Transactions on Power Electronics*, vol. 30, no. 11, pp. 6213–6220, Nov. 2015. DOI: 10.1109/TPEL.2015.2414453.
10. G. Xu *et al.*, "Improving Dynamic Wireless Charging System Performance for Electric Vehicles Through Variable Speed Limit Control Integration," in *2024 IEEE Intelligent Transportation Systems Conference (ITSC)*, Vienna, Austria, Oct. 2024, pp. 3104–3110.
11. A. Ahmad, M. S. Alam, and R. Chabaan, "A Comprehensive Review of Wireless Charging Technologies for Electric Vehicles," *IEEE Transactions on Transportation Electrification*, vol. 4, no. 1, pp. 38–63, Mar. 2018. DOI: 10.1109/TTE.2017.2771619.
12. W. Kim, K. Na, and K. Choi, "A Current Sensor Fault-Detecting Method for Onboard Battery Management Systems of Electric Vehicles Based on Disturbance Observer and Normalized Residuals," *International Journal of Control, Automation and Systems*, vol. 21, pp. 3563–3573, Nov. 2023. DOI: 10.1007/s12555-023-0377-8.
13. M. Noreen, M. T. Fouladfar, and N. Saeed, "Evaluation of Battery Management Systems for Electric Vehicles Using Traditional and Modern Estimation Methods," *Network*, vol. 4, no. 4, pp. 586–608, 2024. DOI: 10.3390/network4040029.
14. G. F. Roth, J. C. Kephart, and S. W. Post, "Measurement of Electrical Conditions of Rechargeable Batteries." "Wireless charging for electric vehicles: A comprehensive review of technologies, challenges, and solutions," Journal of Power Sources, vol. 660, Art. no. 238501, Dec. 2025, doi: 10.1016/j.jpowsour.2025.238501.
15. Magnetic coupler geometry optimization for wireless EV charging, reference details required. Battery management integration for wireless EV charging, reference details required. Electromagnetic shielding techniques for wireless EV charging, reference details required.
16. Adaptive control strategies for wireless EV charging, reference details required.
17. IoT-enabled monitoring in wireless EV charging systems, reference details required.
18. Dynamic wireless charging for electric vehicles: Recent advances and challenges, reference details required. V. Ramakrishnan, D. Savio A., C. Balaji, R. Narayanamoorthi, P. Vishnuram, T. Yang, M. Bajaj, R. S. Rathore, and I. Zaitsev, "Design and Implementation of a High Misalignment-Tolerance Wireless Charger for an

Electric Vehicle with Control of the Constant Current/Voltage Charging," *Scientific Reports*, vol. 14, Art. no. 13165, 2024. DOI: 10.1038/s41598-024-63952-6.

19. J. Li, "Review on the Applications of Intelligent Algorithm in Wireless Charging System for Electric Vehicles," *Energies*, vol. 18, no. 3, Art. no. 592, 2025. DOI: 10.3390/en18030592.
20. P. V. Nandankar, A. Chaturvedi, P. S. Akram, M. SivaramKrishnan, S. K. Jayabalan, Y. D. Jelila, *et al*., "Experimental Optimization of an IoT-Driven Load Adaptive Wireless Charging System for Electric Vehicles Using Response Surface Methodology," *Scientific Reports*, vol. 15, Art. no. 43530, 2025. DOI: 10.1038/s41598-025-27484-x.
21. A. R. Singh, R. S. Rathore, W. Jiang, A. Thakare, R. S. Kumar, C. B. Khadse, *et al*., "A Scalable Cloud-Integrated AI Platform for Real-Time Optimization of EV Charging and Resilient Microgrid Energy Management," *Scientific Reports*, vol. 15, Art. no. 37692, 2025. DOI: 10.1038/s41598-025-21531-3.
22. Z. Wang, L. Zhao, and X. Zhang, "Dynamic Wireless Charging Load Forecasting for Electric Vehicles Based on Data and Model Co-Driven Method," *Electric Power Systems Research*, vol. 249, Art. no. 112087, 2025. DOI: 10.1016/j.epsr.2025.112087.
23. "Artificial Intelligence-Driven Methodological Insights into Wireless Charging and Sustainable Energy Management Schemes: A Survey," *Engineering Applications of Artificial Intelligence*, vol. 159, Part B, Art. no. 111700, 2025. DOI: 10.1016/j.engappai.2025.111700.
24. "Enhancing Electric Vehicle Mobility Through Dynamic Wireless Charging Based on Coil-Induction Power Transfer Methods to Advance Smart Grid Infrastructure," *Discover Electronics*, vol. 2, Art. no. 88, 2025.
25. P. Mallikarjun, S. R. G. Thulasiraman, P. K. Balachandran, *et al*., "Economic Energy Optimization in Microgrid with PV/Wind/Battery Integrated Wireless Electric Vehicle Battery Charging System Using Improved Harris Hawk Optimization," *Scientific Reports*, vol. 15, Art. no. 10028, 2025. DOI: 10.1038/s41598-025-94285-7.
26. P. V. Nandankar, A. Chaturvedi, P. S. Akram, *et al*., "Experimental Optimization of an IoT-Driven Load Adaptive Wireless Charging System for Electric Vehicles Using Response Surface Methodology," *Scientific Reports*, vol. 15, Art. no. 43530, 2025. DOI: 10.1038/s41598-025-27484-x.
27. D. Kavitha and B. Sharmila, "Smart Battery Management in EVs Using IoT, Blockchain, and Machine Learning," *Scientific Reports*, vol. 15, Art. no. 37650, 2025. DOI: 10.1038/s41598-025-21605-2.

28. "Artificial Intelligence-Driven Methodological Insights into Wireless Charging and Sustainable Energy Management Schemes: A Survey," *Engineering Applications of Artificial Intelligence*, vol. 159, Part B, Art. no. 111700, 2025. DOI: 10.1016/j.engappai.2025.111700.