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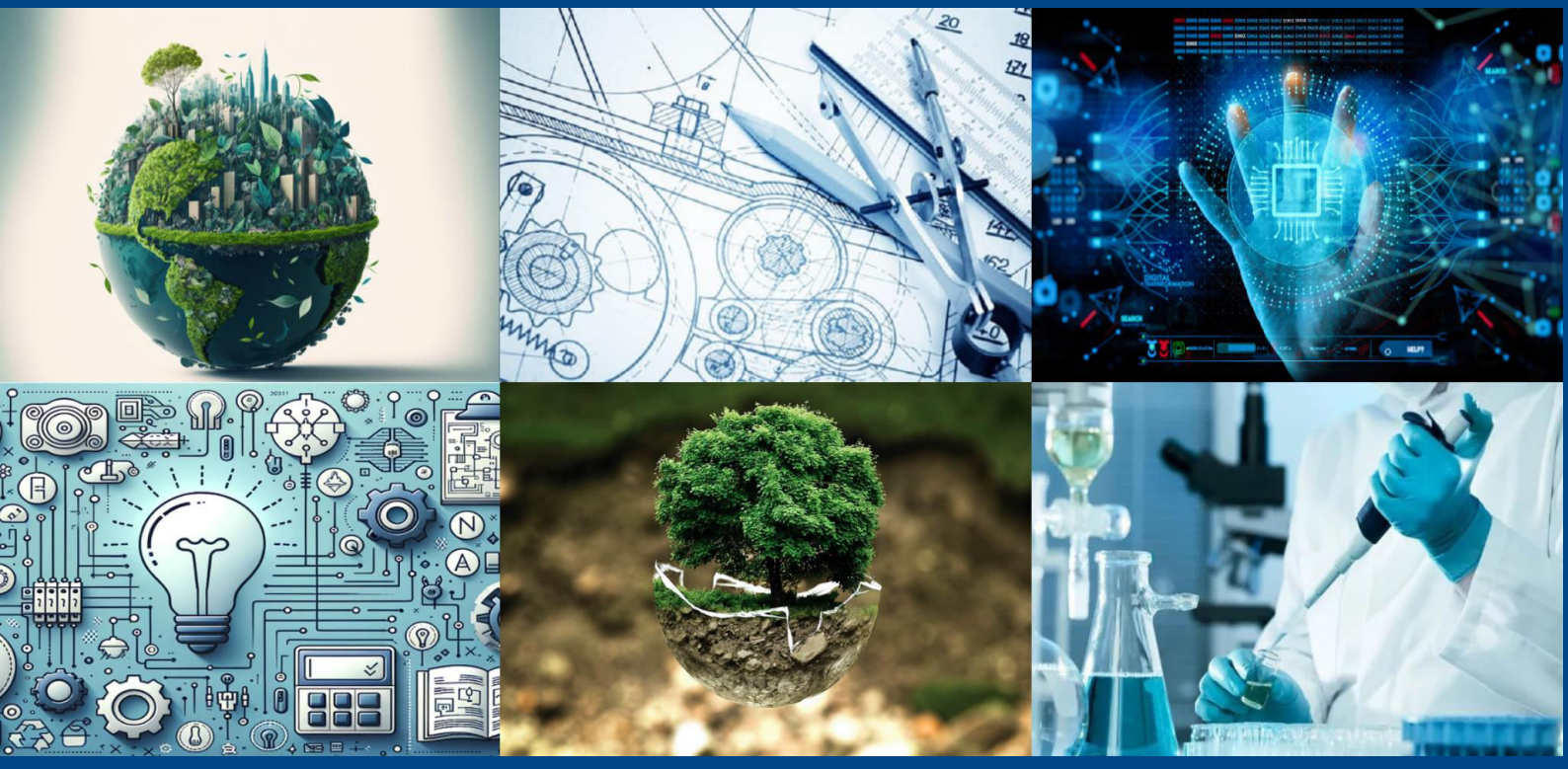

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Wireless Electric Vehicle Charging Station

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ABSTRACT: Wireless Electric Vehicle (EV) charging is a transformative innovation that eliminates the need for manual cable connections and enhances user convenience. This research paper presents the design and implementation of a wireless EV charging station integrated with IoT capabilities using ESP8266 and Arduino Nano. The system is built to promote automation by incorporating an RFID-based authentication mechanism for access control and a transmitter-receiver coil setup for wireless power transmission. An LCD is used for user interaction and system feedback. This work aims to develop a prototype that demonstrates real-time EV authentication and seamless wireless charging, ensuring energy efficiency and secure access. With the exponential growth of electric mobility, developing smart and user-friendly charging infrastructures is critical. The proposed system not only offers wireless power transfer but also supports user identification and monitoring through IoT. The integration of RFID technology helps maintain charging records and prevents unauthorized access. This research contributes to the smart grid and green transportation ecosystem by merging hardware control with internet-based monitoring, paving the way for more intelligent and scalable EV charging networks.

KEYWORDS: Wireless Charging, Electric Vehicle, IoT, ESP8266, RFID, Arduino Nano, Smart Energy, LCD Display, Automation, Transmitter Coil, Receiver Coil

I. INTRODUCTION

Electric Vehicles (EVs) are becoming a vital solution to reduce carbon emissions and decrease reliance on fossil fuels. However, conventional plug-in charging methods can be inconvenient and susceptible to wear and tear over time. As a response, wireless charging technologies have emerged, offering safer and more user-friendly alternatives. These systems transmit power without direct electrical contact using electromagnetic induction, enhancing durability and user comfort.

In this paper, we propose a prototype wireless charging station for EVs that utilizes RFID-based access control and IoT-based monitoring. The integration of Arduino Nano and ESP8266 enables the system to interact with users, control hardware components, and send data to cloud platforms for remote monitoring. The use of transmitter and receiver coils allows for efficient wireless energy transfer, and the RFID mechanism ensures that only registered users can access the system.

The proposed system not only reduces human intervention in EV charging but also increases safety and accessibility. It also creates opportunities for scalable integration into smart cities where automated charging infrastructure can interact with other intelligent transportation systems. By bridging electronics and communication technologies, our system is a step toward efficient and autonomous charging infrastructure.

II. LITERATURE REVIEW

1. Zhang et al. (2020) proposed a resonant inductive coupling method for dynamic EV charging, achieving high power efficiency across a moving platform.
2. Ali et al. (2019) reviewed various wireless EV charging systems using inductive and capacitive methods and emphasized the importance of coil alignment and frequency control.
3. Ahmed et al. (2020) explored the integration of IoT for smart grid-based EV charging, where load management was dynamically adjusted using ESP8266 modules.
4. Prabhu et al. (2018) designed a wireless power transmission system using Arduino for mobile devices and indicated its applicability to EV systems.
5. Narayan and Gupta (2019) examined RFID-based systems for secure EV access control and real-time energy monitoring.

6. Sharma et al. (2021) combined solar power and IoT to build a smart wireless charging station, reducing grid dependency.
7. Wu et al. (2017) analyzed the coil design optimizations for wireless EV charging, improving energy transfer efficiency.
8. Mehta and Suresh (2020) focused on wireless power transfer safety and shielding techniques to reduce electromagnetic interference.
9. Patel et al. (2022) proposed an AI-integrated smart charging station using sensor fusion, where EVs were charged based on predicted battery health.
10. Kavitha et al. (2019) demonstrated the usage of ESP8266 and Arduino Nano in remote energy management systems.
11. Singh and Bansal (2020) developed a prototype RFID-enabled smart grid EV charging system integrated with Android app monitoring.
12. Kumar et al. (2021) tested high-frequency coils with improved materials for faster and safer wireless EV charging in real-time prototypes.

III. RELATED WORK

Several previous works align with the goals of this research. First, many researchers have used Arduino microcontrollers for wireless energy transfer experiments. For example, Arduino Uno was frequently paired with coils to test inductive power transfer. However, these systems lacked real-time access control and user feedback.

A number of projects focused on integrating RFID technology into access systems for public transport and building access, but their application in EV charging security has not been extensively explored. Integrating RFID with wireless charging adds a critical layer of security and personalization to the process.

Other IoT-based charging systems used NodeMCU or Raspberry Pi to upload data to cloud servers, but many did not combine the feature with wireless energy transmission. Our work merges both communication and hardware-level functionality into a single, compact station.

Recent work by Ali et al. (2019) experimented with combining renewable sources and IoT in smart charging. Though successful, it was limited in terms of real-time access control. Our system overcomes this limitation by pairing RFID with IoT.
Furthermore, most previous wireless charging projects focused on static systems. Our work proposes a modular and portable prototype, making it suitable for low-cost public deployment or residential use.

Motivation
The rapid adoption of EVs necessitates innovation in charging infrastructure. Traditional plug-in stations face challenges such as connector damage, weather exposure, and user inconvenience. A wireless solution can eliminate these issues by reducing physical contact and enhancing user autonomy.

Security is another critical concern. Unauthorized use of charging stations can lead to energy theft and increased operational costs. This motivates the use of RFID technology to restrict access to authenticated users only, ensuring secure and traceable power usage.Integrating IoT enables remote monitoring and control, which is essential for deploying scalable smart grids and EV networks. By building a working prototype with common, affordable components, we aim to inspire further development in low-cost, intelligent EV charging solutions.

IV. PROPOSED SYSTEM

The proposed system consists of a transmitter coil connected to a power source and a receiver coil embedded in the EV. The Arduino Nano handles the control logic, while the ESP8266 enables cloud connectivity for remote monitoring. An LCD displays charging status and user information.

When an RFID tag is scanned by the RFID reader, the system checks for authentication. If access is granted, the transmitter coil is activated and begins transferring power to the receiver coil through inductive coupling. The status is shown on the LCD, and data is sent to the cloud for record-keeping.

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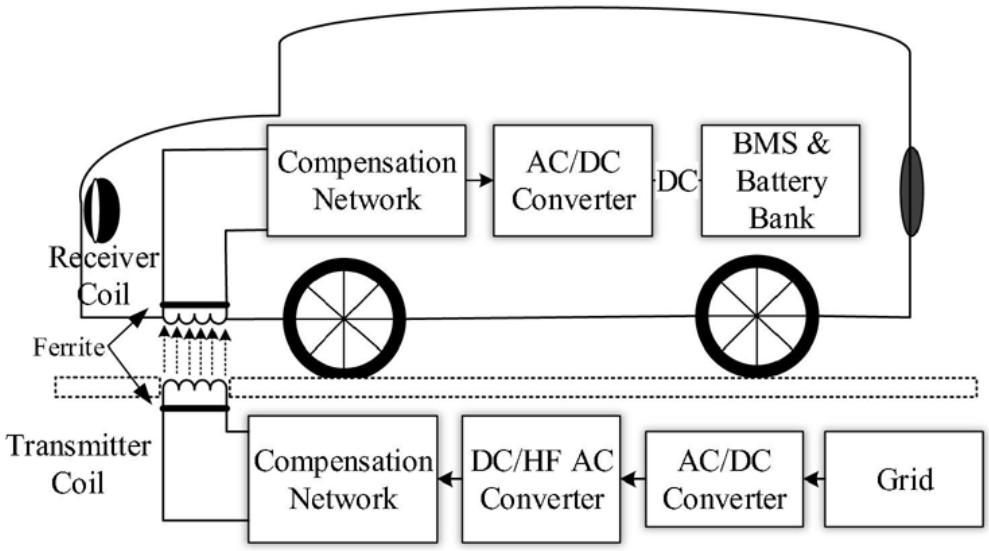
This setup ensures secure, cable-free, real-time monitored EV charging. It leverages the power of embedded systems and cloud integration to offer a compact, scalable, and user-friendly charging station model.

V. SYSTEM ARCHITECTURE



Components:

- Arduino Nano
- ESP8266 Wi-Fi Module
- Transmitter & Receiver Coils
- RFID Reader & Tag
- LCD Display
- Power Supply

Flow:

RFID Scan → Arduino Auth Check → Enable Wireless Charging → Display Status → ESP8266 Sends Data to Cloud

Objectives

- To design a wireless EV charging system using Arduino Nano and transmitter-receiver coils.
- To implement secure user authentication using RFID tags.
- To enable IoT monitoring via ESP8266 for real-time data tracking.
- To display real-time status on an LCD for user feedback.
- To build a low-cost, scalable prototype for public or residential deployment.

Modules Used

1. RFID Authentication Module
2. Wireless Power Transfer Module
3. Control and Logic Module (Arduino Nano)
4. IoT Communication Module (ESP8266)
5. User Interface (LCD Display)

Algorithms Used

- **RFID Authentication Algorithm**:
  Checks UID of scanned tag against stored IDs.
- **Wireless Charging Control Algorithm**:
  Enables coil only upon successful authentication.

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- **Data Transmission Algorithm (ESP8266)**:
  Sends charging status and user ID to server/cloud.

VI. CONCLUSION

Wireless EV charging stations integrated with IoT and RFID offer a promising solution to conventional plug-in methods. Our prototype demonstrated secure, efficient, and remote-controlled charging using cost-effective components. The system enhances safety and user experience while reducing the need for manual intervention.

The integration of RFID allows for access control, making the system more secure. LCD displays provide real-time feedback to users, while ESP8266 ensures that all transactions and charging statuses are available for review, which can be particularly useful for smart city integration.

This research proves that combining wireless technology, embedded systems, and cloud services can provide scalable and user-friendly EV charging infrastructure. Future enhancements will further improve efficiency, energy management, and user convenience.

VII. FUTURE SCOPE

Future versions of the system could support faster charging with high-frequency coils and dynamic alignment for better energy transfer. Integration with mobile apps and payment gateways could also enable a fully autonomous public charging solution.

Additionally, combining the system with renewable energy sources like solar panels can make it more eco-friendly. Predictive AI models can be used to manage power distribution based on traffic patterns and user demand.

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