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WIRELESS ELECTRICAL VEHICLE CHARGING STATION

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ABSTRACT

The rapid adoption of electric vehicles (EVs) has brought forth the need for more efficient, user-friendly, and intelligent charging solutions. This project presents the design and development of a Wireless Electrical Vehicle Charging Station integrated with Artificial Intelligence (AI) to enhance the convenience, efficiency, and automation of the EV charging process. The proposed system utilizes inductive power transfer (IPT) technology to enable contactless energy transmission between the charging station and the vehicle, eliminating the need for physical connectors and reducing wear and tear.AI algorithms are incorporated to optimize charging efficiency, predict charging times, manage power distribution based on usage patterns, and ensure safety protocols. Additionally, the system can detect the vehicle's alignment with the charging pad and automatically adjust parameters for maximum power transfer. Real-time monitoring and data analytics further enhance the system's reliability and performance.This innovative approach not only simplifies the user experience but also contributes to the development of smart, sustainable transportation infrastructure, supporting the global transition towards cleaner energy and smarter mobility solutions.

Keywords: Electric Vehicles (EV), Wireless Charging, Artificial Intelligence (AI), Inductive Power Transfer (IPT), Smart Charging System, Sustainable Transportation, Energy Management, Automation, EV Infrastructure.

I.INTRODUCTION

The global shift towards sustainable transportation has led to a significant rise in the adoption of Electric Vehicles (EVs), driven by growing environmental concerns, advancements in battery technology, and supportive government policies. However, the widespread use of EVs brings new challenges one of the

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most pressing being the need for efficient, accessible, and user-friendly charging infrastructure. Traditional plug-in charging stations, though effective, often suffer from issues such as physical wear, user inconvenience, and exposure to environmental conditions.To address these limitations, **wireless charging technology** specifically **Inductive Power Transfer (IPT)**—has emerged as a promising alternative. By enabling contactless energy transfer between the charging station and the vehicle, IPT eliminates the need for physical connectors, ensuring a safer and more reliable charging experience. However, for wireless charging to be truly efficient and adaptive, it requires intelligent control and optimization mechanisms.This project proposes an innovative solution that integrates Artificial Intelligence (AI) with wireless EV charging systems. AI enhances the system's functionality by enabling real-time monitoring, smart alignment detection, efficient energy distribution, charging time prediction, and dynamic load management. Such an intelligent system not only improves the performance and convenience of EV charging but also supports the development of smart, automated, and sustainable urban mobility infrastructure.By leveraging both wireless power transfer and AI-driven control systems, this project aims to pave the way for the next generation of EV charging stations—efficient, intelligent, and environmentally friendly.

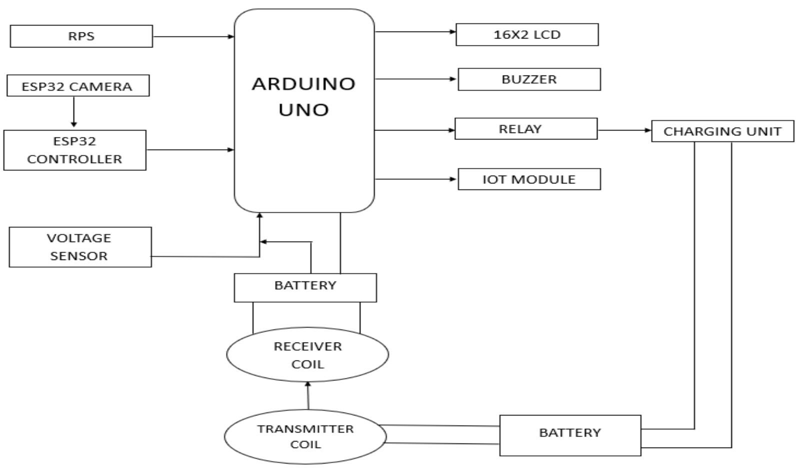

Fig.1. Proposed block diagram.

II.EXISTING SYSTEM

The current electric vehicle (EV) charging infrastructure predominantly relies on wired charging stations. These systems require users to manually plug in a charging cable to connect the EV with a power supply. While functional, this approach presents several limitations. The physical connectors used in plug-in systems are prone to wear and tear due to repeated use, which can lead to maintenance issues and increased costs over time. Additionally, these connectors are often exposed to environmental elements like rain, dust, and temperature variations, which can affect safety and reliability.Moreover, manual operation can be inconvenient for users, especially in public or high-traffic charging areas. The current systems also lack intelligent features such as real-time optimization, automatic alignment detection, and dynamic power management. This results in inefficient energy distribution, potential overload during peak hours, and a lack of predictive insights for users and operators alike. The absence of AI and automation means the existing setup is limited in both user experience and system performance.

Survey of research:

1. Wireless Charging for Electric Vehicles: A Survey and Comprehensive Guide

This comprehensive survey explores the evolution of wireless charging technologies for EVs, categorizing them into static, quasi-dynamic, and dynamic charging systems. It delves into the technical aspects, including coil design, compensation topologies, and converter configurations. The study also addresses operational considerations such as infrastructure planning, economic analyses, and policy implications. By providing a holistic view, it serves as a valuable resource for researchers, policymakers, and industry stakeholders aiming to understand and advance wireless EV charging solutions.

2. Precise Coil Alignment for Dynamic Wireless Charging of Electric Vehicles with RFID Sensing

This research addresses the critical challenge of coil misalignment in dynamic wireless power transfer (DWPT) systems. It introduces an innovative RFID-based alignment system utilizing coherent phase detection and maximum likelihood estimation algorithms to achieve sub-10 cm accuracy. The system's efficacy is validated through laboratory and experimental tests, demonstrating its potential to enhance DWPT efficiency. The study also discusses implementation challenges and proposes solutions, contributing to the advancement

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of reliable and efficient dynamic wireless charging for EVs.

3. LSTM-Based Adaptive Vehicle Position Control for Dynamic Wireless Charging

This study presents a novel approach to enhancing charging efficiency in dynamic wireless charging (DWC) systems using Long Short-Term Memory (LSTM) neural networks. By predicting the optimal lateral position for maximum electromagnetic strength, the system adjusts the vehicle's trajectory in real-time. Simulations indicate a significant improvement in charging efficiency compared to traditional lane-centering methods. This integration of AI into vehicle control systems showcases the potential of machine learning in optimizing wireless charging processes.

4. Smart and Sustainable Wireless Electric Vehicle Charging Strategy with Renewable Energy and Internet of Things Integration

This paper explores the integration of wireless power transfer (WPT) with renewable energy sources and Internet of Things (IoT) technologies. It outlines a system where IR sensors detect vehicle presence, triggering automated charging processes managed by a central controller. The study emphasizes the role of AI and IoT in optimizing energy distribution, enhancing user experience, and promoting sustainable urban mobility. By combining WPT with smart technologies, the research highlights a pathway toward efficient and eco-friendly EV charging infrastructure.

5. A Holistic Review on Advanced Bi-directional EV Charging Control Algorithms

This review examines advanced control algorithms for bi-directional EV charging, focusing on Grid-to-Vehicle (G2V) and Vehicle-to-Grid (V2G) interactions. It discusses the challenges posed by the randomness of charging events and vehicle mobility. The paper highlights the importance of AI-driven optimization in managing charging schedules, energy trading, and providing ancillary services to the power grid. A case study illustrates the economic benefits of joint optimization in routing and charging scheduling, underscoring the potential of AI in enhancing the efficiency of EV charging networks.

III.PROPOSED SYSTEM

The proposed system presents a modern, intelligent solution to the challenges faced by traditional electric vehicle (EV) charging stations. It introduces a **Wireless Electric Vehicle Charging Station** powered by **Artificial Intelligence (AI)** to offer a contactless, efficient, and user-friendly charging experience.At the core of the system is **Inductive Power Transfer (IPT)** technology, which enables wireless energy transmission between the charging pad and the vehicle. This eliminates the need for physical connectors, thereby reducing mechanical wear, minimizing maintenance, and improving safety in various weather conditions. The absence of cables also enhances user convenience and allows for more flexible station designs.To ensure optimal performance, the system is equipped with **AI-based control mechanisms**. These intelligent algorithms handle real-time monitoring of the charging process, predict charging time based on battery status and vehicle type, and manage power distribution dynamically when multiple vehicles are connected. The AI also assists in **automatic alignment detection**, ensuring the vehicle is correctly positioned over the charging pad for maximum energy transfer efficiency.A **smart user interface**, accessible via a mobile app or web platform, provides users with real-time updates, charging progress, estimated time to full charge, and alerts. The AI component continuously learns from usage patterns and environmental conditions to optimize energy consumption and improve overall system efficiency over time.In summary, the proposed system integrates **wireless charging and AI technologies** to create a next-generation EV charging station that is safer, smarter, and more sustainable. It aims to revolutionize EV infrastructure by enhancing user experience, reducing operational costs, and supporting the global move toward clean and intelligent transportation solutions.

IV WORKING METHODOLOGY

The working of the proposed Wireless Electric Vehicle Charging Station Using AI begins with the implementation of Inductive Power Transfer (IPT) technology, where a primary coil embedded in the charging pad generates a magnetic field using high-frequency alternating current. When an electric vehicle equipped with a secondary coil is positioned over the pad, the magnetic field induces current in the vehicle's coil, enabling wireless energy transfer.

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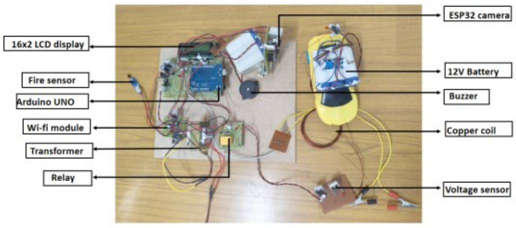

Fig.2. Hardware kit

To ensure efficient energy transmission, sensors such as ultrasonic or IR are used to detect the presence and alignment of the vehicle. Artificial Intelligence (AI) algorithms analyze this sensor data to determine the exact position of the vehicle and provide alignment feedback or automatic adjustments if necessary.

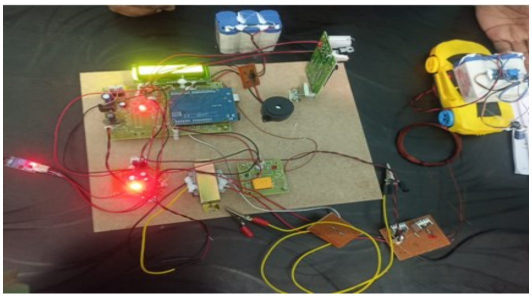

Fig.3. ESP32 detect the vehicle image.

Once alignment is confirmed, the AI system begins monitoring and controlling the charging process in real-time. It predicts the required charging time, optimizes power delivery, and ensures safety by detecting anomalies like overheating or misalignment. The system also features dynamic load management, especially when multiple vehicles are charging simultaneously.

Fig.4. In web server display vehicle image.

A user interface, accessible via a mobile app or web dashboard, provides live updates on charging status, estimated completion time, and alerts for safety or misalignment issues. Meanwhile, the system continuously logs charging data and uses AI analytics to improve performance, efficiency, and user experience over time. This intelligent methodology ensures a seamless, safe, and efficient wireless charging process, contributing to the advancement of smart EV infrastructure.

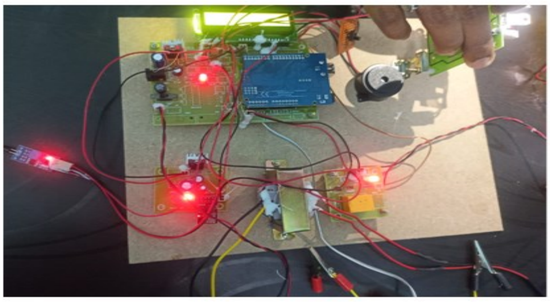

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Fig.5. Vehicle detected Charging on condition.

IV.CONCLUSION

The proposed Wireless Electric Vehicle Charging Station integrated with Artificial Intelligence presents a futuristic and sustainable solution to the current challenges in EV charging infrastructure. By eliminating the need for physical connectors through Inductive Power Transfer (IPT) and enhancing operational efficiency with AI-based control systems, the project ensures a safer, more convenient, and intelligent charging experience. AI plays a pivotal role in optimizing energy transfer, predicting charging times, aligning vehicle positions, and managing power loads effectively. The user interface further improves usability by providing real-time status updates and feedback. As the demand for electric vehicles continues to rise, this system contributes significantly to building smart, scalable, and eco-friendly urban mobility infrastructure. With further research and real-world deployment, such innovations can accelerate the global transition to cleaner transportation solutions.

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