An Integrated Wireless Electric Vehicle Charging System with Parking Availability Awareness

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***Abstract*—The rapid growth of electric vehicles EVs has increased the demand for efficient charging infrastructure and intelligent parking management. Conventional wired charging systems rely on manual connections, leading to cable wear, safety concerns, and the absence of real-time parking availability information. To overcome these limitations, this paper presents an integrated system for wireless EV charging with real-time parking availability. The proposed solution combines IOT-based parking detection with wireless power transfer to automate parking slot identification and charging initiation. Ultrasonic sensors and ESP32 microcontrollers are used to detect vehicle presence and manage charging operations, while a web-based monitoring platform provides real-time status and charging cost information. By eliminating physical connectors and integrating smart monitoring, the system enhances user convenience, improves safety, and enables efficient utilization of EV charging infrastructure. The proposed approach supports the development of intelligent and sustainable transportation systems.**

***Index Terms*—Electric Vehicles, Wireless EV Charging, Smart Parking System, Internet of Things, Real-Time Monitoring**

I. Introduction (Heading 1)

The rapid adoption of Electric Vehicles EVs has significantly increased the demand for efficient, safe, and user-friendly charging infrastructure. Along with charging availability, effective parking management has become a critical requirement in urban environments, where space constraints and growing vehicle density pose additional challenges. Conventional wired EV charging systems rely on manual plug-in connections, which often result in cable wear and tear, safety concerns, and user inconvenience. Moreover, most existing charging stations lack real-time information about parking slot availability, making it difficult for users to identify vacant charging-enabled parking spaces. To address these challenges, this work focuses on the integration of wireless EV charging with intelligent parking management. Wireless power transfer technology eliminates the need for physical connectors, thereby improving safety and reducing maintenance issues, while IoT-based parking systems enable real-time detection of vehicle presence and slot availability. By combining these technologies, the proposed system provides automated parking slot detection, wireless charging initiation, real-time monitoring, and charging cost estimation through a centralized platform. This integrated approach improves infrastructure utilization, enhances user convenience, and contributes toward the development of smart and sustainable transportation systems.

II. Literature review

Several studies have been conducted on wired and wireless electric vehicle charging systems. Earlier research focused mainly on wired charging methods, which are efficient but suffer from limitations such as cable damage and safety concerns. Recent research has explored wireless charging techniques using inductive coupling, which improve safety by eliminating physical connectors. In parallel, IOT-based smart parking systems have been developed using sensors to monitor parking slot occupancy in real time. However, most existing systems treat parking management and EV charging as separate solutions. The lack of integration between charging systems and parking availability creates inefficiencies and user inconvenience. Therefore, there is a clear research gap in developing an integrated system that combines wireless EV charging with real-time parking slot detection.

III. Problem Statement

Current EV charging and parking systems operate independently, leading to inefficient utilization of charging infrastructure. Wired charging methods require manual operation and are prone to safety issues, while conventional parking systems lack real-time occupancy information. This separation results in increased waiting time, improper slot usage, and reduced convenience for EV users. Therefore, an integrated system is required to provide automated parking detection, wireless charging, and real-time monitoring.

IV. Objectives

[1] To design a wireless electric vehicle charging system using inductive coupling
[2] To detect parking slot availability in real time using IoT sensors
[3] To integrate wireless charging with smart parking management
[4] To automate the EV charging process without manual intervention
[5] To provide real-time monitoring of parking and charging status
[6] To improve safety by eliminating physical charging cables
[7] To support smart city and smart transportation applications

V. Proposed System

The proposed system presents an integrated solution that combines wireless electric vehicle EV charging with real time parking availability using Internet of Things IOT technology. The system is designed to overcome the limitations of conventional wired charging and isolated parking management by providing a unified, automated, and user-friendly platform. The core idea of the proposed system is to detect the availability of parking slots using IOT sensors and initiate wireless charging automatically when an EV is parked in a designated charging slot. Ultrasonic sensors are deployed at each parking slot to identify vehicle presence, and the collected data is processed using an ESP32 microcontroller. Once a vehicle is detected and properly positioned over the wireless charging pad, the system enables inductive power transfer without the need for physical connectors. In addition to charging automation, the system continuously monitors charging duration and operational status. A centralized web-based dashboard displays real-time information such as parking slot availability, charging state, and estimated charging cost. By integrating parking detection, wireless power transfer, and real-time monitoring into a single system, the proposed solution improves infrastructure utilization, enhances safety, and provides a seamless experience for EV users.

VI. System Architecture

The system architecture consists of ultrasonic sensors, an ESP32 microcontroller, a wireless charging module, and a web-based monitoring interface. Ultrasonic sensors are responsible for detecting vehicle presence in parking slots. The ESP32 acts as the central controller, processing sensor data and controlling charging operations. The wireless charging module transfers power from the transmitter coil to the receiver coil using inductive coupling. The web dashboard displays real-time information such as slot availability, charging status, and estimated cost, ensuring transparency and ease of use..

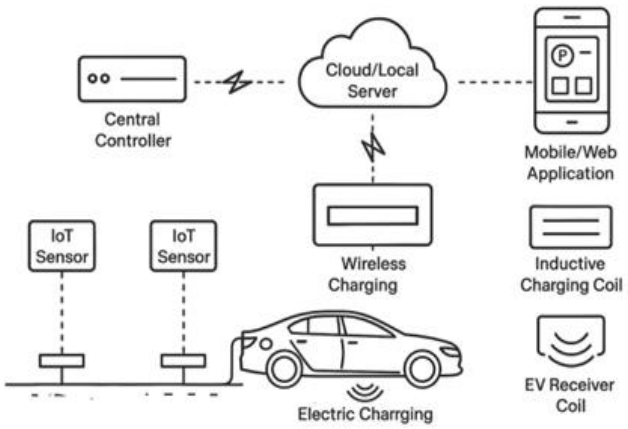


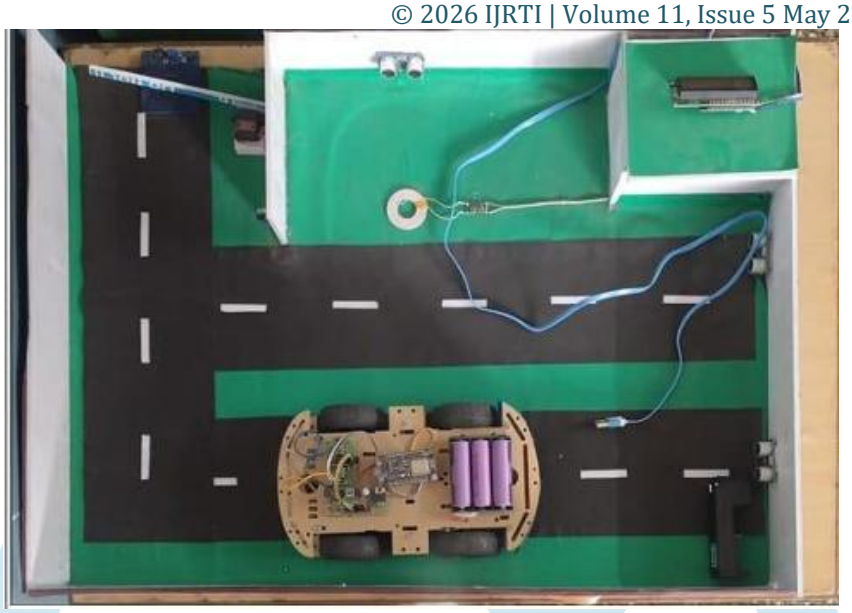
Fig 1: System Architecture

VII. Working Of The System

The operation of the proposed system follows a sequential and automated process. When an EV enters the parking area, ultrasonic sensors continuously monitor each parking slot to detect vehicle occupancy. Once a vehicle is detected in a charging-enabled slot, the ESP32 microcontroller verifies proper positioning and activates the wireless charging module. Wireless power transfer is initiated using inductive coupling, allowing energy to be transferred safely from the charging pad to the vehicle without physical contact. During the charging process, the system monitors charging duration and operational status in real time. Relevant data is transmitted to the web dashboard, where users can view parking availability, charging progress, and cost estimation. When the vehicle leaves the parking slot, the system automatically stops charging and updates the slot status as available. This fully automated workflow minimizes manual intervention, improves safety, and ensures efficient utilization of charging infrastructure.

VIII. Results And Discussions

A functional prototype was developed to evaluate the integration of wireless EV charging with real-time parking availability. The prototype demonstrates the coordination between parking slot detection, wireless charging, and real time monitoring. Parking slot occupancy was accurately detected using ultrasonic sensors, and the status was updated dynamically on the monitoring interface.



IX. Future Scope

[1] Integrating advanced wireless charging technologies to reduce charging time and increase efficiency.
[2] Extending support to multiple parking slots with centralized monitoring for larger parking facilities.
[3] Mobile Application Integration: Allowing users to reserve parking slots, monitor charging status, and receive notifications remotely.
[4] Adding automatic billing systems with digital payment gateways based on charging duration and energy consumption. Incorporating solar panels or other renewable energy sources to promote sustainable charging solutions.
[5] Connecting the system with smart city platforms for real-time parking and charging data to support traffic management and urban planning.

X. Conclusion

The proposed system successfully integrates wireless electric vehicle charging with real-time parking slot availability using IOT technology. The system eliminates the need for physical charging cables, thereby improving safety and reducing maintenance. Real-time monitoring of parking slots and charging status enhances user convenience and efficient utilization of infrastructure. The experimental results show that the system is reliable, scalable, and suitable for smart parking and smart city applications. With further improvements, the system can support advanced features and large-scale deployment.

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