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IOT Based Wireless EV Charging Station

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Abstract: *The adoption of Electric Vehicles (EVs) is growing rapidly, driven by environmental concerns and the transition to sustainable energy. Traditional EV charging infrastructure, reliant on wired connections, faces challenges such as wear, inconvenience, and inefficiency. This paper introduces the "Wireless Solar EV Charging Station," an innovative solution that integrates wireless charging technology, solar energy, and IoT-driven automation. Leveraging inductive coupling, the system enables wireless energy transmission for seamless charging at designated parking spots, eliminating the need for physical cables. Solar panels make the station self-sustaining, with the ability to supply excess energy back to the grid, promoting renewable energy integration. An IoT-based framework automates operations, including real-time user balance checks, fee deductions, and account updates, enhancing user interaction. A novel feature of smart parking slot management without physical sensors allows users to reserve slots via a mobile application, ensuring guaranteed charging upon arrival. The system, powered by a Node MCU microcontroller, verifies credentials, initiates charging, monitors battery status, and updates availability on an LCD display and the app in real time. This integrated approach offers an efficient, user-friendly, and sustainable solution for modern EV charging needs, contributing significantly to green energy adoption.*

Keywords: Wireless charging, Solar energy, IoT, Inductive coupling, EV charging station, Smart parking, Renewable energy, Node MCU, Energy conservation, Sustainable infrastructure

I. INTRODUCTION

In recent years, the adoption of Electric Vehicles (EVs) has accelerated due to growing environmental awareness and the shift towards sustainable energy. However, traditional EV charging infrastructure relies heavily on wired connections, which can be cumbersome, prone to wear, and inconvenient for users. To address these challenges, the "Wireless Solar EV Charging Station" project presents a forward-thinking solution that combines wireless charging technology, solar energy, and IoT-driven automation to create a more efficient and user-friendly EV charging experience. This system leverages inductive coupling to enable wireless energy transmission, allowing vehicles to charge seamlessly without physical cables at designated parking spots. By incorporating solar panels, the charging station is self-sustaining and can also supply excess energy back to the grid, promoting renewable energy integration. The use of an IoT framework allows for automated operations, such as real-time user balance checking, fee deduction, and account updates, creating a seamless interaction for users. A key innovation in this project is the addition of smart parking slot management without the need for physical sensors. An IoT-enabled reservation system lets users reserve slots through a mobile application, ensuring a guaranteed parking and charging spot upon arrival. Once parked, the system verifies user credentials, initiates the charging process, and updates slot availability in real time on both the app and an LCD display via a Node MCU microcontroller. Additionally, the battery status is monitored and displayed, giving users full visibility of their charging process. This integrated approach not only enhances the convenience and efficiency of EV charging but also supports energy conservation by harnessing solar power. The result is a streamlined, sustainable EV charging infrastructure that addresses the needs of modern users while contributing to a greener future.

II. LITERATURE SURVEY

Sr. No.	Title of paper	Author name	IEEE journals/conference
1	A Federated Byzantine Agreement Model to Operate Offline Electric	Javad Fattahi	23 August 2023

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	Vehicle Supply Equipment.		
2	Mutual and Batch Authentication With Conditional Privacy-Preserving Scheme for V2G Communication System,	Jegadeesan Subramani; Azees Maria; Arun SekarRajasekaran; Babji Prasad Chapa,	13 May 2024
3	Joint Routing and Wireless Charging Scheduling for Electric Vehicles With Shuttle Services.	Yongsheng Cao; Yongquan Wang; Demin Li; Xuemin Chen,	11 October 2022
4	Dynamic Charging Optimization for Mobile Charging Stations in Internet of Things.	Huwei Chen; Zhou Su,	17 September 2018

III. METHODOLOGY

To address the limitations of traditional EV charging systems, the Wireless Solar EV Charging Station follows a structured methodology that combines wireless charging technology, solar energy integration, and an IoT-based reservation and billing system to create an efficient, sustainable, and user-friendly solution.

Wireless Charging through Inductive Coupling: The system uses inductive coupling technology to enable cable-free charging. This involves placing inductive coils in parking slots that transfer energy wirelessly to EVs equipped with compatible receivers. This setup eliminates the wear and tear associated with cables, simplifying the charging process for users.

Solar Power Integration: Solar panels are installed to power the charging station, reducing dependency on the grid and enhancing sustainability. Any excess solar energy generated is fed back into the grid, promoting renewable energy usage and potentially reducing operational costs.

IoT-Based Automation and Real-Time Monitoring: A Node MCU microcontroller handles real-time monitoring of battery and slot status, ensuring that data on charging progress, availability, and energy usage is continuously updated. This data is displayed on both an LCD screen at the station and a mobile Android app for user convenience. The IoT framework enables automated billing and account management, checking user balances, deducting fees, and updating account statuses seamlessly. This automation improves accuracy, reduces human intervention, and enhances user satisfaction.

Smart Parking Slot Reservation: To address parking availability issues, an IoT-enabled reservation system is integrated. Users can reserve parking slots in advance via a mobile app, which ensures a guaranteed spot upon arrival. This smart slot management removes the need for physical sensors by tracking parking reservations and slot status digitally.

User Authentication and Charging Initialization: Upon parking, the system verifies user credentials and initiates the charging process automatically. This streamlined approach reduces waiting times, optimizes slot usage, and provides a smooth, hassle-free experience for users

This methodology creates a highly efficient EV charging solution that addresses key issues of cable management, energy sustainability, slot availability, and user convenience, making it a robust addition to EV infrastructure.

OBJECTIVE

Develop a Wireless Charging System: Implement inductive coupling technology to enable seamless, cable-free charging of Electric Vehicles (EVs).

Integrate Solar Energy: Utilize solar panels to create a self-sustaining charging station, reducing reliance on non-renewable energy sources and promoting environmental sustainability.

Automate Operations with IoT: Design an IoT-driven framework for real-time monitoring and automation, including user balance verification, fee deduction, and account updates.

Enhance User Convenience: Create a mobile application for reserving parking and charging slots, ensuring guaranteed availability and minimizing user effort.

Smart Parking Slot Management: Implement a sensor-free, IoT-enabled system to manage parking slot occupancy dynamically and update availability in real time.

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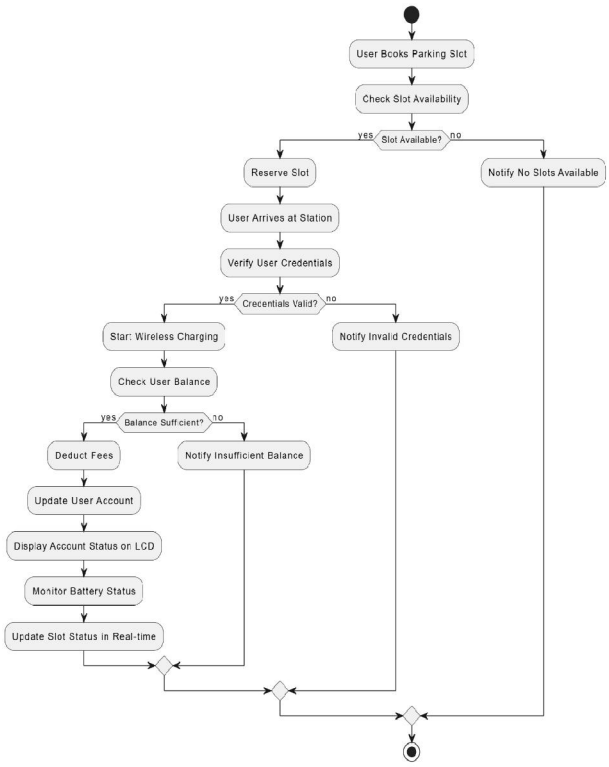
Battery Monitoring and Feedback: Provide users with real-time battery status updates and progress monitoring through an LCD display and mobile app.
Promote Energy Efficiency: Facilitate energy conservation by utilizing renewable solar power and enabling the station to supply excess energy back to the power grid.
Support Sustainable EV Infrastructure: Develop a streamlined, user-friendly charging solution that addresses the limitations of traditional wired systems, contributing to the global shift toward green energy solutions.

PROBLEM DEFINATIONS

The increasing demand for electric vehicle (EV) charging stations highlights key challenges: conventional wired charging systems are inconvenient, maintenance-intensive, and rely heavily on grid electricity, which limits sustainability. Additionally, inefficient parking slot management and lack of real-time account handling contribute to poor user experiences. This project addresses these issues by developing a Wireless Solar EV Charging Station that combines inductive coupling for wireless charging, solar power for sustainable energy, and an IoT-based system for automated billing and smart parking reservation without physical sensors. This approach aims to offer a more efficient, eco-friendly, and user-centered EV charging solution.

FLOW CHART



COMPONENTS REQUIRED

ESP8266 – Microcontroller to transfer data.
LCD 16x2 – Display output.
Jumper Wires – For connection of system
Voltage Sensor – To calculate voltage of battery.
Buzzer – for alerts of system
RFID Tag and Reader – for authentication of user
Connecter and PCB – for mounting project

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FUCTIONAL REQUIREMENTS

- Wireless Charging: Enable EVs to charge wirelessly using inductive coupling at designated parking spots. Automatically initiate charging when a vehicle is parked in a reserved slot.
- Solar Energy Integration: Harvest energy from solar panels to power the charging station. Feed excess solar energy back to the power grid for renewable energy utilization.
- IoT Automation: Provide real-time user account balance checks, fee deductions, and charging session updates. Display parking slot availability and charging status via a mobile app and LCD display.
- Smart Parking Management: Allow users to reserve parking slots via a mobile application. Dynamically manage and update parking slot occupancy without physical sensors.
- User Authentication: Verify user credentials before initiating the charging process. Ensure secure communication between the mobile app and the charging station.
- Battery Monitoring: Display real-time battery status updates during the charging process. Notify users when charging is complete.
- Mobile Application: Provide an interface for slot reservations, account management, and real-time updates.
- Node MCU Microcontroller: Manage data flow between the IoT framework, sensors, solar panels, and user interfaces.

NON FUCTIONAL REQUIREMENTS

- Performance: Ensure efficient energy transmission with minimal loss during wireless charging. Provide real-time updates with a maximum latency of 2 seconds.
- Scalability: Support integration of additional parking slots and charging units as demand grows.
- Reliability: Ensure a 99% uptime for the charging station and associated systems.
- Security: Secure user data and transactions using encryption and authentication protocols.
- Usability: Provide an intuitive mobile app interface for seamless user interaction.
- Energy Efficiency: Maximize the utilization of solar power and minimize reliance on grid energy.
- Maintainability: Design the system for easy updates and component replacements.
- Environmental Impact: Ensure all materials used are environmentally friendly and adhere to sustainability standards.

IV. CONCLUSION

The "Wireless Solar EV Charging Station" presents an innovative and sustainable approach to addressing the limitations of traditional EV charging infrastructure. By integrating wireless charging technology, solar energy, and IoT-driven automation, this system offers a seamless, efficient, and eco-friendly solution for modern EV users. The use of inductive coupling eliminates the need for cumbersome cables, while solar panels ensure energy self-sufficiency and contribute to renewable energy adoption. IoT-enabled features, such as real-time monitoring, automated fee deduction, and smart parking slot management, enhance user convenience and operational efficiency.

This project not only supports the global shift towards sustainable transportation but also aligns with the vision of creating a greener future through advanced technology and energy conservation. The proposed system has the potential to significantly impact the adoption of EVs by addressing user challenges and improving the overall charging experience, ultimately contributing to a cleaner and more sustainable world.

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