AI based Smart EV Charging Spot Finder using Machine Learning Techniques

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Abstract: The "Smart EV Charging Spot Finder" is an innovative system designed to enhance the convenience of Electric Vehicle (EV) users by providing a seamless and efficient way to locate nearby charging stations location. This system continuously monitors the EV's battery level and automatically alerts the user when the charge is low. The battery level is monitored using sensors, and when it falls below a predefined threshold, The system uses GPS to identify and display the nearest charging stations automatically within a certain radius. This system combines both GPS and RFID where GPS is used to identifies the vehicle's real-time location and locates nearby charging stations and RFID for secure access and authentication at the stations. The IoT enabled system integrates with a database to fetch real time information about charging station location, manages vehicle data, battery status ensuring accurate and reliable data for the user. This project also includes a friendly User Interface (UI), such as LCD display in the vehicle to display the nearest station location, distance along with step-by-step navigation. The ESP32 microcontroller coordinates all system functions, making real-time decisions. The system ensures a seamless and efficient charging experience for users, this allows EV owners to make informed decisions about when and where to charge their vehicles, reducing downtime and improving the overall charging experience.

Keywords: ***Smart EV charging, RFID-based Authentication, GPS based Navigation, User Interface Display, Scalability and Compatibility***

I. INTRODUCTION

As the adoption of Electric Vehicles (EVs) continues to rise due to their environmental benefits and cost savings, the demand for a reliable and easily accessible becomes increasingly essential. However, a major challenge faced by EV owners is locating nearby charging stations efficiently, especially when traveling long distances or in unfamiliar areas. An RFID authentication system ensures that only authorized users can access charging station information, adding an extra layer of security. The GPS sensor enables real-time location tracking of electric vehicles, helping drivers identify the nearest available charging stations efficiently. The LCD display provides real-time updates on charging station availability and battery status, while the keypad interface allows users to manually search for nearby stations based on their location preferences.

A PHP-based web application, hosted on a dedicated web server, allows station administrators to upload and update charging station details. These details are stored in a MySQL database, ensuring that the ESP32 microcontroller can retrieve the most up-to-date station information whenever a user searches for a charging location. By combining hardware components such as the ESP32, RFID system, GPS sensor, LCD and keypad with software components like the web application and MySQL database, the Smart EV Charging Spot Finder provides an integrated and efficient solution for EV users. This project not only enhances the accessibility of EV charging networks but also contributes to the advancement of smart infrastructure by making the charging process more convenient, secure.

II. LITERATURE REVIEW

The increasing adoption of Electric Vehicles (EVs) has brought about the need for a reliable and accessible charging infrastructure, as highlighted by several studies.

Anderson et al. (2020) emphasize that one of the major challenges for EV owners is locating nearby charging stations, especially in remote areas, which contributes to "range anxiety." Various solutions have been oposed to address this, such as GPS-based EV charging station finders, which help users identify nearby charging points in real-time (Hossain et al., 2018; Wang and Yang, 2021). Additionally, IoT-based charging systems, as discussed by Rahmanietal. (2019) and Alametal.(2020), have proven effective in providing real-time status updates of charging stations, allowing users to monitor station availability and charge progress remotely.

RFID-based authentication, implemented by Zhou et al. (2020) and Chen et al. (2018), adds an extra layer of security by ensuring only authorized users can access charging stations, improving safety and preventing misuse. Moreover, the importance of a user-friendly interface in EV charging systems is highlighted by Natarajan et al. (2021), who explored mobile app-based solutions with GPS and navigation capabilities. Web-based integration for dynamic data management, as suggested by Mishra et al. (2019), ensures that charging station information remains accurate and up-to-date, offering a more reliable experience for users.

III. PROPOSED SYSTEM HARDWARE

ARCHITECTURE

The proposed hardware architecture of the Smart EV Charging Spot Finder system integrates several key components to create a seamless and efficient charging experience for Electric Vehicle (EV) owners. At the heart of the system is the ESP32 microcontroller, which manages communication between various components, including the battery level sensor, GPS module, RFID reader, and LCD display. The battery sensor continuously monitors the EV's battery status and triggers alerts when the charge falls below a preset threshold, prompting the system to search for nearby charging stations using the GPS module. The system then accesses real-time station data from a centralized server/database via the Wi-Fi/Bluetooth communication module, ensuring up-to-date information is available. The RFID authentication system ensures secure access to charging stations, while the LCD display provides real-time information such as the station's location, distance, and step-by step navigation. Additionally, the keypad allows manual search for stations based on user preferences. This hardware setup is designed for scalability, compatibility with different EV models, and ensures and the smooth and secure operation of the system, ultimately improving the EV charging experience for users.

IV. PROPOSED SYSTEM SOFTWARE

ARCHITECTURE

The software architecture of the Smart EV Charging Spot Finder system is designed to ensure seamless communication and efficient operation between the hardware components while providing a user-friendly experience. At it score, the software runs on the ESP32 microcontroller, which manages the main tasks such as monitoring the vehicle's battery level, receiving GPS data, handling RFID authentication, and displaying relevant information on the LCD display. The system queries a cloud-based MySQL database via a web-based PHP application to retrieve up-to-date charging station information, including station location, availability, and charger type. The software also manages communication between the vehicle and the cloud database via Wi-Fi/Bluetooth, ensuring the system receives real-time updates on charging station status and availability.

V. CONCLUSION

The Smart EV Charging Spot Finder system offers a robust and efficient solution for addressing the increasing demand for accessible and secure EV charging infrastructure. By integrating RFID authentication, an ESP32 microcontroller, and a real time web-based platform, the system ensures seamless access to updated charging station data. The inclusion of a vehicle battery status display further enhances user convenience, allowing EV owners to plan their charging needs effectively. With real-time synchronization and centralized data management, the system improves security, efficiency, and scalability,

making it a reliable choice for modern EV charging networks. Overall, the proposed system streamlines the charging process, enhancing the overall user experience while ensuring sustainability and adaptability in the evolving EV landscape.

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