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Mobile Application for EV Charging Station Locator and Real Time Slot Booking

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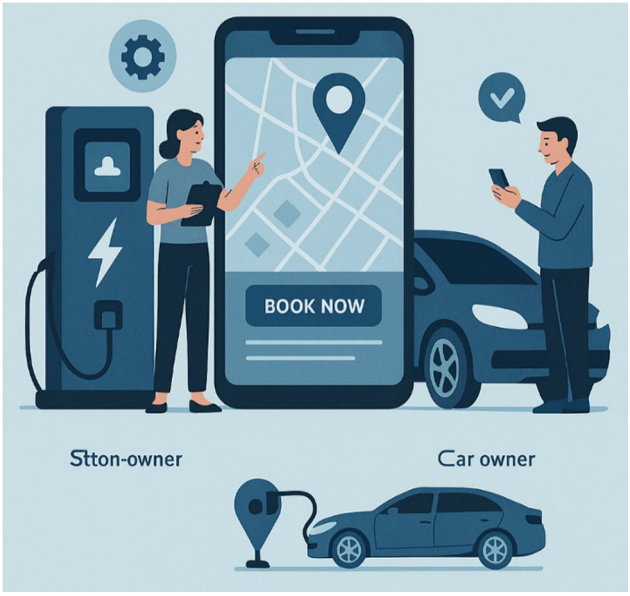
Abstract: ***EV Charging Station Locator and Slot Booking System is a web-based application developed to provide electric vehicles (EV owners) with an optimized solution for searching nearby charging stations, verifying real-time availability, and charging slot reservations. With the rapid deployment of EVS, the system addresses the need for efficient infrastructure by providing features such as geolocation-based transmitter search, slot availability, and real-time updates for GPS-enabled navigation. The platform improves user convenience by booking EV owners in advance, reducing wait times, and ensuring a problem-free charging experience. Integrating real data with user design ensures an intuitive experience while simultaneously optimizing the use of charging stations. The system not only benefits EV owners, but also supports efficient management of charging infrastructure and contributes to sustainable transport.***

Keywords: Web application, EV charging station finder, real-time slot booking, GPS navigation, geolocation, sustainable transportation, charging infrastructure management, user-friendly platform.

I. INTRODUCTION

With electric vehicles (EVs) becoming increasingly popular, the demand for network-efficient charging networks has increased considerably. One of the biggest challenges for EV owners is finding available charging stations and ensuring slits without delay. The project focuses on developing mobile applications that simplify the EV charging process by providing real-time locations and providing live availability updates, slot reservations and secure payment integration. The mobile application supports fast identification users near the charging point using enhanced GPS-based mapping and live data feeds. By integrating real-time slot availability, users can check if the station has an open slot before it arrives to ensure a smoother and more problem-free charging experience. The app also has instant slot reservations, allowing drivers to book charge points in advance, reducing wait times and optimizing charging station usage. Secure digital payments further enhance the convenience of use by activating seamless transactions within the app. With a user-friendly interface and comprehensive features such as detailed station profiles, pricing information, user ratings, and real-time notifications, the application aims to optimize your EV charging experience. This project will contribute to increased adoption of electrical capabilities and sustainable transportation solutions by reducing uncertainty related to store loading and optimizing route planning [1].



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II. MOTIVATION

The main motivation for this project is to overcome a wide range of challenges. With the growing assumptions of electric vehicles, traditional methods for finding the existence of electric vehicles, existing infrastructure and load points are becoming increasingly insufficient. Many drivers are uncertain due to outdated or incomplete information regarding station availability, charging speed, and pricing. Failure to book a load slot in advance often leads to long latency, unplanned rounds, inefficient energy management, and causes inconvenience to both individual users and fleet operators. This project aims to close these gaps by developing a mobile application that provides real-time locations, live slot availability and immediate booking capabilities.

The system allows users to access the latest information, optimize the charging process, minimize delays, and improve the convenience of ordinary users. Additionally, the initiative addresses the broader goal of promoting environmental sustainability by promoting widespread adoption of electric vehicles. A secure payment gateway, a user-friendly interface, and integration, and functions tailored to both personal and commercial EV users improve the functionality of the system. By optimizing resource usage and reducing downtime, this application contributes to a more intelligent and efficient charging ecosystem that supports a growing shift towards clean energy and sustainable mobility [2].

III. RELATED WORK

In recent years, the growth of electric vehicles (EVs) has developed a variety of applications to improve access to charging stations. Notable apps like Plug share, ChargePoint, and EVGO provide users with the opportunity to find charging stations, check availability and plan routes based on load outages. These applications play a key role in supporting EV deployments by addressing the reach that users have experienced. Station owners often lack tools to manage their reservations and use or update ward status in real time. This creates inefficiency in ward use and changes satisfaction.

When the proposed project recognizes this gap, he offers a mobile dual-roll application that serves both the car owner and the word manager. Car owners benefit from known features such as location search and booking, but station owners have access to the admin dashboard that allows them to monitor stations, update availability and view user activity. This comprehensive approach is aimed at improving the EV charging process experience for all involved [3].

Kumar et al. (IRJET, 2023) This system presents a mobile application using the Flutter framework to help EV owners locate charging stations, check real-time availability, and book charging slots. The app integrates Google Maps API for navigation and displays information about charging stations, such as connector types, availability, and pricing. Users can also report inaccuracies and filter stations based on preferences. The system aims to address the growing need for charging infrastructure and improve user convenience.

Sumit S. Muddalkar et al. (IJARSCT, 2022) This application, developed using Android Studio with Java and Kotlin, provides EV owners with nearby charging station locations, real-time availability, and navigation assistance. It also allows users to book charging slots based on car type and charging port. The app uses Firebase for real-time database management and Google Maps API for navigation. It includes features like profile management, slot booking, and station addition, making the system efficient for both users and station vendors.

Aashish Joshi et al., Real-Time Vehicle Tracking System Using Arduino, GPS, GSM, and Web-Based Technologies, International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Vol. 8, Issue 4, July-August 2021, pp. 122-128.

Awasthi, A., Venkitusamy, K., Padmanaban, S., Selvamuthukumaran, R., Blaabjerg, F., & Singh, A.K. (2017). Optimal planning of electric vehicle charging station at the distribution system using hybrid optimization algorithm. Energy, 133, 70–78.

IV. METHODOLOGY

The methodology for the development of mobile applications for locators and real-time slot reservations for EV charging stations follows a systematic approach aimed at ensuring functionality and user satisfaction. It starts with an analytical analysis that determines the requirements for both EV users and charging station operators. This is followed by system design, with architecture and user interface planned along with real-time reservation capabilities. The data collection and integration phase focus on collecting live information from charging stations such as slot availability, load type, and pricing. During the app development phase, both front-end and back-end components are implemented to provide a smooth and interactive experience. The application then undergoes rigorous testing and debugging to ensure performance and user friendliness. Finally, the app is used for public use and can be adapted to continuous maintenance and new technical trends [3].

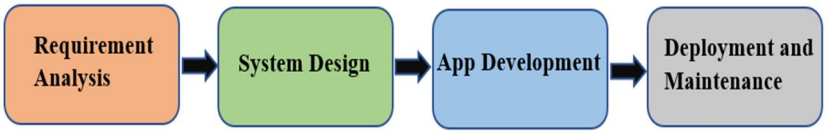

Figure 1: Process of Data Collection

A. Requirement Analysis

This early stage focuses on a comprehensive understanding of the needs and expectations of two key user groups. Owner and charging station operator. Through research, interviews and research on existing applications such as Plug share and ChargePoint, the project identifies key limitations regarding current solutions, such as lack of real-time slot reservations, lack of double-roller support, and lack of user experience. Based on this, the core requirements are defined: real-time availability, location-based search, seamless slit reservation, user registration/registration for both roles, and backends that support dynamic data processing.

B. System Design

Defining the system architecture, including the mobile app interface, real-time data integration, and booking mechanisms.

1) Front-end design using Flutter for a responsive and modern UI across Android and iOS.
2) Back-end architecture powered by Firebase services (Authentication, Fire store Database).
3) Defining user roles (Car Owner and Station Owner) with separate dashboards.
4) Real-time integration of Google Maps API to allow users to locate nearby stations.
5) Designing booking logic, time-slot handling, and data sync between users and stations. Wireframes and flowcharts are created to visualize user journeys and technical workflows.

C. App Development

The user interface is developed in flutter to ensure a consistent experience across the device. Prices and reservation slots have been developed.

D. Security and Maintenance

Security is an important aspect of mobile applications. It will take over user data, reservation transactions, and ward management. This project implements various measures to ensure safe operation.

1) Authentication: Make sure that only validated users (station owners and EV owners) can access their respective roles and features using secure registration methods such as email/password based registrations.
2) Data Encryption: User data, reserved documents, and station information are encrypted by Firebase to protect against unauthorized access or data leaks. Only authenticated users allow you to prevent read/write, manipulate, or unauthorized access to data related to your role.

V. IMPLEMENTATION

The EV charging station implementation and real-time slot reservation application involves the integration of several components, each for electric vehicles (EVs) and charging station operators. This ensures a seamless and efficient experience from searching for stations to bookings and shopping [4].

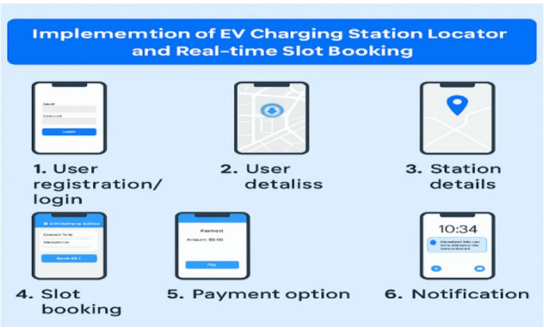

Figure 2: Process of Deployment

A. User Registration and Authentication

At the heart of the application is a secure and intuitive user registration system. The app supports role-based access and enables two key users: EV owners and station operators. Users can register and authenticate via e-mail, mobile phone number, or social registration. Firebase authentication is integrated to manage user registration information and ensure secure access, and user roles are stored in the Fire store database. This allows personalized access to features such as booking, payments, and station management, depending on your role.

B. User Location Access

Once successfully registered, application access requires access to the user's location to identify nearby EV charging stations. This feature runs through Device-GPS and is integrated into Google Maps-API, and visually renders available stations through the card interface. By using Glocalization data, the app not only increases the convenience of EV users, but also ensures that you will see the most relevant charging options based on proximity, route, or preferences.

C. Station Details

If a user selects a specific charging station from the card or list view, the application contains extensive information about the station. This concludes:

- Station name and physical address
- Load type (AC/DC, high speed/slow). Actual integration in Fire store ensures that all data provided is up to date

D. Slot Booking System

One of the central features of the application is the real-time slot reservation system, which allows users to reserve charging slits based on availability. This system is extremely important for avoiding long waits and attacking stations. User:

1) Select station
2) Select time window and date
3) Confirm reservations as soon as slots are reserved. Data is updated in a cloud database to prevent double bookings and notify ward operators. Booking confirmation is also linked to the user's account to receive simple access and changes if necessary.

E. Payment Integration

To make it easy to experience a smooth, cashless experience, the app integrates secure payment gateways such as Razor pay and Stripe.

Users can pay for reserved slots or energy consumption directly from the application. The system is a safe transaction protocol for word operators. This feature is optimized to reduce the administrative burden on managing manual payments.

VI. EXPERIMENTAL DETAILS

To evaluate the real-world effectiveness and accuracy of the EV Charging Station Locator and Real-Time Slot Booking mobile application, a series of field tests and observations were conducted. Below are the key experimental activities and findings [5].

A. Live Station Detection via GPS Mapping

1) The app was tested in multiple urban and semi-urban locations.
2) Using GPS-based location services integrated via the Google Maps API, the app successfully identified nearby EV charging stations within a 5–10 km radius.
3) Stations were marked accurately on the map interface with real-time markers and availability status.

B. Station Detection and Real-Time Updates

Upon launching the app and enabling location services, nearby stations were automatically rendered on the integrated map interface. Each station marker displayed availability in real time. Changes made to a station’s slot status (e.g., booking, cancellation) were reflected instantly across all active devices. This behavior confirmed efficient backend synchronization through Firebase’s event-based listeners.

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C. Slot Booking and Payment

Test users were able to book charging slots with custom percentage selections. On successful booking, slot status changed to "Reserved," and a confirmation with digital receipt was sent. Razor pay was used to process mock payments. The redirection and transaction completion averaged 1.8 seconds, consistent with acceptable user experience thresholds.

D. System Response Time Analysis

The app was stress-tested with simulated concurrent users using Firebase Emulator Suite and network throttling tools. Average response times were measured for key operations such as map rendering, slot booking, and payment completion

Action Performed	Average Response Time (ms)	Success Rate (%)	System Behavior/Notes
Owner registers charging station	850	100	Data successfully stored in Firebase
Admin verifies charging station	700	100	Status updated in real-Time
User views verified stations on map	950	98	Occasionally delayed on low-end device
Slot booking with Custom % charge	1100	100	Pricing calculated accurately
Razors pay payment Integration	1800	95	Minor lag observed during redirection
User registration with valid data	800	100	Form validation passed

Experimental User Actions and System Response Times

VII. CONCLUSION

The development and investigation of EV charging station locators and real-time slot reservation mobile applications have greatly improved the accessibility and efficiency of EV shops. By integrating real-time slot availability updates and an enhanced reservation system, the app reduces search times, minimizes latency, and improves user-friendly. User feedback highlights user-friendliness and effectiveness in addressing common challenges among EV owners. Additionally, the system benefits charging station operators by optimizing slot utilization and reducing traffic congestion.

This innovation contributes to a more sustainable transportation ecosystem that supports a global shift towards clean energy solutions. Future improvements include AI-controlled predictive analytics for demand forecasting and integration in smart grid systems to further improve efficiency.

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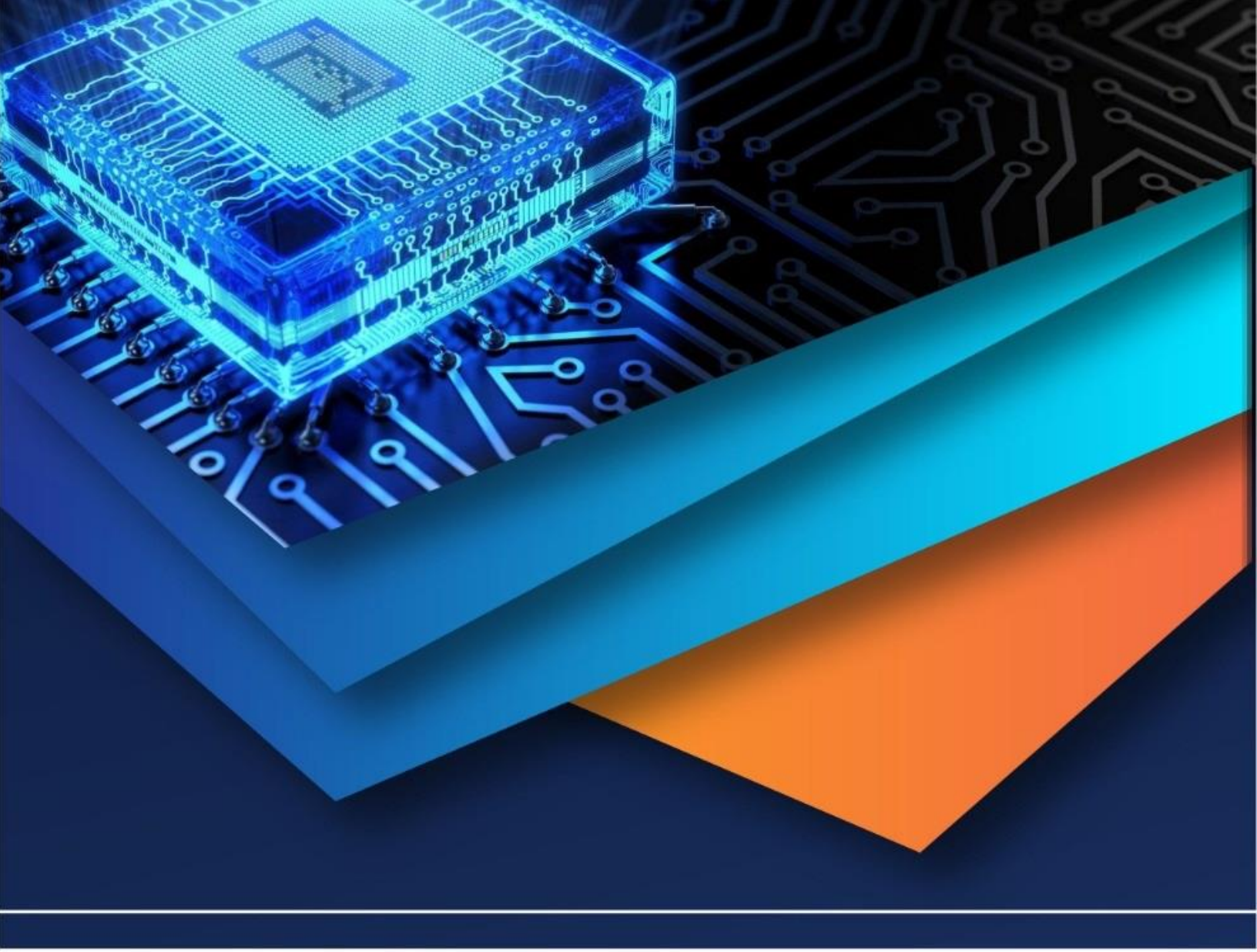

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