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INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 04, April 2025, pp : 329-333

e-ISSN : 2583-1062
Impact Factor : 7.001

ELECTRIC VEHICLE CHARGING STATION BOOKING & FINDER APP

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ABSTRACT

The ever-increasing population of India accompanied by the recent concerns regarding fossil fuel depletion and environmental pollution has made it indispensable to develop alternate mode of transportation. Electric Vehicle (EV) market in India is expanding. For acceptance of EVs among the masses, development of charging infrastructure is of paramount importance. This work formulates and solves the charging infrastructure-planning problem for city, that will develop as a smart city soon. The allocation of charging station problem was framed in a multi-objective framework considering the economic factors, power grid characteristics such as voltage stability, reliability, power loss as well as EV user's convenience and random road traffic.The advent of alternative vehicle technologies such as Electrical Vehicles (EVs) is an efficient effort to reduce the emission of carbon oxides and nitrogen oxides. Ironically, EVs poses concerns related to vehicle recharging and management. Due to the significance of charging station infrastructure, electric vehicles' charging stations deployment is investigated in this work. Its aim is to consider several limitations such as the power of charging station, the average time needed for each recharge, and traveling distance per day. Initially, a mathematical formulation of the problem is framed. In this work is proposed the design of a system to create and handle Electric Vehicles (EV) charging procedures. Due to the electrical power distribution network limitation and absence of smart meter devices, Electric Vehicles charging should be performed in a balanced way, taking into account past experience, weather information based on data mining, and simulation approaches. In order to allow information exchange and to help user mobility, it was also created a mobile application to assist the EV driver on these processes.Then, this problem is optimized by application,with the objective to calculate the necessary number of charging stations then finding the best positions to locate them to satisfy the clients demand.In this paper, the potential need for electric vehicles, charging station infrastructure and its challenges for the Indian scenario are studied.One of the app's key features is the ability to book charging slots in advance, allowing users to avoid waiting times and manage their schedules effectively. This advanced booking system enables monitoring of the charging progress directly through the app, from initial plug-in to completion.Users can view the expected costs, which can be settled either at the charging station or seamlessly through the app's secure payment gateway. The app's design not only enhances convenience for EV drivers but also contributes to the efficient use of charging infrastructure by optimizing slot allocation and reducing congestion. This comprehensive approach addresses the growing demand for a robust EV charging network, promoting sustainable transportation solutions in a rapidly developing urban environment.

Keywords: Optimization, Traffic, Electric Vehicle (EV), Charging Station, Charging Locator, EV Charger Finder, Charging Infrastructure, GPS Navigation, Route Optimization, Charging Network, User-friendly Interface, Mobile Application, Charging Cost, Smart Charging

1. INTRODUCTION

Today, India is one of the fastest growing economies in the world, but its increasing dependency on oil imports, rising environmental concerns and growing need for sustainable mobility solutions are posing serious economic and social challenges for the country.Rising fuel costs, growing public awareness and concern over environmental issues such as local urban air quality and global warming, combined with higher performance batteries mean that electric vehicles (EVs) are becoming an attractive alternative to internal combustion engine vehicles (petrol/diesel). Increased market penetration of electric vehicles will increase electricity loads, may place increasing demands on electricity grids. It will also require the installation, management and maintenance of compatible recharging infrastructure. Careful analysis, planning and management will be needed to reduce the costs of and to optimise placement of this recharging infrastructure and to minimise the impacts on electricity grids. The goal of this study is to determine the optimal number and locations of electric vehicle charging stations in the area supplied by the main electricity grid in city, taking account the expected location, number and movement/ charging patterns of electric vehicles.From general aspects of energy, with reduction of greenhouse gas emission target and to have a non-polluting, reliable and sustainable energy system, almost all automotive companies are committed to switching to Electric Vehicles (EVs) rather than keeping conventional cars, which work with Internal Combustion Engine (ICE). Although electric vehicles are quite expensive in comparisonto conventional cars, the most motivating news is that users can get benefit with a lower spending on

maintenance and operation costs. However, governments encourage people by giving users subsidies and invest in EV Charging Stations Infrastructure to help companies make this transition smoother from ICE Vehicles (ICEV) to the new generation of cars. The efficiency of EV relies on many parameters such as its battery, the power of charging stations, etc.Thus, regarding this methodology, by optimizing the distance between charging stations, the cost will be minimized. Charging Station (CS) infrastructure deployment is the most significant issue for the EV industry.In the last decade, the electric vehicle market has seen a rapid evolution with the ongoing development in the automotive sector. The sensitivity of different governments across the world toward a cleaner environment has increased the demand for electric vehicles and EV charging station apps. Developed countries including the USA, UK, and Germany are promoting the use of electric vehicles for reducing emissions, that's why electric vehicles are observing huge growth. In automotive cars, the electric vehicle industry is being dominated by global players like Tesla, BYD, BMW, Volkswagen, and Nissan.When a customer buys an electric car, then you can't maintain it in an ordinary way. You will require some apps especially a charging station finder app to find charging stations. An electric vehicle charging station finder app can save from any trouble in times of need. You can't be careless like the ordinary petrol or gasoline car whose fuelling stations are everywhere. In fact, you'll have to be more strategic about refueling, but with the help of apps that direct you to EV charging stations near you. In this system, we will be going through every aspect of an EV charging station finder app.Searching charging stations for electric vehicles is an important issue for the drivers which need the implementation of smart charging infrastructure network. Charging Station selection algorithms involve the overall information obtained through interactions between the EVs- EVs and EVs- Charging Station selection server through the mobile network, delivering information regarding availability of charging slot at nearest CS, thus minimizing individual waiting time and provide improved efficiency.In order to address the concerns of potential investors, the government of india is planning to be technology ready in adopting the standards and looking at Viability Gap Funding programs to encourage the market.Solving the charging station placement problem requires the positioning of the charging stations in the road network considering economic factors, operating parameters of the power grid, and EV users' ease. The present work utilizes a two-stage modelling of the charging station placement problem as illustrated in the subsequent sub-sections. It is expected that the two-stage planning model will reduce the computational time and effectively locate the charging stations.In general,EV vehicle charging station finder app which are used to solve the EV Charging Station locating problem, are usually focused on maximization of the clients need or minimization of the travel costs. Some optimal locating charging station problems of electric vehicles have been considered in recent years.Charging station selection server identifies the current location of the rider vehicle and taps the range available within it. It proposes all the charging station within the range to the rider. The server communicates with the other vehicle and determines the road traffic conditions and estimates the time required and the charge remained in the battery until the charging station is found within the range ready for charging.It also suggests the shortest route to the station depending on the road traffic condition.To save time, users have the option to book a charging slot in advance. This advance booking feature allows them to monitor the charging progress in real-time within the app, from initiation to completion.It also allows the rider to select the type of the charger and books the slot so that least time can be required for charging i.e. less waiting time.The server uses mobile network to communicate with the vehicle and station. It also proposes the current metering scheme at particular station and compares with other station price. It also can be done through a demand based metering system where EVs will be charged according to peak time and peak load.Existing fuel stations, bus depots, metro stations and shopping complexes can be considered as initial locations for deployment of chargers.

2. METHODOLOGY

1. Requirement Analysis

- Conduct market research to identify user needs and pain points.
- Gather requirements from stakeholders including EV users, charging station owners, and service providers.
- Define key functionalities such as station discovery, real-time availability, booking, and payment integration.

2. System Design & Architecture

- Design system architecture with front-end, back-end, and database components.
- Choose a suitable technology stack (e.g., React Native for mobile app, Node.js for backend, Firebase or MySQL for database).
- Develop an API-based architecture for seamless communication between different modules.

3. User Interface (UI) & User Experience (UX) Design

- Create wireframes and prototypes to visualize the application layout.

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- Implement user-friendly navigation with a focus on accessibility and responsiveness.
- Optimize the UI for both mobile and web platforms.

4. Database Development

- Design a relational database schema for managing user profiles, charging stations, bookings, and payments.
- Implement cloud-based storage solutions for scalability and reliability.

5. Implementation & Development

- Develop the front-end interface for users to search, filter, and book charging stations.
- Implement backend services to manage real-time data, user authentication, and transactions.
- Integrate APIs for location services (Google Maps API), payment gateways, and third-party EV networks.

6. Testing & Quality Assurance

- Conduct unit testing to ensure individual components work as expected.
- Perform integration testing to verify seamless communication between modules.
- Carry out user acceptance testing (UAT) to gather feedback from beta users and improve functionality.

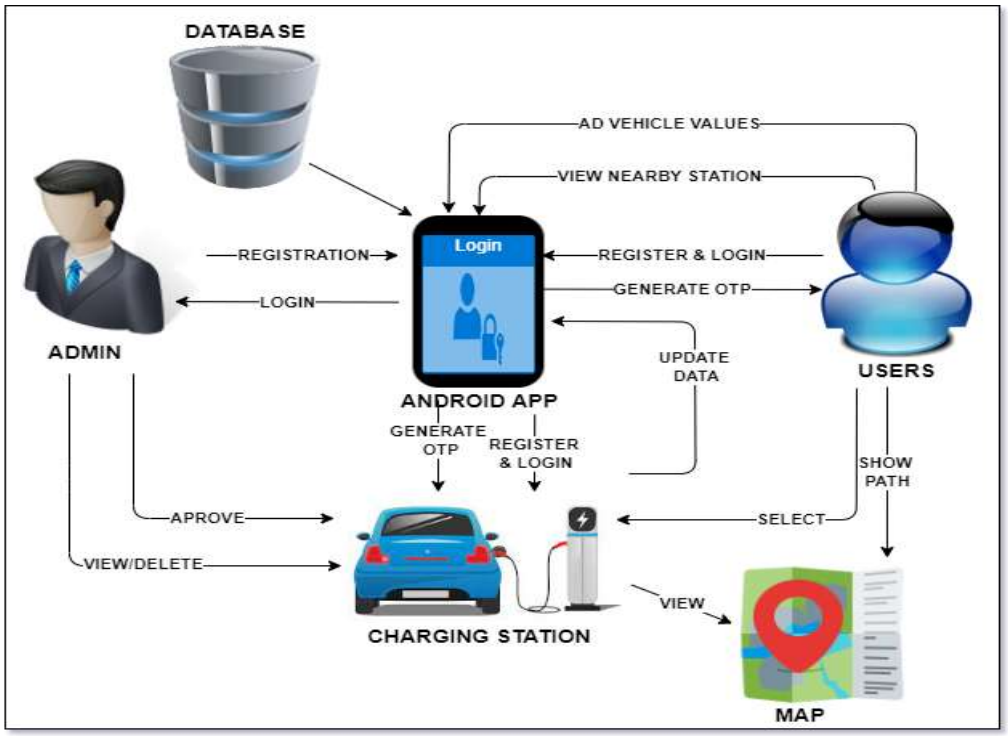
7. Deployment & Launch

- Deploy the application on platforms like Google Play Store and Apple App Store.
- Set up cloud-based hosting for backend services.
- Ensure security compliance with encryption and secure payment processing.

8. Maintenance & Updates

- Monitor user feedback and address any technical issues.
- Roll out periodic updates with new features and performance improvements.
- Implement machine learning algorithms to predict station availability and optimize user experience.

3. MODELING AND ANALYSIS



4. RESULTS AND DISCUSSION

Results

The development and implementation of the **Electric Vehicle Charging Station Booking & Finder App** successfully provided users with a seamless platform to locate and reserve charging stations. The application incorporated key functionalities such as real-time station availability, user authentication, payment integration, and navigation assistance. Below are the key outcomes:

1. **Efficient Station Discovery**: Users were able to find nearby charging stations using GPS-based location services integrated into the app. The real-time data ensured that users received up-to-date information on station availability.
2. **Seamless Booking System**: The app enabled users to reserve charging slots, reducing wait times and congestion at charging stations.
3. **Integrated Payment System**: Secure online transactions allowed users to make hassle-free payments for charging services.
4. **User-friendly Interface**: The app's intuitive design facilitated smooth navigation, making it accessible to a wide range of users.
5. **Enhanced User Experience**: Feedback and rating options allowed users to share their experiences, leading to improved service management by station operators.
6. **Data Analytics for Operators**: Charging station operators could access usage analytics, helping them optimize station management and maintenance schedules.

Discussion

The results demonstrate that the **Electric Vehicle Charging Station Booking & Finder App** significantly improves the accessibility and convenience of EV charging infrastructure. Several key points emerged from the implementation and user feedback:

1. **Impact on EV Adoption**: By reducing range anxiety and providing a structured charging process, the app encourages more users to consider EV adoption.
2. **Scalability and Network Expansion**: The platform's potential scalability allows for the inclusion of more charging stations, expanding the network and improving service reliability.
3. **Technical Challenges and Solutions**:
   - **Real-time Data Accuracy**: Ensuring up-to-date station availability required robust API integration with charging station databases.
   - **Payment Security**: Secure payment gateways and encryption techniques were employed to safeguard transactions.
   - **Load Balancing**: The system managed high user traffic efficiently through cloud-based server solutions.
4. **User Adoption and Feedback**: Initial user feedback indicated high satisfaction with the ease of finding and booking charging stations. However, users suggested additional features such as predictive station availability and integration with smart home charging systems.
5. **Environmental and Economic Benefits**: The app contributes to reducing carbon footprints by promoting efficient EV usage and reducing idle time at charging stations, leading to lower energy waste.

5. CONCLUSION

The **Electric Vehicle Charging Station Booking & Finder App** successfully addresses a major challenge in the EV ecosystem by making charging infrastructure more accessible and user-friendly. While the current implementation meets primary objectives, future improvements such as AI-driven booking predictions, renewable energy integration, and expanded station networks will further enhance the app's impact. The project underscores the importance of technological innovations in accelerating EV adoption and creating a sustainable transportation future.

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