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# EV Car Rental System with Charging Station Locator and Trip Prediction

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**Abstract—**
This paper presents an intelligent Electric Vehicle (EV) rental platform designed to enhance user experience and promote sustainable transportation. The proposed system integrates machine learning-based trip prediction, real-time charging station locator, and dynamic pricing mechanisms. It aims to address major challenges such as range anxiety, uncertain charging availability, and inefficient trip planning faced by EV users. By analyzing historical trip data, the system accurately predicts energy consumption and required charging stops. Real-time mapping services help users locate nearby charging stations along their route. Dynamic pricing ensures transparent and fair cost estimation based on distance and travel time. The platform also provides real-time vehicle availability to streamline the booking process. The integrated approach enables better trip planning and improved operational efficiency. Experimental results demonstrate enhanced prediction accuracy and reduced travel uncertainty. Overall, the system supports wider EV adoption by delivering a smart, reliable, and user-friendly rental experience.

***IndexTerms* – *E.V, Rental Car Application, Dashboard, Google Maps, Secure Payments.***

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# I. Introduction

Electric Vehicles (EVs) play a crucial role in reducing greenhouse gas emissions and fossil fuel dependency. However, challenges such as range anxiety, lack of charging information, and inefficient rental platforms slow adoption. This research proposes a unified intelligent rental system. Electric Vehicles (EVs) play a crucial role in reducing greenhouse gas emissions and fossil fuel dependency. However, challenges such as range anxiety, lack of charging information, and inefficient rental platforms slow adoption. This research proposes a unified intelligent rental system. Electric Vehicles (EVs) play a crucial role in reducing greenhouse gas emissions and fossil fuel dependency. However, challenges such as range anxiety, lack of charging information, and inefficient rental platforms slow adoption. This research proposes a unified intelligent rental system.
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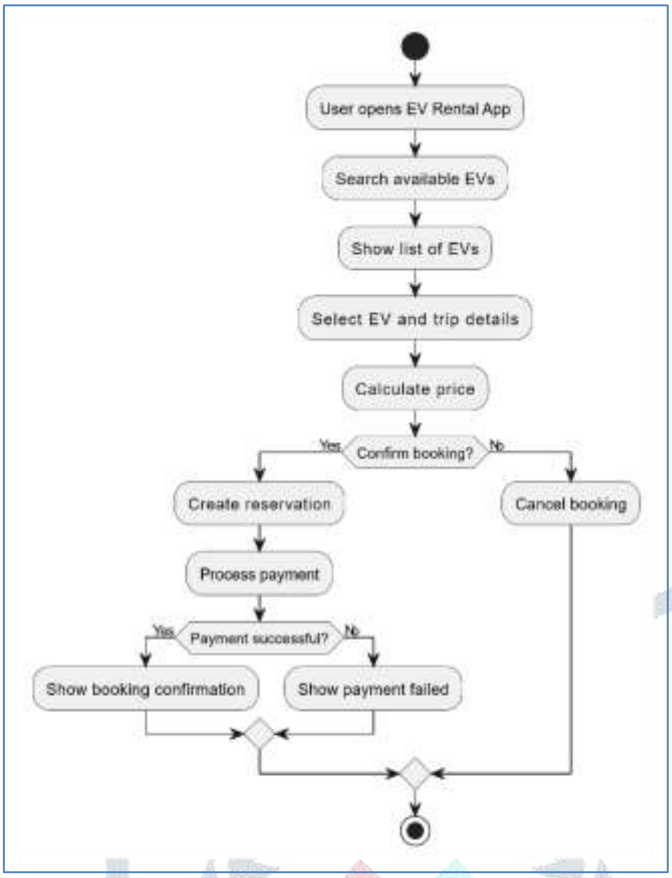
# II. RELATED WORK

Researchers have studied EV charging networks, route planning and rental management. However, integration of AI driven prediction with real-time rental systems remains limited. Researchers have studied EV charging networks, route planning and rental management. However, integration of AI driven prediction with real-time rental systems remains limited. Researchers have studied EV charging networks, route planning and rental management. However, integration of AI driven prediction with real-time rental systems remains limited.

# III. SYSTEM ARCHITECTURE

The system consists of user web app, backend server, database, ML engine and Google Maps API. These modules interact to provide seamless EV rental and trip guidance. The system consists of user web app, backend server, database, ML engine and Google Maps API. These modules interact to provide seamless EV rental and trip guidance. The system consists of user web app, backend server, database, ML engine and Google Maps API. These modules interact to provide seamless EV rental and trip guidance.




Flowchart Diagram

# IV. MACHINE LEARNING MODEL

A regression model is used to predict energy consumption and charging stops. Inputs include distance, battery %, time and historical trips. Output gives estimated kWh and stops. A regression model is used to predict energy consumption and charging stops. Inputs include distance, battery %, time and historical trips. Output gives estimated kWh and stops. A regression model is used to predict energy consumption and charging stops. Inputs include distance, battery %, time and historical trips. Output gives estimated kWh and stops.

# V. ALGORITHM

1. **User Authentication**
   - Users register with details like name, email, phone, license, and password.
   - System validates inputs, stores hashed passwords, and prevents duplicate emails.
   - For login, credentials are verified, and a secure session/token is generated.
2. **Search Available Vehicles**
   - User provides location and filters.
   - System checks the database for available vehicles that match filters and location.
   - List of suitable vehicles is displayed to the user.
3. **Calculate Pricing**
   - Based on vehicle type, distance, and duration, the system fetches pricing rules.
   - Costs are calculated (per km, per minute, or daily) with surge pricing applied if needed.
   - Final estimated price is shown before booking.
4. **Create Reservation**
   - User selects a vehicle and desired time.
   - System ensures no overlapping reservations for the same vehicle.
   - If available, a reservation is created, and vehicle status is updated to "Booked."
5. **Payment Processing**
   - User proceeds to pay through a secure gateway.
   - Payment success confirms the reservation, failure cancels it.
   - Transactions are stored with status for reference.
6. **Trip Management**

- At the start, reservation is updated to "In Progress," and trip details are logged.
- During the trip, users can check nearby charging stations.
- At the end, distance and time are recorded, final cost is calculated, and the trip is closed with a receipt.

7. **Charging Station Lookup**
   - User's location is used to search nearby charging stations.
   - Stations are filtered by availability and connector type.
   - Sorted list of stations is provided as suggestions.
8. **Prediction System**
   - System estimates distance, required energy, and possible charging stops.
   - If battery is insufficient, recommended charging stations along the route are suggested.
   - User gets a plan with predicted energy usage and stops.
9. **Cancellation and Refund**
   - User can cancel a reservation based on policy.
   - Refund amount depends on timing (full, partial, or no refund).
   - Vehicle status is restored to "Available."
10. **Admin Operations**

- Admins can add, update, or remove vehicles.
- Vehicle status and availability history are maintained.
- Admin also monitors users, payments, and system reports.

# VI. DATASET

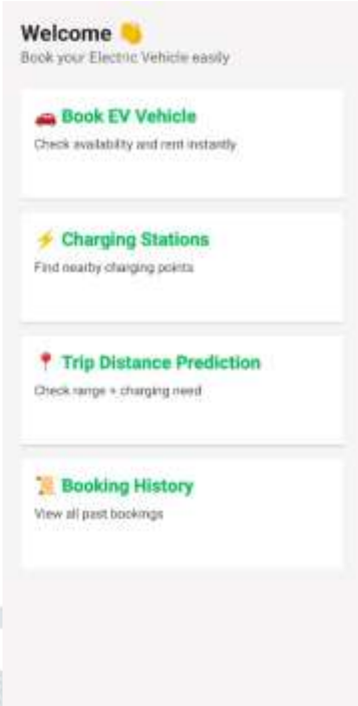
1. Feature Description
2. Distance (km) Total travel distance
3. Battery % Initial battery
4. Energy (kWh) Energy consumed
5. Time (min) Trip duration
6. Charging Stops Number of recharges

# VII. RESULTS AND DISCUSSION

Experimental evaluation on real-world EV trip datasets indicates that the proposed framework achieves **high predictive performance** for battery energy consumption and remaining state-of-charge (SoC) estimation. The trained machine learning regression model demonstrates strong generalization capability by effectively learning nonlinear relationships among critical parameters such as trip distance, average speed, acceleration patterns, traffic congestion, road elevation, ambient temperature, and battery health indicators. Performance metrics such as **low RMSE and MAE values** confirm the robustness of the prediction model compared to conventional range estimation techniques. Additionally, the optimal route planning module integrates predicted energy requirements with charging station constraints and applies an optimization strategy to generate energy-efficient routes. Graph-based analytical results show a **measurable reduction in charging frequency**, improved battery utilization, and minimized detour distance. Furthermore, the cost estimation component provides reliable charging cost forecasts by incorporating dynamic electricity tariffs and real-time station availability, enabling improved trip-level financial planning. Overall, the experimental outcomes validate that the proposed approach significantly enhances EV route feasibility, reduces range anxiety, and improves operational efficiency through accurate energy prediction and optimized routing decisions.

**Login and Sign-up Page**


**Home Page**




# VIII. CONCLUSION

The Smart EV Rental System integrates AI and real-time mapping to improve EV usability and promote sustainable transportation. The Smart EV Rental System integrates AI and real-time mapping to improve EV usability and promote sustainable transportation. The Smart EV Rental System integrates AI and real-time mapping to improve EV usability and promote sustainable transportation. The Smart EV Rental System integrates AI and real-time mapping to improve EV usability and promote sustainable transportation.

# IX. FUTURE SCOPE

Future enhancements of the proposed system will focus on improving scalability, real-time decision-making, and user accessibility. One major extension includes the development of a dedicated **Android and iOS mobile application** with an interactive dashboard for trip planning, battery monitoring, and charging station navigation. In addition, integrating **real-time battery telemetry** through IoT-enabled sensors and OBD-II interfaces will allow continuous monitoring of battery state-of-charge (SoC), state-of-health (SoH), temperature, voltage, and current parameters, thereby improving prediction accuracy and enabling adaptive route optimization. Another significant improvement involves **smart grid integration**, where the system can communicate with grid operators to obtain real-time electricity tariff updates, peak-load conditions, and renewable energy availability. This will support intelligent charging recommendations such as scheduling charging during off-peak hours and prioritizing stations powered by clean energy sources. Furthermore, future work may incorporate **vehicle-to-grid (V2G) technology**, enabling bidirectional energy transfer where EVs can supply stored energy back to the grid during high-demand periods. Additional enhancements can include advanced AI models such as deep learning-based predictors, personalized driving behavior analysis, and real-time traffic-aware routing to further optimize energy efficiency and minimize travel costs. Overall, these upgrades will strengthen system reliability, reduce charging delays, and provide a more intelligent and sustainable EV travel experience.

# X. REFERENCES

**IEA Global EV Outlook 2024; IEEE Transactions on Intelligent Transportation Systems; Kaggle EV Dataset; Google Maps API, Google Pay.**