

Visualization Tool for Electric Vehicle Charge and Range Analysis

Abstract

Electric vehicles (EVs) rely on battery energy storage systems whose performance directly affects driving range and charging efficiency. A visualization tool for EV charge and range analysis helps users, engineers, and policymakers understand battery behavior, energy consumption, and charging patterns. The tool improves decision-making, reduces range anxiety, and supports efficient energy management.

1. Introduction

Electric vehicles are rapidly replacing conventional fuel vehicles due to environmental benefits and reduced operating costs. Accurate battery monitoring and range prediction are essential for efficient EV usage.

2. Objectives

- Monitor EV battery State of Charge (SOC)
- Predict driving range
- Visualize charging behavior
- Improve energy efficiency and user confidence

3. Key Concepts

State of Charge (SOC): Percentage of remaining battery capacity.

Driving Range: Estimated distance the EV can travel with available charge.

Factors Affecting Range: Temperature, driving behavior, terrain, battery health, and load.

4. System Architecture

- Data Acquisition: Battery voltage, current, SOC, temperature, speed, GPS
- Data Processing: SOC estimation, range prediction, energy calculations
- Visualization: Dashboards, charts, alerts
- User Interface: Web and mobile dashboards

5. Visualization Features

- SOC Gauge
- Range Prediction Chart
- Charging Curve Graph
- Energy Consumption Graph
- Temperature Heatmap

6. Tools & Technologies

- Python (Matplotlib, Plotly, Dash)
- Power BI / Tableau
- MATLAB
- JavaScript (D3.js)

7. Advantages

- Reduces range anxiety
- Enhances battery lifespan
- Supports data-driven decisions
- Optimizes charging planning

8. Challenges

- Data accuracy issues
- Battery aging effects
- Environmental variability
- Integration complexity

9. Future Enhancements

- AI-based predictive analytics
- Smart grid integration
- Real-time traffic & terrain analysis

- Mobile app alerts

10. Conclusion

Visualization tools for EV charge and range analysis play a vital role in improving EV usability and adoption. They provide real-time insights, predictive analytics, and interactive dashboards that enhance energy efficiency and decision-making.