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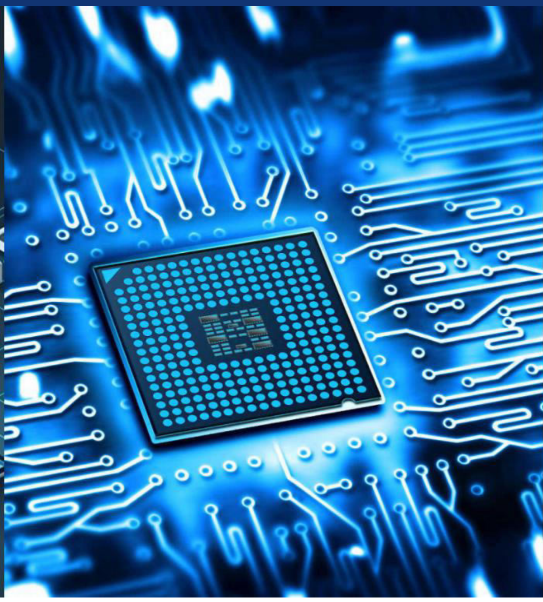


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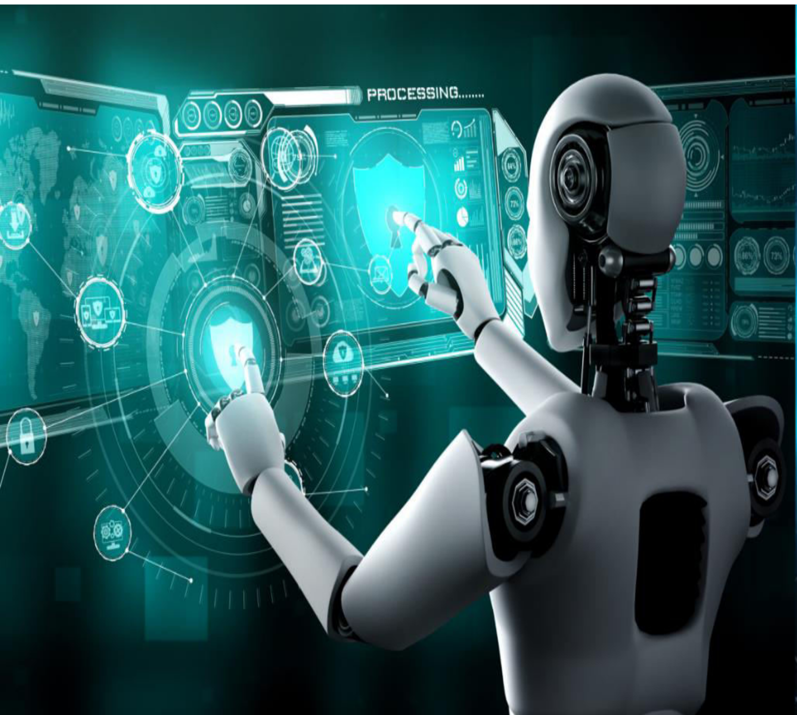

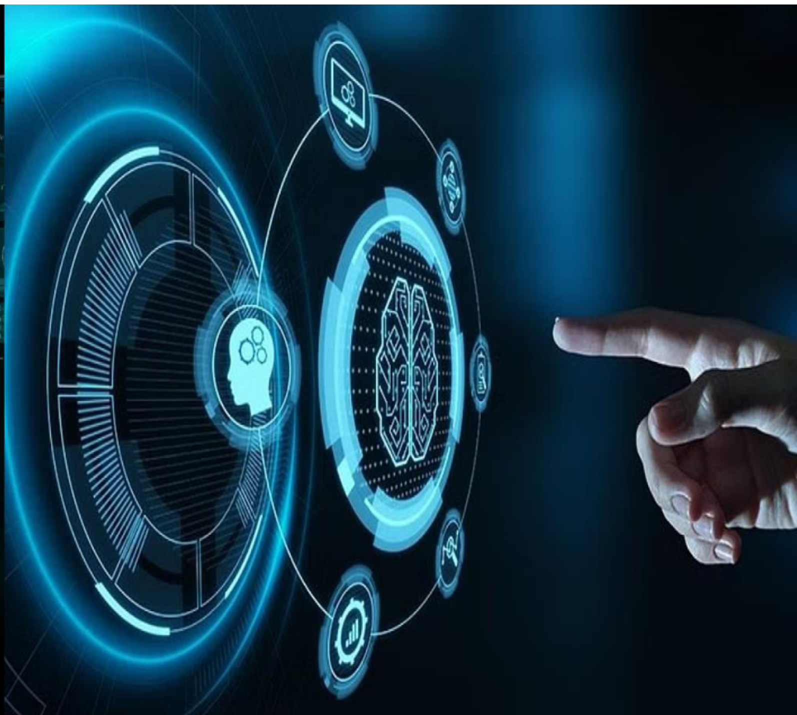

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Intelligent Traffic Prediction and Route Analysis System for Tamil Nadu Urban Roads Using XGBoost and Dijkstra Algorithm

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ABSTRACT: Traffic congestion has become a major challenge in urban areas of India due to the rapid increase in the number of vehicles and limited road infrastructure. This paper proposes an Intelligent Traffic Prediction and Route Analysis System designed specifically for Tamil Nadu's urban road network. The system analyzes traffic data to study congestion patterns across different time periods using key parameters including vehicle count, average speed, time of day, and road conditions. The XGBoost machine learning model is employed for accurate traffic congestion prediction and classification into four levels. The Dijkstra algorithm computes shortest paths between locations, while Yen's K-Shortest Paths algorithm provides multiple alternative routes. Route visualization is achieved using the Leaflet.js map library integrated with a Flask backend and React/TypeScript frontend. The system features color-coded traffic visualization, voice-based alerts, time-based travel predictions, and a comprehensive traffic analytics dashboard. Results demonstrate high prediction accuracy and route computation within 100 milliseconds for all tested source-destination pairs.

KEYWORDS: Traffic Prediction, XGBoost, Dijkstra Algorithm, Route Optimization, Leaflet.js, Flask, Smart Transportation, Tamil Nadu

I. INTRODUCTION

The rapid urbanization and increasing number of motor vehicles in Indian cities have created unprecedented levels of traffic congestion. Urban road networks in Tamil Nadu's major cities such as Chennai, Coimbatore, Madurai, Trichy, and Salem face daily gridlock, especially during peak hours. This not only wastes commuters' time and fuel but also contributes significantly to air and noise pollution.

Traditional traffic management systems rely on fixed signal timing and human intervention, which are insufficient for dynamic traffic conditions. With machine learning advancements, intelligent routing systems can now guide commuters through less congested paths. The proposed system addresses existing limitations by combining XGBoost-based prediction with Dijkstra's routing algorithm and an open-source Leaflet.js interface — making it self-contained and cost-effective.

Section II reviews related work. Section III describes the system architecture. Section IV presents implementation with screenshots. Section V discusses results and Section VI concludes with future directions.

II. RELATED WORK

A. Tiwari et al. (2020): Used CCTV cameras and YOLO-based detection to dynamically adjust signal timing. Limitation: detection accuracy drops during adverse weather and nighttime.

B. Moses & Rathi (2020): Applied Linear Regression, Random Forest, and SVM on historical traffic data. Limitation: No user-facing interface or real-time route guidance.

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C. Chhatpar et al. (2020): Used Google Maps API with ML for congestion prediction. Limitation: Cannot function offline or in API-restricted environments.

D. Meena et al. (2020): ML-based prediction for intelligent transportation systems. Limitation: High computational complexity limits scalability on low-cost hardware.

The proposed system addresses all these gaps with a unified, self-contained platform integrating prediction, route optimization, and interactive visualization.

III. SYSTEM ARCHITECTURE AND METHODOLOGY

A. System Architecture

The system follows a layered client-server architecture. The frontend is built using React with TypeScript and Tailwind CSS. The Flask REST API backend serves traffic data and ML predictions. Data flow: (1) User authenticates via email/Google OAuth; (2) User selects source and destination from 40+ Tamil Nadu locations; (3) Dijkstra/Yen's algorithms compute routes; (4) XGBoost predicts congestion levels per segment; (5) Color-coded routes display on the Leaflet.js map.

B. Data Collection and Preprocessing

Traffic data for Tamil Nadu cities was collected from Kaggle and supplemented with synthetic zone-based patterns. The dataset includes route name, zone type, city, geographic coordinates, and hourly traffic scores for all 24 hours on weekdays and weekends. Data was cleaned, missing values handled, and scores normalized to 0–100. Peak hours (8–10 AM and 5–7 PM on weekdays) were assigned higher congestion scores.

C. XGBoost Prediction Model

XGBoost was selected for its performance on tabular datasets and resistance to overfitting. Features include hour of day, zone type, city, day type, and vehicle count. The model classifies congestion as Low (0–30), Moderate (31–60), High (61–80), or Very High (81–100) for any given route segment and time.

D. Route Calculation

Dijkstra's algorithm finds the shortest path using traffic-adjusted travel time as edge weights. Yen's K-Shortest Paths algorithm provides K non-overlapping alternative routes, giving commuters flexibility to choose short, medium, or long route options.

IV. IMPLEMENTATION

Login Page: The login module supports both guest access and account-based authentication with email/password form validation and Google OAuth. Authentication state is managed via a custom React context (auth.tsx), persisting user sessions across page navigations using Firebase Authentication.

Home Dashboard: The RouteMaster home dashboard displays key system capabilities: 500+ Locations, 24/7 Predictions, AI Powered routing, and Smart Routing. The Latest Route Saved section enables instant re-run of previous journeys.

Route Planner: The route planner panel allows users to enter a start location (or use live geolocation), destination, and desired reach time. Live Navigation, Reminders, and Recent Searches panels are displayed alongside the Leaflet.js interactive map.

Tamil Nadu Map View: The Leaflet.js map is centered on Tamil Nadu, covering all major cities including Coimbatore, Chennai, Madurai, Salem, and Trichy. Users can zoom, pan, and click route segments to view detailed traffic information.

Additional Features: The system also provides vehicle count estimation per route segment; voice traffic alerts via Web Speech API; time-based travel prediction for bike, car, and bus; a Recharts-powered analytics dashboard with

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peak hour and city-wise analysis; and AI-powered route suggestions via Groq API (LLaMA 3.3 70B) with local fallback.

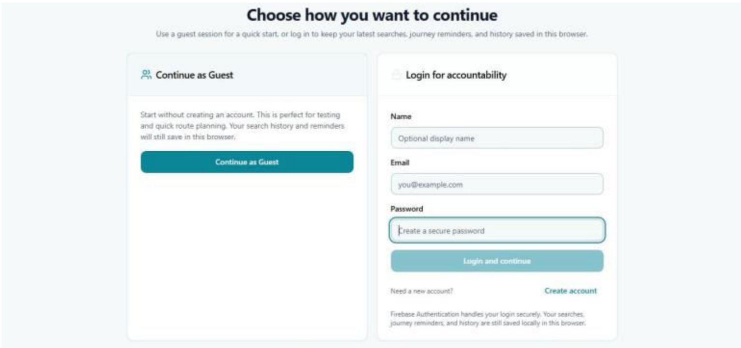

Fig. 1. Login Page — Guest and Account Authentication

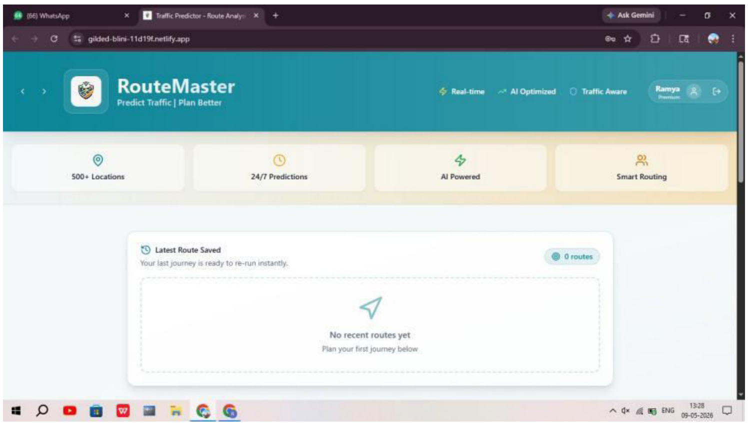

Fig. 2. Home Dashboard — RouteMaster Interface

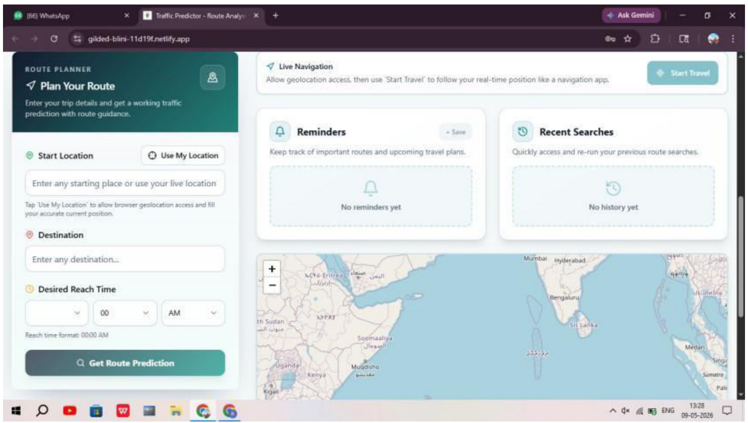

Fig. 3. Route Planner with Map and Navigation Features

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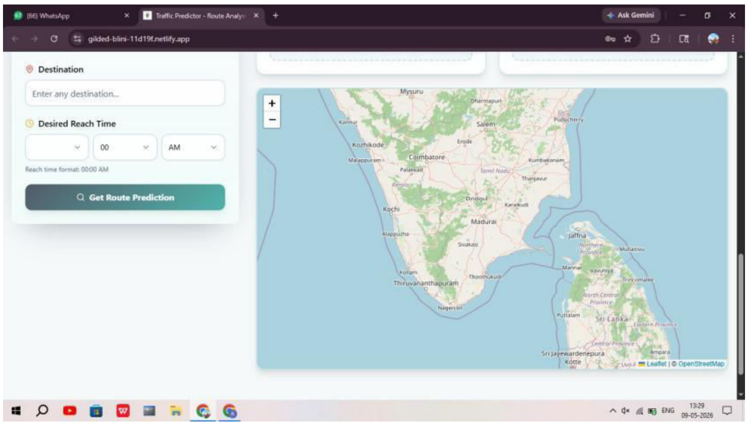

Fig. 4. Leaflet.js Map — Tamil Nadu Road Network Coverage

V. RESULTS AND DISCUSSION

Prediction Accuracy: The XGBoost model achieved high classification accuracy across all four traffic categories with consistent performance across zone types. Peak-hour predictions for Software Company and Main City zones closely reflected real-world patterns in Chennai and Coimbatore, with robustness across weekday and weekend traffic scenarios.

Route Optimization Performance: Dijkstra's algorithm computed shortest-path routes efficiently between all 40+ Tamil Nadu locations. Yen's algorithm provided up to three alternative routes per query. Route computation completed in under 100 milliseconds for all tested source-destination pairs, meeting real-time response requirements.

Usability and System Performance: The color-coded map visualization (Green/Yellow/Red) effectively communicated traffic conditions at a glance. Voice alerts functioned across Chrome, Firefox, and Edge. The Flask backend handled concurrent sessions within acceptable response times, with frontend load time under 3 seconds on standard broadband.

VI. CONCLUSION AND FUTURE WORK

This paper presented an Intelligent Traffic Prediction and Route Analysis System that effectively addresses urban traffic congestion in Tamil Nadu. The integration of XGBoost for prediction, Dijkstra and Yen's algorithms for route optimization, and Leaflet.js for interactive visualization delivers a self-contained, cost-effective smart city transportation solution. The system demonstrates that open-source tools can be effectively combined for practical smart city deployment without costly proprietary APIs.

Future enhancements include: real-time API integration (HERE Maps, TomTom); LSTM and Transformer models for long-horizon prediction; dedicated Android/iOS mobile app; smart traffic signal integration; expansion to all Tamil Nadu districts; and cloud deployment on AWS or Azure for statewide smart city infrastructure.

REFERENCES

[1] J. Tiwari, A. Deshmukh, G. Godepure, K. Upadhyaya, and U. Kolekar, "Real Time Traffic Management Using Machine Learning," in Proc. ic-ETITE, IEEE, 2020, pp. 1–6.
[2] A. Moses and P. Rathi, "Vehicular Traffic Analysis and Prediction using Machine Learning Algorithms," in Proc. ic-ETITE, IEEE, 2020, pp. 1–6.
[3] P. Chhatpar, N. Doolani, S. Shahani, and P. R. Lalwani, "Machine Learning Solutions to Vehicular Traffic Congestion," Int. J. Computer Applications, 2020.
[4] G. Meena, D. Sharma, and M. Mahrishi, "Traffic Prediction for ITS using Machine Learning," in Proc. ICETCE-2020, IEEE, pp. 145–149.

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 9.927| ESTD Year: 2013|

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(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

[5] T. Chen and C. Guestrin, "XGBoost: A Scalable Tree Boosting System," in Proc. 22nd ACM SIGKDD, pp. 785–794, 2016.
[6] E. W. Dijkstra, "A Note on Two Problems in Connexion with Graphs," Numerische Mathematik, vol. 1, no. 1, pp. 269–271, 1959.
[7] J. Y. Yen, "Finding the K Shortest Loopless Paths in a Network," Management Science, vol. 17, no. 11, pp. 712–716, 1971.
[8] V. Agafonkin, "Leaflet.js: An Open-Source JavaScript Library for Interactive Maps," 2023. [Online]. Available: https://leafletjs.com