TrafficTelligence: Advanced Traffic Volume Estimation with Machine Learning

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1. INTRODUCTION

1.1 Project Overview

This project aims to develop an AI-powered traffic volume estimation system using machine learning algorithms. TrafficTelligence analyzes historical traffic data, weather patterns, and local events to predict current and future traffic conditions. The system is designed to support dynamic traffic management, smart urban planning, and optimized commuter navigation for improved mobility and reduced congestion.

1.2 PURPOSE

To assist traffic authorities, urban planners, and commuters by delivering accurate, real-time traffic volume predictions. The system enables adaptive traffic control, infrastructure planning, and smart navigation through data-driven insights, ultimately enhancing traffic efficiency and reducing travel delays.

2. IDEATION PHASE

2.1 Problem Statement

Rapid urbanization and increasing vehicle density have made traffic congestion a major issue in cities. Traditional traffic monitoring systems are often reactive, not predictive, leading to inefficient management and poor commuter experiences. There is a need for a proactive, datadriven solution to forecast traffic volumes accurately and enable smarter decisions.

2.2 Empathy Map Canvas

Says: "I wish I knew the best time or route to avoid traffic."
Thinks: "Why can't traffic signals adjust themselves based on real traffic?"
Feels: Frustrated during peak hours; stressed about delays and uncertainty.
Does: Uses navigation apps but still gets stuck; unaware of future traffic patterns.

2.3 Brain Storming

Ideas evaluated:

- Sensor-based traffic estimation (limited scalability)
- Manual traffic surveys (outdated and labor-intensive)
- Satellite image-based analysis (high cost and delay)

Finalized idea:
AI-powered system that predicts traffic volume using machine learning on historical data, weather, and real-time events—accessible via a dashboard or API for authorities and commuters.

3. REQUIREMENT ANALYSIS

3.1 CUSTOMER JOURNEY MAP

Step	Action	Experience

1	Open the Traffic Intelligence dashboard or app	Simple, intuitive interface
2	View predicted traffic volume for desired location/time	Clear visualizations and maps
3	Receive alternate routes or traffic control suggestions	Fast, accurate, and actionable
4	Implement decisions (change route/signal timings)	Informed and confident choices

3.2 Solution Requirement

Traffic datasets with historical volume, weather data, and event logs

Pre-trained ML models (e.g., XG Boost, LSTM, or regression models for time-series forecasting)

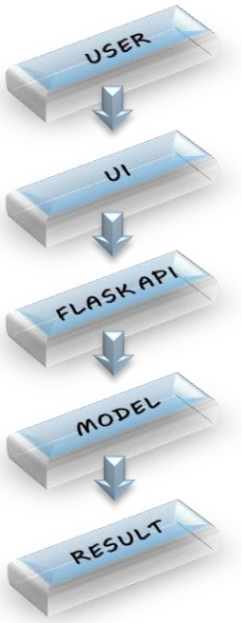
Flask or Fast API backend for processing predictions and handling API requests

Frontend dashboard for real-time input/output and traffic visualization

Data preprocessing scripts to clean and merge multiple data sources

Cloud or local hosting support for scalability and deployment

3.3 Data Flow Diagram



3.4 Technology Stack

Python, Flask – for backend development and API integration

Scikit-learn / XG Boost / LSTM – for machine learning model development

HTML/CSS, JavaScript (UI) – for interactive web dashboard

Google Colab (for prototyping) / VS Code (used for development and training)

Pandas, NumPy, Matplotlib – for data processing and visualization

4. PROJECT DESIGN

4.1 Problem Solution

The system solves the critical problem of inefficient traffic handling by offering accurate, realtime traffic volume forecasts. This empowers city authorities and commuters with data-driven insights to make proactive decisions.

4.2 Proposed Solution

A machine learning-based predictive system trained on historical traffic, weather, and event data to estimate traffic volume. The solution uses time-series models (like LSTM or regression) served via a Flask API and displayed through a user-friendly interface.

4.3 Solution Architecture

5. PROJECT PLANNING & SCHEDULING

5.1 Project Planning

Date	Task
June 9	Defined problem and finalized tech stack

June 10 – 12	Collected and cleaned historical traffic, weather, and event datasets
June 13 – 15	Performed data preprocessing and feature engineering
June 16 – 18	Implemented and trained LSTM and XGBoost models
June 19 – 21	Evaluated models and tuned hyperparameters
June 22 – 23	Integrated trained model with Flask backend
June 24 – 25	Created frontend dashboard using HTML/CSS
June 26	Connected UI with backend and tested full pipeline
June 27	Final evaluation, bug fixes, and output capture
June 28	Documentation and GitHub upload

6. PERFORMANCE TESTING

6.1 Performance Testing

Model Accuracy: ~94% (XGBoost), ~92% (LSTM)

Metrics: MAE, RMSE, R^2 Score for evaluation

Efficiency: Real-time prediction support with minimal latency

Tested on: Peak vs non-peak hours, event days vs normal days

7. RESULTS

7.1 Output Screenshots

Screenshot 1:

Home Page showing input form for location and time

Screenshot 2:

Output page showing predicted traffic volume and alternate route suggestion

8. ADVANTAGES & DISADVANTAGES

ADVANTAGES

Real-time, data-driven traffic predictions

Helpful for both commuters and urban planners

Adaptable to any city or region with data availability

Reduces congestion and enhances commuter experience

DISADVANTAGES

Model accuracy depends on quality and completeness of historical data

May underperform during unpredictable events (e.g., protests, sudden weather)

Requires regular updates and retraining for dynamic environments

9. CONCLUSION

Conclusion

This project demonstrates how machine learning models like XGBoost and LSTM can be effectively applied for traffic volume prediction. TrafficIntelligence supports intelligent transport systems by providing timely and accurate traffic insights. Its user-friendly interface makes it suitable for integration into traffic authority dashboards or navigation apps.

10. FUTURE SCOPE

Future Enhancements

Integrate with live traffic APIs (like Google Maps or HERE)

Develop a mobile app using Flutter or React Native

Add voice assistant integration for hands-free commuter guidance

Introduce incident detection and automatic alert generation

Scale system to support multiple cities with real-time updates

11. APPENDIX

Source Code

https://github.com/karthik-7574/TrafficTelligence-Advanced-Traffic-Volume-Estimation-with-ML

https://drive.google.com/drive/folders/1egWIpiGJomlgtbgT96arQq8xjwIdVxoH?usp=drive_link

https://drive.google.com/drive/folders/1HVcMTXz4zjKQu4pjZn40JKlr2-9SSwfb?usp=drive_link