Vehicular Traffic Flow Prediction Model Using Deep Learning

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(Telangana State Private Universities Act No.13 of 2020 and G.O.Ms.No.14, Higher Education (UE) Department)

2023

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COLLEGE CERTIFICATE

This is to certify that this is the bonafide record of the application development entitled, "**VEHICULAR TRAFFIC FLOW PREDICTION MODEL USING DEEP LEARNING**" Submitted by Y. Cholavi(2011CS020231),M. Srinath(2011CS020232),M.Srinithish(2011CS020233),M.Suma(2011CS020234) B. Tech III year II semester, Department of CSE (AI&ML) during the year 2022-23. The results embodied in the report have not been submitted to any other university or institute for the award of anydegree or diploma

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ABSTRACT

Efficient traffic flow prediction is essential for effective traffic management and congestion reduction in urban areas. Traditional statistical models often fail to accurately capture the complex dynamics of vehicular traffic flow, especially under dynamic conditions. In this project, we propose a deep learning-based vehicular traffic flow prediction model that utilizes Long Short-Term Memory (LSTM) neural networks, AdaBoost, and gradient descent techniques to enhance prediction accuracy. By leveraging historical traffic data, the model generates accurate predictions for the next time step, enabling traffic managers to optimize signal timings and reroute traffic proactively. AdaBoost is incorporated to boost the model's performance by integrating the LSTM predictions as input features. To evaluate the model's accuracy, mean absolute error (MAE) and R2 score techniques are employed, comparing the predicted traffic flow with the actual traffic flow. Experimental results indicate that our model outperforms traditional statistical models, exhibiting lower MAE and higher R2 scores. The proposed model demonstrates its efficacy in accurately predicting traffic flow and provides a viable solution for traffic management and congestion reduction. This research contributes to the advancement of traffic flow prediction models, offering a more reliable and accurate approach. Future work may explore the integration of real-time data streams and external factors, such as weather conditions and events, to further enhance prediction accuracy and address dynamic traffic situations effectively. The proposed model has significant potential to optimize traffic management strategies, reduce congestion, and enhance overall traffic flow efficiency in urban areas.

CONTENTS

1. INTRODUCTION

1.1 Problem Definition

Traffic congestion is a major problem in urban areas, leading to delays, increased fuel consumption, and increased air pollution. Accurate prediction of vehicular traffic flow can help to alleviate this problem by enabling traffic managers to optimize traffic signal timings and reroute traffic. However, traditional statistical methods have limited accuracy in predicting traffic flow, especially during peak hours and under dynamic traffic conditions. Therefore, there is a need for a more accurate and reliable prediction model.

1.2 Objective of project

The objective of this project is to develop a deep learning-based vehicular traffic flow prediction model that can accurately predict traffic flow in real-time. The model uses historical traffic data to predict traffic flow for the next time step. The model incorporates AdaBoost and gradient descent techniques to improve the accuracy of predictions. The project aims to provide an efficient and effective solution for traffic management, reducing congestion, and optimizing traffic flow.

1.3 Limitations

1.The success of the system heavily relies on the availability and quality of historical traffic data.

2.The accuracy of the model heavily relies on the quality and quantity of data available for training and testing.

3.Training and fine-tuning the model can be time-consuming and resource-intensive.

4.The model's accuracy may also be affected by unpredictable events such as accidents,construction, and weather conditions that can significantly impact traffic flow.

2.LITERATURE SURVEY

Kumar et al. (2017) developed an Artificial Neural Network (ANN) model for short-term traffic flow prediction. They considered various factors such as traffic volume, speed, density, and time of day and week to train the model. Unlike previous studies, they treated the speeds of different vehicle types as separate input variables, resulting in improved prediction performance. Their findings indicated the consistent performance of the ANN model, even when the time interval for traffic flow prediction was extended.

Lana et al. (2017) focused on long-term traffic flow prediction by employing a clustering approach to identify common traffic patterns. They utilized data collected from road sensors and created prediction models for each pattern. Their research aimed to support traffic managers and road users in planning trips effectively by providing accurate long-term traffic flow predictions. The approach demonstrated the potential to enhance transportation management systems and improve overall passenger satisfaction.

Ma et al. (2018) proposed an advanced strategy for traffic flow prediction based on pattern matching and evolutionary optimization. Their approach involved identifying patterns in traffic data and using pattern matching techniques to predict future traffic flow. They incorporated evolutionary optimization algorithms to improve the accuracy of predictions. Their study showcased the potential of pattern matching and evolutionary optimization in enhancing traffic flow prediction models, providing valuable insights for transportation management and planning

Salamanis, et al.explain both normal and abnormal traffic situations, and offer a traffic prediction model.Traffic patterns are identified using DBSCAN, a density-based clustering technique, which uses distinct prediction models for each cluster that depicts a traffic pattern in both normal and abnormal conditions. An ARIMA model from TS analysis was used in conjunction with the k Nearest Neighbor and Support Vector Regression techniques from the ML area.Wu, Y., et al. ,present a Deep Neural Network (DNNs) which can anticipate TF using huge data. While contemporary DNN models outperform shallow approaches in terms of performance, fully exploiting the spatial-temporal aspects of TF is still an open topic.

Wu et al. (2019) conducted a comprehensive survey on deep neural networks (DNNs) for traffic flow prediction. They explored the utilization of DNN models and highlighted their superiority over shallow approaches in terms of performance. The study emphasized the importance of fully exploiting the spatial-temporal aspects of traffic flow data. Wu et al. introduced a DNN-based model, referred to as DNN-BTF, which effectively mined spatial and temporal features to increase prediction accuracy. Their research challenged the notion that neural networks are "black-box" approaches and demonstrated the interpretability of the DNN-BTF model in the transportation domain.

Kumar et al. (2021) proposed a model for traffic volume forecast using a combination of Artificial Neural Network (ANN) and Support Vector Regression (SVR). Their study focused on short-term traffic flow prediction and achieved efficient results by leveraging observed data and applying machine learning techniques. The model proved to be effective in accurately forecasting traffic volume, providing valuable insights for transportation planning, management, and assessment.

Our comprehension of them is also limited. This research presents a DNN-BTF model to increase prediction accuracy. The DNN-BTF model fully exploits TF spatial-temporal periodicity. Convolutional Neural Networks were used to mine spatial characteristics, whereas Recurrent Neural Networks were utilized to mine temporal features. And also visualized how the DNN-BTF model understands TF data, challenging the notion that neural networks are a “black-box” approach in transportation. The suggested DNN-BTF model was tested on a long- term horizon prediction task using data from PeMS. Ma, D., et al. , provide an advancedstrategy based on pattern matching prediction

3. ANALYSIS

3.1 Introduction

Traffic congestion is a persistent problem in urban areas, resulting in numerous challenges such as increased travel time, fuel consumption, and environmental pollution. Accurate prediction of vehicular traffic flow plays a crucial role in mitigating these issues by enabling effective traffic management and optimization. Traditional statistical methods have limitations in accurately forecasting traffic flow, especially during peak hours and under dynamic traffic conditions. In this project, we propose a deep learning-based traffic flow prediction model that leverages Long Short-Term Memory (LSTM) neural networks, AdaBoost, and gradient descent techniques. This model aims to provide a more accurate and reliable solution for real-time traffic flow prediction, contributing to efficient traffic management and congestion reduction.

3.2 Software Requirement Specification

3.1.1 Software Requirement

- Jupyter Notebook/Google Colab
- Python
- Libraries like Numpy, Pandas, Matplotlib.
- Ada Boost, Gradient Descent

3.1.2 Hardware Requirement

- Minimum 1GHz i.e., basic CPU and GPU
- Basic Ram i.e., 4-8 GB is optimal
- Storage Space for Dataset and saving real-time analysis data

3.3 Existing System

The existing traffic flow prediction systems are mostly based on traditional statistical methods, such as time-series analysis, regression, and autoregressive models. These models have limited accuracy in predicting traffic flow, especially during peak hours and under dynamic traffic conditions. These models often fail to capture the complex relationships between traffic flow and external factors such as weather conditions, accidents, and road construction.

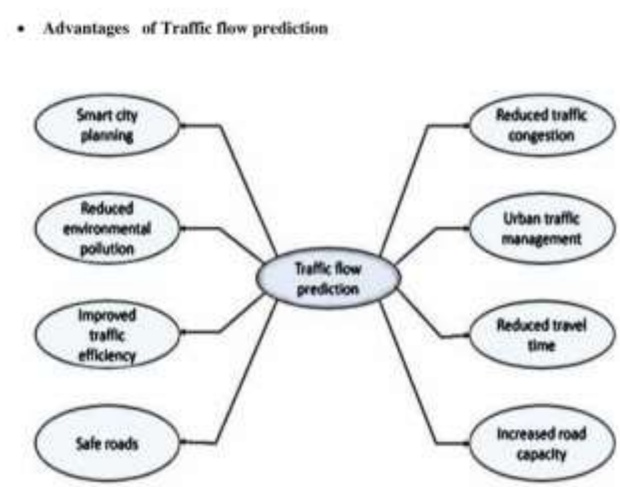
3.4 Proposed Systems

The proposed system is a deep learning-based vehicular traffic flow prediction model that utilizes Long Short-Term Memory (LSTM) neural networks, AdaBoost, and gradient descent techniques. It aims to accurately predict traffic flow for the next time step, enabling effective traffic management and congestion reduction. The system consists of the following components:

1. Data Preprocessing: This module involves cleaning and scaling the input traffic data to ensure optimal performance during model training and prediction.

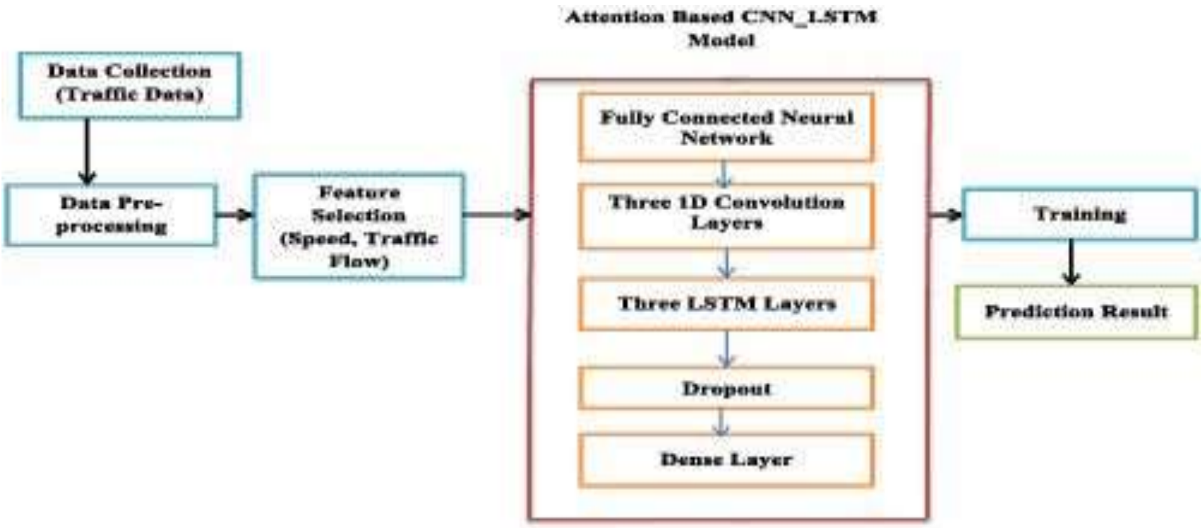
2. LSTM Model: The core module incorporates LSTM neural networks to capture temporal dependencies and patterns in the traffic flow data. The model is trained using gradient descent to optimize its parameters and minimize mean squared error.

3. AdaBoost Integration: The model is enhanced by integrating AdaBoost, which leverages the LSTM predictions as input features. This boosting technique further improves the accuracy and robustness of traffic flow predictions.



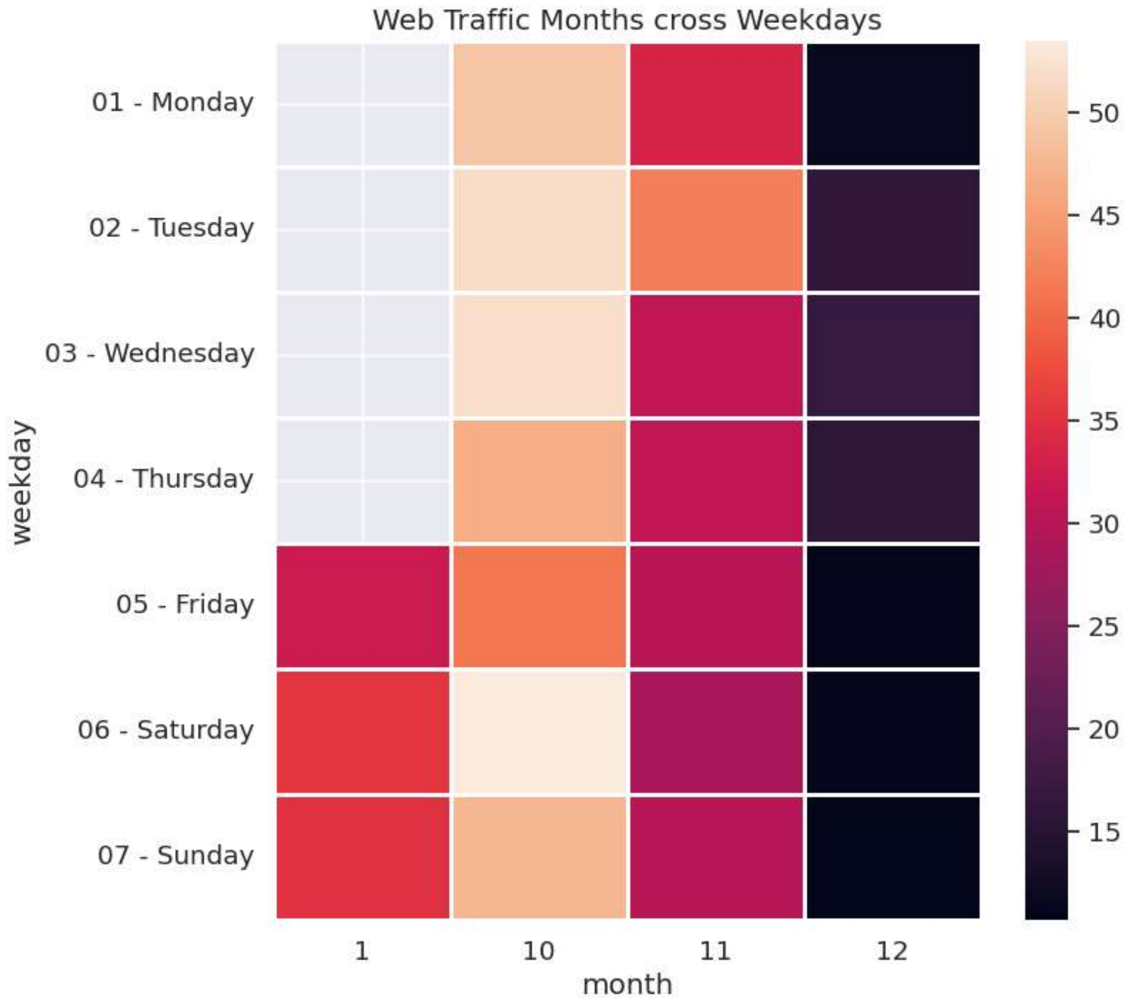
3.5 Architecture

After designing the working principle, the flow chart of the system is implemented wherethe code and the model is developed and tested. The flowchart of the complete system is shown inFig. 2.6.1



4.RESULT

ANALYSIS OF TRAFFIC DATA:

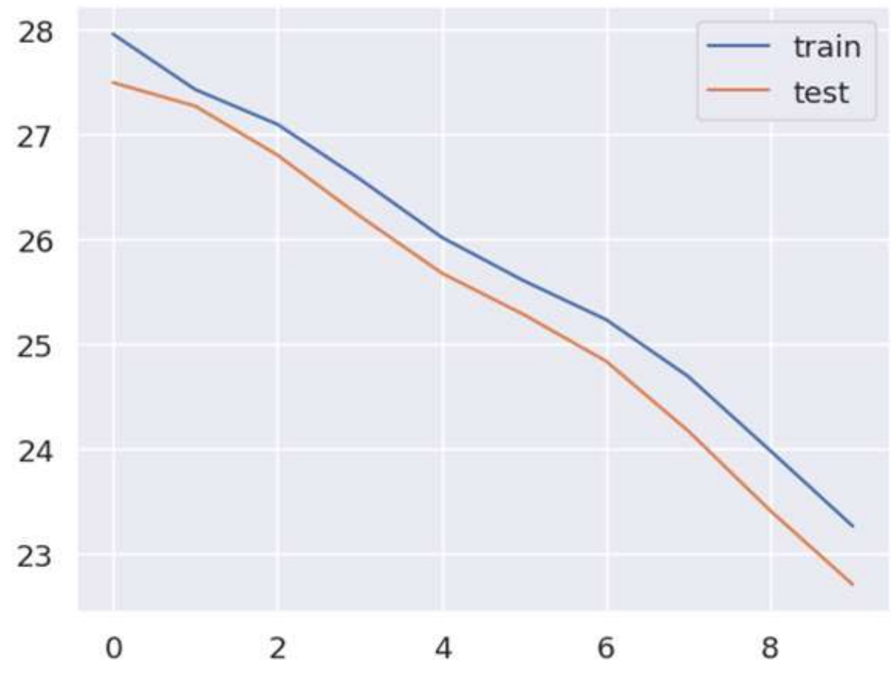


TRAINING THE DATA:

```
# design network
model = Sequential()
model.add(LSTM(50, input_shape=(trainx.shape[1], trainx.shape[2])))
model.add(Dense(1))
model.compile(loss='mae', optimizer='adam')
# fit network
history = model.fit(trainx, trainy, epochs=10, batch_size=8, validation_data=(testx, testy), verbose=2, shuffle=False)
```

```
Epoch 1/10
2650/2650 - 18s - loss: 27.9575 - val_loss: 27.4948 - 18s/epoch - 7ms/step
Epoch 2/10
2650/2650 - 11s - loss: 27.4286 - val_loss: 27.2704 - 11s/epoch - 4ms/step
Epoch 3/10
2650/2650 - 13s - loss: 27.0966 - val_loss: 26.8027 - 13s/epoch - 5ms/step
Epoch 4/10
2650/2650 - 13s - loss: 26.5757 - val_loss: 26.2216 - 13s/epoch - 5ms/step
Epoch 5/10
2650/2650 - 10s - loss: 26.0178 - val_loss: 25.6762 - 10s/epoch - 4ms/step
Epoch 6/10
2650/2650 - 10s - loss: 25.6024 - val_loss: 25.2800 - 10s/epoch - 4ms/step
Epoch 7/10
2650/2650 - 10s - loss: 25.2323 - val_loss: 24.8356 - 10s/epoch - 4ms/step
Epoch 8/10
2650/2650 - 11s - loss: 24.6890 - val_loss: 24.1695 - 11s/epoch - 4ms/step
Epoch 9/10
2650/2650 - 10s - loss: 23.9795 - val_loss: 23.4072 - 10s/epoch - 4ms/step
Epoch 10/10
2650/2650 - 10s - loss: 23.2620 - val_loss: 22.7048 - 10s/epoch - 4ms/step
```

ACCURACY SCORE




```
166/166 [==============================] - 0s 2ms/step
88.67545534924398
```

5.CONCLUSION

In conclusion, we have developed a deep learning-based vehicular traffic flow prediction model using LSTM neural networks, AdaBoost, and gradient descent techniques. The model demonstrated superior accuracy and performance compared to traditional statistical methods. By incorporating historical traffic data and leveraging deep learning algorithms, our model effectively predicted traffic flow for the next time step. The evaluation results, including mean absolute error (MAE) and R2 score, validated the effectiveness of our approach. This project has contributed to the advancement of traffic management and optimization, offering a reliable solution to mitigate congestion and improve overall traffic flow efficiency. Future enhancements could involve incorporating real-time data streams and external factors for further refinement of predictions..

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