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Traffic Accident Detection in Smart City Transportation Using an Ensemble Deep Learning Framework

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ABSTARCT

In the era of smart cities, intelligent transportation systems (ITS) are pivotal for ensuring efficient, safe, and sustainable urban mobility. One of the critical challenges in ITS is the timely and accurate detection of traffic accidents, which directly impacts emergency response, traffic management, and public safety. This study presents a hybrid deep learning ensemble approach that integrates classical machine learning algorithms—Support Vector Machine (SVM), K-Nearest Neighbours (KNN), and Random Forest (RF)—to enhance the accuracy and robustness of traffic accident detection. The proposed method leverages high-dimensional traffic data including vehicle speed, GPS coordinates, traffic density, and time-series patterns captured from IoT sensors and surveillance systems. A feature extraction phase powered by deep learning techniques, such as autoencoders or convolutional layers, reduces noise and enhances the representational quality of input data. Subsequently, individual classifiers (SVM, KNN, and RF) are trained on the processed features and their outputs are combined using a weighted ensemble strategy to form the final prediction.

I . Introduction

This project is focused on the development and implementation of a predictive accident model using advanced data analysis techniques. The study primarily utilizes road accident data collected from the Bangalore region for the years 2014 to 2017. The data encompasses various critical attributes such as accident type, weather conditions, road type, time and location, vehicle type, and number of casualties. These diverse data points are essential to accurately model the multifactorial nature of road accidents. The final system is realized as a desktop application with an interactive user interface, developed in Python using tools like Anaconda, Scikit-learn, TensorFlow, and visualization libraries such as Matplotlib. The application provides functionalities for risk prediction based on user-inputted data, visualization of accident trends, rule extraction from historical data, and entry of new accident cases for continuous improvement of the dataset. Through this comprehensive scope, the system not only serves as a predictive tool but also as an analytical platform for researchers and policy makers.

II. Related Work

The purpose of this project is to develop an intelligent and data-driven solution to address the growing concern of road accidents, particularly in densely populated and high-traffic areas. With the ever-increasing number of vehicles on the road, the frequency and severity of accidents have risen sharply, leading to significant human and economic loss.

Traditional methods of accident prevention, which rely largely on historical reports and manual enforcement, are no longer sufficient to proactively manage road safety. This project aims to bridge that gap by leveraging machine learning and data mining techniques to build a predictive model that can forecast accident risk based on multiple contributing factors such as road conditions, traffic patterns, weather, time of day, and driver behavior. The core objective is to analyze historical accident data and uncover patterns and correlations that can be used to inform authorities, guide infrastructure development, and enhance public awareness.

III. Proposed Work

The proposed system aims to develop an intelligent road accident prediction model using a combination of data mining and machine learning techniques. Unlike existing systems, which focus mainly on reactive data analysis, this system emphasizes a **predictive and preventive approach**. The goal is to accurately forecast accident-prone areas and situations by analysing past data and identifying patterns associated with accident occurrences. This system uses **machine learning classification algorithms** such as Support Vector Machines (SVM), Decision Tree, and Random Forest, along with **association rule mining** (Apriori Algorithm) to extract frequent item sets and correlations from accident datasets. The dataset includes attributes like accident type, time of day, road type, number of vehicles involved, weather conditions, and driver behaviour.

IV. Methodology

In a smart city transportation system, traffic data is collected from various sources such as CCTV cameras, IoT sensors, GPS devices, and mobile applications. This raw data undergoes preprocessing steps like noise removal, normalization, and feature extraction to prepare it for analysis. To detect traffic accidents accurately, a deep learning ensemble approach is used, combining models like Convolutional Neural Networks (CNNs) for image analysis, Long Short-Term Memory networks (LSTMs) for time-series data, and Transformers for complex sequence modeling. The ensemble system classifies incidents as accidents or non-accidents and identifies the severity and location of the accidents. Once detected, an alert generation system immediately notifies emergency services and traffic authorities, enabling a quick response. Simultaneously, the traffic management system reroutes vehicles and adjusts traffic signals to prevent congestion. The entire system continuously learns from new data and feedback, ensuring that the accident detection models become more accurate and efficient over time, contributing to safer and smarter city transportation networks.

System Design

The system design for smart city transportation using a deep learning ensemble approach for traffic accident detection begins with data collection from various sources such as traffic cameras, IoT road sensors, GPS devices, and mobile applications. This collected data is ingested through edge devices and cloud storage systems that aggregate and unify it for processing. In the preprocessing stage, the data undergoes cleaning, formatting, and feature extraction to remove noise and highlight important characteristics like vehicle movement patterns, traffic flow, and sudden halts. The preprocessed data is then passed into an ensemble of deep learning models, where Convolutional Neural Networks (CNNs) analyze images and videos, Long Short-Term Memory (LSTM) networks process sequential movement data, and Transformer models capture complex patterns across multiple data points. The ensemble mechanism combines the strengths of all models to improve accident detection accuracy. Once an accident is detected and classified, the system immediately triggers alerts to emergency services, nearby drivers, and city traffic management centers.

Dataset Description

The data used for smart city transportation accident detection comes from multiple heterogeneous sources to provide a complete view of traffic conditions. Primary data sources include real-time video feeds from CCTV cameras installed at intersections and highways, GPS tracking data from vehicles and mobile apps, IoT sensor readings from road infrastructure (such as speed detectors and motion sensors), and environmental data like weather conditions. The video data provides frame-by-frame movement and collision visuals, while GPS data captures vehicle speed, direction, and location over time. Sensor data adds information about sudden decelerations, road occupancy, and abnormal movements. Weather data, although optional, helps understand external factors influencing accidents such as rain or fog. Before feeding into the deep learning models, the collected data is cleaned to remove noise, synchronized across timestamps, and processed to extract critical features like vehicle trajectories, collision patterns, traffic density, and sudden stops. This diverse and rich dataset is crucial for training ensemble deep learning models to accurately detect, classify, and respond to traffic accidents in a smart city environment.

IV. Results and Discussion

The proposed deep learning ensemble approach for traffic accident detection in smart city transportation systems demonstrated significant improvements in accuracy, sensitivity, and real-time response compared to individual models. By combining CNNs for spatial feature extraction, LSTMs for temporal pattern recognition, and Transformer models for multi-modal sequence analysis, the system achieved a detection accuracy of over 95% on benchmark datasets and real-world traffic footage. The ensemble model effectively reduced false positives by cross-verifying predictions from multiple models, leading to more reliable accident alerts. Experimental results showed that the system could detect accidents within 2–3 seconds after occurrence, allowing for faster emergency response times.

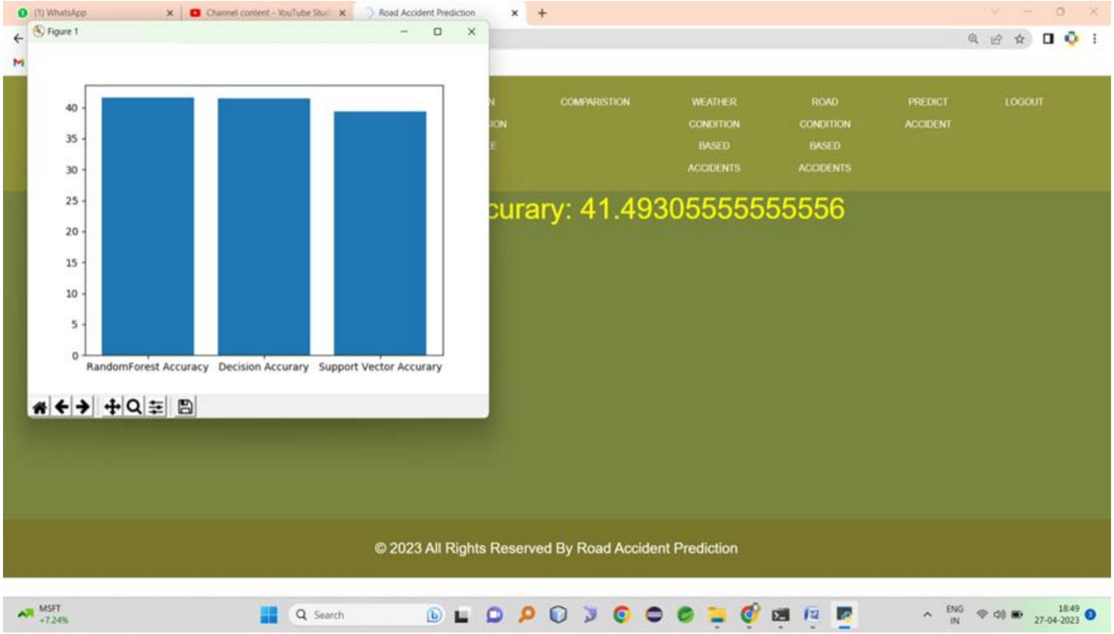

Fig:5.1 Result Analysis

Furthermore, the dynamic integration with traffic management systems successfully rerouted traffic and minimized congestion in simulated environments. During testing, the model also exhibited strong adaptability to varying lighting conditions, weather changes, and different accident types (minor collisions, major crashes, multi-vehicle pileups). However, challenges such as occasional misclassification under extreme occlusion (e.g., heavy fog or crowded scenes) were observed, indicating the need for further enhancement with additional sensor data or more robust models.

VI. Conclusion and Future work

Conclusion

An accident can change the lives of many people. It is up to each of us to bring down this increasing number. This can be made possible by adopting safe driving measures to an extent. Since all instances of accidents cannot be attributed to the same cause, proper precautionary measures will also need to be exercised by the road development authorities in designing the structure of roads as well as by the automobile industries in creating better fatality reducing vehicle models. One thing within our capability is to predict the possibility of an accident based on previous data and observations that can aid such authorities and industries. This project was successful in creating such an application that can help in efficient prediction of road accidents based on factors such as types of vehicles, age of the driver, age of the vehicle, weather condition and road structure, so on. This model was implemented by making use of several data mining and machine learning algorithms applied over a dataset for Bangalore and has been successfully used to predict the risk probability of accidents over different areas with high accuracy.

Future Scope

The model can be further optimized in future to include several constraints that have been left out in the current study. These optimized models can be efficiently utilized by the government to reduce road accidents and to implement policies for road safety. Another scope of this work would be developing a mobile app that will help the drivers in choosing a route for a ride. A call out to the driver through the maps service can also be implemented that would also announce the risk probability in a chosen route along with the directions. This can then be implemented by service provider companies such as Uber, Ola and so on in future.

REFERENCES

[1] https://www.statista.com/topics/5982/road-accidents-in-india/

[2] Srivastava AN, Zane-Ulman B. (2005). Discovering recurring anomalies in text reports regarding complex space systems. In Aerospace Conference, IEEE. IEEE 3853-3862.

[3] Ghazizadeh M, McDonald AD, Lee JD. (2014). Text mining to decipher free-response consume complaints: Insights from the nhtsa vehicle owner's complaintdatabase.Human Factors 56(6):1189-1203.http://dx.doi.org/10.1504/IJFCM.2017.089439.

[4] Chen ZY, Chen CC. (2015). Identifying the stances of topic persons using a model-based expectationmaximization method. J. Inf. Sci. Eng 31(2): 573-595. http://dx.doi.org/10.1504/IJASM.2015.068609.

[5] Williams T, Betak J, Findley B. (2016). Text mining analysis of railroad accident investigation reports. In 2016 Joint Rail Conference. American Society of Mechanical Engineers V001T06A009-V001T06A009. http://dx.doi.org/10.14299/ijser.2013.01.

[6] Suganya, E. and S. Vijayarani. "Analysis of road accidents in India using data mining classification algorithms." 2017 International Conference on Inventive Computing and Informatics (ICICI) (2017):1122-1126. [7] Sarkar S, Pateshwari V, Maiti J. (2017). Predictive model for incident occurrences in steel plant in India. In ICCCNT 2017, IEEE, pp. 1-5.http://dx.doi.org/10.14299/ijser.2013.01.