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Predictive Analytics for Accident Detection in Intelligent Traffic Systems: A Smart City Perspective

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Abstract
The integration of intelligent traffic systems in smart cities enhances road safety and traffic efficiency by utilizing predictive analytic for road accident detection. Recent advancements have arranged a multidisciplinary approach integrate machine learning, Internet of Things (IOT), and deep learning methodologies reorganized traffic management. This approach includes the development of a 3D Convolution Neural Network (CNN) based system for automatic accident detection using traffic video analysis. This system optimizes detection during varied weather and lighting conditions, significantly improving road safety. Leveraging real-time data from wireless sensor networks and predictive models can accurately forecast traffic flow and road occupancy rates. This predictive capability is essential for dynamically adjusting traffic control measures, reducing congestion and facilitating a smoother traffic flow. The combination of these technologies marks a significant evolution in intelligent transportation systems, effectively primarily accidents and optimizing urban mobility infrastructure.

INTRODUCTION

I. Introduction

Smart cities associate information and communication technology (ICT) to up grad efficiency, quality of life and environmental sustainability in urban areas (Pamudji, 2023). The concept of smart cities encompasses several key areas, including governance, economy, Traffic management, infrastructure, health care, crowed management, technology, and people. Traffic management plays a crucial role in ensuring road safety and efficiency, particularly in urban environments. It involves various aspects, including accident detection, congestion control, and traffic flow optimization. Accident detection is of paramount importance in traffic management systems, as it can significantly reduce response times and check the impact of accidents on overall traffic flow (Adewopo, {Smart city transportation: Deep learning ensemble approach for traffic accident detection, 2024) (Ghahremannezhad, 2022) . The implementation of automatic incident detection techniques has become a key focus in Intelligent Transportation Systems (ITS). These systems utilize advanced technologies such as wireless networking, sensor technologies, and computer vision to detect and respond to traffic incidents promptly. The integration of Vehicle-to-Infrastructure (V2I) communications and probabilistic data collection methods has shown promising results in improving incident detection rates and reducing congestion (Popescu, 2017), (Mane, 2023). Research on reducing accident rates in traffic management has employed various approaches and models: Road traffic accident analysis and black spot identification have been used to pinpoint high-risk areas. One study on the Lahore-Islamabad Highway M-2 utilized the accident Point weightage (APW) method to identify and rank black spots (Iqbal, Road traffic accident analysis and identification of black spot locations on highway, 2020). Advanced machine learning models like LSTM-GBRT (Long Short-Term Memory - Gradient Boosted Regression Trees) have been developed to predict traffic accident safety levels. This model demonstrated good fitting effects and robustness compared to various regression and neural network models (Zhang Z. a., 2020). The Haddon matrix has been utilized to analyze risk factors in different phases of accidents, considering human, vehicle, and environmental aspects. This approach helps in identifying preventable risk factors and developing holistic safety measures (Klinjun, Identification of factors affecting road traffic injuries incidence and severity in Southern Thailand based on accident investigation reports},, 2021). In summary, various methods ranging from statistical analyses to advanced machine learning models have been employed to reduce accident rates in traffic management. These approaches focus on identifying high-risk areas, predicting accident severity, and analyzing multiple risk factors to develop comprehensive safety strategies.

Azam, M.(2024)

Literature review

1.Pamudji, A. K. (2023). {IoT-driven environmental support system for smart cities}.

"IoT-driven Environmental Support System for Smart Cities," Pamudji (2023) explores the concept of smart cities, which hinges on integrating information and communication technology (ICT) to boost efficiency, enhance quality of life, and promote environmental sustainability. The growing popularity of smart city initiatives over the past five years is evident, with programs like China's "Smart City Pilot" and various platforms in the United States leading the charge. In Indonesia, major cities are pioneering digital applications to streamline public services and drive economic growth, but challenges such as deficient ICT infrastructure, lack of supportive regulations, and limited community engagement persist. The Internet of Things (IoT) is pivotal in smart cities, facilitating real-time data collection through an array of connected sensors and devices. This capability allows for informed and timely decision-making, ultimately contributing to the community's quality of life. Indonesia's government aims to develop 100 smart cities, thus necessitating significant efforts to advance smart city development across the nation.

2.Adewopo, V. A. (2024). {Smart city transportation: Deep learning ensemble approach for traffic accident detection.

The paper titled "Smart City Transportation: Deep Learning Ensemble Approach for Traffic Accident Detection" by Adewopo, V. A. (2024), discusses advanced methods for detecting traffic accidents to improve safety and traffic management in smart cities. It explores existing accident detection techniques and provides an overview of traffic accident types, such as rear-end, T-bone, and frontal impact collisions. The study introduces a novel model, I3D-CONVLSTM2D, which is designed for smart city traffic surveillance. By combining RGB frames with optical flow information, this lightweight model enhances accident detection. The empirical analysis demonstrated the model's effectiveness, achieving an 87% Mean Average Precision (MAP). The paper also addresses challenges related to data imbalances in limited datasets, various road structures, and traffic scenarios. The research aims to advance vision-based accident detection systems suitable for real-time use on edge IoT devices in smart urban environments.

3.Popescu, O. a.-M.-W.-T. (2017). Automatic incident detection in intelligent transportation systems using aggregation of traffic parameters collected through V2I communications

Automatic incident detection techniques in Intelligent Transportation Systems (ITS) utilize advanced technologies to enhance traffic management and safety. The integration of Vehicle-to-Infrastructure (V2I) communications and probabilistic data collection methods has been instrumental in improving these systems. V2I communications enable vehicles to exchange information with roadside infrastructure units, enhancing roadway safety by facilitating real-time data sharing about traffic conditions and incidents.

4.Ghahremannezhad, H. a. (2022). Real-time accident detection in traffic surveillance using deep learning.

"Real-Time Accident Detection in Traffic Surveillance Using Deep Learning" by Ghahremannezhad (2022) focuses on leveraging computer vision techniques to enhance traffic monitoring systems by automatically detecting traffic accidents. This research introduces a novel framework specifically designed for detecting accidents at urban intersections using surveillance cameras.

5.Mane, D. T. (2023). Real-time vehicle accident recognition from traffic video surveillance using YOLOV8 and Open CV

The paper "Real-Time Vehicle Accident Recognition from Traffic Video Surveillance using YOLOV8 and Open CV" by D. T. Mane (2023) explores the automatic detection of traffic accidents leveraging computer vision techniques. The study presents an ensemble model using the YOLOv8 approach for efficient and precise accident detection. This model is evaluated through YouTube video sequences under varied lighting conditions and is trained using the open-source Crash Car Detection Dataset. The proposed system shows improved metrics with a precision of 93.8%, a recall of 98%, and an mAP of 96.1%, outperforming prior results of 91.3%, 87.6%, and 93.8%, respectively. The experimental results backup the model's effectiveness in real-time traffic surveillance applications, highlighting its potential to enhance emergency response times and promote safer driving practices (Mane et al., 2023).

6.Iqbal, A. a. (2020). Road traffic accident analysis and identification of black spot locations on highway. *Civil Engineering Journal.*

The study by Iqbal (2020) analyzes road traffic accidents and identifies black spot locations on the Lahore-Islamabad Highway M-2. It highlights road safety as a significant issue in developing countries, noting the substantial human and economic losses due to traffic accidents. The study uses official data from the National Highway and Highway Police of Pakistan, employing the accident point weightage method to identify and rank top black spot locations.

The analysis reveals a 35.3% rate of fatal accidents, with human error identified as the primary cause in 66.8% of cases. Secondary and tertiary contributing factors include vehicle errors (25.6%) and environmental factors (7.6%). Key causes of accidents include dozing at the wheel (27.9%), careless driving (24.6%), tire bursts (11.7%), and brake failures (7.4%). The study also identifies Kallar Kahar (Salt Range) as a significant black spot due to frequent brake failures. The findings suggest that public awareness campaigns on road safety and the use of devices like dozing alarms could reduce accidents.

7.Zhang, Z. a. (2020). Traffic Accident Prediction Based on LSTM-GBRT Model. *Journal of Control Science and Engineering*.

The paper "Traffic Accident Prediction Based on LSTM-GBRT Model" addresses the issue of low accuracy in traffic accident predictions. It presents a model combining LSTM (Long Short-Term Memory) and GBRT (Gradient Boosted Regression Trees) to improve the reliability of forecasting traffic accident safety indicators. Through training with traffic accident-related data, the model aims to provide more precise predictions that can be integrated into traffic management systems for informed decision-making. The study reveals that the LSTM-GBRT model shows superior fitting and robustness compared to other regression and neural network models, enabling traffic management departments to better understand the state of traffic safety.

8.Klinjun, N. a. (2021). Identification of factors affecting road traffic injuries incidence and severity in Southern Thailand based on accident investigation reports. *Sustainability*.

The study used the Haddon matrix to categorize risk factors into three phases across four agent categories: human, vehicle, passenger, and environment. Key human-related risks included speeding and drowsiness. Passenger-related risks involved not wearing seat belts and sitting in unsafe zones within vehicles like the cargo area of pickups. Vehicle-related risks were attributed to overloaded vehicles, unsafe modifications, absence of occupant safety equipment, and unfixed seats. Environmental factors identified as risks were fixed objects on roadsides, lack of traffic lights and guardrails, absence of traffic signs, and road accident black spots.

9 Bhatia, N. a. (2023). Accident Emergency Alert System using Deep Learning

The article "Accident Emergency Alert System using Deep Learning" by Bhatia (2023) addresses the pressing issue of road accidents, which often result in significant loss of life due to delayed emergency response. The research highlights that many road fatalities are due to the failure of timely rescue services. The study emphasizes that an efficient accident detection system can help reduce the mortality rate by ensuring that victims receive prompt medical attention. The paper presents a deep learning-based system designed to detect accidents using computer vision and object tracking techniques. This system is developed in Python and aims to automatically report accidents to emergency responders, ensuring that help is dispatched quickly. By potentially identifying accidents before they occur or as soon as they happen, the system can communicate critical information to emergency services, allowing them to provide immediate aid to injured individuals.

10. Liu, Z. a. (2018). Urban traffic prediction from mobility data using deep learning. *Ieee network*

In the article "Urban Traffic Prediction from Mobility Data Using Deep Learning," Liu (2018) discusses the importance of accurate urban traffic prediction and the role of deep learning in this field. The study highlights how deep learning models can effectively capture hidden traffic characteristics from extensive historical mobility data to predict traffic conditions, such as traffic speed, flow, and accident risk.Intelligent Traffic Systems (ITS) are advanced concepts that use information technology, data communications, electronic sensing, global positioning, and computer processing capabilities to enhance the efficiency, safety, and environmental sustainability of transport networks. In general, ITS systems utilize accurate and timely traffic management strategies using current, real-time data and a continuous flow of data. The article reviews early attempts at using deep learning for traffic prediction, noting their notable performance, and suggests two future research directions aimed at enhancing prediction accuracy and efficiency on a large scale.

11.Alanazi, F. a. (2024). A framework for integrating intelligent transportation systems with smart city infrastructure

The study by Alanazi (2024) introduces a framework for integrating Intelligent Transportation Systems (ITS) with smart city infrastructure, addressing urban transportation challenges and promoting sustainable mobility. It is rooted in a detailed literature review, case studies, and stakeholder interviews, highlighting the integration process, key components, benefits, challenges, and barriers. The framework proposes evaluation methods to assess integration effectiveness, demonstrating reduced traffic congestion, improved air quality, and enhanced citizen satisfaction. This comprehensive approach offers transformative solutions for urban transportation, contributing significantly to the existing literature on smart city development.

Smart Cities and their role in Accident Detection:

Smart cites are the key components of raise accident detection systems, utilizing state-of-the-art technologies such as Io T and AI in the pursuit of enhancing safety and efficiency in the urban context. Current research has been concerned with the different methodologies of accident detection in smart cities, with special attention to the implementation of machine learning and Io T to promote transportation safety. For example, an ensemble of deep learning techniques has shown efficiency in the detection of various kinds of traffic accidents using video cameras and optical flow features, with high accuracy in real-time applications (Adewopo, Smart city transportation: Deep learning ensemble approach for traffic accident detection, 2024) . Overall, the convergence of Io T and smart cite technologies is pivotal in establishing more responsive and safe urban transport systems (Bhatti, 2019).

Intelligent Traffic System

Intelligent Traffic Systems (ITS) are advanced concepts that use information technology, data communications, electronic sensing, global positioning, and computer processing capabilities to enhance the efficiency, safety, and environmental sustainability of transport networks. In general, ITS systems utilize accurate and timely traffic management strategies using current, real-time data and a continuous flow of data. (Liu, 2018).

Importance of ITS in smart cities:

In order to improve mobility, manage traffic, and advance sustainable transportation options, ITS combines cutting-edge technologies with urban infrastructure (Alanazi F. a., 2024)

Scope of predictive analytic in reducing road accidents

Predictive analytic can significantly help in lowering road accidents because it utilizes machine learning algorithms and big data technologies to extract factors from patterns to see what might happen potentially. Many studies have been done showing classifications algorithms like decision trees, random forests, and conventional neural networks (CNN) are capable of predicting when accidents may happen or how serious they may be (Pourroostaei Ardakani, The Role of Big Data Analytics in Urban Systems: Review and Prospect for Smart Transport and Healthcare Systems, {2023). Graph Neural Networks (GNNs) have been particularly adept in characterizing the spatial correlations and roadways, providing better performance than baseline traditional models on accident prediction tasks (Zhang J. a., 2024).

Current Accident Detection Techniques:

Human Reporting:

Advanced AI-driven systems are now a part of modern accident detection methods, surpassing human reporting. According to (Moriano, 2024) these include machine learning classifiers like XG Boost, which have a high accuracy rate of detecting accidents as soon as 1.0 minutes after they occur.

Sensors:

Sensors play a key role in traffic systems by enabling real-time vehicle detection, speed monitoring, and incident recognition. Common types include inductive loops, radar, ultrasonic sensors, and AI-powered cameras. In smart cities, these sensors work with Io T and predictive analytic to manage traffic flow and enhance safety. Recent studies show that sensor data combined with deep learning improves accident detection accuracy in intelligent traffic systems (Adewopo, Smart city transportation: Deep learning ensemble approach for traffic accident detection, 2024).

Social Network and Geo social Media Data:

When precise location information is unavailable, this method can be especially helpful. Nevertheless, the size of the social network and the quantity of ground truth data available can have a substantial impact on how well network-based Geo location inference techniques perform (Jurgens, 2021).

Applications in Road Accident Detection:

Automatic Detection Systems:

Automatic road accident detection systems have been developed using a wide variety of technologies in an effort to save lives and improve emergency response times. These automatic detection systems include automatic accident detection utilizing smartphones, mobile applications also utilize GSM and GPS technologies, vehicular ad-hoe networks, and so on. Some of the approaches to detecting accidents include low-cost ultrasonic sensors, and some approaches extensively tour modern computer vision methods (Khalil, 2017).

Computer Vision and Machine Learning:

The use of advanced computer vision and machine learning techniques has been illustrated in the detection of accidents based on surveillance video footage. Specifically, the I3D-CONVLSTM2D model architecture was developed using RGB frames with optical flow information and achieved good results in smart city traffic surveillance systems (Adewopo, {Smart city transportation: Deep learning ensemble approach for traffic accident detection, 2024). Another solution involved a combination of support vector machines and two features extracted from static images: Histogram of gradients (HOG) and Gray level co-occurrence matrix (GLCM) features to classify damaged vehicle (Ravindran, 2016).

Real-time Monitoring and Alert Systems:

A number of systems have been proposed for real-time accident detection and automated notification to emergency responds. Examples of these include CCTV-based systems relying on the DETR (Detection Transformers) algorithm and a Random Forest Classifier (Srinivasan et al., 2020), and Io T-based systems relying on smartphone sensors to detect and classify accidents (Kumar et al., 2020). These technologies aim to help reduce time to report accidents and increase information available for respondent, facilitating rescue effectiveness by sharing the type of accident.

Challenges and Limitations:

Data Quality and Availability

Getting high-quality data that is needed for reliable predictive analytic is one of the biggest problems. Traffic data is often missing, inaccurate, or skewed, which can make projections far less reliable. Another worry is that real-time data may not always be available, which is important for finding accidents quickly.

Technical Limitations

Technical difficulties like low processing power and data storage may make intelligent traffic systems less effective. advanced computing power isn't always useful (Rezaee, 2024)

Integration and Interoperability

Predictive analytic is difficult to integrate with current traffic management systems because of the inefficiencies caused by a lack of interoperability between systems and data sources, as well as the need for comprehensive strategies and standardized protocols to align different industries and technologies (Alzghaibi, 2025).

Privacy and Security Concerns

Data protection through cryptography techniques and secure protocols is crucial, but difficult to implement consistently across all systems.The deployment of intelligent traffic systems frequently involves the collection and analysis of sensitive personal data, raising privacy and security concerns (Hari, 2016).

Cost and Resource Constraints

(Wang, 2020)), while not directly addressing traffic system costs, presents a cost-efficient approach to estimating traffic flow in large road networks. It acknowledges that traffic sensing devices are typically distributed sparsely due to high installation and maintenance costs. The study proposes a data-driven method combining license plate recognition data with taxi GPS trajectory data as a more affordable alternative to installing additional traffic sensing devices (Wang, 2020).

Societal and Organizational Challenges

Obstacles may include societal acceptance of new technologies and organizational resistance to change. Widespread adoption of intelligent traffic systems depends on educating stakeholders and the public about their features and advantages (Khurshid, 2024).

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Meta Table 1:

Domain/Area	Pamudji (2023)	Adewopo (2024)	Ghahremannezhad (2022)	Popescu (2017)	Mane (2023)	Iqbal (2020)	Zhang (2020)	Klinjun (2021)	Bhatia (2023)	Liu (2018)	Alanazi (2024)	Pourroostaei Ardakani (2023)	Zhang (2024)	Moriano (2024)	Jurgens (2021)	Khalil (2017)	Ravindran (2016)	Srinivasan (2020)	Rezaee (2024)	Alzghaibi (2025)	Hari (2016)	Wang (2020)	Khurshid (2024)
Smart Cities	✔	✔	✔	✘	✔	✘	✘	✔	✔	✘	✔	✔	✔	✔	✘	✔	✔	✔	✘	✔	✔	✔	✔
Internet of Things (IoT)	✔	✔	✘	✔	✔	✘	✔	✔	✔	✘	✔	✔	✔	✔	✔	✘	✔	✔	✔	✔	✔	✔	✔
Machine Learning	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Deep Learning	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Real-time Traffic Monitoring	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Accident Detection	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Predictive Analytics	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Traffic Flow Optimization	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Emergency Response Systems	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Vehicle-to-Infrastructure (V2I) Communications	✔	✔	✔	✔	✔	✘	✔	✔	✘	✔	✔	✔	✘	✔	✔	✘	✔	✔	✔	✔	✔	✔	✔
Data Quality & Availability	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Data Integration	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

& Interoperability																							
Privacy & Security Concerns	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Cost & Resource Constraints	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Scalability	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔									

The table provides a comprehensive overview of how various research papers contribute to the key domains of intelligent traffic systems. It highlights the role of technologies like machine learning, deep learning, and IoT in addressing critical challenges such as real-time traffic monitoring, accident detection, and predictive analytics. All of the papers emphasize the importance of integrating data from multiple sources to optimize traffic flow and enhance emergency response systems. Furthermore, privacy, security concerns, and data quality are crucial aspects addressed by these studies, ensuring the systems' reliability and ethical standards. The scalability of these systems is also a common thread, reflecting the need for solutions that can expand to larger urban areas or even nationwide
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Meta Table 2:

Author(s)	Year	Method/Model Used	Application Area	Key Findings	Future Work
Pamudji, A. K.	2023	IoT systems	Smart Cities	Environmental support through Io T	Integration with real-time monitoring
Adewopo, V. A.	2024	Deep learning ensemble	Traffic Accident Detection	Improved detection accuracy	Model generalization
Ghahremannezhad, H.	2022	Deep learning	Traffic Surveillance	Real-time accident detection	Scalability studies
Popescu, O. et al.	2017	V2I data aggregation	Incident Detection	Enhanced incident identification	Deployment in urban areas
Mane, D. T.	2023	YOLOv8, OpenCV	Traffic Surveillance	Accurate accident recognition	Real-time system improvement
Iqbal, A.	2020	Statistical analysis	Accident Analysis	Black spot identification	Policy recommendations
Zhang, Z.	2020	LSTM-GBRT	Accident Prediction	High accuracy in prediction	Expanded datasets
Klinjun, N.	2021	Accident reports	Injury Severity	Identified key factors	Broader regional studies

		analysis			
Bhatia, N.	2023	Deep learning	Emergency Alert Systems	Fast alert generation	Hardware integration
Liu, Z.	2018	Deep learning	Urban Traffic	Predictive mobility analysis	Real-time traffic systems
Alanazi, F.	2024	Integrated framework	Smart Cities	ITS-smart city linkage	Smart infrastructure refinement
Pourroostaei Ardakani, S.	2023	Review	Smart Transport/Healthcare	Big data role outlined	Practical implementations
Zhang, J.	2024	Optimization, Sensor Fusion	Freeway Traffic	Improved traffic estimation	Real-world application
Moriano, P.	2024	Spatiotemporal Analysis	Accident Detection	Reduced detection time	Cross-city validation
Jurgens, D.	2021	Social network analysis	Geolocation Prediction	Critical practice review	Algorithm enhancement
Khalil, M.	2017	Satellite view	Congestion Detection	Effective remote sensing	Real-time alerts
Ravindran, V.	2016	Machine vision	Accident Detection	Improved detection precision	Integration with ITS
Srinivasan, A.	2020	DETR algorithm	Road Accidents	New detection approach	Algorithm refinement
Rezaee, Z.	2024	Data modeling	Urban Traffic	Insight into Tehran traffic	Scalability to other cities
Alzghaibi, H.	2025	Mixed-methods	EHR Systems	Implementation barriers found	Overcoming institutional barriers
Hari, P. B.	2016	Survey	WSN Security	Highlighted challenges	Enhanced WSN protocols
Wang, P.	2020	Multi-source data	Traffic Flow Estimation	Accurate flow predictions	Increased source diversity
Khurshid, A.	2024	Policy evaluation	Sustainability	Adoption drivers identified	Cross-national studies

Discussion:
The literature review indicates major advancements in the area of intelligent transportation systems (ITS) especially in real-time traffic accident prediction and detection. The prevailing methodologies entail the employment of deep learning models like YOLOv8, LSTM-GBRT, and DETR, which have made the area advance towards better accuracy, velocity, and efficiency. These models find their applications in traffic monitoring, urban traffic flow forecasting, emergency management systems, and integration with smart city infrastructure. Further, big data analytic and multi-source sensor fusion are also helping to facilitate data-driven decision-making for managing urban transport. One such trend is the move away from conventional statistical processing towards sophisticated AI systems with real-time monitoring and predictive capabilities. For example,

research utilizing YOLOv8 and Open CV has recorded significant improvements in the accuracy of vehicle accident detection compared to previous vision-based methods. Nevertheless, most such systems continue to be limited by the requirement for extensive annotated datasets, which complicates their scalability and applicability across disparate environments.Though the literature offers a number of new models and frameworks, the shared void is that there are few integrated and saleable systems deploy able across city-wide infrastructures.

Additionally, much of the research is based in urban or Western environments, with ample data and applicability gaps in higher accident-rate regions, especially in developing nations. Limited coordination between traffic authorities, data scientists, and policymakers is another challenge, usually resulting in under-utilization of research outputs in real-world applications. In spite of these difficulties, the real-world impacts of ITS are significant. Intelligent traffic monitoring systems are increasingly able to decrease emergency response times, enhance traffic flow, and provide data for supporting efficacious policy choices. These observations highlight the need for ongoing investment in data infrastructure, real-time analytic, and cross-industry collaborations to enable growth in sustainable smart cities.

Conclusion:

This review highlights the increasing role of artificial intelligence, IOT and big data in reshaping contemporary transport systems. The use of deep learning and data models in the detection of accidents, traffic forecasting and integration into intelligent cities is found to be not only viable but inevitable in tackling urban mobility problems. Though numerous technological strides have been made there are still key gaps in scalability, exclusivity and integration with policy measures. Future studies must focus on the creation of adaptive and interpret able AI models, promote cross-disciplinary collaboration and ensure solutions are contextually appropriate to various urban environments.

Future Work:

In terms of future directions, the papers suggest improving integration, interoperability, and real-time decision-making within smart cities. There is a significant focus on refining predictive models with larger datasets to enhance accuracy and efficiency in traffic management. Additionally, several studies point to cost-effective alternatives and the importance of low-cost sensors for wider deployment. Privacy and security concerns remain pivotal in ensuring the safe collection and use of data. Lastly, developing systems that can scale effectively across different environments is a key area for further research and development.

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