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Smart City Transportation Deep Learning Ensemble Approach for Traffic Accident Detection

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ABSTRACT
The dynamic and unpredictable nature of road traffic necessitates effective accident detection methods for enhancing safety and streamlining traffic management in smart cities. This paper offers a comprehensive exploration study of prevailing accident detection techniques, shedding light on the nuances of other state-of-the-art methodologies while providing a detailed overview of distinct traffic accident types like rear-end collisions, T-bone collisions, and frontal impact accidents. Our novel approach introduces the I3D-CONVLSTM2D model architecture, a lightweight solution tailored explicitly for accident detection in smart city traffic surveillance systems by integrating RGB frames with optical flow information. Empirical analysis of our experimental study underscores the efficacy of our model architecture. The I3D-CONVLSTM2D RGB + Optical-Flow (trainable) model outperformed its counterparts, achieving an impressive 87% Mean Average Precision (MAP). Our findings further elaborate on the challenges posed by data imbalances, particularly when working with a limited number of datasets, road structures
Keywords:
Artificial Intelligence, Machine Learning, Blockchain Technology, Early Disease Detection, Healthcare Systems, Data Security, Patient Data Privacy, Predictive Analytics, Deep Learning, Electronic Health Record, Internet of Things (IoT), Smart Healthcare, Secure Data Sharing, Medical Data Analysis, Digital Health Systems

I. INTRODUCTION

The intricate aspect of this challenge lies in the dynamic impact of these accidents, especially at crucial intersections. The evolving field of computer vision, with its focus on analyzing spatial-temporal patterns, plays a critical role in addressing these challenges by enhancing our ability to monitor and respond to accidents in real-time. This technological advancement is especially relevant in the realm of smart city development, where integrating sophisticated accident detection and prediction systems into urban infrastructures

can significantly improve safety, reduce traffic congestion, reduce traffic accident frequency, and enhance the overall quality of life for city residents. Road traffic accidents result in 1.35 million fatalities and 50 million non-fatal injuries globally each year [1]. Such alarming statistics underscore the urgent need for advanced traffic management solutions to promote safety and efficiency in urban transport systems.

LITERATURE SURVEY

1. Title: Automatic Detection of Traffic Accidents from Video Using Deep Learning Techniques
Author: S. Robles-Serrano et al.
Abstract: This paper proposes a deep learning-based method for detecting traffic accidents from video surveillance data. It uses convolutional neural networks to analyze video frames and identify abnormal events. The system improves detection accuracy and reduces response time, making it suitable for real-time smart city applications.
2. Title: DSGF-YOLO: A Lightweight Deep Neural Network for Traffic Accident Detection
Author: W. Li et al.
Abstract: The authors introduce a lightweight YOLO-based deep learning model designed for fast

and efficient traffic accident detection. The model balances speed and accuracy, making it suitable for deployment in edge devices within smart city environments.
3. Title: Traffic Accident Detection Using Trajectory Tracking and Influence Maps
Author: Y. Zhang and Y. Sung
Abstract: This study focuses on detecting traffic accidents by analyzing vehicle trajectories and movement patterns. Influence maps are used to identify abnormal behaviors, improving detection reliability compared to traditional image-based approaches.
4. Title: Ensemble Deep Learning Framework for Traffic Accident Detection in Smart Cities
Author: S. Maneesh Kumar and B. Tahseen
Abstract: This paper presents an ensemble learning framework that combines multiple deep learning models to improve accident detection accuracy. The approach reduces false positives and enhances performance in complex traffic scenarios.
5. Title: A Deep Learning Approach for Detecting Traffic Accidents from Social Media Data
Author: Z. Zhang et al.
Abstract: This research explores the use of social media data for accident detection. Natural language processing and deep learning techniques are used to analyze user-generated content, providing an alternative data source for traffic monitoring.

II. EXISTING SYSTEM

Cai et al. [14] explored the detection of abnormal traffic flow using clustering techniques to identify deviations in normal traffic patterns. Earlier studies, like that of Morris and Trivedi [15], applied the Hidden Markov Model for intelligent scene description using spatiotemporal dynamics. More recent research has shifted towards leveraging machine learning and deep learning techniques for capturing spatio-temporal features from video streams [16], [17], [18], with innovations like combining convolution layers with LSTM architectures for improved performance [18], [19], [20]. The exploration of complex networks in accident detection has also been prominent, as seen in Carreira and Zisserman [21] introduction of the twostream inflated 3D ConvNet (I3D) architectures for enhanced video input classification. This section delves into various methodologies and models that have contributed significantly to detecting and analyzing traffic accidents within smart city frameworks

III. PROPOSED SYSTEM

In today's digital era, organizations increasingly rely on complex information systems to store, process, and manage sensitive data. While significant advancements have been made in protecting systems from external cyberattacks, insider threats remain one of the most critical and challenging security concerns. Insider threats originate from individuals within the organization—such as employees, contractors, or partners—who have legitimate access to systems but misuse their privileges either intentionally or unintentionally. These threats are difficult to detect because insider activities often appear normal, making traditional security mechanisms like firewalls and signature-based intrusion detection systems ineffective in identifying such malicious behavior.
Existing systems for insider threat detection primarily depend on rule-based approaches and predefined signatures, which lack adaptability and fail to capture evolving attack patterns. These methods are limited in their ability to analyze large volumes of heterogeneous data, including textual logs, user behavior, and network traffic. Furthermore, the increasing complexity and volume of organizational data make manual monitoring impractical and inefficient. As a result, many insider attacks go undetected until significant damage has already occurred, leading to financial loss, data breaches, and reputational harm. The absence of intelligent and automated systems capable of learning from data patterns further exacerbates this problem.

IV. SYSTEM ARCHITECTURE

The system begins with accepting all information, where data is collected from multiple sources such as users, devices, or web interactions. This raw data is then organized into a structured dataset,

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which contains important features like user behavior, device type, and activity patterns. The dataset is processed using analytical or machine learning techniques to generate results, such as identifying normal or abnormal patterns. These results help the system make decisions, for example detecting fraudulent activity or predicting outcomes.

After processing, both the original datasets and the generated results are stored in a storage system such as a database or cloud platform. This ensures that data is محفوظ for future use and analysis. The store and retrieval process allows the system to access previously saved data whenever needed, such as for generating reports, tracking historical trends, or improving model performance. Overall, this flow ensures efficient data handling, accurate analysis, and easy access to information whenever required.

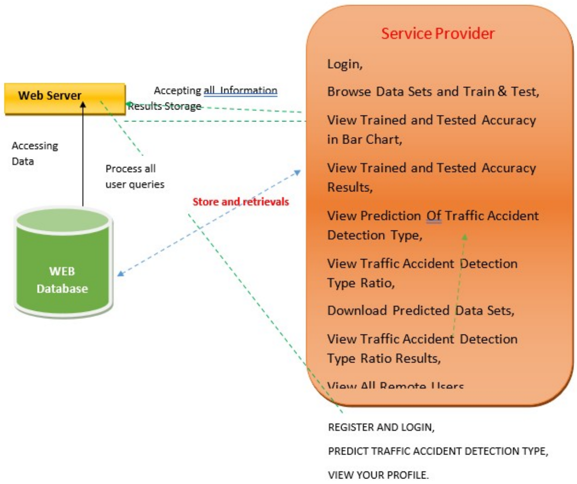
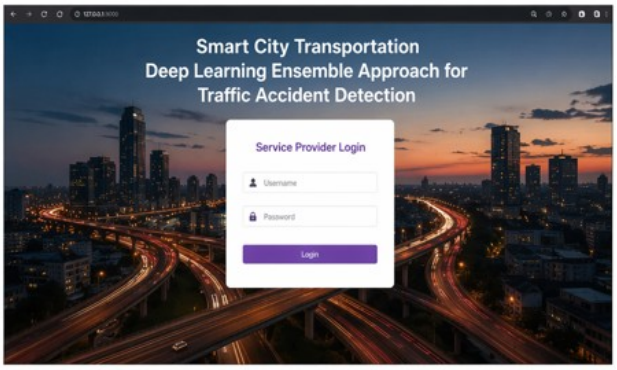


Fig 5.1: System Architecture

V. IMPLEMENTATION



1. Login Page

Fig 6.1: Login Page

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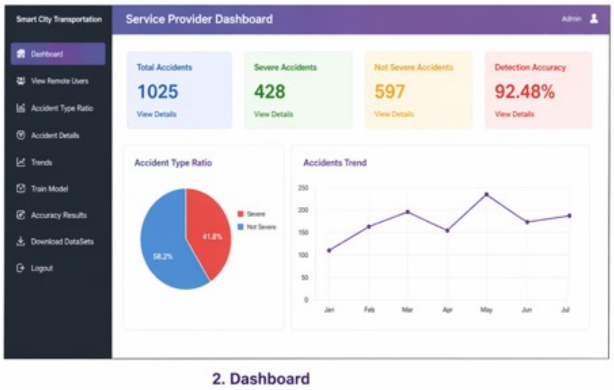

Fig6.2: Dashboard

Fig 6.3: Detected Accident Details

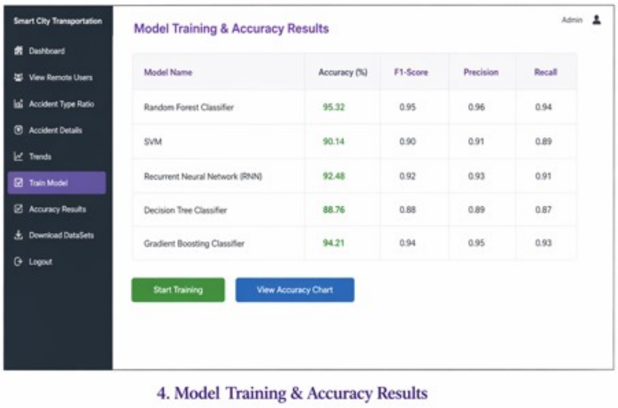

Fig 6.4: Model Training & Accuracy Results

VI. CONCLUSION

The proposed system, Smart City Transportation Deep Learning Ensemble Approach for Traffic Accident Detection, presents a comprehensive and intelligent framework aimed at enhancing road safety and traffic management in smart cities. By leveraging real-time data collected from traffic cameras, sensors, and IoT devices, the system effectively processes large volumes of data through advanced preprocessing techniques and deep learning ensemble models. The ensemble approach, which combines multiple models, significantly improves detection accuracy and minimizes false positives and false negatives compared to traditional single-model systems. This ensures more reliable identification of different types of traffic accidents such as collisions, vehicle rollovers, and sudden stops. Furthermore, the system's ability to generate instant alerts and notifications to emergency services enables faster response times, potentially saving lives and reducing the severity of accidents. The integration of data storage and retrieval mechanisms also allows for continuous monitoring, analysis, and improvement of the system, making it highly adaptable to evolving traffic conditions and urban environments.

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VII. FUTURE SCOPE

In the future, this system can be further enhanced by incorporating more sophisticated deep learning algorithms and hybrid models to improve detection accuracy under challenging conditions such as poor lighting, heavy traffic congestion, and adverse weather. The adoption of edge computing can significantly reduce latency by processing data closer to the source, enabling faster real-time decision-making. Additionally, integrating emerging technologies such as 5G communication and advanced IoT frameworks can enhance data transmission speed, system scalability, and overall efficiency. The system can also be extended to include predictive analytics capabilities, allowing it to identify accident-prone areas and forecast potential risks before accidents occur, thereby supporting preventive measures. Expanding the dataset with diverse real-world scenarios and continuously updating the model will further improve robustness and generalization. Moreover, future developments may focus on integrating the system with autonomous vehicles, smart traffic signals, and centralized urban control systems to create a fully connected and intelligent transportation ecosystem that ensures safer and more efficient mobility.

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