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Automatic Traffic Video Summarization for Indian Roads using Yolo

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ABSTRACT: Traffic surveillance systems generate a massive amount of video data on a daily basis, especially on Indian roads where traffic conditions are highly dynamic and complex due to heterogeneous vehicles, unpredictable pedestrian movement, and frequent rule violations. Manually monitoring and analyzing these long-duration traffic videos is time-consuming, inefficient, and prone to human error, making it difficult for authorities to extract meaningful insights in real time. Existing systems primarily focus on simple recording or basic motion detection and lack the ability to automatically identify and summarize important traffic events such as congestion, accidents, and violations. To address these limitations, the proposed system introduces an automated traffic video summarization framework using a hybrid YOLOv8 and Convolutional Neural Network (CNN) approach. YOLOv8 is employed for real-time object detection and localization of vehicles, pedestrians, and other road users, generating bounding boxes and confidence scores, while the CNN model extracts deep spatial and temporal features to analyze motion patterns and identify significant events across video frames. The system processes continuous traffic video input, extracts relevant frames, tracks detected objects, and selects key events based on predefined criteria to generate concise and informative video summaries. This approach reduces data redundancy, minimizes storage requirements, and enhances the efficiency of traffic monitoring systems. Experimental results demonstrate improved accuracy, faster processing, and reliable detection of critical traffic events, making the system suitable for real-world deployment in smart traffic management and surveillance applications. Overall, the proposed framework provides an efficient, scalable, and automated solution for transforming lengthy traffic videos into meaningful summaries, supporting better decision-making and improved road safety.

KEYWORDS: YOLOv8, Traffic Video Summarization, Object Detection, Convolutional Neural Networks(CNN), Smart Traffic Management, Indian Roads

I. INTRODUCTION

The rapid increase in urbanization and the growing number of vehicles on Indian roads have created complex traffic conditions that demand efficient monitoring and management systems. Traffic surveillance cameras installed across highways, intersections, and city roads continuously generate large volumes of video data, making manual analysis highly time-consuming, labor-intensive, and impractical for real-time decision-making. The heterogeneous nature of Indian traffic, which includes a mix of cars, buses, trucks, two-wheelers, auto-rickshaws, pedestrians, and animals, further complicates the process of extracting meaningful insights from long-duration videos. Traditional traffic monitoring systems mainly rely on continuous recording or basic motion detection techniques, which lack the capability to automatically identify and highlight critical traffic events such as congestion, accidents, abnormal movements, and traffic rule violations. These systems require significant human effort to review footage and often fail to provide concise summaries, leading to delays in response and inefficient resource utilization. With the advancement of artificial intelligence and computer vision, deep learning-based approaches have emerged as powerful solutions for automated video analysis. Among these, the You Only Look Once version 8 (YOLOv8) algorithm stands out due to its high accuracy, real-time detection capability, and efficiency in handling complex visual environments. This project, titled “Automatic Traffic Video Summarization for Indian Roads Using YOLO,” aims to develop an intelligent system that converts lengthy traffic surveillance videos into short, meaningful summaries containing only significant events. The system processes input traffic videos, extracts frames, and applies YOLOv8 to detect and localize various road

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users such as vehicles, pedestrians, and animals with bounding boxes and confidence scores. Detected objects are then tracked across frames to analyze motion patterns, including speed, direction, and trajectory. Furthermore, Convolutional Neural Networks (CNN) are utilized to extract deep spatial and temporal features for identifying important traffic events based on predefined rules and behavioral analysis. Key segments representing congestion, accidents, sudden stops, and rule violations are selected and merged to generate a concise summary video. By automating traffic video analysis, the proposed system reduces manual effort, minimizes storage requirements, and enhances monitoring efficiency while enabling faster decision-making. It supports real-time surveillance, intelligent transportation systems, and smart city applications, ultimately contributing to improved road safety and effective traffic management on Indian roads.

1.1 SCOPE OF THE PROJECT

The proposed project focuses on developing an intelligent and automated system for summarizing traffic surveillance videos on Indian roads using advanced deep learning techniques. The system is designed to process continuous video input from roadside cameras, highways, and urban intersections, and convert lengthy recordings into short, meaningful summaries by identifying and extracting significant traffic events such as congestion, accidents, sudden stops, abnormal movements, and traffic rule violations. It is capable of detecting and classifying multiple types of road users including cars, buses, trucks, two-wheelers, auto-rickshaws, pedestrians, and animals, reflecting the heterogeneous nature of Indian traffic conditions. The framework utilizes YOLOv8 for accurate object detection and localization, along with CNN-based feature extraction to analyze motion patterns and behavior across frames. The system can be applied in real-world scenarios such as smart traffic management, urban planning, highway monitoring, law enforcement, and incident response systems, enabling authorities to quickly review important events without analyzing entire video footage. It also supports real-time or near real-time processing, making it suitable for live surveillance applications. Additionally, the project aims to reduce data redundancy and storage requirements by summarizing only relevant portions of videos, improving efficiency in data handling and retrieval. The framework is scalable and can be extended to handle large-scale datasets from multiple camera sources across cities, making it adaptable for smart city infrastructure and intelligent transportation systems. It can also be integrated with cloud-based platforms for remote monitoring and analytics, enhancing accessibility and system performance. Overall, the scope of the project encompasses automated detection, tracking, event analysis, and summarization of traffic videos, providing a robust, efficient, and scalable solution for modern traffic monitoring and management challenges.

1.2 OBJECTIVES

The primary objective of this project is to develop an intelligent and automated system for summarizing long-duration traffic surveillance videos into short, meaningful, and informative outputs using advanced deep learning techniques. The system aims to accurately detect and classify various road users such as vehicles, pedestrians, animals, and mixed traffic commonly observed on Indian roads by utilizing the YOLOv8 object detection algorithm. Another key objective is to track detected objects across consecutive frames to analyze motion patterns including speed, direction, and trajectory, enabling a better understanding of traffic flow dynamics. The project also focuses on identifying critical traffic events such as congestion, accidents, sudden stops, abnormal activities, and traffic rule violations through behavioral analysis and predefined rules. Additionally, it seeks to minimize human effort and monitoring time by automating the entire video analysis process, thereby improving efficiency and reducing manual workload. The system aims to generate concise video summaries by selecting and merging only significant frames and events, reducing data redundancy and storage requirements. It also supports real-time or near real-time traffic monitoring, enhancing quick decision-making and incident response by traffic authorities. Another objective is to improve situational awareness and enable data-driven decision-making for effective traffic management and urban planning. The framework is designed to be scalable and adaptable for deployment across multiple locations, including highways, smart cities, and surveillance networks. Overall, the project strives to provide a reliable, efficient, and intelligent solution for traffic video summarization, contributing to improved road safety, optimized traffic control, and the development of smart transportation systems.

II. LITERATURE SURVEY

2.1 A. Padia et al.-This research presents an object detection and classification framework specifically designed for analyzing video data from Indian roads using the YOLOv8 algorithm. The study focuses on handling the complex and heterogeneous nature of Indian traffic, which includes multiple vehicle types, pedestrians, and varying environmental conditions such as lighting and weather. The model is trained and evaluated on real-world datasets, demonstrating its ability to detect and classify road users with reasonable accuracy across diverse scenarios. One of the key strengths of this approach is its adaptability to Indian traffic dynamics, making it suitable for practical surveillance applications.

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However, the system shows moderate precision for certain object classes and does not incorporate higher-level functionalities such as event detection or video summarization. The lack of temporal analysis limits its ability to identify significant traffic events or generate concise summaries, which is essential for intelligent traffic monitoring systems.

2.2 M. Tahir et al.-This study introduces a privacy-preserving traffic video summarization system using the YOLOv5 algorithm, focusing primarily on accident detection and secure data handling. The framework integrates object detection with privacy-aware mechanisms such as encryption and masking to protect sensitive information while analyzing traffic footage. It effectively reduces the length of surveillance videos by extracting segments related to accidents, making it useful for quick incident review. Additionally, the inclusion of privacy-preserving techniques increases system complexity and computational overhead, while limited training data affects the overall performance and generalization capability of the YOLOv5 model.

2.3M. Saraff et al.-This research proposes an advanced traffic video summarization approach using YOLOv8/YOLO11 combined with multi-level masking techniques to improve detection and summarization performance on Indian road datasets. The model achieves high precision and recall in detecting vehicle objects, demonstrating its effectiveness in handling complex traffic environments. The use of multi-level masking allows selective focus on important regions of interest, enhancing the quality of generated summaries by filtering out irrelevant information. This approach supports flexible summarization strategies and improves the interpretability of results. However, the integration of multiple models and masking techniques increases computational requirements and system complexity. Furthermore, the method primarily focuses on vehicle detection and lacks comprehensive analysis of anomalies or diverse traffic events beyond object-level summarization, limiting its applicability in broader intelligent traffic systems.

2.4 V. Jabade et al.-This paper presents a smart CCTV video summarization framework that combines YOLO-based object detection with DeepSORT tracking for efficient event-driven summarization. The integration of detection and tracking enables the system to monitor object movements across frames and generate condensed video outputs highlighting dynamic activities. This fusion approach eliminates the need for manual video review and enhances automation in traffic surveillance systems. The method is particularly effective in identifying moving objects and summarizing their behavior over time. However, the overall performance heavily depends on the accuracy of the DeepSORT tracking algorithm, which may struggle in scenarios involving heavy occlusion or dense traffic conditions. Additionally, the study lacks detailed evaluation metrics and quantitative analysis, making it difficult to assess its performance comprehensively in real-world environments.

2.5 G. Sara and Milidh J.-This study introduces a query-driven video summarization technique using Faster-RCNN combined with a Determinantal Point Process (DPP) for selecting diverse and relevant frames. It incorporates semantic object interactions and advanced frame scoring mechanisms to improve the quality of summarization. While the method effectively enhances diversity and relevance in selected frames, it relies on Faster-RCNN, which is slower compared to single-stage detectors like YOLO, making it less suitable for real-time applications. Additionally, the complexity of the DPP-based frame selection process increases computational overhead, limiting scalability for large-scale traffic video datasets.

2.6 S. Mishra and D. Yadav-This research focuses on vehicle detection in high-density traffic environments using the YOLOv5 algorithm, demonstrating its effectiveness in identifying vehicles in crowded road conditions. The model achieves reasonable precision and recall and performs well on datasets such as KITTI and Indian traffic datasets. Its faster inference capability makes it suitable for real-time detection applications. However, the system faces challenges in handling object occlusions, where overlapping vehicles reduce detection accuracy. Moreover, the study primarily focuses on object detection and does not extend to higher-level tasks such as event detection, behavior analysis, or video summarization. As a result, it lacks the capability to generate meaningful summaries from traffic videos, which is essential for efficient traffic monitoring and decision-making systems.

III. EXISTING SYSTEM

The existing traffic monitoring systems primarily rely on continuous video recording and basic computer vision techniques to observe road activities, especially in surveillance setups across highways, intersections, and urban areas. Most of these systems use traditional object detection models such as YOLOv5 or other machine learning approaches to identify vehicles and pedestrians in video frames. While these methods are effective in detecting objects, they

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mainly focus on frame-by-frame analysis and do not provide comprehensive understanding of traffic behavior over time. In many cases, the systems lack integration of object tracking and temporal analysis, which limits their ability to identify important traffic events such as congestion, accidents, sudden stops, and traffic rule violations. Additionally, existing approaches often require manual monitoring or post-processing of recorded videos to extract useful insights, making the process time-consuming and inefficient. Some advanced systems incorporate tracking algorithms like DeepSORT or privacy-preserving mechanisms, but they still focus on specific tasks such as accident detection or object tracking without generating concise video summaries. Furthermore, these systems struggle to handle the heterogeneous and highly dynamic nature of Indian traffic, where multiple vehicle types, pedestrians, and environmental variations exist. Overall, while current traffic monitoring solutions provide basic detection and surveillance capabilities, they fail to offer an integrated, automated, and scalable approach for event detection, behavior analysis, and video summarization, which are essential for efficient traffic management and real-time decision-making.

3.1 DISADVANTAGES

- Limited Event Understanding: Existing systems mainly perform object detection without analyzing temporal behavior, making it difficult to identify critical events such as congestion, accidents, and traffic violations.
- Dependence on Manual Monitoring: Requires human effort to review long-duration videos, leading to inefficiency, delays in decision-making, and increased workload for traffic authorities.
- Lack of Automated Summarization and Scalability: Unable to generate concise video summaries, resulting in storage of large volumes of redundant data.

IV. PROPOSED SYSTEM

The proposed system introduces an intelligent and automated framework for traffic video summarization on Indian roads using a hybrid combination of YOLOv8 and Convolutional Neural Network (CNN) techniques. The system is designed to process continuous traffic video input from surveillance cameras, highways, and urban intersections, and convert lengthy recordings into concise and meaningful summaries by identifying significant traffic events. The detected objects are further tracked across consecutive frames to analyze motion patterns including speed, direction, and trajectory. A CNN-based model is utilized to extract deep spatial and temporal features from the tracked objects, enabling accurate understanding of traffic behavior over time. Based on predefined rules and behavioral analysis, the system identifies important traffic events such as congestion, accidents, sudden stops, abnormal movements, and traffic rule violations. Relevant frames and video segments corresponding to these events are selected, scored, and merged to generate a concise summary video that captures only essential information. The proposed system overcomes the limitations of existing methods by integrating detection, tracking, event analysis, and summarization into a unified framework. It reduces manual effort, minimizes storage requirements, and enhances the efficiency of traffic monitoring systems. Furthermore, the system is scalable and adaptable for real-time applications, smart city infrastructure, and intelligent transportation systems, providing a reliable and efficient solution for modern traffic management challenges on Indian roads.

ADVANTAGES

- Automated Detection and Classification: Detects and summarizes key traffic events like congestion, accidents, and violations automatically.
- Improved Spatial–Temporal Accuracy: YOLOv8 and CNN enable precise detection with effective motion analysis.
- Faster and Scalable Analysis: Stores only important video segments, minimizing data redundancy.
- Robust Across Multi-Site Data: The framework supports real-time or near real-time processing and can be easily scaled for large surveillance networks in smart cities and intelligent transportation systems.

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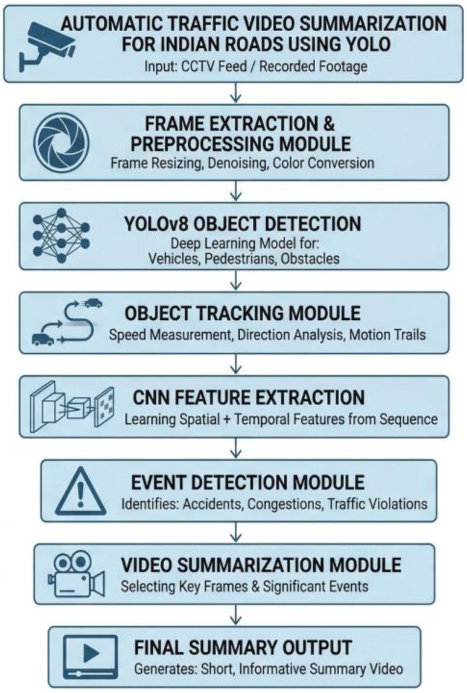
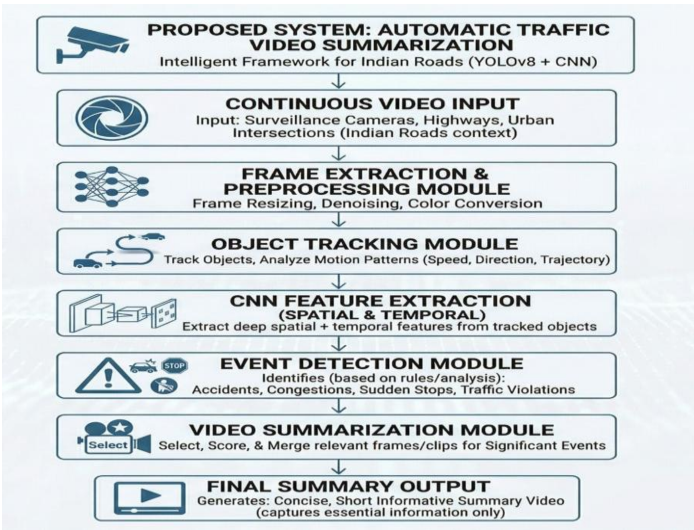
SYSTEM ARCHITECTURE





V. MODULES

1. **Video Acquisition Module**
2. **Frame Extraction and Preprocessing**
3. **YOLO-Based Object Detection Module**
4. **Object Tracking Module**
5. **Event Detection and Analysis Module**
6. **Video Summarization Modul**

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5.1 MODULE DESCRIPTIONS

5.1.1. Video Acquisition Module

This module is responsible for capturing traffic video data from various sources such as roadside CCTV cameras, highways, urban intersections, and recorded video datasets. It ensures continuous and reliable collection of video streams under different environmental conditions including varying lighting, weather, and traffic density. The module supports both real-time video input and pre-recorded footage, making the system flexible for multiple applications. The acquired video data forms the primary input for further processing and analysis in the system. Proper handling and storage of input video streams are maintained to ensure data consistency and availability. This module plays a crucial role in providing diverse and realistic traffic scenarios, which helps in improving the robustness and generalization capability of the overall system.

5.2.2. Frame Extraction and Preprocessing

This module converts the input traffic videos into individual frames for further analysis and processing. It performs several preprocessing operations such as resizing, noise reduction, normalization, and enhancement to improve the quality of frames. These steps help in reducing unwanted variations caused by lighting conditions, camera motion, and environmental noise. The module ensures that all frames are standardized in terms of resolution and format, which is essential for accurate object detection. It also removes irrelevant background information and focuses on regions of interest within the frames. By improving visual clarity and consistency, this module enhances the performance and accuracy of subsequent deep learning models used in the system.

5.1.3 YOLO-Based Object Detection Module

This module utilizes the YOLOv8 algorithm to detect and classify various objects present in traffic video frames, including cars, buses, trucks, two-wheelers, pedestrians, and animals. The model processes each frame and generates bounding boxes along with confidence scores for detected objects. YOLOv8 enables real-time object detection with high accuracy, making it suitable for complex and dynamic traffic environments like Indian roads. This module effectively identifies regions of interest and reduces unnecessary data by focusing only on relevant objects. The detection results are passed to the tracking module for further analysis. It plays a key role in enabling automated understanding of traffic scenes without manual intervention.

5.1.4 Object Tracking Module

The object tracking module is responsible for tracking detected objects across consecutive video frames to analyze their movement and behavior over time. It associates objects using motion-based algorithms and assigns unique identities to each detected entity. This allows the system to monitor parameters such as speed, direction, trajectory, and interaction between different road users. Tracking helps in understanding traffic flow patterns and identifying abnormal movements. It is particularly useful in crowded and high-density traffic scenarios where multiple objects are present simultaneously. This module ensures continuity in analysis by linking detections across frames, which is essential for event detection and behavior analysis.

5.1.5 Event Detection and Analysis Module

This module analyzes the tracked object data to identify significant traffic events based on predefined rules and behavioral patterns. It examines parameters such as object speed, density, movement irregularities, and sudden changes in trajectory to detect events like congestion, accidents, sudden stops, abnormal activities, and traffic rule violations. The module uses both rule-based logic and deep learning features extracted from previous stages to ensure accurate event identification. It filters out irrelevant information and focuses only on meaningful events that require attention. This module plays a crucial role in transforming raw tracking data into actionable insights for traffic monitoring systems.

5.1.6 Video Summarization Module

This module generates the final summarized video by selecting and combining key frames and video segments that represent important traffic events. It evaluates detected events and assigns importance scores to different frames based on their relevance. Only significant portions of the video, such as accidents, congestion, and violations, are extracted and merged sequentially to create a concise summary. This reduces the length of original videos while preserving essential information. The summarized output helps traffic authorities quickly review important events without going through entire recordings. It also reduces storage requirements and improves data retrieval efficiency. This module completes the system by delivering a meaningful and user-friendly output for real-world traffic monitoring applications.

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VI. CONCLUSION

The proposed system for automatic traffic video summarization on Indian roads using YOLOv8 and Convolutional Neural Networks (CNN) provides an efficient and intelligent solution for analyzing large volumes of traffic surveillance data. It addresses the limitations of traditional traffic monitoring systems by enabling automated detection, tracking, event analysis, and summarization of video content. YOLOv8 effectively detects and localizes multiple road users such as vehicles, pedestrians, and animals in complex and heterogeneous traffic environments, while the CNN extracts deep spatial and temporal features to understand motion patterns and traffic behavior. The integration of object tracking further enhances the system's ability to analyze dynamic activities across consecutive frames. Significant traffic events such as congestion, accidents, sudden stops, and rule violations are accurately identified and extracted, allowing the system to generate concise and meaningful video summaries. This reduces the need for manual monitoring, minimizes storage requirements, and improves the efficiency of traffic management systems. The framework demonstrates high accuracy, scalability, and adaptability for real-time and large-scale surveillance applications. It supports quick decision-making and enhances situational awareness for traffic authorities. Overall, the proposed system represents a practical and effective approach for transforming lengthy traffic videos into actionable insights, contributing to improved road safety and the development of intelligent transportation systems.

VII. FUTURE ENHANCEMENT

The proposed system can be further enhanced by incorporating advanced deep learning techniques and expanding its capabilities for more intelligent traffic analysis. Integration of more advanced models such as YOLOv9 or transformer-based architectures can improve detection accuracy and performance in complex traffic scenarios. The system can be extended to include 3D CNNs or spatio-temporal models for better understanding of motion patterns and long-term dependencies in video data. Real-time deployment using edge computing or cloud-based platforms can enhance scalability and enable faster processing for large surveillance networks. Additional features such as predictive analytics can be incorporated to forecast traffic congestion and potential accidents based on historical data. The system can also be improved by integrating automatic number plate recognition (ANPR) and facial detection for enhanced law enforcement and security applications. Multi-camera integration and cross-camera tracking can further improve coverage and accuracy in large urban areas. Incorporating audio analysis and sensor data can provide a multi-modal approach for better event detection and understanding. Future work may also focus on improving robustness under extreme weather conditions, heavy occlusion, and varying lighting environments. Overall, these enhancements aim to make the system more accurate, scalable, and suitable for real-world smart city and intelligent transportation applications.

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