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TRAFFIC SIGNALVIOLATION DETECTION SYSTEM

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***Abstract*— This abstract proposes the rise in urbanization has led to a significant increase in vehicular traffic, which in turn has caused a surge in traffic rule violations, particularly signal violations at intersections which have become a growing concern globally. These infractions contribute to road accidents, property damage, and loss of life, highlighting the urgent need for automated monitoring systems. To address this critical issue and help prevent such consequences, traffic violation detection systems are essential. The proposed system utilizes YOLOv3(You Only Look Once, Version 3), an advanced object detection algorithm, to identify violations such as signal jumping, speeding, and vehicle count monitoring. YOLOv3's single-stage detection approach, which divides input images into grids and predicts bounding boxes along with class probabilities, enables efficient and accurate detection of multiple objects simultaneously. Its multi-scale detection capability allows it to identify vehicles of varying sizes under diverse traffic conditions. The proposed system offers a scalable, automated solution for enhancing road safety and enforcing traffic regulations effectively.**

Keywords—Traffic Signal Violation Detection, YOLOv3, Object Detection, Computer Vision, Signal Jumping, Speed Detection, Vehicle Monitoring, Automated Traffic Enforcement, Road Safety, Real-Time Detection, Deep Learning, Image Processing.

I. INTRODUCTION

In today's rapidly urbanizing world, traffic management has emerged as a critical challenge for governments and city planners. The surge in vehicle numbers has led to a proportional rise in traffic violations, especially red-light jumping, which poses serious safety hazards. Such violations often result in collisions, property damage, injuries, and even fatalities. Traditional traffic enforcement methods relying on human observation or manual video footage inspection are inefficient and prone to errors. With the growing scale of urban traffic, there is a pressing need for automated, intelligent systems that can detect and record violations in real-time, with minimal human involvement and high accuracy.

Advancements in artificial intelligence and computer vision have opened up new possibilities for enhancing traffic law enforcement. Specifically, deep learning has enabled real-time object detection in complex visual environments. One of the most effective models in this space is YOLO (You Only Look Once), with its third iteration, YOLOv3, offering a remarkable balance between speed and accuracy. YOLOv3 is well-suited for real-time applications like traffic surveillance, as it can efficiently process each frame of a video stream, detecting and classifying multiple objects—including vehicles and traffic signals—with high precision.

This project leverages YOLOv3 to develop an automated traffic signal violation detection system. The system continuously analyzes video footage from surveillance cameras installed at intersections. It detects the presence and positions of vehicles, determines the traffic light state (red, yellow, or green), and assesses whether a vehicle crosses the designated stop line during a red signal. Upon identifying a violation, the system captures evidence including annotated images, timestamps, and optionally vehicle information. This evidence can be stored in a database or used by traffic authorities for enforcement and analysis.

YOLOv3 functions by dividing the input image into a grid and predicting bounding boxes and class probabilities for each cell in a single network pass. For this application, YOLOv3 is trained on datasets containing vehicles and traffic lights, enabling it to detect multiple objects in

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dynamic traffic scenes involving different lanes and vehicle types. Its real-time detection capabilities make it highly suitable for live deployments where timely recognition of violations is crucial.

The proposed system incorporates several integrated components to function effectively. It begins with video input from CCTV cameras at intersections, which is processed frame by frame using YOLOv3. The traffic signal status is assessed through a region-of-interest in the frame or using a separate classification model. The system then compares the detected vehicle's location with the stop line during the red signal. If a violation occurs, the system flags the event, captures the relevant frames, and records contextual data. Additional logic helps reduce false positives, accounting for scenarios where vehicles may already be in the intersection before the signal turns red.

II. LITERATURE SURVEY

1. In 2025, David Ugwunushemi Oloriegbe and Braimoh Abdullahi Ikharo presented a study titled "Development of an IoT-Based Traffic Signal Violation Detection System" in the Journal of Engineering Research and Reports. This research addresses the critical issue of traffic signal stop-line violations, which pose significant threats to road safety. The authors designed and implemented an intelligent traffic signal violation system leveraging Internet-of-Things (IoT) technology.

The system utilizes infrared (IR) sensors for vehicular detection and an ESP32 Camera to capture images of violating vehicles. These components are integrated with a programmed microcontroller to detect traffic stop-line signal violations. Upon detecting a violation, the system captures images and transmits them to designated authorities via notification bots on media platforms. The implementation was realized through a prototype build.

In terms of performance, the authors reported that the system achieved 98% accuracy in detecting violations, making it highly reliable under controlled conditions. Moreover, the response time for detecting and reporting infractions was significantly reduced—by up to 60%—compared to manual enforcement methods. These results indicate the system's potential for real-world deployment, particularly in urban areas where traffic volume and violations are high.

2. In the realm of intelligent transportation systems, the detection of traffic signal violations remains a critical area of research. One notable contribution is the study titled "Development of an Automated Red Light Violation Detection System for Indian Vehicles" by Satadal Saha, Subhadip Basu, Mita Nasipuri, and Dipak Kumar Basu, published in 2010. This research addresses the pressing issue of red light violations, which are a significant cause of road accidents in India.

The authors developed an automated system that utilizes video surveillance to detect vehicles violating red traffic signals. The methodology involves capturing video snapshots of road-side surveillance cameras and generating adaptive background images for each camera view. By subtracting the captured images from the corresponding background images, the system identifies potential occlusions over the stop-line during a red signal. This approach enables the detection of vehicles that cross the stop-line when the traffic signal is red, thereby identifying violations.

III. SYSTEM DESIGN

1) Input Unit

The Traffic Signal Violation Detection System begins with the Input Unit, which consists mainly of traffic surveillance cameras placed at road intersections. These cameras continuously capture live video streams or images of vehicles approaching the traffic signal. Additional inputs such as traffic signal status (red, yellow, green) and optional sensors like speed detectors may also be used. This input unit provides the raw data required for identifying any traffic violations.

2) Processing Unit

The captured data is then passed to the Processing Unit, which performs all major operations of the system. First, the preprocessing module extracts individual frames from the video stream and converts them into the required format. These frames are then fed into the YOLOv3 object detection module, which accurately identifies different vehicles such as cars, bikes, buses, and trucks by generating bounding boxes and class labels. After detecting vehicles, the violation detection module analyzes their movements to identify signal jumping, such as crossing the stop line during a red signal. A tracking module is used to follow each vehicle across multiple frames to ensure precise detection of movement patterns. Additionally, the system can calculate vehicle speeds and count the number of vehicles passing through the intersection. All detected violations, along with relevant details, are stored by the data logging module.

3) Output Unit

Finally, the Output Unit presents the processed results to the user or authorities. The system generates automatic violation reports containing important information like the type of violation, vehicle image, date, and time. A real-time alert system can notify traffic authorities through a dashboard, SMS, or email. The user interface dashboard visually displays the live video feed with detected vehicles, bounding boxes, and violation highlights. All data, including images, reports, and vehicle counts, is stored securely in a database for future review or enforcement actions. This output unit ensures proper monitoring, evidence collection, and efficient traffic rule enforcement.

IV. FLOW CHAT

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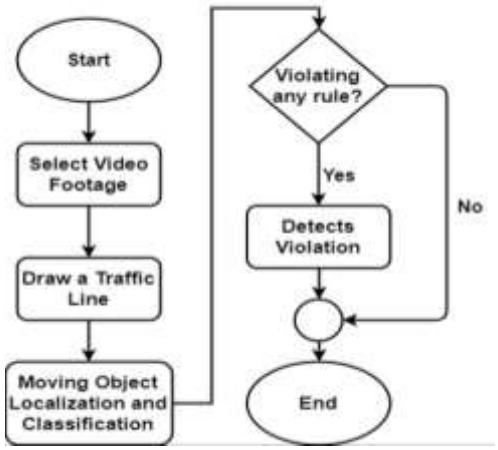

Fig.1.Flow Chart

The flowchart illustrates the step-by-step process of a Traffic Signal Violation Detection System. The system begins with the Start step, after which the user or system selects the video footage captured from traffic surveillance cameras. Once the video is loaded, the next step is to draw a traffic line, which represents a predefined boundary such as a stop line at a traffic signal. This line helps in determining whether a vehicle crosses it during a red signal.

After the line is drawn, the system performs moving object localization and classification, where YOLO or another computer vision algorithm detects and identifies different vehicles in each frame, such as cars, bikes, buses, and trucks. The detected vehicles are then continuously monitored to check if any of them cross the traffic line when they are not supposed to. This decision is represented by the "Violating any rule?" condition in the flowchart.

If the system determines that no rule is being violated, it loops back to continue monitoring the video footage for further frames. However, if the system detects that a vehicle has crossed the line during a red signal or broken another traffic rule, it proceeds to the "Detects Violation" step. Here, the system records the violation details, such as the vehicle type, time of violation, and image of the violating vehicle. Once the violation is recorded, the process moves to the End stage, completing the cycle for that particular detection.

t computation.

V. EXPERIMENTAL RESULT

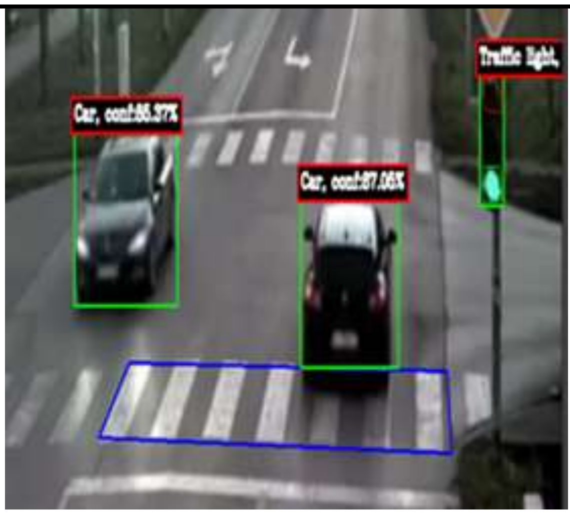

Fig 2:: Output (1) No Violation

Fig 3: Output (2) Car violated the traffic rule

VII.CONCLUSION

The Traffic Signal Violation Detection System using YOLOv3 is a practical and intelligent solution aimed at enhancing road safety and enforcing traffic regulations through automation. By integrating advanced object detection algorithms with real-time video analysis, the system demonstrates how computer vision and deep learning can be effectively applied to modern urban traffic management.

At the core of the project lies the YOLOv3 model, which provides fast and accurate detection of vehicles in video footage. This model, when combined with signal phase recognition and spatial analysis, enables the automatic identification of red-light violations without human intervention. The system successfully addresses key limitations of manual traffic monitoring by offering consistent performance, reduced human error, and faster violation reporting.

Throughout testing, the system proved to be accurate, responsive, and stable under a range of real-world conditions. It maintained reliable performance in daytime environments and delivered satisfactory results even under moderate visual challenges. The use of Python, OpenCV, and deep learning frameworks provided a robust and flexible software environment, while the user interface allowed administrators to interact with the system easily by loading videos and visualizing violation instances clearly. Storage optimization through event-based logging and effective visualization of detected violations further contributed to the system's usability and effectiveness in practical scenarios.

Moreover, the project design is modular and highly adaptable, opening doors for future enhancements such as ANPR (Automatic Number Plate Recognition), cloud integration, multi-angle camera support, and real-time synchronization with traffic signals. These advancements could extend the system's deployment in large-scale citywide monitoring systems or smart city initiatives.

In conclusion, this project successfully achieved its objectives and demonstrated the potential of AI-powered automation in traffic law enforcement. It provided hands-on experience in working with deep learning, image processing, system integration, and practical problem-solving. The solution stands as a valuable foundation for future innovations in intelligent transportation systems and public safety applications.

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