Traffic Rule Violation Detection

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Abstract- The detection of traffic rule violators is a highly desired but tough task because of several challenges including occlusion, illumination, etc., which make it difficult to enforce safety measures on Indian roadways. In order to improve decision-making about traffic laws policy, we present in this paper an end-to-end system for detecting violations, alerting offenders, and storing them for analysis and statistic generation. The suggested method first uses object detection, which is done with YOLO, to identify automobiles. Each vehicle is then examined for the relevant infractions, such as failing to wear a helmet or failing to use a crosswalk. A classifier based on convolutional neural networks (CNNs) is used to identify helmet violations. The Instance Segmentation by Mask R-CNN architecture is used to detect crosswalk violations. Following the detection of infractions, the offenders are alerted and their vehicle numbers are retrieved using OCR. Therefore, a comprehensive autonomous system will support the enforcement of strict traffic regulations.

Keywords- Object Detection, convolutional neural networks (CNNs), R-CNN, OCR, etc

I. INTRODUCTION

Detecting violations and punishing offenders in India is currently done by hand. At the lights, CCTVs continuously record the traffic. When the traffic police team notices a violation, they record the license plate and take a snapshot as proof. They monitor this real-time footage in the control center. Following the entry of the infraction into the database, the offender is notified of the violation and assessed the fine. Due to the manual nature of this process, the staff finds it wearying to continuously monitor the screens and ensure that no offense is overlooked in the middle of the country's heavy traffic.

Although two-wheelers are a very popular form of transportation, there is a significant risk because they have less protection. To lessen the risk, it is strongly advised that bike riders wear helmets. Given the significance of helmets, governments have declared it illegal to ride a bike without one and have ordered that anyone who do so face legal action. However, the passive nature of today's video surveillance devices necessitates a significant amount of human intervention. These systems are usually inefficient since human intervention is involved, and human weariness causes efficiency to decrease over time. Additionally, only one rider from a large number of two-wheeler riders who violate the law can be apprehended at a time, making manual intervention for helmet violations ineffective. Riders on two-wheelers and four- wheelers disregard crosswalks at intersections. When crossing violations are detected manually, it is ineffective and would cause traffic jams since it would disrupt the flow of traffic. CCTV cameras would be very helpful in detecting crossing violations because they would not impede traffic movement and could identify numerous violations at once.

In this research, we present an end-to-end system that uses sophisticated computer vision techniques like as object identification, image classification, and picture segmentation on CCTV footage to detect traffic laws breaches, including not wearing a helmet and cutting the crosswalk. Vehicles are first identified by the Object Detection Algorithm (YOLO), after which they are examined for infractions. A CNN-based image classifier is used to record helmet violations. A

vehicle's violation of a crosswalk is identified by image segmentation using the Mask R-CNN architecture. In the event that a violation or violations are found, the offender is notified and their vehicle number is acquired by OCR.

II. LITERATURE REVIEW

Prem Kumar Bhaskar, et al, “Image Processing Based

Vehicle Detection and Tracking Method" [1], Vehicle tracking and detection are crucial and efficient in the field of traffic surveillance systems, where safety and efficient traffic management are the main priorities. This work addresses the difficulty of recognizing traffic and vehicle information from video frames. Despite the many research that have been done and the various methods that have been employed, there is still room for improvement in this area. To enhance, it is proposed to use the Gaussian mixture model and blob detection techniques to construct a unique algorithm for vehicle data tracking and recognition. To tell the foreground from the background in a frame, we first learn the backdrop. In this instance, the foreground detector identifies the object, and a binary calculation defines the rectangular zones that surround each object that is recognized. To remove noise and precisely identify moving objects, certain morphological techniques have been applied. The final counting is then completed by tracking the discovered items and their territories. We obtained a promising average detection and tracking accuracy of over 91% using the Gaussian Mixture Model and Blob Detection approaches.

Kunal Dahiya, Dinesh Singh, and C. Krishna Mohan, "Automatic Detection of Bike-riders without Helmet using Surveillance Videos in Real-time" [2], This work presents an architecture that uses real-time surveillance footage to automatically identify bikers without helmets. The proposed method initially identifies bike riders from surveillance film by using object segmentation and backdrop subtraction. It then determines whether the biker is wearing a helmet using visual signals and a binary classifier. We also propose a violation reporting consolidation technique that improves the reliability of the proposed system. To evaluate our approach, we have provided a performance comparison of three distinct feature representations for categorization. The experimental findings show that the detection accuracy on actual surveillance data is 93.80%. Furthermore, it has been shown that the proposed method is computationally less expensive and operates in real-time with a processing time of 11.58 ms per frame.

Abdullah Asım, et al, "A Vehicle Detection Approach using Deep Learning Methodologies" [3], The trained vehicle detector will be tested on test data in order to optimize the trained detector's success rate by providing efficient results for vehicle detection. The objective of the project is to effectively train our vehicle detector on sample vehicle data sets utilizing R-CNN and Faster R-CNN deep learning algorithms. The working technique is divided into six main stages. They are loading the data set, designing the convolutional neural network, configuring the training options, training the Faster R-CNN object detector, and evaluating the trained detector in that order. The study's scope also included comparisons between experimental analysis and vehicle detection results, as well as references to Faster R-CNN and R- CNN deep learning approaches.

J. Chiverton, "Helmet presence classification with motorcycle detection and tracking" [4], Despite the fact that helmets are essential for motorcycle riders' safety, requiring their use is a labour-intensive and time-consuming process. Consequently, an automated system for identifying and tracking motorcyclists who wear and do not wear helmets is described and tested. Using both still images and individual picture frames from video footage, the technique uses support vector machines trained on histograms generated from motorbike riders' head region image data. The learnt classifier is included into a tracking system that automatically separates motorbike riders from video data using background removal. The riders' heads are separated and then classified using the trained classifier. In adjacent time periods, each rider constructs a set of locations called as tracks. These tracks are then categorized collectively using the mean of the individual classifier results. The classifier can accurately determine whether or not riders are wearing helmets in still photos, according to experiments. Tests conducted on the tracking system further demonstrate the validity and utility of the classification approach.

Gomathi, et al, "Automatic Detection of Motorcycle without helmet using IOT" [5], India's expanding traffic infraction monitoring and control issues are a result of a number of factors, including the country's large population, increasing commuter population, inadequate traffic signal administration, and rider behavior. Relying solely on physical traffic police to monitor has proven unsuccessful in managing such high traffic volumes and tracking offenses. India's expanding traffic infraction monitoring and control issues are a result of a number of factors, including the country's large population, increasing commuter population, inadequate traffic signal administration, and rider behavior. Relying solely on physical traffic police to monitor has proven unsuccessful in managing such high traffic volumes and tracking offenses.

Aaron Christian P. Uy, et al, “Automated Traffic Violation Apprehension System Using Genetic Algorithm and Artificial Neural Network” [6], In developing countries, the problem of crowded and congested roads is a worry because of inadequate traffic policing. Drivers break the law because they can easily get away with it and avoid being caught. This study suggests an intelligent traffic system that can automatically detect and stop traffic violations, particularly those committed by automobiles that swerve or block the pedestrian lane. The design of the system incorporates three processes: plate localization, plate recognition, and violation detection. Genetic algorithms were utilized for violation detection and plate placement, while an artificial neural network was employed for plate recognition. For the plate number identification to work, the recognized vehicle's position in respect to the camera is essential. Therefore, the recognized plate number will only be supplementary information about the offender; the key information will be the physical attributes of the vehicle that are captured by the violation detection procedure. Based on the results of 48 testing images, the system as a whole was able to detect the aforementioned violations and identify the plate number of the vehicles that were designated as traffic violators with an average accuracy of 90.67% and a program duration of 1.34 seconds.

Samir Ibadov, et al, “Algorithm for detecting violations of traffic rules based on computer vision approaches” [7], We propose a unique method for automatically detecting violations of traffic laws to improve public safety at uncontrolled pedestrian crossings. The algorithm consists of several phases. They are the detection of zebras, cars, and pedestrians. For car detection, we use the faster R-CNN deep learning method. The program does a good job of detecting violations of traffic laws.

Amey Narkhede, et al, “Automatic Traffic Rule Violation Detection and Number Plate Recognition” [8], The population of the world is becoming more urbanized. Traffic infractions have increased significantly as a result of the significantly increased number of cars on municipal roadways. These days, people are more critical. This seriously damages the environment in addition to increasing the number of accidents that could jeopardize lives. The individuals. Finding traffic infractions and their unimaginable repercussions is essential to resolving the alarming issue and preventing future occurrences of the same kind. Implementing the system is crucial.

Pooya Sagharichi Ha, Mojtaba Shakeri, “License Plate Automatic Recognition based on Edge Detection” [9], We provide the Automatic License Plate Recognition System (ALPRS), an image processing tool for license plate recognition in this study. The main ALPRS procedure consists of four steps: The FMH filter removes noise from the image. Background subtraction is accomplished in a simple manner. Using Canny edge detection, the license plate's location is localized. The last step is to extract the letters and numbers using the template matching technique. The recommended algorithms have the following two advantages: The method is highly noise-resistant, to start. The second is that it can handle different colored license plates. Performance of the algorithm is tested on a live video stream. According to the results of our system, the missing rate is around sixteen percent out of seventy car images.

Kaiming He, Georgia Gkioxari, Piotr Doll´ar, Ross Girshick, “Mask R-CNN” [10], For object instance segmentation, we provide a general, flexible, and conceptually simple framework. Our approach successfully identifies objects in an image while simultaneously producing a high-quality segmentation mask for every instance. The method, called Mask R-CNN, extends Faster R-CNN by adding a branch for object mask prediction in addition to the existing branch for bounding box identification. Mask R-CNN has a small overhead compared to Faster R-CNN, operates at 5 frames per second, and is

simple to train. Additionally, Mask R-CNN is easily adaptable to various applications, like estimating human poses with the same framework. We give the best results in the three tracks of the COCO suite of challenges: instance segmentation, bounding-box object detection, and person keypoint detection. Mask R-CNN outperforms all existing, single-model competitors without any extras on all tasks, including the COCO 2016 competition winners. We hope that our simple and effective approach will serve as a solid basis and enable future instance-level recognition studies.

III. PROBLEM STATEMENT

To automate monitoring, improve detection accuracy, and ensure swift penalization. By leveraging deep learning, this system can identify violations in real time, minimize human intervention, and enhance road safety.

IV. OBJECTIVE

1. To develop automated traffic violation detection system using deep learning-based object detection.
2. To implement YOLOv8s for detecting violations such as helmet non-compliance and triple riding.
3. To integrate real-time video analysis for efficient traffic monitoring and law enforcement.
4. To ensure high accuracy and reduce false positives in violation detection.
5. To create a scalable and adaptable system that can be deployed across different road conditions.

V. DESIGN METHODOLOGIES

In this system architecture, we use Object Detection to recognize vehicles after initially feeding the machine an image frame from CCTV footage. YOLO, or "you look only once," is used in object detection to find cars in an image frame.

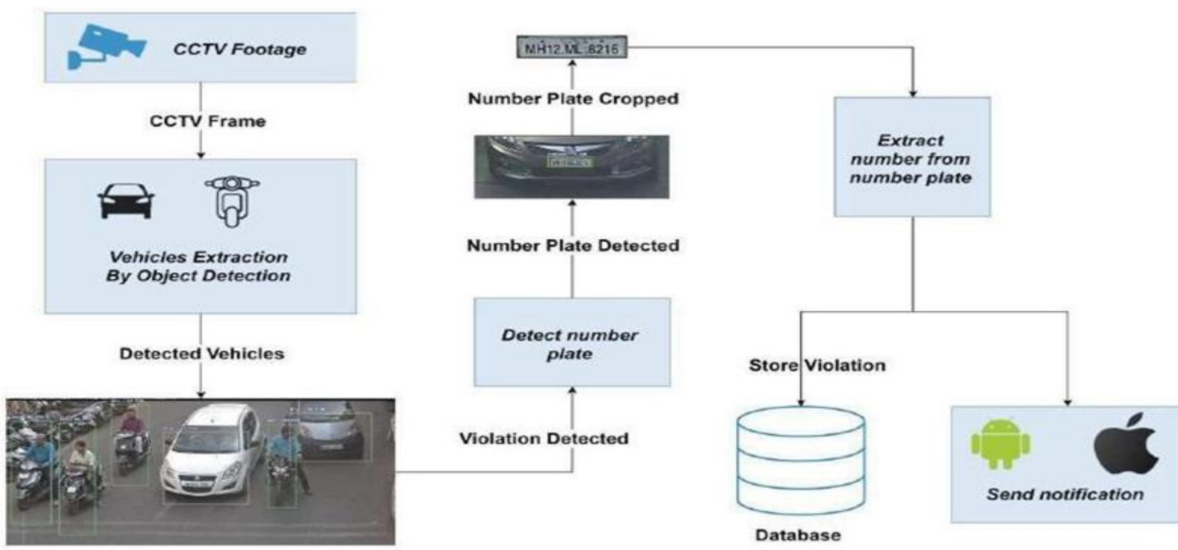

Figure 1: System Architecture

Following vehicle detection, each vehicle is cropped out using the coordinates that the object detection algorithms have provided from the bounding boxes. Every car is now inspected for various infractions. This suggested system includes the following violations: Triple riding violation and Helmet Violation (Two-Wheeler Rider Not Wearing a Helmet). Vehicles with two wheels will be inspected for helmet and triple riding violations, and vehicles with four wheels will be examined for crosswalk violations. A CNN (Convolutional Neural Network) based classifier, which performs well on

visual data, is used to detect helmet violations. By employing Mask RCNN, which uses instance segmentation to compare the coordinates of the vehicle's bottom tire with those of the detected crosswalk, crosswalk violations can be identified. Following the detection of a vehicle violation or violations, object detection is used to find the relevant car's license plate. Once more, YOLO is utilized to identify a vehicle's license plate. The license number is extracted from the license plate using optical character recognition, or OCR. Violations are added to the database and associated violations are communicated to vehicle users. Statistical analysis of past infractions of traffic laws can be obtained from the database.

VI. RESULTS

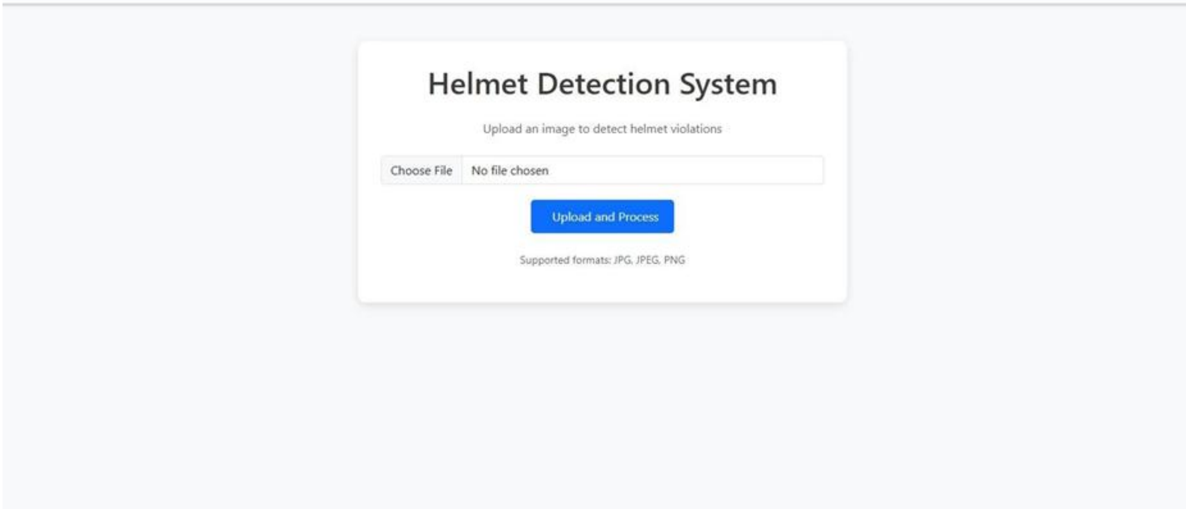

Figure 2: Helmet Detection System

Figure 3: Helmet Detection System Image 1

Figure 4: Helmet Detection System Image 2

Figure 5: Helmet Detection System Image 3

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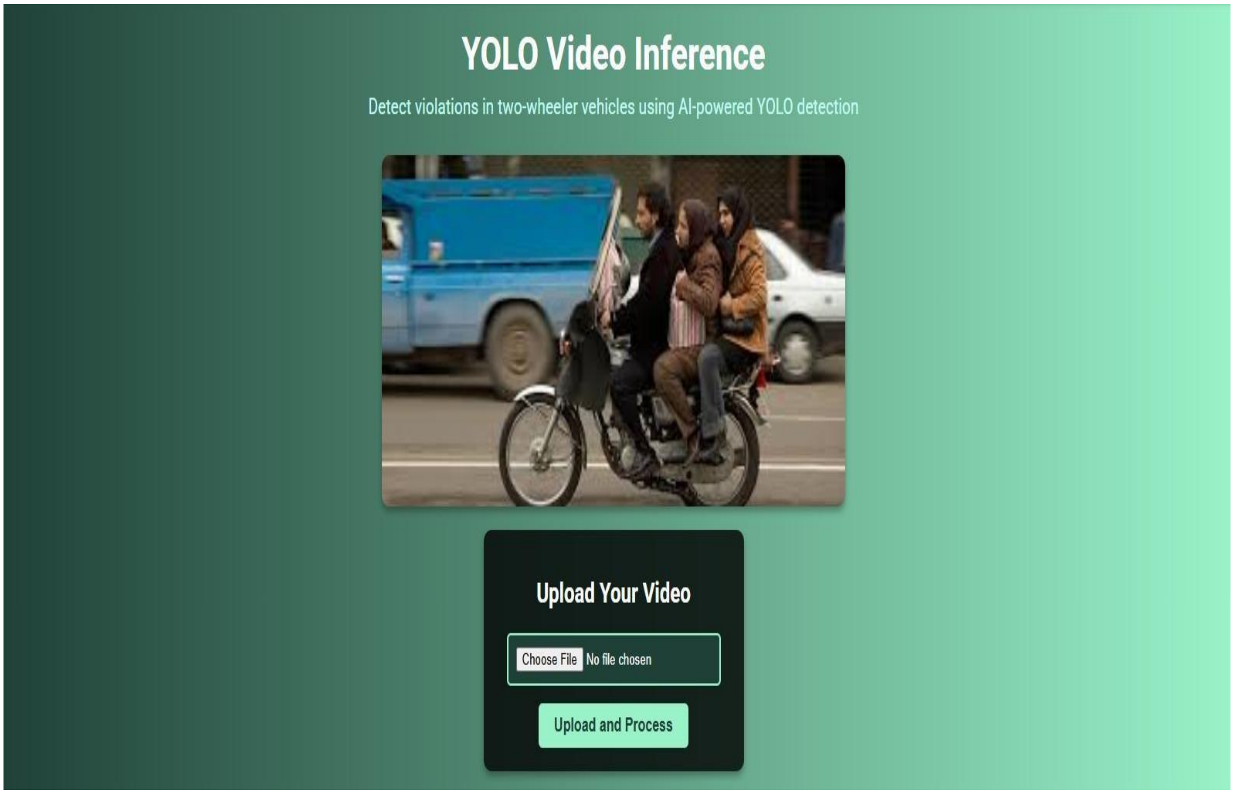

Figure 6: YOLO Video Inference

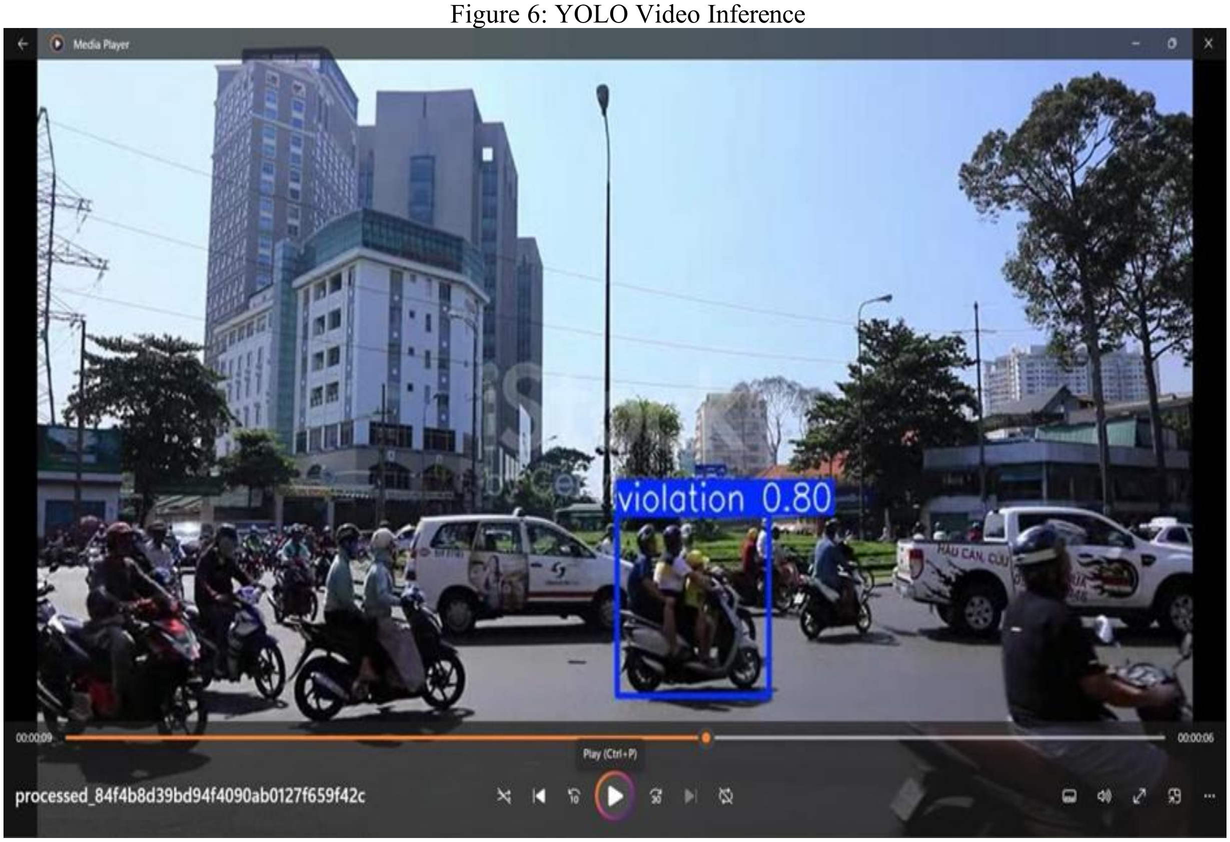

Figure 7: Triple Seat Detection Image 1

Figure 8: Triple Seat Detection Image 2

VII. CONCLUSION

We are implemented traffic rules violation detection. The suggested method uses ideas like CNN, Mask R-CNN, OCR, and Yolo to automatically detect infractions of traffic laws. It easily and precisely accomplishes the intended result, but because it uses ideas like object detection and image segmentation, it demands a lot of processing power. The benefit of the suggested system is that, in comparison to the human-intervened system, it can detect a greater number of infractions. Furthermore, when put into practice, the suggested methodology's end-to-end autonomous system would provide it an advantage in identifying infractions. As a result, stringent laws against breaking traffic laws can be put into place, improving road safety and raising awareness among drivers.

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