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Detecting Traffic Rules Violations using Computer Vision

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Abstract

The growing number of automobiles, particularly in urban areas, has increased traffic congestion and the likelihood of traffic offenses globally due to the growing desire for comfort and convenience. In addition to putting lives in danger, these violations highlight how urgently automated solutions that guarantee compliance with traffic laws and improve road safety are needed. Conventional enforcement techniques, which depend on manual labor, are frequently laborious and have a narrow reach. In order to overcome these obstacles, this study suggests a sophisticated system for detecting traffic violations that uses state-of-the-art computer vision methods to get high accuracy in real-time.

Keywords: *Computer Vision, Deep Learning, Convolutional Neural Networks, Image Classification, Object Detection, Image Segmentation.*

1. Introduction

Traffic monitoring and enforcing rule compliance have become more difficult due to the growing number of cars on the road, especially in urban areas. In addition to making road management more difficult, this increase in traffic also raises the possibility of infractions, collisions, and dangerous circumstances. Conventional traffic monitoring techniques that depend on human observation are frequently ineffective and prone to mistakes [2]. In order to overcome these obstacles, this study suggests an automated system that makes use of computer vision to recognize the registration numbers of violating cars and detect traffic infractions, guaranteeing accountability and timely action [3]. Complex characteristics may be extracted from input photos and videos by computer vision systems. Convolutional Neural Networks (CNNs), a subset of deep learning based on Deep Neural Networks and constructed using TensorFlow, are used in this research [6].

1.1 Traffic Monitoring Systems

Conventional traffic monitoring systems use radar-based equipment, CCTV video, and human observation. These systems frequently malfunction in dynamic traffic settings, are subject to human mistake, and need substantial manual intervention. Recent developments in computer vision have made it possible for automated systems to interpret live video feeds more accurately and efficiently while producing useful insights. The promise of computer vision for real-time traffic analysis, including vehicle recognition and classification, is highlighted by studies by Zhou et al. (2019), which show notable advancements over traditional techniques [5].

1.2 License Plate Recognition (LPR)

The function of automated license plate recognition (ALPR) systems in toll collecting and traffic law enforcement has been thoroughly investigated. The use of optical character recognition (OCR) on static pictures in early systems was constrained by occlusions and inadequate illumination. High accuracy and recall rates are achieved by recent work, such as Li et al. (2020), which incorporates deep learning models like PaddleOCR for text recognition with YOLO for vehicle identification. These systems have shown success in a variety of situations, such as

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law enforcement and traffic control in smart cities [4].

1.3 Lane-Level Speed Estimation

One essential element of contemporary traffic systems is the ability to accurately estimate vehicle speeds at the lane level. Granular speed analysis is made possible by the study by Kim et al. (2021), which shows how convolutional neural networks (CNNs) may be used to track cars in numerous lanes. This technology facilitates data-driven decision-making for road safety and urban planning projects. It is becoming more popular to combine speed estimation and infraction detection as a complete traffic monitoring solution [3].

1.4 Vehicle Classification and Weight Estimation

Classifying vehicles is crucial for determining the makeup of traffic and implementing laws. Axle counting and manual classification are two ineffective and error-prone traditional procedures. According to research by Patel et al. (2022), edge computing is useful for real-time weight estimation and vehicle classification into several categories. These systems offer improved accuracy and scalability by combining ALPR with classification algorithms [4].

2. Proposed System

The suggested system is an AI-powered framework for detecting traffic regulation violations that makes use of cutting-edge deep learning and computer vision methods. The goal of the system is to accurately and efficiently automate traffic monitoring, violation detection, and offending vehicle identification. The limitations of traditional traffic monitoring systems, such as their high manual involvement, limited scalability, and inefficiency in high-traffic situations, will be addressed by this framework [5].

2.1 Real-Time Violation Detection

Use video analytics and deep learning models to identify traffic regulation infractions such illegal lane changes, over speeding, and signal jumping [2].

2.2 Automated License Plate Recognition

Identify infractions in real time by accurately detecting and recognizing license plates using AI-powered methods. Figure 1 shows Outputs.

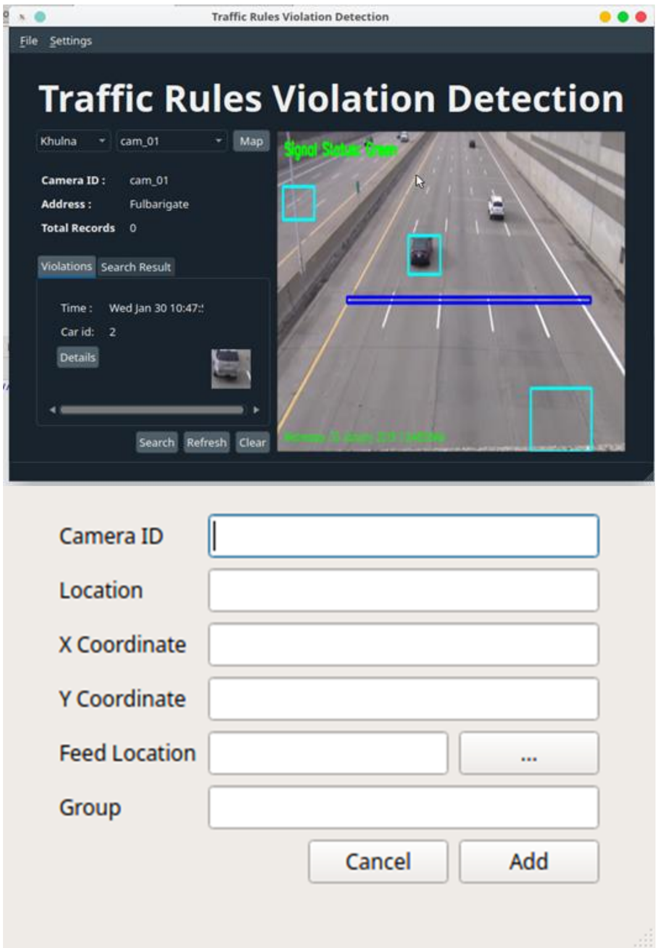

Figure 1 Outputs

3. System Architecture

3.1 Input Data Acquisition

A crucial stage in putting into practice a computer vision system for identifying infractions of traffic laws is input data collecting. This phase entails gathering unprocessed data from multiple sources, verifying its quality, and getting it ready for additional processing [5].

3.2 Preprocessing

Preprocessing is a critical stage in the development of any computer vision system. It involves refining and enhancing the raw data acquired during the input stage to ensure it is suitable for accurate analysis and processing by the subsequent modules. In the context of detecting traffic rule violations, preprocessing is essential for improving the quality of images and videos, reducing noise, and isolating key features required for analysis [4].

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3.3 Object Detection and Tracking Model

In computer vision, object identification and tracking are essential elements, particularly when it comes to identifying traffic infractions. These models recognize things in photos or video streams such as cars, pedestrians, traffic signs, etc. and follow their movements over time [5].

3.4 License Plate Detection and Recognition Module

Vehicle license plates are detected and recognized by this module, which is essential for tracking down infractions and identifying offenders [5].

3.5 Vehicle Classification and Analytical Model

Cars, trucks, motorbikes, buses, and other vehicles are all categorized into several classes by the vehicle classification model. This is helpful for figuring out how traffic moves, examining how the roads are used, and finding particular infractions [5].

3.6 Database Layer

The enormous volume of data produced by traffic monitoring systems, such as video footage, detection results, license plate information, and infraction notices, is stored and managed by the database layer [5]. Figure 2 shows Flowchart.

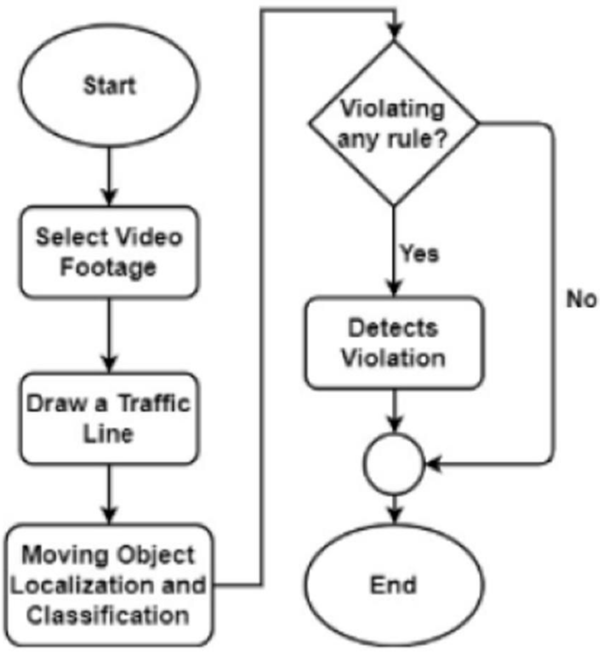

Figure 2 Flowchart

Conclusion

An important step in improving traffic management and guaranteeing road safety is the suggested method for detecting traffic signal violations. The system can effectively detect infractions, categorize automobiles, and produce useful data by leveraging real-time analytics, sophisticated object identification, and license plate recognition. Authorities' monitoring and enforcement procedures are made simpler by the integration of an automated video processing pipeline and web-based interface, which also improves accuracy and decreases manual involvement.

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