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Survey on Automatic Traffic Rule Violation Detection and Fine Collection using Machine Learning

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Abstract

Traffic law violations are a major cause of concern in our society. People's irresponsible and careless attitudes towards driving laws has the potential to weaken the moral fiber of our society. While some progress has been made to update traffic laws, the human factor in our existing system remains a hurdle, resulting in dissatisfactory outcomes that could have been prevented. Legislation has mandated the use of safety belts and helmets by drivers, but with millions of drivers on the roads every day, it is difficult for police officers to monitor compliance. To ensure compliance with traffic regulations and improve road safety, an effective and efficient system for automatic traffic rule violation detection and fine collection is crucial in modern cities. Fortunately, the emergence of technological advancements has enabled Machine Learning techniques to provide solutions to this problem. By leveraging image processing and Machine Learning, our proposed system is able to analyze CCTV footage to detect traffic violations, such as the failure to wear seat belts or helmets. Machine Learning algorithms such as Convolutional Neural Network (CNN) and Automatic Number Plate Recognition (ANRP) can be used to increase the accuracy and efficiency of detecting traffic rule violations and thus improve compliance with the law and road safety.

Keywords: *Machine Learning, Violation Detection, ANRP, CNN.*

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INTRODUCTION

The regulation and implementation of traffic regulations are vital for maintaining safe roads and the smooth operation of traffic in cities and towns globally. As the number of cars on the roads has been rapidly escalating, it is becoming progressively more essential to guarantee that traffic laws are being respected to reduce the risk of collision and guarantee a secure and orderly movement of traffic.

India, a country with a population of 1.4 billion, has millions of two-wheelers on the road, making it one of the largest markets for two wheelers in the world. However, traffic accidents have become a major cause of fatalities among people, with a reported total of 4,12,432 road accidents in 2021 resulting in 1,53,972 deaths and injuring 3,84,448 others. The age group most affected by road accidents is 18-45 years, accounting for 67% of all accidental deaths [1]. Despite the increasing number of traffic accidents, particularly in metropolitan areas, many of these fatalities could have been prevented if drivers had taken proper safety measures such as wearing helmet and seat belts. A 2021 report by Ministry of Road Transport and Highways in India states that 42,593 individuals lost their lives due to mot wearing a helmet, with 70.6% being drivers. Additionally, 16,397 individuals died as a result of not wearing a seat belt, 51.5% of whom were drivers. Non-compliance with wearing helmets and seat belts also resulted in 93,763 and 39,231 injuries respectively [1].

The regulations surrounding traffic violations differ from country to country. In India, traffic law enforcement is guided by the Motor Vehicle Act of 1988, which was passed by Lok Sabha and imposes strict and severe consequences for violation [2]. Here are some of the law's key provisions: Parents of underage drivers will be sentenced to three years in prison, accidents victims will receive higher compensation, and increased fines for reckless driving, drunk driving, and driving without a wearing helmet or seat belt. The law mandates that drivers must wear seat belts and helmets while driving.
Enforcing traffic rules and issuing penalties for violations is a challenging task that requires a lot of human effort and time.

The conventional approach, which is time-consuming and labor-intensive, uses CCTV footage or traffic police personnel stationed at intersections. Law enforcement personnel must monitor millions of photographs every day which

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is a daunting task and the accuracy is questionable because only small number of infractions can be captured in a single image. Consequently, many violators go unnoticed, rendering the system inefficient and ineffective.

In recent years, advances in technology have enabled automation using Machine Learning techniques. To capitalize on these advancements, we propose a system that can detect traffic rule violations. Our system uses CCTV footage as input to a model trained with deep learning techniques such as Convolutional Neural Network (CNN). This model is used to detect violations such as helmet or seat belt detection. Additionally, we are implementing an Automatic Number Plate Recognition (ANRP) system to detect license plates. This system is the used to impose penalties on rule violators. Through this proposed system, there is an improvement in the efficiency and accuracy of detecting traffic rule violations, when compared to traditional methods. This system is beneficial in safety on roads, reducing the number of traffic violations, and increased compliance with rules and regulations. It also ensures that the drivers are held accountable for their actions, which help to maintain order on the roads.

In the upcoming section, we will explore the background of the research and its intended purpose.

BACKGROUND

The background of the study highlights the growing concern of the traffic rule violation due to the increasing number of vehicles on the road. Traditional methods of detecting traffic violations through human effort have proven to be inefficient, time-consuming, labor-intensive, and inaccurate. As a result, there has been a growing interest in using Machine Learning systems for automatic traffic rule violation detection, which can provide a more efficient and accurate solution to the problem. By implementing Machine Learning techniques such as Convolutional Neural Network (CNN) and Automatic Number Plate Recognition (ANRP), the accuracy and efficiency of detecting traffic rule violation can be significantly improved.

The proposed system can enhance road safety by reducing the number if traffic violations and ensuring compliance with traffic regulations. The ultimate goal of this research is to develop a system that can hold drivers accountable for their actions and help in maintaining the order on the road.

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In the next section, we will explore the related work of the current system. This will provide an overview of the utilized technologies and constraints of the system.

Studies on Related Work

The Summary of related works is presented in Table 1 below.

Table 1: Comparison of related work.

Sl. No.	Title	Authors	Technology	Advantages	Limitations
1	Intelligent Traffic Violation Detection.	Roopa Ravish, et. al.	CNN, YOLOv3	Increased prediction ability in all types of vehicles.	It consumes lots of time.
2	An efficient approach to Traffic Violation Detection and Fine Generation.	Isha Sethi, et. al.	OCR	Increased detection of number plate using manually.	A person should be involved to generate the fine by monitoring the images.
3	Study of Different Approaches to develop an Automatic Traffic Rule Violation Detection System.	Dr. Rekha P M,et. al.	CNN, OCR, YOLOv3	Automatic number plate detection which consumes less time.	It was unable to detect some of the characters.
4	Traffic Rule Violation Detection using ML.	Amit Rangwal, et. al.	Three algorithms are used: Edge detection, CNN, K-NN	More violations are scanned and send license plate to the admin.	For large data prediction rate is low.
5	Real Time Automatic Detection of Motorcyclists With and Without a Safety Helmet.	Valanukonda Lakshmi Padmini, et. al.	HOG (Histogram of Oriented Gradients), SVC	It used the real-time traffic surveillance footage.	It was unable to detect in complex background.
6	Accurate seat belt detection in road surveillance images based on CNN and SVM.	Yanxiang Chen, et. al.	CNN, SVM.	It was able to detect in complex background.	Prediction of accurate result is low.
7	Automatic Detection of Vehicle Occupancy and Driver Seat Belt Status using Deep Learning.	Sara Hosseini and Abdol Hosseni Fathi.	YOLOv5	Used for detecting the car's windshield.	It detects only the seat belt of heavy vehicles.
8	Vehicle Safety Belt Detection and Plate Number Recognition	Dr. Uma Rani and Sayed Ahmad Seyar Sawayz.	Hough Transform, OCR	It is used to detect the area where	The prediction rate was low.

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	using Machine Learning.			the vehicle is located using the vehicle outline.	
9	Traffic Rules Violation Detection System.	Mr. M. V. Rajesh, et. al.	YOLOv3, Open CV	It is faster and works more efficiently than humans.	Program has slow runtime.
10	Traffic Rule Violation Detection using Machine Learning.	P. Srinivas Reddy, et. al.	R-CNN, SVM	Used to detect signal violation.	Unable to capture number plate characters.

The Problems

The investigation revealed several issues in the current system, including the following:

- Inability to detect all violations.
- Time-consuming and labor-intensive process.
- Only a limited number of offences are captured.
- Many violators go undetected.

RESEARCH GAPS

In this section, we will discuss the research gaps related to the use of machine learning in automatic traffic rule violation detection and fine collection. The transportation industry is exploring the emerging field of using machine learning to automate traffic rule violation detection and fine collection, which has the potential to revolutionize the enforcement of traffic laws. However, a major challenge in this field is the absence of standardized and extensive datasets to train machine learning algorithms accurately in detecting traffic violations, posing a significant research gap that requires attention to guarantee the effectiveness and precision of automatic traffic rule violation detection with machine learning. The traditional methods of detecting and penalizing traffic rule infractions are time-consuming, tedious, and prone to errors, making it difficult to enforce traffic regulations.

Automating the identification of traffic rule violations with machine learning could save time and resources by eliminating the need for manual intervention. Using machine learning for automatic traffic rule violation detection presents a significant challenge due to the need to process data in real-time, such as video footage from CCTV. Real-time data processing is necessary for the effective use of machine learning models in a practical setting. To enhance the precision

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and effectiveness of machine learning models for automatic traffic rule violation detection and fine collection, the transportation industry needs to tackle the issues of dataset availability and quality. Moreover, practical implementation of a safer and more efficient transportation system demands an improvement in real-time data processing.

CONCLUSION

In summary, adopting Machine Learning techniques for automatic detection of traffic rule violations and collection of fines can considerably enhance road safety and ensure compliance with traffic regulations. The current state of traffic law violations is a pressing issue due to the irresponsible and reckless attitudes of many individuals, which negatively affect the social fabric. Despite noticeable improvements in traffic laws, the human element in our current system remains a liability, leading to unfavorable outcomes that could have been avoided. To address this, our proposed system uses image processing and Machine Learning algorithms, such as Convolutional Neural Network (CNN) and Automatic Number Plate Recognition (ANRP), to analyze CCTV footage and identify traffic violations, including failure to wear helmets or seatbelts. This approach offers significant advantages in terms of efficiency and accuracy of detecting traffic rule violations, which can contribute to safer roads and more compliance with traffic regulations. The deployment of such system in modern cities is imperative for maintain traffic regulations and enhancing road safety for all road users.

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