TRAFFIC RULES VIOLATION DETECTION AND CHALLAN GENERATION SYSTEM

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ABSTRACT

The growing number of automobiles in cities can lead to traffic jams and shows that traffic infractions are getting worse these days in India and many other countries. This causes more accidents that could endanger people's lives as well as significant property destruction. Therefore, Traffic violation detection systems are required to address this issue and stop such unfathomable outcomes. The system presented in the research makes use of camera footage to automatically identify traffic rule violations. The proposed system unveils a blend of OpenCV, Convolutional Neural Networks (CNN), You Only Look Once (YOLO), and KD Tree Algorithms. It integrates OpenCV's precision in image processing, CNN's adeptness in feature extraction, YOLO's real-time object detection prowess, and the KD Tree's preciseness in nearest neighbor searches. Together, these elements form the core of an intricate system set to tackle the complex challenges of traffic violation detection and enforcement. Diving deep into the role of each component, we elucidate their symbiotic relationship in optimizing system accuracy, speed, and scalability.

KEYWORDS: *Neural Network, Data Science, Deep Learning,*

1. INTRODUCTION

Despite the significant automation in the detection and issue of challans concerning speed and signal breaches utilizing radars and back-end technologies being deployed in advanced nations, detecting and monitoring traffic offenses has been a tough procedure. If one considers infractions of other traffic regulations, such as improper packaging, failure to wear a safety belt or helmet, failure to carry required documentation, etc., there is still room for improvement in the automation of the corresponding administrative tasks and the issue of corresponding challans.

These days, object tracking is frequently utilized in traffic, restaurants, security, autos, stores, cameras, and inspections. Finding a moving object's position within a video frame is the aim of object tracking. Any object-tracking application starts with object detection. Objects must first be recognized by image processing software before they can be processed further. Finding the presence and placement of an object instance within an image frame is the aim of object detection.

A study looked at the template matching method for identifying things in various scales and variants. Another method for object recognition takes advantage of features found in the object, such as geometry and contextual knowledge. Deep learning's recent introduction has opened up new possibilities for object recognition. The You Only Look Once (YOLO) algorithm is a well-known method that detects objects by using a convolutional neural network. The quick processing speed of the YOLO algorithm is its benefit. In addition, YOLOv3 improved the YOLO detector's speed and accuracy over more sophisticated methods of object recognition. Many sectors are changing thanks to object identification, which has applications ranging from business productivity to personal safety. Numerous fields of machine vision, such as image retrieval, security, surveillance, automated car systems, and machine inspection, use object detection and recognition.

1.1 Optical Character Recognition

Optical Character Recognition or Optical Character Reader, often abbreviated as an OCR, is the conversion of images by mechanical or electronic means Type, write, or print text to machine-encoded text, either from a scanned document or a photograph of a document, a photograph of a scene, The text of a comment superimposed over an image, extracting the characters from your image or video.

1.2 Medical Imaging

Medical Imaging tools play a significant role in helping physicians diagnose, plan, and implement image-guided therapy interventions. Accurate, robust, and fast-tracking deformable anatomical objects, such as the heart is a key task in medical image analysis.

1.3 Autonomous Cars

Autonomous driving is among the best instances of why object detection is necessary. An automobile must be aware of its surroundings to determine whether to accelerate, brake, or turn. What are the things in the area around the car? To accomplish this, object identification is needed, and the car would essentially be trained to identify a predetermined collection of items, such as vehicles, pedestrians, traffic lights, road signs, bikes, and motorbikes.

1.4 Surveillance System

For recognizing and tracking things in monitored settings, monitoring systems use object detection and recognition. These systems use methods such as YOLO or Faster R-CNN to categorize and localize items within a scene through analysis of video feeds or photographs. The identified items are then identified by extracting attributes like form, color, or texture, sometimes with the use of CNNs or other machine-learning methods. Subsequently, object-tracking algorithms track the movements of identified items over an extended period, enabling ongoing observation and examination. Surveillance systems may improve security, identify suspicious activity, track traffic, and trigger warnings or replies as necessary by combining these features. This improves situational consciousness and safety as a whole.

2. Literature Survey

Zhemin Liu et.al. This research seemingly suggests a somewhat automated pipeline for detecting possibly unlawful parking from beginning to finish. You Only Look Once Version 3(YOLO3), a deep learning-based object identification system, is used to somewhat and maybe accurately distinguish cars. Error-tolerance measures are already used in movement tracking, which uses template matching and Intersection over Union (IoU) computations to potentially determine how long the vehicle infraction was stationary in a way. License plates are kind of read using Open ALPR for the most part.

Shubham Kumar Chandravanshi et.al. proposed a model which covers People's cavalier and careless attitude towards breaking traffic laws which are tearing away the moral fabric of modern society. Despite the fact that the country's traffic laws have dramatically improved over the last several years, the human element in the current system still poses a risk and results in subpar results that might have been far better. The fact that traditional and electronic challans are distributed slowly and sometimes include errors also becomes a reason for encouraging careless driving. This proposal automates the process of identifying traffic offenders using object identification and object tracking and producing the E-challans by instantly obtaining the vehicle information from the RTO following the extraction of number plate data number plate detection. An E-challan is promptly issued to the offender through email and text messages once an infringement is reported. These adjustments will increase effectiveness, precision, and resilience to human error.

R Shreyas et.al. proposed an Automatic Number Plate Recognition (ANPR) system built on top of existing image processing technologies to particularly identify cars committing traffic offenses such as excessive speed and lane infringement at street traffic lights. The suggested system is employed primarily for road traffic monitoring and can kind of monitor every car for infractions of traffic rules and report them to the appropriate authorities so that they can take appropriate action, resulting in an orderly flow of traffic and fewer accidents at intersections.

B. V Kakani et.al. present an enhanced approach to OCR-based license plate recognition by kind of utilizing a neural network trained with like object features.

K.T. Ilayaraja et.al. presented an incredibly inconvenient and messy model for license plate recognition utilizing a quite flimsy ResNet Convolution Neural network and some other stuff. The not-so-clever method is kind of effective at maybe recognizing car numbers and retrieving some random ownership information from like the regional database or something. Even at speeds of up to 10 km per hour, it sometimes displays not-so-great precision, which is quite meh. Character recognition might sort of be the major topic of this research, possibly because of its complexity and the vast untapped potential it has in the field of data analytics.

Shaji Thorn Blue et.al. proposed research that would like to improve the precision of item detection by improving the quality of the boundary boxes formed around them. The proposed approach used YOLOv3 as a foundation model, which resulted in more precise border boxes around the items in the image, and used edge detection, local pixel values, and the pretrained COCO dataset to essentially enhance the accuracy of the border box enclosing the item.

N.Palanivel et.al. present a well-organized vehicle plate detection system using such as image segmentation, border detection, and greyscale conversion to achieve accurate license plate identification under varying illumination conditions and potential disturbances on Indian roads and restricted areas.

R. Krishna Moorthy et.al.The conventional manual approach to traffic monitoring faces challenges in preventing congestion and adhering to traffic rules. To address this, a pioneering method is introduced in this study, employing multiple Internet-connected CCTV cameras to automate traffic signal lights at road junctions. The method encompasses two core phases: Vehicle Detection System and Traffic Scheduling Algorithm.

Richard G et.al. This research recommends the numerous segmentation methods are organized into four basic categories. The classical method, as it is commonly called, employs ways to segment the input picture into labeled parts. To dissect a picture is to try to separate its constituent parts so that they may be more easily categorized. The second group of methods sidesteps dissection in favor of segmenting images in one of two ways: either overtly, by classifying the picture according to specified windows, or implicitly, by classifying subsets of spatial information gleaned from the complete image

3. TECHNOLOGY STACK

3.1 PYTHON

Python is a widely used high-level, general-purpose programming language. Guido van Rossum created it in 1991, and the Python Software Foundation has worked to improve it since. Programmers can explain their ideas in fewer lines of code because to its syntax, which was designed with code readability in mind. Python is a programming language that allows for speedier work and more efficient system integration. Python has two primary versions: Python 2 and Python 3.

It is compatible with the GNU General Public License and may be used on Linux, Windows, and Mac OS.

3.2 ANACONDA NAVIGATOR

Anaconda is an open-source software package for large-scale scientific computing, data analysis, and big data processing. It contains applications such as Jupyter and Spyder. Anaconda supports Python and R programming languages. Python is used with the Anaconda sub-application Spyder. Python users may utilize OpenCV in Spyder. The Conda package management system manages package versions. The Anaconda distribution includes a desktop graphical user interface (GUI) named Anaconda

Navigator. Navigator simplifies the administration of conda packages, environments, and channels by eliminating the need for command line operations. It also lets you run popular Python scripts.

3.3 SPYDER

Spyder is an advanced scientific environment created both by and for scientists, engineers, and data scientists, built in Python. It provides a special fusion of the sophisticated editing, analysis, debugging, and profiling powers of an all-inclusive programming tool with the scientific suite's data exploration, interactive execution, in-depth inspection, and stunning visualization capabilities.

3.4 SQLITE

A self-contained, serverless, zero-configuration, transactional SQL database engine is implemented by the in-process library SQLite. This database is zero-configured, which eliminates the need for system configuration, much like other databases. Unlike other databases, the SQLite engine may be linked statically or dynamically with your application, depending on your needs. SQLite uses direct access to its storage files.

3.5 IMUTILS

It is a set of handy functions for OpenCV in Python that make common image processing jobs easier. For typical operations like scaling, rotating, interpreting, and presenting pictures in OpenCV, it offers a collection of assistance methods. The volume of boilerplate code required to complete these activities is decreased and the code is made simpler by these methods. Although inutile isn't a component of the original OpenCV library, it is frequently used in conjunction with it to improve processes for image processing, It's very helpful for computer vision application development.

4. METHODOLOGY

The "AI-Based Traffic Signal Violation Detection and Challan Generation System" is developed using a methodical approach, which is described in the methodology section. In this study, the CNN model, OpenCV methods, pre-processing of the data collection, and OCR for extraction are all covered in detail. There are three primary processes in the Automatic E-Challan Generation (AECG) system's operation. At first, a camera is used to take pictures or videos.

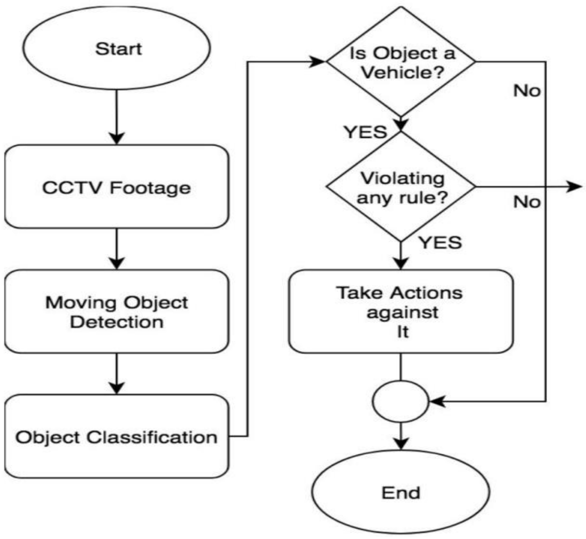

Fig. 1: Architecture of the system

After that, the recorded photos or videos are sent to the CNN models, which are set up on a Raspberry Pi 4 real-time processing board. This stage produces the outputs that come from the CNN models. The CNN model's output image is pre-processed using the KD Tree technique in the second stage. The image is smoothed after the CED algorithm is applied, which results in the creation of another image.

The Optical Character Recognizer is then used to the freshly created image in order to extract numerical data from the photographs. The CNN model's output image is preprocessed using openCV algorithms, and then another image is created after the original was smoothed. This generated image is then sent to an optical character recognizer, which extracts numbers from the image. Ultimately, the extracted numbers are cross-referenced with the information gathered in the database to confirm the vehicle owner's details. A challenge is generated if a match is discovered.

4.1 CONVOLUTIONAL NEURAL NETWORK

Widespread applications for image identification and categorization include convolutional neural networks. Convolutional neural networks are extensively used in the field of facial identification in addition to their pervasive use in scene classification and object detection.

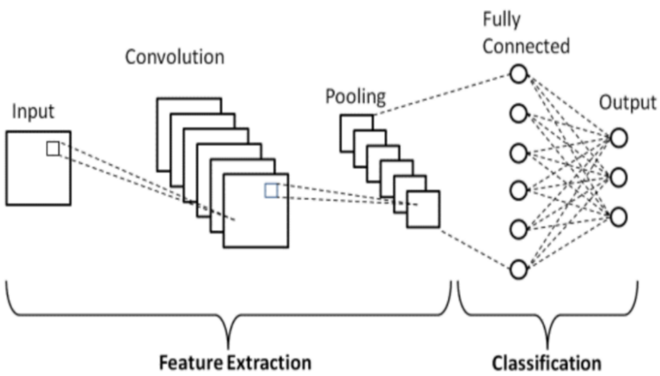

Fig. 2: Convolutional Network

4.2 CONVOLUTION LAYER

The convolution layer initiates the process of feature excretion by detecting edges, corners, and textures within the groundwork for subsequent layers to identify foundational visual features.

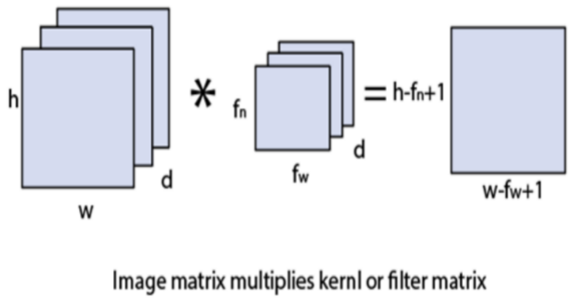

Fig. 3: Convolution Process

4.3 OPENCV

Since its founding in 1999, OpenCV, a crucial open-source computer vision toolkit, has transformed image processing and computer vision research. It enables researchers and developers to take on a broad range of tasks, from basic image modification to sophisticated object detection and recognition, by providing a comprehensive suite of modules and algorithms. OpenCV's ability to integrate machine learning and real-time capabilities propels innovation across various domains, despite ongoing constraints related to computational complexity and scalability.

4.4 YOLOv3

YOLOv3, which builds on the achievements of its predecessors, represents the pinnacle of real-time object detection thanks to its novel design and exceptional performance. Its distinguishing characteristic is its capacity to identify things across several scales in a single forward pass, allowing for speedy and precise identification of items in complicated settings. The design of YOLOv3 demonstrates its inventiveness, with a strong blend of deep neural networks and innovative approaches including feature pyramid networks and skip connections.

These architectural improvements improve the model's capacity to handle objects with different sizes and aspect ratios in addition to improving detection accuracy. To further establish YOLOv3 as a cutting-edge object detection framework, it also introduces the idea of bounding boxes, which helps to better localize objects and speed up the detection process. YOLOv3 has numerous practical uses in a variety of industries, such as industrial automation, medical imaging, autonomous cars, and surveillance systems. Its real-time image processing capabilities make it indispensable for applications like object tracking, traffic management, and security monitoring that call for quick decisions and actions. Furthermore, the adaptability and effectiveness of YOLOv3 have opened the door for creative uses in fields including environmental monitoring, retail analytics, and augmented reality.

Even with its astounding powers, YOLOv3 has its share of difficulties. Small or complexly shaped objects may be difficult for the algorithm to recognize, and occlusion and cluttered scene handling are still areas that need more research. Furthermore, YOLOv3's processing demands might make it difficult to implement on devices with limited resources, encouraging the algorithm's efficiency optimization while compromising performance.

5. EXPERIMENTAL RESULTS

The use of a broad dataset is important to the project's success. We captured many photos of automobiles to train our model and demonstrate that the method is both cost-effective and accurate. In our experiment, we recreated a real-world event by feeding two photos into the automated system. Initially, views from closed-circuit video would be collected, and items would be recognized using Yolov3 and computer vision.

After detections are classified, vehicles are screened for further processing. This is carried out by surrounding the detected object in a defined bounding box to indicate that it is being watched. When monitoring autos, the center of each box acts as a reference point and is represented by a green dot for detection.

It now decides if the automobile breaks any regulations while monitoring its behavior. When an automobile breaches the restrictions, the signal in the upper left corner immediately turns red. All of this is controlled through the graphical user interface (GUI); when we pick the Detail option, a window with the license plate and an image of the vehicle appears. We could generate a ticket by entering the plate details. The number plate, the regulation breached, and the fine assessed on the vehicle are all documented in a.txt file located in the "Tickets" folder.

Fig. 4: Graphical User Interface

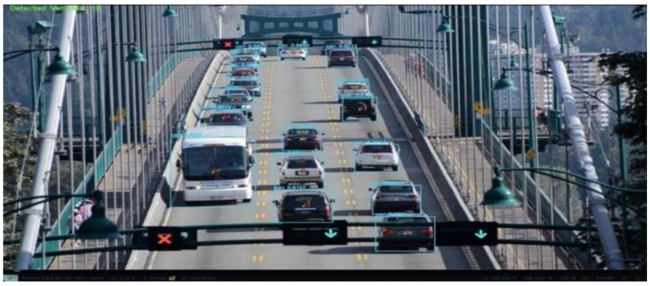

Fig. 5: Vehicle Detection in Input Frame

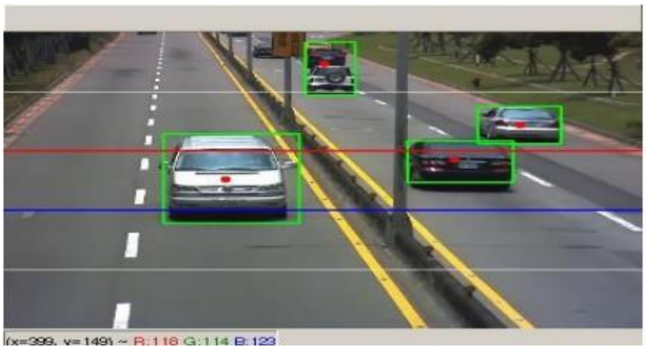

Fig. 6: Direction Violation

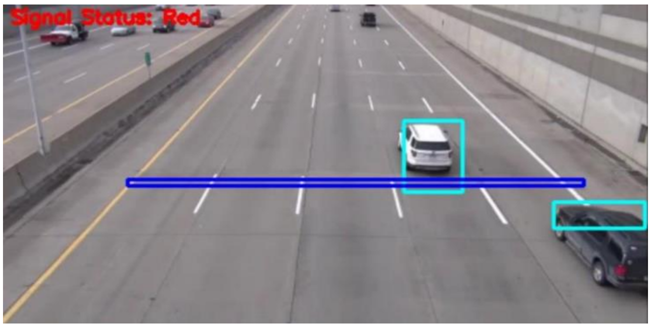

Fig. 7: Traffic Signal Violation

```
########################################
#  License Number        |             #
#                        UP 81 BR 2386 #
#  Rule Broken :                       #
#       Crossed line while red light   #
#  Fine :                              #
#                                100.0 #
########################################
```

Fig. 8: Challan Generated

6. CONCLUSION

The implementation of an AI-Based Traffic Signal Violation Detection and Challan Generation system utilizing a blend of advanced technologies marks a significant step towards modernizing traffic violation management. The integration of Convolutional Neural Network for accurate vehicle detection, and canny edge detection for effective image preprocessing. The successful demonstration of the system's capabilities, as validated through experimentation on real-world images, substantiates its ability to identify violations, extract number plates, and generate timely challans. This holistic approach addresses challenges posed by blurred images, background clutter, and varying lighting conditions, ensuring robustness in different scenarios. The system's performance achieved accuracy, and efficiency underscores its viability for application in traffic management, promoting safer roads and streamlined enforcement processes. As the roadways embrace automation and smart solutions, the AI-Based Traffic Signal Violation Detection and Challan Generation system stands as a testament to the fusion of cutting-edge technologies with the imperative need for enhanced traffic regulation and enforcement.

7. FUTURE SCOPE

The system's future potential is quite promising in terms of improving traffic control and road safety. Improving the precision and effectiveness of violation detection systems is one of the main areas of progress.

Using constant optimization as well as training on a variety of datasets, the system can attain increased accuracy in recognizing different types of traffic violations.
Furthermore, the system's ability to adjust to changing traffic patterns and circumstances increases its efficacy in implementing rules in a variety of contexts.

Beyond enforcing capabilities, the project's future focus includes improvements to the challan-generating procedure. The technology can speed up the issue of citations while maintaining precision and openness in the penalties evaluation procedure by automating and digitizing administrative processes. The effortless handling of payments and record-keeping made possible by integrating with centralized databases can improve convenience for both law enforcement and those who violate the system.

Furthermore, the initiative may have an influence on society that goes past the implementation of traffic laws. The system can generate an environment of traffic law compliance and accountable driving using data-driven conclusions and targeted interventions that raise awareness among the public and educate individuals. Also, the technology can assist in relieving traffic jams, reduce emissions, and enhance overall road safety results by empowering authorities to distribute resources more wisely based on real-time knowledge.

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