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Vehicle Surveillance System using Deep Learning

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ABSTRACT: The increase in number of vehicles on the road is being observed day by day, and the responsibilities that should be upheld by vehicle owners are frequently neglected. To ensure that the rules defined by the RTO are adhered to by every vehicle owner, the "Vehicle Surveillance System using deep learning" is proposed. This system is designed to capture vehicle data through web-app, with the identification of vehicles being achieved through the recognition of their number plates, and the extraction of characters from the plates. Once the vehicle's number plate is recognized, the vehicle's information and owner's details will be verified with RTO data using Application programming interface (API). If any unfulfilled criteria are identified by the system, a notification will be generated. Vehicle detection is carried out using the Common Objects in Context Single Shot MultiBox Detection (COCOSSD) model, while the Russian model is utilized for number plate recognition. The extraction of characters from the number plate is executed through Optical Character Recognition (OCR), which includes character extraction and segmentation.

KEYWORDS: Vehicle Compliance, Real-Time Monitoring, Number Plate Recognition, Character Extraction, COCOSSD Model, Russian Model, Optical Character Recognition (OCR), Application Programming Interface (API), etc

I. INTRODUCTION

In view of the presence of a diverse range of vehicles on the road, including two-wheelers and four-wheelers, the issues often arises, such as unpaid fines, expired insurance, and other concerns. It is crucial to establish a reliable means of identifying and categorizing these vehicles. This identification process encompasses not only recognizing the vehicle but also extracting characters from the license plate. Following the recognition of number plate data, subsequent procedures are implemented to verify if the vehicle has outstanding fines, expired insurance, or other issues. This sequence commences with the initial step of car license plate identification. In general, number plate recognition algorithms encompass four distinct phases [1]:

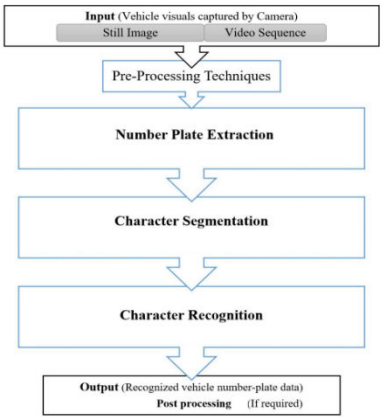

Fig. 1. Basic Flow of Number Plate Recognition [15]

1. Vehicle image capture
2. Number plate detection

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3. Character segmentation
4. Character recognition

Once the vehicle is successfully recognized, the data obtained can be employed for any necessary post-processing procedures. The efficacy of the number plate detection and character segmentation steps significantly impacts the accuracy of character recognition. Refer to Fig 1 for a visual representation of the fundamental flow of the Number Plate Recognition System.

The research paper discusses the deployment of distinct methodologies for the purpose of vehicle detection and subsequent license plate recognition. A majority of these Automatic Number Plate Recognition (ANPR) systems are founded upon established techniques, including K-Means in conjunction with Convolutional Neural Networks (CNN) [1], YOLO [2], Faster R-CNN [3], OpenCV [4], and CNN integrated with TensorFlow [5]. It is noteworthy that, despite variations in their specific approaches, these systems uniformly adhere to a standardized sequence of operations encompassing vehicle identification, license plate recognition, character segmentation, and character recognition.

II. LITERATURE SURVEY

A. Vehicle Tracking and Surveillance

In the realm of vehicle tracking and surveillance, various methods have been proposed to enhance the accuracy and efficiency of real-time monitoring. One notable study, denoted as Paper [1], introduces an automated vehicle tracking system employing state-of-the-art deep learning models like YOLO and the IMAGEAI framework. Additionally, this paper emphasizes the significance of data collection and annotation, which is crucial for training the models. Impressively, the results demonstrate high accuracy in car detection (98.5%), number plate detection (97%), and Optical Character Recognition (96.7%).

In a similar vein, Paper [2] explores the use of OpenCV, the CAMSHIFT algorithm, and Gaussian background modeling for vehicle detection and tracking. One of the remarkable features of this approach is its ability to accurately track vehicles, even in scenarios where they overlap, demonstrating the robustness of the CAMSHIFT algorithm in handling occlusions and deformations.

Another study, Paper [6], presents a novel approach utilizing Faster R-CNN for the real-time detection of vehicle number plates via surveillance cameras. To boost accuracy, this research combines OCR techniques with advanced machine learning models, ultimately achieving a commendable 91% accuracy in detecting number plates and retrieving vehicle owner information.

Furthermore, Paper [7] focuses on the integration of the YOLO algorithm for real-time vehicle detection and license plate recognition. The study leverages a combination of algorithms, including Convolutional Neural Networks (CNNs), Optical Character Recognition (OCR), and transfer learning. In addition to discussing license plate recognition, this research extends its scope to the detection of motorcycle riders without helmets from CCTV images.

Lastly, it's worth noting that while not a paper in the traditional sense, the passage detailing the benefits of video-based vehicle detection technology over traditional methods provides essential context for the practical applications of the research discussed in the surveyed papers.

B. License Plate Detection and OCR

In the domain of license plate detection and Optical Character Recognition (OCR), several studies have made significant contributions to enhance the precision and efficiency of these tasks. In Paper [3], real-time license plate detection is achieved using computer vision technology and Convolutional Neural Networks (CNNs) with TensorFlow. The research underscores the importance of the network architecture, which includes input layers, convolutional layers, activation layers, pooling layers, and fully connected layers. Training the model with 25,000 steps and eight batches results in a high accuracy ranging from 70% to 99%. Additionally, the study provides insight into the presence of vehicle license plates in images, which are marked with green boxes to indicate successful detection.

Paper [5] places its focus squarely on number plate recognition via Optical Character Recognition (OCR). The study elaborates on the step-by-step process, starting from image capture, processing, and finally character recognition. The paper introduces techniques like binary image processing, adaptive thresholding, character segmentation, feature

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extraction, and OCR through Template Matching. Notably, the study highlights a comparison between clustering and character segmentation techniques, demonstrating that character segmentation consistently outperforms clustering, achieving an 82% recognition rate for characters in various forms and dimensions.

Furthermore, Paper [4] presents an innovative approach based on Convolutional Neural Networks (CNNs) for high-accuracy real-time car license plate detection. This method introduces the MD-YOLO framework, which leverages precise rotation angle prediction and a fast intersection over union evaluation strategy. The research evaluates and compares the Split Training Model (ALMD-YOLO) and the End-To-End Model to showcase improved performance. The emphasis here lies on the importance of accurately predicting the rotation angle of multi-directional license plates, as any deviation from the true angle significantly impacts the overlap between predicted bounding boxes and ground truth.

C. Models Accuracy

Model & Accuracy	
CNN	70% - 99%
OpenCV with OCR	91%
Easy-OCR	82%
YOLO with IMAGEAI	98.5%

Each paper shows the model accuracy for number plate detection. The Convolutional Neural Network (CNN) demonstrates a broad accuracy range, spanning from 70% to 99%, highlighting its adaptability and potential for high precision [3,4,7]. OpenCV with Optical Character Recognition (OCR) achieves an accuracy of 91%, signifying its effectiveness in accurately identifying number plates [2]. Easy-OCR, while still maintaining a respectable 82% accuracy, excels in handling challenging scenarios such as blurry images. On the other hand, the YOLO model integrated with IMAGEAI showcases an impressive accuracy rate of 98.5%, emphasizing its suitability for precise and efficient number plate detection in real-world surveillance scenarios [1].

III. PROPOSED ALGORITHM

The proposed methodology for the Vehicle Surveillance System using deep learning outlines a structured sequence of steps for effective implementation. It commences with the real-time capture of vehicle images by a camera, followed by vehicle detection utilizing the COCOSSD model. Subsequently, the system employs a Russian model for precise number plate recognition and the Easy-OCR for character extraction from the detected number plate. Following this, the system cross-references the extracted information with a database of vehicle details to determine whether notifications should be dispatched to the appropriate department or the vehicle owner. Notably, the choice of COCOSSD for vehicle detection is motivated by its suitability for detecting clearly visible vehicles and number plates. Real Time Vehicle Compliance Monitoring System is based on below algorithms based on carried literature survey. System needs to follow below sequence in order to be implemented successfully.

i) Real-time Image Captured by Camera: The picture of the vehicle is collected by a webcam.
ii) Detect Vehicles: COCOSSD model will get used to detect vehicles.
iii) Number Plate Recognition: Once vehicles are detected number plate should get detected using Russian Model.
iv) Character Recognition: easy-OCR helps to recognize characters from detected number plate.
v) Check Vehicles Data: The vehicle details are cross-referenced with RTO data to determine whether a notification should be sent to a specific department or the vehicle owner.

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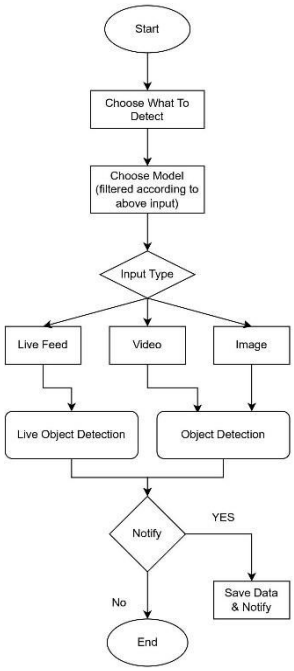

Fig. 2. Flow of Vehicle Surveillance System using deep learning

A. **Model Integration for Vehicle Surveillance System**:

i) COCOSSD: COCOSSD has been integrated into this project due to its alignment with project objectives. A slight reduction in accuracy, compared to the YOLO model, is a desirable characteristic for our specific needs. This choice is motivated by COCOSSD's proficiency in the detection of vehicles that are clearly visible and in close proximity to the camera. Accurate recognition of number plates is ensured through the utilization of this model. If the YOLO model were employed, there could be a risk of erroneous detection of very small or distant vehicles, potentially resulting in inaccurate number plate recognition due to their reduced size and greater distance from the web-camera.

ii) Russian Model: The Russian model plays a crucial role in our system as it is the most suitable model for swiftly identifying number plates when a video frame is passed through it. With this model, we can accurately crop the number plate region from the frame and subsequently feed it to our Optical Character Recognition (OCR) system for seamless text extraction.

iii) Easy-OCR: The inclusion of Easy-OCR is essential as it stands out for its exceptional accuracy in text extraction [5]. This model outperforms other alternatives like Tesseract, especially when handling blurry or less than optimal frames. The ability of Easy-OCR to maintain high accuracy, even under challenging conditions, makes it an invaluable component in our system.

B. **Data Retrieval and Management**:

Upon successful text extraction from the number plates, the retrieved data is sent to our database system using a secure API key. This data retrieval process enables us to access vital information about the identified vehicles, which includes details related to PUC and insurance. If either the PUC or insurance is found to have expired, an automated fine notification is promptly dispatched to the owner's mobile number. Additionally, the database is updated to record these fines, contributing to a streamlined record of violations.

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IV. ISSUES AND CHALLENGES

Below are issues and challenges regarding "Vehicle Management and Surveillance using deep learning" :

i) Environmental Conditions: Factors such as the intensity of sunlight and fog can significantly impact the recognition of number plates.

ii) Speed of Vehicle: The speed of the vehicle presents a unique challenge to accurate number plate detection. High-speed vehicles may pass by the monitoring system too quickly for effective recognition.

iii) Obstructed or Damaged Plates: Vehicles with obscured, damaged, or altered number plates may pose challenges for accurate recognition. The system must account for such variations and adapt to handle these situations effectively.

iv) Variability in Plate Designs: Number plate designs and formats can vary widely across regions and countries. Ensuring the system can recognize different plate styles is crucial for its applicability on a broader scale.

V. CONCLUSION

The "**Vehicle Surveillance System using deep learning**" showcases advanced capabilities. The system serves a dual purpose: not only does it facilitate the identification of non-compliant vehicles, but it also supports recovery agents in spotting defaulters. Its primary goal is to mitigate violations of RTO regulations. This project represents a significant leap in efficient and data-driven Management and Monitoring through Surveillance System.

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