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Object Detection and e-Challan Generation Systems for Traffic Violation: A Review

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***Abstract*: The rapid growth of urbanization has seen a vast migration to the cities. This compounded with the growing population has led to an increase in the number of vehicles owned by people. The large number of vehicles on the road has resulted in many people not following the traffic rules. This together with human error has led to many accidents causing trauma and grief in society. One way to reduce the number of lawbreakers, is to use some automatic number plate recognition (ANPR) and then generate an e-challan. The generation of e-challan, can help to motivate the vehicle users to be more careful while driving and follow traffic rules thus reducing the number of accidents. In this paper we present a discussion of various object detection and e-challan generation methods.**

***Keywords*: ANPR, e-Challan, Object detection.**

1. Introduction

The pre-pandemic world's most significant public wellbeing issue was road accidents. According to the World Health Organization (WHO) one million people die on the world's roads per year [1]. Most of the world's fatalities on the roads happen in low-pay and centre-pay nations, although these nations only accounted for approximately half the world's vehicles. The data also shows that around 1.3 lakh people died on Indian roads, topping the worldwide list of fatalities from road crashes [2]. As per the Road Accident Report for 2019, generated by the Ministry of Road Transport and Highways, 449,002 accidents occurred in India during 2019, leading to 151,113 deaths (i.e. 34% resulted in death) [3]. Over-speeding accounted for 63-74 % of these accidents. The working-age group of 18-60 represented 84 % of the total road accident deaths.

The elements of fast urbanization, absence of proper road design, non-existent injury prevention programs, and impoverished authorization of transit regulations have deteriorated the circumstance. Checking the parked or passing car number plates manually is very demanding of humans. With advancement in technology, traffic monitoring is often done by computers using image processing and machine learning. Identification of automobiles is possible by identifying their number plates. It not only saves the labour force but do much more, like giving the vehicles count on the road, alert for parking violation and other similar violations. In the presence of a vehicle violating the traffic rules, generating an e-challan using his/her License Plate (LP) number can also be done. A fully automated system as shown in Figure 1, which automatically detects and recognizes number plates can go a long way in increasing the efficiency of detection.

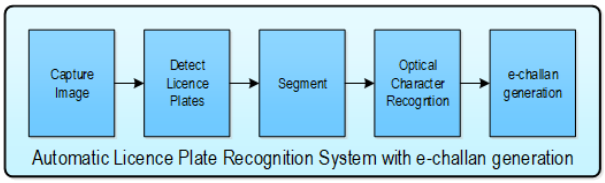

Fig. 1. A block diagram of an automatic licence plate recognition system with e-challan generation

The paper is organized as follows: Section 2 discusses the research done by several authors on Licence Plate (LP) detection and recognition, and e-Challan generation. Lastly, Section 3 presents the conclusion and gives direction towards the proposed future work.

2. Literature Review

A. K. Singh et al. [4], developed their ANPR system for the detection and recognition of the Indian number plates. They used Support Vector Machines (SVM) algorithm and then trained to get the fine-tuned data set for most Indian Licence plates. A highly trained Artificial Neural Network (ANN) is used to recognize characters from the number plate. SQL is used to manage the database. The integration of a database helps to store the information of all Indian blacklisted vehicles. Detection and recognition of white, yellow and black number plates enhances the software's capability.

M. D. Ramteke et al. [5], used Background Extraction & Analysis (BEA) algorithm for digital image processing of the image of the road. The algorithm involves background withdrawal from the image with objects. Then, this withdrawal background image is compared to the image with objects. For edge detection, the image is captured via a camera and converted to a grey image and black & white image. Next, directing these transformed images to different edge detector methods takes place. The edge detector methods include Sobel, Prewitt, Robert, and Canny. The authors found the Canny edge

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detector to be the most accurate out of the four edge detector methods used.

R. Shreyas et al. [6], proposed a system that monitors road traffic activities to distinguish the vehicle during traffic violations, like a vehicle's speed, and detects the violation at the road traffic lights path violation. At first, the system detects any vehicle violating the traffic rules and then captures the vehicle's image. Image segmentation technique helps to extract the LP number from the vehicle. Then the owner is identified and is alerted about the penalty by a Short Message Service (SMS) with the assistance of the Global System for Mobile Communication (GSM) module. Optical Character Recognition (OCR) helps in the character recognition on the number plate. The system is executed and simulated using MATLAB©. The adoption of MATLAB© to develop the Graphical User Interface (GUI) helps the user in recognizing the characters. The LP number is then displayed on the desktop GUI screen.

F. Patel et al. [7], implemented a system that involves capturing the vehicle's image, extracting a region of interest and then, character segmentation. An advanced camera of 16-megapixel captures the image of the vehicle. Further, the system receives the image for extraction of license plate recognition. To enhance the efficiency and speed to process the LP extraction, the original colour image is converted into a greyscale image. The dilation of the binary mask helps to outline the closed area and then connected objects of the border are removed. The bounding box method is used on the number plate to identify every character and results in the extraction of the LP number. Finally, utilization of the template match technique matches every character with the total alphanumeric database individually.

A. R. Welekar et al. [8], developed a system where OCR along with an android application is used for efficient e-challan generation. For the generation of e-challan, firstly, the variety plate is detected and, then the record form is fetched. In the case of an android application, it consists of a login module for officers and, there are three options to make challan, view graph, and view details. The number plate is recognized using an edge detection algorithm. With the help of the fetch option, fetching of data from the database takes place. After entering the violation details, there is an automatic selection of the sections of the law. The violator receives two messages. The first message contains the e-challan number, the fine amount and the details of the violator, and the second message contains a link in which the proof of violation is stored.

A. R. Welekar et al. [9], also implemented a smart monitoring system in which the first step is to verify the vehicle and identify the vehicle owner. In the presence of a rule violation, the officer can take action against the owner using the Quick Response (QR) code sticker. The RTO provides the QR code sticker to the vehicle owner. This sticker can help the traffic police to scan and get the details of the owner. The violation of traffic rules will lead the traffic police to generate the receipt and, then the receipt is sent to the owner's mobile number and, then the owner can fill the form and register for challan payment.

P. N. Chowdhury et al. [10], proposed a vehicle detection model to control traffic. In the model, pixel comparison of foreground and background images is executed instead of edge detection. Thus, the effectiveness of the system is improved. After pre-processing of the image, the daytime images and nighttime images undergo different processing methods. For daytime, execution of the conversion of RGB images to greyscale images takes place. Then, a mask created with specific coordinates for a particular road uncovers the road portion of the background image from the foreground image. For nighttime, extraction of the road portion of the foreground image takes place by utilizing a mask generated for a particular road with distinct coordinates. The average accuracy of day and night time for the proposed model is 95%.

A. Rao et al. [11], proposed a system for vehicle counting for traffic management. It is based on background subtraction and blob detection. The detected blobs are examined and then filtered to emanate objects. Their algorithm is based on segmentation and uses feature vectors to classify foreground objects from the background, in this case, vehicles. The system uses a camera module to take video footage of the traffic. Execution of the frame-by-frame processing of the video input takes place. These frames undergo two operations, which are background subtraction and Canny edge detection.

N. Jichkar et al. [12], proposed and experimentally evaluated an automated system, called Challan System, and vehicle verification. An application is created for traffic police officers so that the QR Code present on the vehicle can be scanned and used to verify the vehicles. OCR algorithm utilizing Image Processing helps in transforming the image of the number plate taken is transformed into text format. First the number plate numbers are framed. Then converted to RGB and further converted to greyscale. Edge detection algorithm is used for individual segmentation of each character. Extraction of the violator's details from the database takes place to generate a challan. The owner of the vehicle and the RTO office receive the challan via a text message. The updating of the generated challan information generated takes place in the database.

A. Kumar et al. [13], proposed a smart traffic violation detection system (S-TVDS) to detect a road traffic violation and assist a human-based traffic control system. The model S-TVDS uses open-source tools like Python, OpenCV, and TensorFlow 2.0 to train and test the core of the system model, and therefore it is cost-effective. By a web of Internet of Cameras (IoC), the input video shots are fed inside the modelled system and then converted into frames. The extracted frames are processed over the cloud processor to resize and clean for the final scaled input. Next, a pre-trained Convolutional Neural Network (CNN) backbone and a customized deep learning model takes the input to process the statistics. The model will predict a class of traffic violation from the decided classes as per the supervised learning network. According to the predicted class, the nearest concerned security guard or traffic police station receives the alert in real-time for quick action. With the help of this system model, it detects the type of violation and ensures its recognition.

P. Kakade et al. [14], proposed a traffic management system called Trafficborne Warning and Control System, which

Table 1
Summary of object detection and e-challan generation methods

Sr. No.	Year	Author	Some details of the method
1	2015	A. K. Singh et al. [4]	ANPR System using ANN, SVM and SQL
2	2016	M. D. Ramteke et al. [5]	BEA Algorithm and Edge Detector Methods - Sobel, Prewitt, Robert and Canny
3	2017	R. Shreyas et al. [6]	Image Segmentation, SMS using GSM, OCR, MATLAB© GUI
4	2018	F. Patel et al. [7]	Enhanced efficiency using Greyscale image conversion, use of bounding box and matching template
5	2018	A. R. Welekar et al. [8]	OCR and Android App
6	2018	A. R. Welekar et al. [9]	QR Code sticker on the vehicle
7	2018	P. N. Chowdhury et al. [10]	Pixel comparison of foreground and background images is executed instead of edge detection, Both for daytime and night time use
8	2018	A. Rao et al. [11]	Video footage of traffic is processed frame-by-frame
9	2019	N. Jichkar et al. [12]	QR Code present on the vehicle, challan sent via a text message
10	2019	A. Kumar et al. [13]	S-TVDS uses Python, OpenCV, TensorFlow 2.0 and IoC
11	2019	P. Kakade et al. [14]	Trafficborne Warning and Control System
12	2019	Shashank Srikanth et al. [15]	Five features model recidivism traffic violations, dataset trained using multiple classifiers
13	2020	R. Srinath et al. [16]	Uses Vehicle Identification Number (VIN) and Aadhar card

involves real-time object detection, license plate recognition with k-Nearest Neighbors (KNN) algorithm, and a system for an e-challan generation. For the generation of e-challan. Firstly, the vehicle number plate is detected using KNN and, then the license plate (LP) is recognized using the OCR algorithm. The information corresponding to the LP helps in the generation of e-challan and, then the offender receives the notification via SMS. The system includes a website and an application for the generation and maintenance of e-challans.

Dataset statistics used by S. Srikanth et al. [15], found that there have been around 3 million e-challans within Ahmedabad and performed spatial analysis and then proposed a group of five features to model recidivism in traffic violations. The dataset is then trained using multiple classifiers. Initially, pre-processing of data is done to clean to update the location field of all the e-challans to perform spatial analysis, then characterizing the user behaviour, the issued challan will be analyzed whether the user has paid challan or not. During festive days, the temporal analysis represents the number of e-challans issued that show a rise or a fall. Different classifiers such as Logistic Regression, Linear Support Vector Machines (LSVM), Multi-Layered Perceptron (MLP), Random Forest, and XG-Boost, are used for the practical prediction of recidivism of traffic rule violations. A higher AUC (Area under the ROC Curve) score indicates the model's better classification ability. Out of all the classifiers, estimation shows that the random forest classifier is one of the most efficacious operating models as it holds the feature importance.

R. Srinath et al. [16], proposed an automated e-challan system that features a smart vehicle recognition using a chassis number or Vehicle Identification Number (VIN). The length of VIN is 17-digits and, every vehicle manufactured is assigned a unique VIN. The system proposed the creating of a GUI and linking the database to it. The database will have information about the registered vehicles along with the details of the owner. An application was created, which had a drop-down list to select the type of offence and image capture to scan the documents such as Aadhar card. After entering the Aadhar card number and the chassis number, the official gets the driver's details. The traffic official using a GUI interface, forwards the e-challan link via a message and an email. The police capture the vehicle using an omnidirectional camera. The licence number plate is then updated in the server. If there is an omission of scanning of the chassis number, then an option exists in the system to charge a penalty from the staff on duty, which minimizes the degree of corruption [16].

3. Conclusion and Future Work

In this paper we surveyed the work done in Automatic Licence Plate detection and e-challan generation systems for the past five years. We see how emerging technologies give an impetus to develop an end to end system that is fully automated. For object detection, edge detection algorithms are most preferred, especially the Canny edge detection method. This is followed by OCR. e-challan generation is commonly hosted on websites and android applications and notification is sent via SMS.

There seems to be a gap in research of object detection methods for e-challan systems that do not involve edge detection. For an e-challan system using object detection or license plate recognition, not many machine learning algorithms were used. More work can be carried out to incorporate machine learning and deep learning with e-challan systems for greater efficiency and faster processing.

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