

Original Article

Vehicle Registration and Traffic Violation Details Detection System by Capturing the Vehicle Number Plate in Sri Lanka

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Abstract

In most parts of the world, traffic law violations have been identified as a significant cause of road fatalities, with the majority occurring in developing countries. It is impossible for a police officer to distinguish between the license numbers of vehicles that break the laws and the license numbers of speeding vehicles. The main objective of this study is quickly identify vehicles that have broken traffic rules and collect information about their owners. For vehicle identification, this device employs image detection and character recognition technologies.

The extracted vehicle number can be compared with database to see whether this vehicle belongs to the right person or not, as well as vehicle details, driver reference, and traffic violation details etc. As a result, developing such a method as a solution to various traffic problems is critical.

Keywords: *Image Processing, Number plate detection, OCR API*

Introduction

With the increase in population and vehicles on the road, many issues such as traffic violations, from active to inactive or cancel it depending on the traffic infringement.

public safety, increasing roadside accidents, and increasing the workload of traffic police and government have arisen in Sri Lanka. This project would aid in reducing these problems around the country and reducing the workload of traffic police officers.

In Sri Lanka, currently, there is no proper way to handle the above-mentioned traffic violation and vehicle details. Many of these operations were carried out manually with the help of books. If a suspicious vehicle has been identified, there is no way to obtain information on previous traffic offences or vehicle registration information immediately. There is no computerized system to maintain the details, and all records are kept in traffic police log books [1]. As a result, by developing a mobile application, this method resolves all of these issues.

The suggested application includes a function for capturing or manually entering the vehicle number plate, as well as processing the picture of the captured vehicle number plate. By certain vehicle number plate it displays registration information. It keeps digital record of prior traffic infractions as well as a driving license information details. The traffic officer has the authority to change or delete those data and alter the status of the driver's license

Literature Review

Kadir Mahamad described how image processing and optical character recognition were used to perform an automated number plate detection of letter sets of plates. Using the LABVIEW platform, an imperative system of training interface was developed [3].

As streets are crowded and a large number of vehicles drive by, number plate identification requires a high degree of accuracy, according to Kuldeepak et al [4]. They were able to achieve a precision of 98% in this study by optimizing various parameters. It is critical that for the identification of stolen cars and car monitoring, 100% accuracy cannot be compromised. As a result, improved precision streamlining is needed. Additionally, streaks, blurred regions, and smudges of different text styles and sizes should be recalled. This work should be expanded in order to reduce errors caused by them.

According to AmrBadr et al. automatic identification of car license plate numbers has been an indispensable aspect of daily life. This research focuses on Morphological operations, Histogram modulation, and Edge discovery Techniques for plate localization and character segmentation in an Automatic Number Plate Recognition System (ANPR). Character detection and identification was done using Artificial Neural Networks [5].

This study consists of information from the ANPR system. The ANPR system consists of the following steps:

- Vehicle image capture
- Pre-processing

electronic road charges and other illegal activities [7].

- Number plate extraction
- Character segmentation
- Character recognition

The ANPR system works in the following steps:

- Locate the vehicle and obtain the document image of the vehicle from the front or rear of the vehicle.
- Place and extract the number plate.
- Apply image segmentation strategies to segmentation of certain neural network technologies, mathematical morphology, colour analysis and histogram analysis. (Segmentation aims to recognize single characters. Optical character recognition (OCR) is one of the strategies that use a database stored for a single alphanumeric character to recognize each character.)

Kwon and his teammates suggested character recognition method using an optical character reader technology for smartphone applications. Camera on the android smartphone captures documents and then OCR is applied according to the language database. Since some language is added to the database. Different languages can be easily recognized. Since simulation results, can be seen the test results in English, Korean, Japanese, Chinese recognition [6].

Meghana, SagarImambi, Sivateja, & Sairam designed an image recognition system for the number plate monitoring system that is automated. It identifies vehicles using image processing technologies which can be used in densely populated and restricted areas to quickly identify vehicles that breach traffic laws as well as the owner's name, address, and other information. It can also be used if the car is used for terrorist and smuggling activities, invalid number plates, stolen cars, collect

"Vehitrack," an android-based traffic rule violation detection system, was created by Singh. The primary goal of this project is to

eliminate illegal activity such as stolen cars and to track motor vehicle traffic. The car number was extracted from the image using this method, which processed the image. The system compared this derived picture from the database to determine if the car belonged to the right person or not, as well as whether the records were valid [8].

Namrata Shirodkar and Preksha Uchil suggested a method for collecting tolls electronically using an image processing technique that can identify a vehicle's number plate and thus deduct the toll volume. It is possible to attempt to eliminate corruption from toll checkpoints in India using this strategy [9].

Goyal and Bhatia developed a system called ANPR which is an image-processing innovation which is used to perceive vehicles by their tags. This expertise is ahead of time ubiquity in security and traffic installation. Tag Recognition System is an application of PC vision. PC vision is a technique for using a PC to take out abnormal state information from a digital image. The useless homogeneity among various tags for example, its dimension and the outline of the License Plate [10].

Sanap and Narote created a survey about advanced road traffic systems and found lot of important details about LPR algorithms. So the development of advanced road traffic system provides vehicle numbers that can be used for surveillance analysis [11].

Methodology

- OCR Detector Processor - A very simple Processor which gets detected TextBlocks and adds them to the overlay as OCR Graphics.

This mobile application's main purpose is to identify captured vehicle number plate texts and digits. The App includes a camera capability that may be used to capture the vehicle number plate. After capturing the image, the App reads the registration number from the vehicle's number plate using Google's Android OCR API and Vision API. The App employs regular expressions to match the conventional pattern/format of registration numbers in Sri Lanka after recognizing the number plate. Following the validation procedure, the database will be queried for matching vehicle number plate information. In addition, the app features a Flashlight feature that allows you to record a good image at night.

Camera functions can be separated as following:

- Camera Source - Manages the camera in conjunction with an underlying.
- Camera Source Preview - Manages the camera preview (Swap width and height sizes when in portrait, preserving the correct aspect ratio, crops size to maintain the proper aspect ratio etc.)

OCR function contains the following:

- OCR Capture Activity - detects text and displays the value with the rear facing camera. During detection overlay graphics are drawn to indicate the position, size, and contents of each Text Block. (Initializes the UI and creates the detector pipeline, Handles the requesting of the camera permission etc.)

- OCR Graphic - Graphic instance for rendering TextBlock position, size, and ID within an associated graphic overlay view.

- Result – Fetches the extracted vehicle number plate details from the Firebase Database

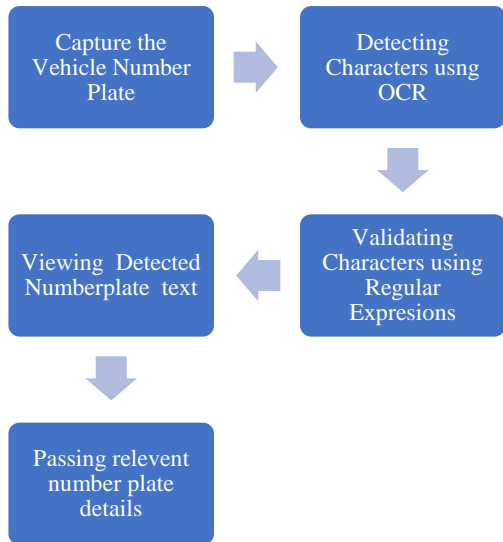


Figure 1: Number Plate Detection Flow

A. Text Recognition API Overview

Text recognition is the process of detecting text in images and video streams and recognizing the text in them. Once detected, the recognizer identifies the actual text in each block and divides it into lines and words. The scripting API can detect Latin-based texts (French, German, English, etc.) on the device in real time.

Text recognizer divides text into blocks, lines and words. Generally:

- A block is a set of continuous lines of text, such as paragraphs or columns
- A line is a group of consecutive words on the same vertical axis.

- A word is a group of consecutive alphanumeric characters on the same vertical axis.

The image below shows the descending order of each text structures. The first block marked with cyan is the text block. The second groups of blocks highlighted in blue are lines of text. Finally, the third sets of blocks highlighted in navy blue are words.

The App can recognize letters and digits in the vehicle number plate using this Text recognition API.

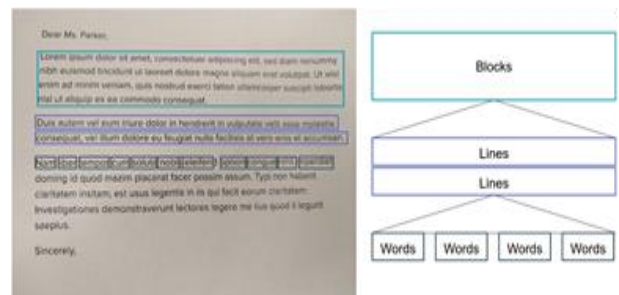


Figure 2 - Text structure

B. Regular Expressions

A regular expression is a sequence of characters that forms a search pattern. When you search for data in a text, you can use this search pattern to describe what you are searching for. A regular expression can be a single character, or a more complicated pattern. Regular expressions can be used to perform all types of text search and text replaces operations.

This app also uses regular expressions to match the standard pattern/format of registration numbers in Sri Lanka.

```

//validation setting
String REGEX = "[a-zA-Z]{2,3}\\s*[0-9]{4}\\s*[0-9]{4}"; //regular expression
Pattern number; //a pattern of compiled regex
Matcher matcher; //helps in matching the regex
text = mText.getValue();

//fixing
Matcher m = Pattern.compile("[0-9]{2}[0-9]{2}").matcher(text);
text = m.replaceAll( replacement: "");
m = Pattern.compile("[WP|NC|SP|CP|DP|SG|BP|SP|WP|NP|SP|BP]").matcher(text);
text = m.replaceAll( replacement: "");

//final touch
text = Pattern.compile("\\s{0-3}").matcher(text).replaceAll( replacement: "");
text = text.replaceAll( regex: "(^)", replacement: "").trim();

```

Figure 3 - Regular Expressions

Using above regular expressions the app is formatting the detected number to correct format. It can only recognize character starting from English letters with numbers afterwards. Then it removes province like: WP/SP/NC etc. and removes the dash symbol at the final stage. This application may store records of traffic infraction data in addition to vehicle registration details. After each driver has entered their traffic infractions, a search feature has been developed to find past traffic violation details for that driver. Entering the driver's license number or NIC number will bring up those data.

I. ARTEFACT

It is always debatable the possibility of utilizing innovative technologies on detecting vehicle registration details and traffic violation details by capturing vehicle number plate in Sri Lanka. Throughout the implementation of the system, the research aimed to reduce the possibility of intruder threats and protect the application and data responsibly. As a result, in order to achieve the desired results, the proposed artefact was planned and implemented using cutting-edge technical features.

A. Number plate recognition accuracy test

1) Mobile Application:

- Android Studio (IDE)
- Google Firebase (Database)
- Google ML KIT
- XML
- JAVA
- OCR API
- Vision API

2) Features:

- Capture vehicle number plate
- Detect text from the captured image
- Search relevant number plate from firebase
- View vehicle registration details and past traffic violation details
- View driver licence details and update driver licence's status.
- Backup and Restore Database

Results

The application was vigorously tested for possible bugs and all the test cases were successfully accomplished because this system developed by checking each functions one by one since the beginning. After developing each function it's checked for possible bugs. Through the development process, system encountered bunch of errors such as code errors, Android SDK version mismatches, incompatible widget issues and much more. All of those issues resolved by the support of inbuilt debugging tool of Android studio and the help of internet.



Figure 4: Number plate detection camera screen with flash light & zoom feature

Many tests were carried out to make sure the application is stable and deliver the best user experience. The app was tested for its character recognition accuracy on detecting different vehicle number plates under different lighting conditions.

N o	Actual Vehicl e Numb er Plate	Atte mpt No	Detect ed Vehicl e Numb er Plate	Pass/F ail	Percen tage %
1	CBB5 921	1 2 3	CBB59 21 CBB59 21 BB592 1	Pass Pass Fail	66.66
2	QL990 4	1 2 3	QL990 4 OL996 4 QL990 4	Pass Fail Pass	66.66
3	KS959 7	1 2 3	KS959 7 KS959 7 KS959 7	Pass Pass Pass	100
4	ND87 40	1 2 3	PND87 40 ND874 0 ND874 0	Fail Pass Pass	66.66
5	ND49 57	1 2 3	ND495 7 ND495 7 ND495 7	Pass Pass Pass	100
6	KN70 67	1 2 3	KN706 7 KN706 7 KN706 7	Pass Pass Pass	100
7	GK38 95	1 2 3	GK389 5 GK389 5 GK389 5	Pass Pass Pass	100
8	QZ181 5	1 2 3	OZ181 5 QZ181 5 QZ181 5	Pass Pass Pass	100
9	KL603 6	1 2 3	KL603 6 KL603 6 KL603 6	Pass Pass Pass	100
10	CAA2 350	1 2 3	CAA2 350 CAA2 350 CAA2 350	Pass Pass Pass	100

1	CAO	1	CAO	Pass	100			
1	5294	2	5294	Pass		3	KO1	
		3	CAO	Pass			556	Pass
			5294				KQ1	
			CAO				556	
			5294					
1	KW0	1	KW0	Pass	100			
2	678	2	678	Pass				
		3	KW0	Pass				
			678					
			KW0					
			678					
1	KQ1	1	KO1	Fail	33.33			
3	556	2	556	Fail				

Table 1: Test Result

The same vehicle number plate was captured three times and its number recognition accuracy was evaluated. In two out of three attempts, the app was able to detect the number. The quality of the captured picture, the lighting condition of the situation, the distance between the number plate and the mobile camera, and the quality of the mobile camera all influence this.

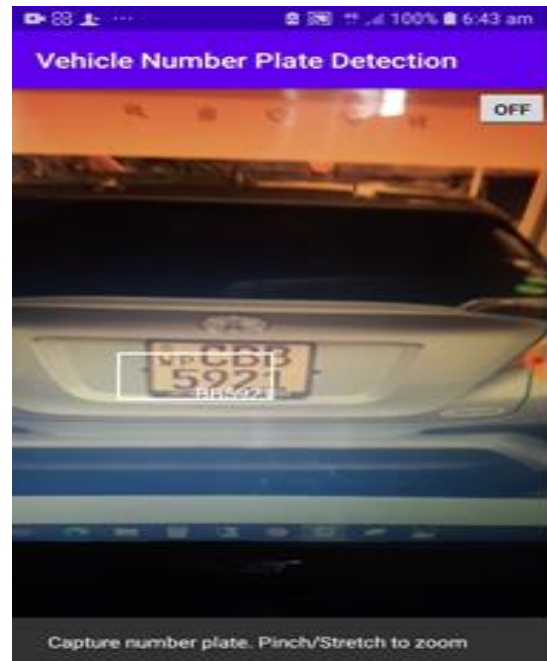


Figure 5 - BB5921-Fail



Figure 6 - CBB5921-Pass

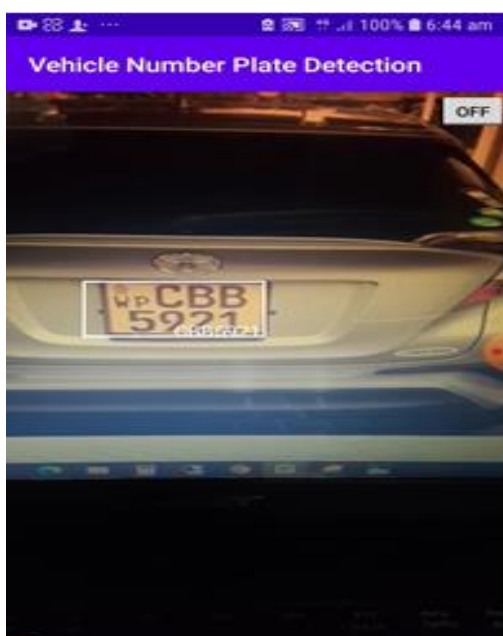


Figure 7 - CBB5921-Pass

Number plate recognition test was not 100% successful as there were some numbers and letters that Android OCR miss extracted and, the possible reasons for this inaccuracy should be due to image quality and the character format of the number plate as all the number plates are not in the same format. To do test, system used different sizes of number plate images. Sometimes letter Q was identified as O; also number 0 was identified as 6. And if a user face this problem he/she

might use the manual enter function or can try changing the aiming distance from the number plate. Also there is a flash light option in the application to use flash light to detect a number plate at low light.

B. Stability and functional test of application

The screenshots below demonstrate how the system works in relation to the characteristics discussed in section IV.

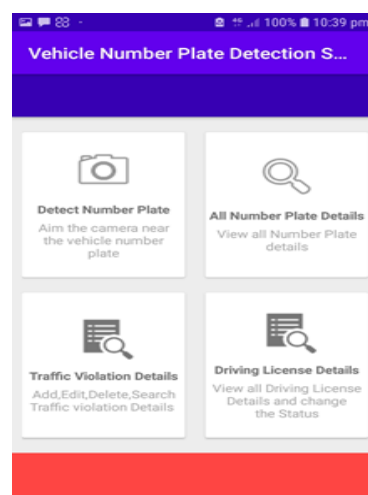


Figure 8: Main Menu page

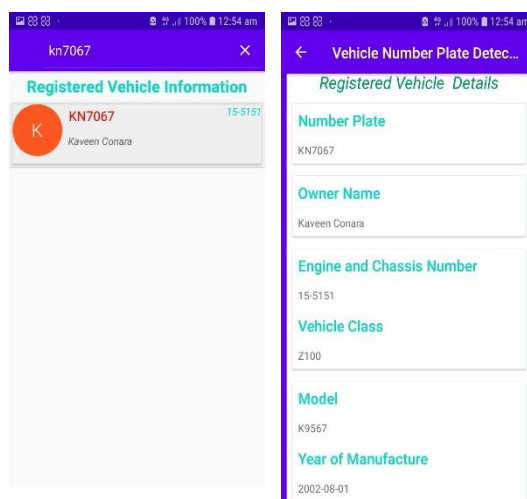


Figure 9: Search & view vehicle registration details

Figure 12: Driving license details & status

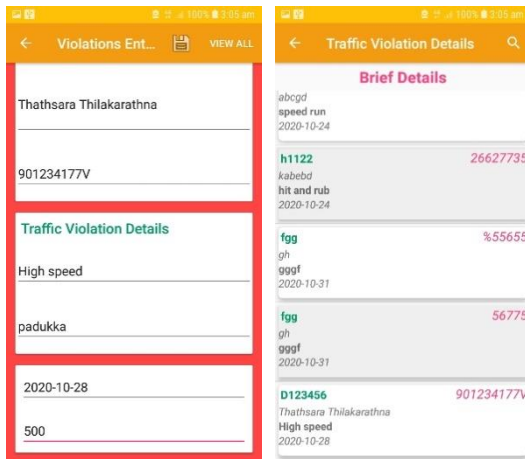


Figure 10: Entered violation details

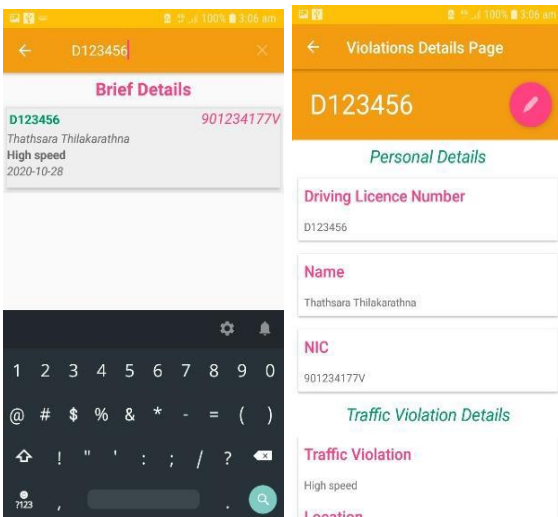
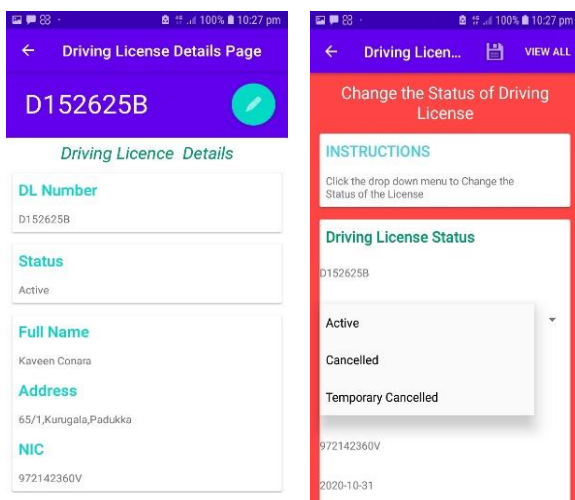


Figure 11: Search & view traffic violation details



II. FUTURE WORKS

Number plate detection is currently achievable in portrait mode, which is one of the system's limitations. In the future, the landscape mode may be introduced for a more compatible user interface. Also at this stage, this software detect only modern number plate formats such as "AA-1234, AAA-1234". It should be improved to identify older number plate formats such as "12-1234, 123-1234", "4 ഓടി - 4756". Furthermore number plate identification should be possible by video processing as well.

Conclusion

With the support of Android OCR and vision APIs, this proposed application detect the number plate and extract the appropriate character with an average degree of accuracy.

The observed characters were validated and the final output was fixed using regular expressions. Then this application search relevant vehicle number plate and retrieve registration details from the Google Firebase Real-time database. It can also keep computerized past traffic violation entry record and a driving license detail log. Those records may also be edited or deleted by the traffic officer. According to the traffic infringement, the officer may change status of the driver's license either to active or cancelled.

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