Advances in Parallel Computing Technologies and Applications
D.J. Hemanth et al. (Eds.)

doi:10.3233/APC210139

Intelligent Framework for Number Plate Detection and Recognition in Toll Using Image Processing Techniques

Ambika M [a,1], Asifa Refasi A [b], Atchaya Devi S [b], Dhivya B [b], Leelarani KP [b] and Raghuraman G [c]

[a] *Assistant Professor, Department of Computer Science and Engineering, K.Ramakrishnan College of Engineering, Tamil Nadu, India*
[b] *Undergraduate Student, Department of Computer Science and Engineering, K.Ramakrishnan College of Engineering, Tamil Nadu, India*
[c] *Associate Professor, Department of Computer Science and Engineering, SSN College of Engineering, Tami Nadu, India*

Abstract. The revolution in communication and embedded systems Electronic Toll Collection, the new era of intelligent transportation systems enables the automatic collection of Toll fees from the prepaid account through RFID. Yet there is lack of security in the existing system, number plate detection and recognition can be made. In the existing system detection is made with condition random field algorithm. Recognition method is implemented by optical character recognition. A system can be designed to extract the number plate from vehicle automatically using image processing technique, match with database automatically and generate the One Time Password(OTP) and bill without any delay and identify the theft vehicles. This is done by using Image processing and motion capturing technology

Keywords. Condition Random Field Technique, Image Processing Technique, Binarization, Artificial Intelligence.

1. Introduction

Vehicle registration is the process of registering vehicle with a government authority. The purpose of motor vehicle registration is to make a unique identity of the vehicle and to establish a link between a vehicle and an owner or user of the vehicle. For transportation certain amount of money should be paid to pass through the toll booth. To save money and energy minimum human interface is made in Toll plazas. With the revolution in communication and embedded systems Electronic Toll Collection(ETC), the new era of intelligent transportation systems(ITS)has been started. Electronic toll collection method has been implemented to collect money in toll automatically without human interference and to save time. FASTag system has been implemented recently to collect money in toll. This method is done by sensing the RFID of the individual using sensor, and money

[1] Ambika M, Department of CSE, K.Ramakrishnan College of Engineering, Tamil Nadu.
E-mail: mani.ambika@gmail.com

is taken from the respective person's bank account. In the existing system there occurs some disadvantages like double payments and it is also insecure .To overcome these disadvantages number plate detection and recognition method can be implemented by using image processing technology .The components in Digital Image processing is shown in Figure 1.

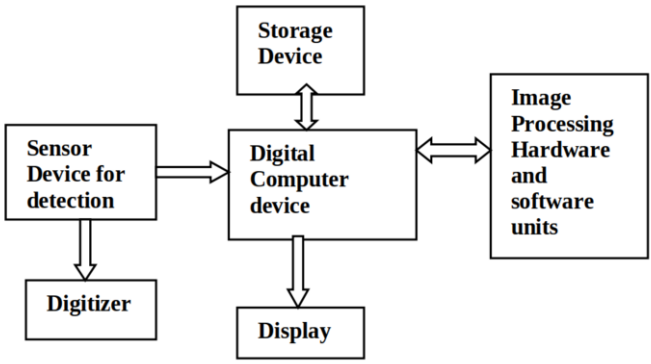

Figure 1. Components of Digital Image Processing

The transportation system has become an important aspect in the present situation and it act as a essential signs of the urban modernization level, but it also causes serious problems concerning transport system. Due to automation, minimum human interference is required and this provides the facility so that the time and energy can be saved and efficiency can be improved. The revolution of communication and embedded systems Electronic Toll Collection(ETC), the new era of intelligent transportation systems(ITS) has been started for the purpose of collecting money in Toll booths. Toll collections can be made electronically by various methods like ETC using laser technology, RFID, Barcode technology and GPS.

The number plate detection and recognition method involves the detection of number plate to generate toll bill automatically. The image of the number plate will be captured and it will undergo Binarization process to detect the foreground and background image of the number plate. Using the Condition Random Field algorithm obtained image will be detected. The detected text will be recognized and it will be converted to character using Optical Character Recognition. Once the detection and recognition process is completed the number plate details will be verified with the data stored in the database. Only when the data intersects with the detected and recognized number plate an One Time Password(OTP) will be sent to the respective vehicle owner's mobile number. Or otherwise an intimation message will be sent to the respective person's mobile number.

2. Literature Survey

License Plate Recognition process requires closest accuracy even when the image is captured from different angle, different distance. The authos of [1] proposed new advanced OCR engines extend the capability of accuracy into pre-processing for source images, sounds-like matching and for grammatical measurements for getting more accu-

racy. Machine Learning play a major role in various fields of application one could say it is making the life simpler [2, 3]. Sharma [4] implemented algorithm which detected Nepali number plates The author used the various morphological operation like dilation, erosion, sobel edge detection, fill image, opening and closing for plate area localization and segment the image by using segmentation algorithm and the obtained accuracy of normalized cross correlation was 67.98% and phase correlation was 63.46%. Ghangurde et al. [5] used CNN for detecting number plate. The system interface created by [5] is user-friendly and is easier to use and the system has the capability of detecting number plate for different conditions for all Indian number plates. Simalar method also employed by [6, 7] which uses CNN for licence plate localization which reduces background interference. Manual toll collection os one of the main issue which creates the traffic For combat this issue semi or fully automated system is needed. One of the solution is usage of RFID for quick processing [8–12]. This could greately reduce the burdern for travellers from traffic jam. Li et al. [13] presented a jointly trained network for simultaneous car license plate detection and recognition and by using this network, license plates can be detected and recognized all at once in a single forward pass, with both high accuracy and efficiency.

3. System Architecture

In the existing system, the number plate is detected using the Tag which is affixed on the vehicle. But when occurs some problem like double payment during the amount detection using the RFID. There occurs some error when the Tag get damaged during the process of detection. Apart from these limitations stolen vehicles cannot be identified easily in the present Toll plaza system. The system architecture represents the structural way of the execution of the process. The flow of execution of the process as mentioned in Figure 2.

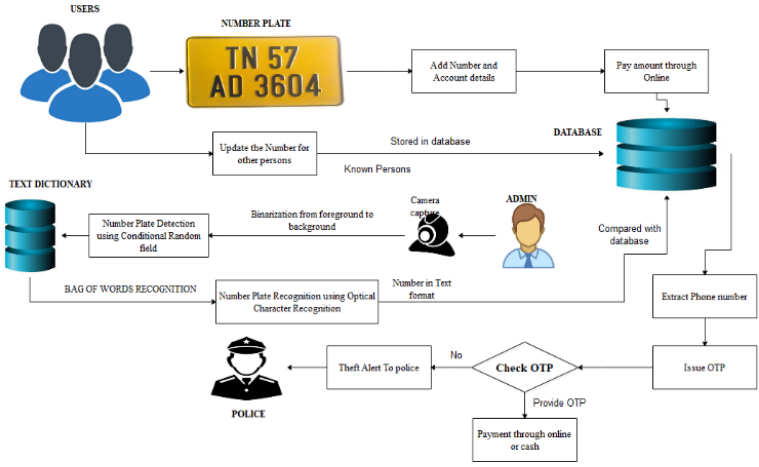

Figure 2. Architecture diagram

1. The user should register with for receiving unique ID and password. Where all the details are stored in a database.
2. Once when the registration is completed the user can access the web portal provided for them using the Unique ID and password.
3. The user can also make the payment through online mode and the user can also update their mobile number according to their preference.
4. When the vehicle enters the Toll the admin will capture the Image of the number plate. The captured will undergo Binarization process to detect the foreground and background of the number plate.
5. With the extracted text the number plate is detected using Condition Random Field and Recognized using Optical Character Recognition.
6. With the Recognized data the details of the number plate will be matched with the data base.
7. Only when the OTP matches amount will be taken from the persons account. Or otherwise an intimation message will be sent to respective person and nearby police station.

4. Proposed Methodology

Each vehicle will be provided with a license plate number which contains unique ID for identification purpose. This license plate is captured by an image. When the vehicle reaches the toll booth web camera capture the license plate with number. Number plate digits are detected using Conditional random field algorithm. Recognition is done using. Optical Character Recognition. Based on the recognized number, OTP verification is made to predict the theft vehicles and to send alert to the authorized person.

The ETC method has rapidly becoming the most innovative technology for the commuters who pass through the toll plaza. In this module, user will be provided with a unique user ID and password. User should register their details such as name, mobile number and other details of the user stored in a database. Admin is responsible to maintain all details in single database.

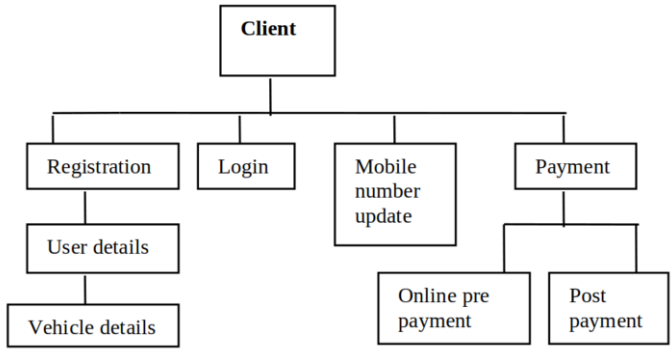

Figure 3. Framework for Toll collection System

The framework construction consist of the Home page where there will be options for the user and admin to login. Through this portal user can login using their unique

user credentials and admin can login using their unique credentials. In admin page there will be separate tab to access and store the details. The framework construction for Toll collection system is shown in Figure 3.

The acquired image is completely unprocessed. In this module, admin can capture the image of the number plate through web camera. Camera will capture the image, then the Binarization technique is used to detect the foreground pixels. The process involved in Image acquisition method is shown in Figure 4.

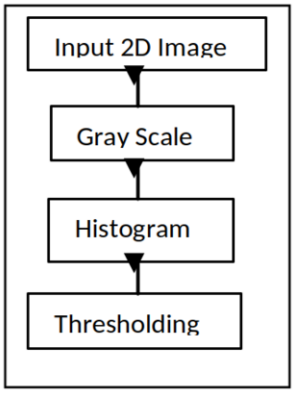

Figure 4. Method in Image Acquisition

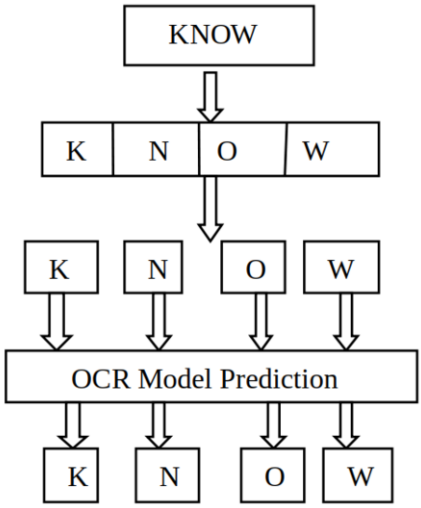

Figure 5. Text Recognition In OCR

Binarization is an important preprocessing step in several document image processing and Image classification tasks. Image Binarization is the process of separation of each pixel values into two collections, black as a foreground and white as a background. Thresholding technique is used for document image Binarization. The basic idea for fixed Binarization method is described as under. T shows global threshold value. Apart from that another method is also designed for Binarization in which the threshold is decided in accordance with the region. In Binarization method the image is divided into several regions or windows. Each region calculates and decides their own local threshold and then converts their region into two – tone region with the help of their local threshold. In Fixed Thresholding Binarization method fixed threshold value is used to assign 0's and 1's for all pixel positions in a given image. The Binarization process is represented as Eq. (1)

$$g(x,y) = \begin{cases} 1 & f(x,y) \geq T \\ 0 & otherwise \end{cases} \tag{1}$$

In Text Detection and Recognition module, implementation of number detection approach based on text strokes values which is defined in the form of minimum and maximum values in order to obtain the license plate only and remove other very small or very large identified objects which were outside the threshold range is done. The objects passed successfully through predefined threshold criterion will be forwarded to the train-

ing process. In this module, text strokes in number plate are detected using Conditional Random field. Detected texts are drawn as bounding box. The purpose of Optical Character Recognition algorithm is to recognize the text. Optical Character Recognition (OCR) is a piece of software that converts printed text and images into digitized text form such that it can be manipulated by machine.

Conditional Random Field algorithm is a discriminative undirected probabilistic graphical model that represents the relationship between different variables. The structure of a CRF model helps to estimate the unobserved ones given with the observed one. CRF learns the probability of occurrence of each character and assigns it to the word tree and thus the path with the highest probability is recognized as the correct sequence of characters forming the word.

Linear chain CRF can be described as follows, Let x be inputs vector, y is the label vector, and w is the weight vector, P(y/x) is defined as follows,

$$P_w(y|x) = \frac{1}{Z_w(y_i.x)} exp \sum_{i=1}^{n} w_i f_i(y_i, y_{i-1}, x) \tag{2}$$

Where:

$$Z_w(y_{i-1}.x) = \sum_{y \varepsilon Y} exp(\sum_{i=1}^{n} w^T f_i(y_i, y_{i-1}, x)) \tag{3}$$

From Eqs. (1) and (3), Conditional Random Fields is described as

$$P_w(y|x) = \frac{1}{Z_w(x)} exp \sum_{j=1}^{n} \sum_{i=1}^{m} w_i(y_{j-1}, y_{i,x,j}, x) \tag{4}$$

Optical character recognition(OCR) is the method of converting an images which is handwritten, printed or typed text. The text is encoded into the machine-encoded text, either from a scanned document, a photo of a document, a scene-photo or from subtitle text superimposed on an image. The recognition of Image in Optical Character Recognition is shown in Figure 4. Following are the characteristics of Optical Character Recognition, Differentiate word contours associated with image. Eg: OpenCV contours, Image cropping. Differentiate letter contours associated with word contour image. Eg: OpenCV contour dilation, Image cropping. Preprocess letter images according to trained OCR input. Eg: Keras Framework in Detection, PIL library in image. Consolidate predictions associated OCR model to text.

In membership access method user can book the travel previously to select source and destination of their travel. After that calculate the toll amount and pay on online. User can also updates their neighbor numbers for future verification. In this module, user can update booking details in the system. The booking details are such as booking id, booking name, source, destination, toll plaza details, vehicle types, amount, date and vehicle image details etc. These details are stored in the system. So the admin can easily view user booking details in the system. Users are also updated with day by day toll plaza information in the system.

After verify the owner details, send OTP to owner mobile number. Payment may be online or cash on delivery. If OTP is not submitted within seconds, then it is automatically

considered as theft vehicle. And automatically intimation message will be Sent to the owner of the vehicle and also to the nearby police station. An OTP is more secure than a static password, especially the password created by the user, which can be weak and/or reused across multiple accounts. OTPs may replace authentication login information or may be used in addition to it in order to add another layer of security. This system is used to take care of the security features which includes the generation of the OTP to the particular owner or with the person with which the vehicle is linked with.

When the OTP is not submitted within seconds it is indicated that the vehicle is a theft vehicle and the report is sent to the near by police station and to the owner's mobile which is linked to the database. Then the owner will be able to get back his/her vehicle with the appropriate proof related to that vehicle. Through this method the online payment is also possible with the correct submission of the OTP within seconds. As already mentioned the owner's bank account will be linked to the database and through which the payment is possible when crossing a toll booth.

5. Implementation and Discussion

Figure 6. Home Page

5.1. Framework construction

The framework construction is implemented using the Flask library function where it is used to build web applications. The From and Text field library functions are used to build the essential text boxes as per the requirements.

5.2. Image Detection and recognition

In this method the image is detected and converted into text using PIL library function which is used in different image processing functions. The process of image detection and recognition is shown in Figure 10. My sql is used as the back end in which all the personal data is stored. The new data will also get updated in the database and it is also accessible

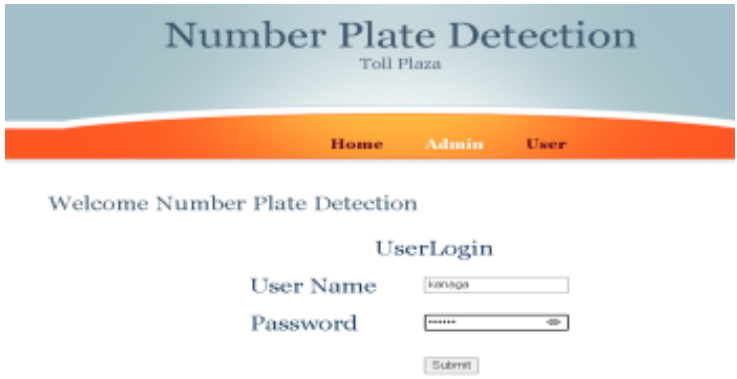

Figure 7. Admin login

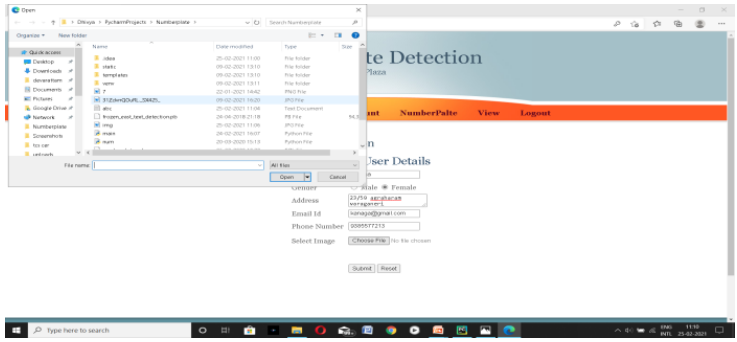

Figure 8. New User Registration

Figure 9. User Login

5.3. Membership access

In this module the user can select their start and destination place and they can also pay for it through online mode. The information regarding the amount for each toll and the number of toll passed will be accessible to the user.

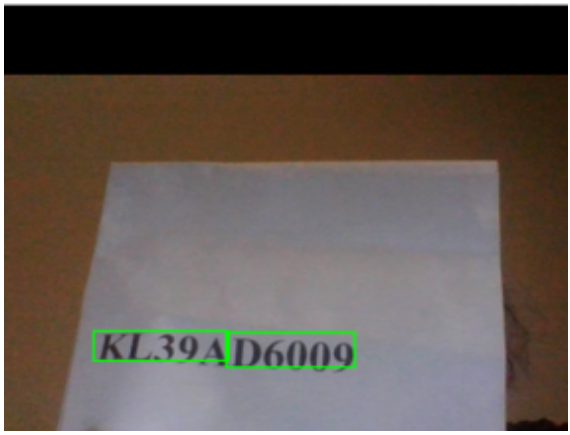

Figure 10. Image Detection and Recognition

Figure 11. User Details

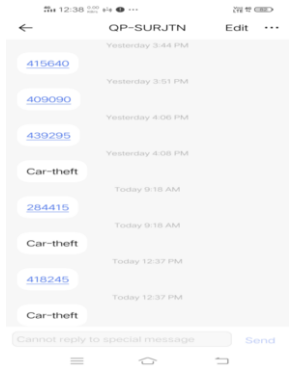

Figure 12. OTP Intimation message

5.4. Payment with alert system

Real time alert system is the important module where the money will be taken form a person's account only after verifying the OTP By comparing the stored data OTP will be sent to the respective persons mobile number using IoT framework. Using the Grisp environment OTP is generated and sent to the registered mobile number.

6. Conclusion and Future Enhancement

Toll Tax Management System is a web based application that can provide all the information related to toll plazas and the passenger checks in either online and pays the amount, then he/she will be provided by a receipt. It can be widely implemented on toll tax places .This system make saves time of driver and also of person on service for taking toll tax .This system automate the whole process of toll tax. The proposed system uses less cost to implement and require fewer changes to the current system. It provides the tracking system for theft vehicle which is secured and highly reliable. E-toll system can help

to achieve proper traffic management, appropriate toll collection and improves security. Thus a system used as an Automated Toll collection booth, based on image processing saves the time at toll booth, minimizes the fuel consumption during the ideal condition of the vehicle. Also it serves in providing the tracking system for theft vehicle which is secured and highly reliable can be obtained. In this project we can implement more features advance technique in future enhancement. It can be widely implemented on toll tax places. This system make saves time of driver and also person on service for taking toll tax. It provides security for both toll fees and vehicle. Parking system with alert can be implemented in future to avoid parking vehicles in NO PARKING areas. This system reduces unwanted traffic jams and will be more useful for Traffic police.

References

[1] Venkateswari P, Steffy EJ, Muthukumaran DN. License Plate cognizance by Ocular Character Perception'. International Research Journal of Engineering and Technology. 2018 Feb;5(2):536-42.

[2] Anand J, Sivachandar K. An edge vector and edge map based boundary detection in medical images. International Journal of Innovative Research in Computer and Communication Engineering. 2013 Jun;1(4):191-3.

[3] Wei A. Machine learning-based detection of mountain soil composition and environmental and ecological management of tourist areas. Arabian Journal of Geosciences. 2021 May;14(10):1-4.

[4] Sharma G. Performance analysis of vehicle number plate recognition system using template matching techniques. Journal of Information Technology & Software Engineering. 2018 Apr;8(2):1-9.

[5] Ghangurde C, Gokhale A, Joshi R, Bhandarkar M. Automatic number plate recognition for different fonts and non-roman script. International Journal of Advance Scientific Resarch and Engineering Trends. 2019;4(14):21-25.

[6] Li X. Real-time License plate number detection based on image contour. InJournal of Physics: Conference Series 2020 Oct 1 (Vol. 1650, No. 3, p. 032073). IOP Publishing.

[7] He Z, Xiao Z, Yan Z. License Plate Location and Recognition on Neural Network. InJournal of Physics: Conference Series 2020 Sep 1 (Vol. 1642, No. 1, p. 012012). IOP Publishing.

[8] Satyasrikanth P, Penna M, Bolla DR. Automatic toll collection system using RFID. IJCSMC. 2016 Aug;5(8):247-25.

[9] Bhavke A, Pai S. Advance automatic toll collection & vehicle detection during collision using RFID. In 2017 International Conference on Nascent Technologies in Engineering (ICNTE) 2017 Jan 27 (pp. 1-5). IEEE.

[10] Balamurugan K, Elangovan S, Mahalakshmi R, Pavithra R. Automatic check-post and fast track toll system using RFID and GSM module with security system. In2017 International Conference on Advances in Electrical Technology for Green Energy (ICAETGT) 2017 Sep 23 (pp. 83-87). IEEE.

[11] Syafei WA, Listyono AF. Hardware design of queuing free environmental friendly automatic toll gate using RFID. In2017 4th International Conference on Information Technology, Computer, and Electrical Engineering (ICITACEE) 2017 Oct 18 (pp. 142-146). IEEE.

[12] Yu HY, Chen JJ, Hsiang TR. Design and implementation of a real-time object location system based on passive RFID tags. IEEE Sensors Journal. 2015 Sep;15(9):5015-23.

[13] Li H, Wang P, Shen C. Towards end-to-end car license plates detection and recognition with deep neural networks. IEEE Transactions on Intelligent Transportation Systems. 2017 Sep:1-9.