Pollution Check Control Using License Plate Extraction via Image Processing

Shivani Garg and Nidhi Mishra

Abstract The main objective of this paper is pollution check control using license plate detection. In this paper, we extract the information about the vehicle owner by using registration number. So initially, we extract the registration number from the license plate after that compare the registration number to the local database. If registration number is stored in the database, then we retrieve the detail of the vehicle owner. The first key step of this work is to extract the registration number from the license plate for the retrieval of information about the vehicle owner. The extraction of license plate is divided into four parts: first one is preprocessing of image, second is localization of license plate, next step is segmentation of the characters in the license plate, and final step is recognition of characters from the segmented license plate. Apart from that we have also extended our research work to pollution fine implementation and vehicle entry restriction for particular area, vehicle which are more than 10 years old.

Keywords Number plate recognition · License plate · Pollution fine control

1 Introduction

License plate detection plays a major role in the world because vehicles are increasing day-by-day and pollution is also increasing due to increase of vehicle number. In this paper, we introduce the pollution fine control; in this, we impose fine on the vehicle owner whose pollution check date is expired. In commercial cities, the commercial places or near the buildings, parking areas are built, but the problem with those areas is that it does not have enough space. So to manage space

S. Garg (✉) · N. Mishra
Department of Computer Science & Engineering,
Poornima University, Jaipur, India
e-mail: garg.shivani14@gmail.com

N. Mishra
e-mail: nidhi.mishra@poorinma.edu.in

of these parking lots, proper management and proper use of parking space are necessary, as this will improve the efficiency and reduces management cost. A single person in the parking areas is not enough to manage all kind of activities such as charging persons to place vehicle, how to control vehicle's in and out space. This has made necessary to use the system of automatic plate recognition which in turn provide benefit like reduces management cost required to control and manage parking areas. Also to reduce road accidents and stolen vehicles cases, the number plate recognition system is highly effective which can not only help police (by reducing their man power), but also can track vehicles whenever needed.

The images of various vehicles have been acquired, and thereafter submitted to the MATLAB software where they are first resize the image and then convert it into gray scale images. Then, we use median filter to remove the noise in the image. Brightness, contrast, and intensity adjustments are made to optimum values to enhance the number plate and its digits. The output is saved in a notepad. Objective of proposed work is to create the modules for traffic regulation using a system of number plate detection. The input of the module is a part of the captured image, and output is a number which is a editable form of license plate. Basically, the proposed system recognizes all kinds of number plates of different varieties.

The rest of the paper is organized as the follows: Sect. 2 presents the background and related research of the proposed work. Section 3 describes the architectural design of proposed work. Section 4 elaborates the methodologies of proposed system. Section 5 highlights the experimental set up and results, and finally, Sect. 6 concludes the proposed work.

2 Backgrounds and Related Work

Previously, different work had already been carried out in the area of license plate recognition. There are five divisions in this system, which are input image, pre-processing of image, localization of the license plate in vehicle image, character segmentation from the license plate, and character recognition from the segmented license plate. The work of first two divisions should be done in an accurate way so that license plate can be easily searched and localized. Thus detection will greatly affect the efficiency and the speed of the whole license plate recognition system.

In the earlier works, the edge detection techniques was found to be an important technique that works by changing brightness of the plates, but this technique could not be used for images. But they can be applied to complex images due to their sensitivity to the unwanted edges.

Seyed Hamidreza Mohades Kasaei et al. (2011) have presented a real-time and robust technique of license plate detection and recognition; it uses the morphology and template matching. The performance of corrected plate's identification and localization was 98.2%, and correctly recognized characters were 92% [1].

Abdul Mutholib et al. (2013) have presented the optimization of ANPR algorithm on limited hardware of Android mobile phone. Proposed algorithm was based

on Tesseract library. The template matching-based OCR will be compared to artificial neural network (ANN)-based OCR. Results on 30 images showed that the recognition rate of license plate was 97.46%, and the processing time in recognition of license plate was 1.13 [2].

Farajian et al. [3] studied different techniques and compared them. Author finds out that every technique has own limitations, and some method gives better results under some conditions. This paper will lead to select the best technique for detection just according to circumstance. After this survey, author concludes that there was no ideal technique which is suitable for all circumstances [3].

Anagnostopoulos et al. (2008) have applied a method to locate the license plates, which consist of three stages: initially, used the Sobel operator that will fetch the vertical edges of the image of vehicle. After that applied the integral image and HSV color space [4].

Pratik Madhukar Manwatkar et al. (2014) In this paper, author has reviewed and analyzed different methods to find out the text characters from the images. Author has discussed some application of text recognition system [5].

3 Architectural Design of Proposed Work

Figure 1 presents the architectural design of our proposed system of traffic regulation using number plate detection. In this work, we have performed data preprocessing as the first step of number plate detection.

The overall description of the design specification as shown in Fig. 1 is explained below.

3.1 Input Image

The initial step of license plate extraction system is to select an input vehicle image. This image contains license plate of vehicle. After the selection of the image, preprocessing of the image is performed.

3.2 Preprocessing of Image

This is the second step of license plate recognition system. Preprocessing is very essential for the good quality performance of character segmentation.

Preprocessing steps are:

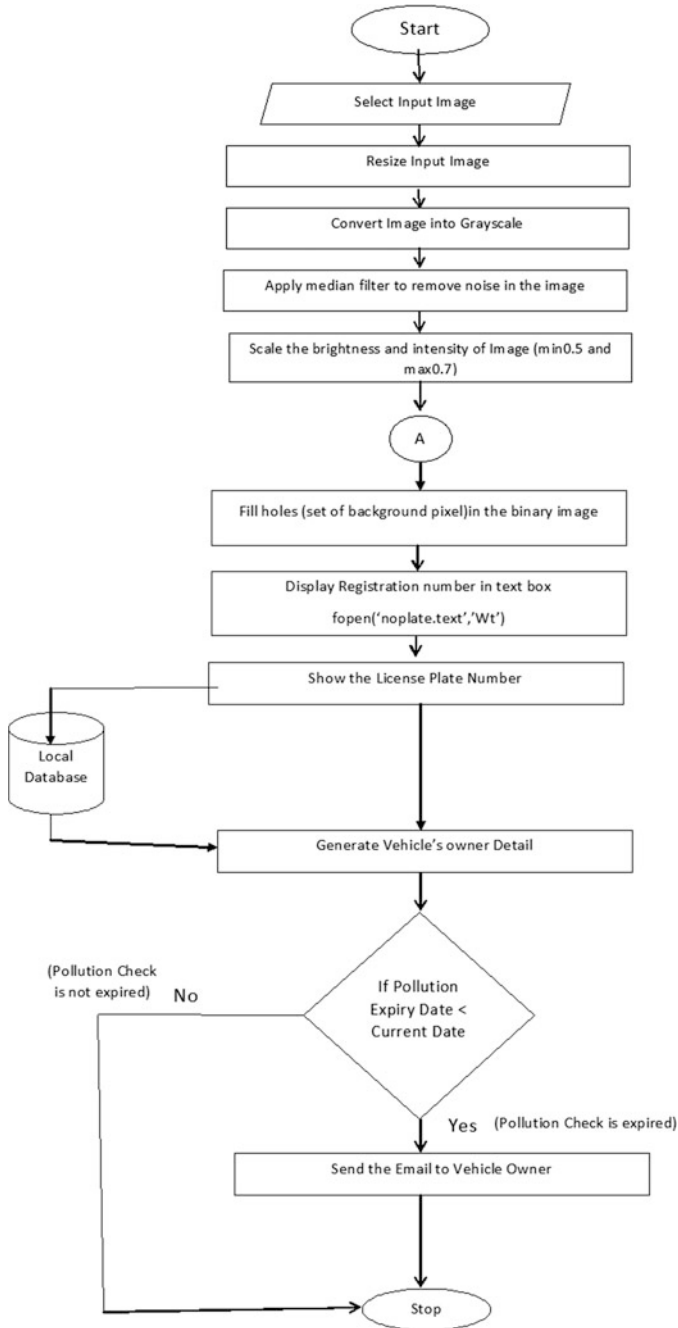1. Resizing image
2. Rgb-to-gray conversion

Fig. 1 Process flow diagram

3. Noise removal (median filter)

Preprocessing of an image means "preparation" of the sample/image to introduce it to an algorithm for specified task such as recognition of image, feature extraction.

3.3   Brightness and Intensity of Image

After preprocessing of the image, we adjust the brightness and intensity of the image. To scale the intensity in MATLAB, we use imadjust() function. Intensity of the image is the average of the intensities of all pixels in image. Brightness can be increased or decreased by simple addition or subtraction to the image matrix.

3.4   Fill Holes in the Binary Image

A general use of the flood-fill process is to fill "holes" in image. Holes fill in the binary image are performed because of representation of foreground objects in the image. In our system, we use imfill() function to fill the holes in the binary image.

3.5   Display Registration Number in the Text Box

After filling the holes in the image, we obtain a number from the image. This number is displayed in the text box. This is the registration number of the vehicle.

3.6   Local Database

We create a local database which contains the information of vehicle owner. When registration number is obtain, then our system compared this registration number to the database. When match is found in the database, then all the details of the vehicle owner are obtained.

3.7   Pollution Fine

This system mainly works on the pollution fine control. In this, if pollution check date is expired, then fine is imposed on the vehicle's owner. This fine is impose by sending the mail to the owner of the vehicle, and when pollution check is not expired, then no mail is sent to the vehicle owner and no fine is imposed on the owner.

4   Methodologies

The main goal of this system is to focus on the localization and recognition of the numbers present in license plate of a vehicle. We locate the license plate part of the vehicle from every images first and then register them to a reference image by template matching in same precision. We use a simple templates matching to recognize the letters in the estimated trained images. Before the processing of two proposed phase for the solution, input images need to preprocess of accurate output. The following sections describe the process of these methods step-by-step. This paper, based on the image processing methods, gives the image pretreatment, for the position of license plate on the whole image of vehicle.

To make the vehicle license plate recognition, multiple small phases must implement such as image acquisition, preprocessing of image, localization of license plate, segmentation of alphanumeric code, recognition of license plate code.

4.1   Image Preprocessing

Image preprocessing considerably increase the consistency of an optical examination for the specific feature detection. In the license plate, we generally use resizing of image and then convert into gray scale image. To resize the image, we are using imresize(); in this, width of the image is 400 and height of the image is adjusted accordingly to maintain the aspect ratio. After that we use rgb2gray() to convert the resized image into gray scale image.

4.2   License Plate Localization

In license plate localization, first we must have to find the location of the number plate in whole vehicle image for identification of registration number. To execute the system from input image to the output characters as in editable form, localization process takes important role. For the localization, basically, we use median filter to filter out the noise in the image; in this, noise type is pepper and salt. Dilation is performed after the noise removal from the image; then, we locate the license plate in the input image.

4.3   Segmentation of Alphanumeric Code

Segmentation of alphanumeric code is a key step in license plate extraction system. Many difficulties are in this step, which are noise presence in the plate area,

alphanumeric codes are not properly aligned. If the alphanumeric codes in license plate are in ideal condition, that is, codes are sufficiently separated, code segmentation may be accomplished directly from vertical and horizontal segmentation. In this, it detects the horizontal lines in the image with a pixel value zero. After that, the image is converted into gray scale image, and then, we simply use 'for' loop to detect the portion of the image that had connected objects with pixel value of zero.

4.4 Recognition of Alphanumeric Code

Recognition of alphanumeric code is a process for the automatic conversion of alphanumeric code into editable text. After segmentation, alphanumeric codes of the license plate system need to carry on recognition for all isolated alphanumeric code. The template matching technique is an appropriate technique for the recognition of particular alphanumeric code. This technique is used in binary images, properly built templates, and it also obtained fine results for gray scale images. In this character recognition, we adjust the brightness and intensity of the image. After that, we fill the holes present in the binary image, and in the end, we use template matching technique to recognize the characters from the image. Finally, the output is displayed in the text box that is registration number of the vehicle.

4.5 Pollution Fine Controller and Driver Information Fetcher

After the character recognition, we checked the owner name, city, address, registration number of vehicle, and contact number. After recognition of the vehicle registration number, we compare the registration number to the local database. If the match is found, then we get the detail of the vehicle owner. Then, we compare the registration number to pollution control table, then we get the expiry date of the pollution check of vehicle owner. If current date is in the valid range, then all are OK, otherwise the fine is to be calculated and the fine can be send on manual basis or automatically on e-mail, and the details will be send by fetching the details required from the local database record using the registration number. Structure of the database of the local database will look like (Fig. 2).

Structure of the database of the **pollution control** will look like (Fig. 3).

Vehicle plate number	Name	City	E-mail Id	Date of registration
RJ14CJ5252	Krishan Pal	Jaipur	garg.shivani41@gmail.com	12/16/2013

Fig. 2 Structure of the database of the local database

Fig. 3 Structure of the database of the pollution control

Registration number	Date of pollution check	Expiry date
RJ14CJ5252	6/18/2015	12/18/2015

The main objective of this work is to present more proficient way of pollution control testing for vehicle by using alphanumeric code segmentation and recognition. In proposed system, we manually created the database of vehicle license plate image. The license plate image is converted into text image by using alphanumeric code recognition.

5 Experiment Results

The proposed system was evaluated by taking vehicle input image manually, and the result obtained is shown in the following steps

- Input image
- Resize the input image
- Convert image into gray scale image
- Apply median filter to remove the 'pepper and salt' noise
- Scale brightness and intensity of the image
- Fill holes in the binary image
- Display the license plate number
- Compare with database
- Display the Vehicle owner detail
- If pollution check is expired, then mail is send to vehicle owner (Figs. 4, 5, 6, 7, 8, 9 and 10).
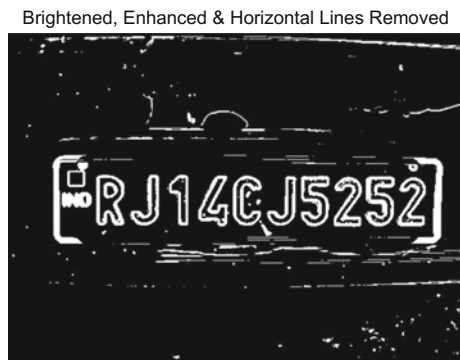
Fig. 4 Input image

Input Image

Fig. 5 Resize input image

Resized Input Image

Fig. 6 Gray scale conversion

Grayscale Converted

Fig. 7 Scale brightness and intensity

Brightened, Enhanced & Horizontal Lines Removed

The experiments have been performed to test the performance of proposed system and to measure the processing time and recognition rate. Totally, 22 images were taken under various time, conditions, and angle as shown in Tables 1 and 2.
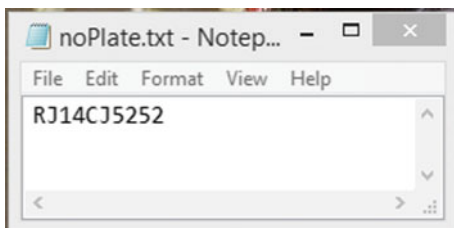
Fig. 8 Fill holes in binary image

Holes Filled

Fig. 9 Final image

Final Image With Objects of High Pixel Area

Fig. 10 Registration number

After the character recognition, registration number of the license plate is recognized; then, we compare the registration number to the manually created local database of vehicle owner detail. If vehicle registration number is found in the local database, then detail of the vehicle owner is displayed as shown in Fig. 11.

The registration number will be matched with the local database record of pollution check control. If the previous registration number is found in with the pollution control database, we get the expiry date and the date of pollution check shown in Fig. 12.

Table 1 Results of license plate detection

S. No.	Number plate	Recognized output	Processing time (s)	Recognition rate (%)
1	RJ14CJ5252	RJ14CJ5252	7.17	100
2	AFR420	AFR4Z0	3.90	83.33
3	AKH343	AKH343	4.11	100
4	AED632	AEQ632	3.99	83.33
5	AWR310	AWR310	3.25	100
6	AXZ016	AXZ016	4.10	100
7	RJ14CH7058	RJ14CH7058	6.89	100
8	RJ07CA6393	RJ07CA6393	8.01	100
9	RJ14CJ0724	QJ14CJ0724	8.45	90
10	RJ142C2901	RJ142C2009	6.81	80
11	RJ14CU5794	RJ14CU5794	6.96	100
12	RJ14CK8175	RJ14CK8175	6.76	100
13	RJ26CA2638	RJZ6CAZ638	7.64	80
14	MH12DE1433	RH1ZDE1433	6.10	80
15	RJ14CU5794	RJ14CU5794	7.05	100
16	RJ07CA6393	RJ07CA6393	8.59	100
17	RJ14TD5156	RJ14TD5956	8.42	90
18	RJ14LC7419	RJ14LC7489	8.54	90
19	RJ26CA2638	RJZ6CAZ638	8.26	80
20	RJ27CD4244	RJZ7CD4244	8.37	90
21	RJ26TA1260	RJZ6TA1260	8.22	90
22	RJ26CA3767	RJ26CA3767	6.80	100

Table 2 Performance of proposed license plate detection

	Total accuracy	In percentage (%)	Recognition rate (in %)
License plate detection	(11/22) * 100	50	92.57

Fig. 11 Display vehicle owner detail

Personal Details:
Name: Krishan Pal
Email-id – garg.shivani41@gmail.com
Address- Jaipur
Polution fine on car RJ14CJ5252 of Rs 1000
Confirm email id: garg.shivani41@gmail.com
Vehicle wit License Plate Number RJ14CJ5252 is allowed to enter

Fig. 12 Pollution check
control database

Fig. 13 E-mail sent to the
vehicle owner regarding
expiry date of pollution check

helpdesk@ranthamboretigervilla.com
to me
Vechicle Details for number AKH343
 Personal Details:
Email-id – garg.shivani41@gmail.com
Name: Rashmi Rathi
Address- Jaipur
Polution valid upto 2016-10-31

Fig. 14 E-mail sent to the
vehicle owner regarding fine

helpdesk@ranthamboretigervilla.com
to me
Vechicle Details for number RJ14CJ5252
 Personal Details:
Email-id – garg.shivani41@gmail.com
Name: Krishan Pal
Address- Jaipur
Fine imposed of Rs 1000

Case 1: If pollution check expiry date is valid, then an e-mail is sent to vehicle owner, which contains the information of pollution check expiry date as shown in Fig. 13.

Case 2: If pollution check date is not valid, then e-mail is sent to the vehicle owner regarding fine imposed,. as shown in Fig. 14.

6   Conclusion

The main aim of this work is to improve security of registered number plate in India. The proposed approach finds pollution check control of vehicle and extracts the driver information using license plate detection method. In proposed work, if pollution check date is expired, then mail is sent to the vehicle owner regarding fine imposed, and if pollution check date is not expired, then mail is sent to the vehicle owner regarding pollution check expiry date. We can also restrict the vehicles

which are 10-year old or more than 10-year old in our work. The experimental results show that this approach can achieve outstanding and robust detection performance in pollution fine controller and vehicle restriction area. For the experimentation, totally 22 images of license plate were tested. The overall system performance of the system is measured on the basis of accuracy and recognition rate; recognition rate is 92.57% and accuracy is 50%. The limitation of the proposed system is that it fails to recognize some characters, which are '1', '2', and 'R'. Future work has also been discussed to recognize the double line license plate and multiline license plate. We will also increase the template matching database.

References

1. Liu, C. C., Luo, Z.: Extraction of vehicle license plate number using license plate calibration. In: IET International Conference on Frontier Computing. Theory, Technologies and Applications, Taichung, 2010, pp. 187–192 (2010)
2. Mesleh, A., Sharadqh, A., Al-Azzeh, J.: An optical character recognition. Contemp. Eng. Sci. **5**(11), 521–529 (2012)
3. Farajian, N., Rahimi, M.: Algorithms for license plate detection: a survey. In: First International Congress on Technology, Communication and Knowledge (ICTCK 2014) 26–27 November 2014
4. Babu, C.N.K., Subramanian, T.S., Kumar, P.: A feature based approach for license plate-recognition of Indian number plates. In: IEEE International Conference on Computational Intelligence and Computing Research (ICCIC), Coimbatore, pp. 1–4 (2010)
5. Madhukar, P., Singh, K.R.: Text recognition from images. Int. J. Adv. Res. Comput. Sci. Softw. Eng. **4**(11) (2015)
6. Rabee, A., Barhumi, I.: License plate detection and recognition in complex scenes using mathematical morphology and support vector machines. In: International Conference on Systems, Signals and Image Processing, Dubrovnik, Croatia, 12–15 May 2014
7. Chen, B., Cao, W., Zhang, H.: An efficient algorithm on vehicle license plate location. In: Proceedings of the IEEE International Conference on Automation and Logistics Qingdao, China September 2008
8. Aytekin, B., Altuğ, E.: Increasing driving safety with a multiple vehicle detection and tracking system using ongoing vehicle shadow information. In: IEEE International Conference on Systems Man and Cybernetics (SMC), Istanbul, pp. 3650–3656 (2010)
9. Wazalwar, D., Oruklu, E., Saniie, J.: Design flow for robust license plate localization. In: IEEE International Conference on Electro/Information Technology (EIT), Mankato, MN, pp. 1–5 (2011)
10. Sulaiman, N., Jalani, M., Mustafa, M.: Development of automatic vehicle plate detection system. In: IEEE 3rd International Conference on System Engineering and Technology, 19–20 Aug 2013
11. Bhatia, N.: Optical character recognition techniques: a review. **4**(5) May (2014)
12. Aghdasi, F., Ndungo, H.: Automatic licence plate recognition system. In: 7th AFRICON Conference in Africa, Gaborone, vol. 1, pp. 45–50 (2004)
13. Vamvakas, G., Gatos, B., Stamatopoulos, N., Perantonis, S.J.: A complete optical character recognition methodology for historical documents, DAS′08. In: The Eighth IAPR International Workshop on Document Analysis Systems, Nara, pp. 525–532 (2008)
14. Haneda, K., Hanaizumi, H.: A flexible method for recognizing four-digit numbers on a license-plate in a video scene. In: IEEE International Conference on Industrial Technology (ICIT), Athens, pp. 112–116 (2012)

15. Zheng, L., Samali, L., Yang, L.T.: Accuracy enhancement for license plate recognition. In: 10th International Conference on Computer and Information Technology (CIT), Bradford, pp. 511–516 (2010)
16. Kulkarni, P., Khatri, A., Banga, P., Shah, K.: A feature based approach for localization of Indian number plates. In: IEEE International Conference on Electro/Information Technology, Windsor, ON, pp. 157–162 (2009)