Smart Transport System using Automatic Number Plate Recognition

Vinay B K, Sunil Kumar K H, Malini M D

Abstract*: In this paper, a *Smart Transport System using Automatic Number Plate Recognition (ANPR) of a vehicle is proposed. License plate number of a vehicle is recognized to check the details of the vehicle like the make, type of the vehicle, checking for traffic rule violations and to collect the toll in hospitals, highways, tech parks, paid parking slots of shopping malls, and supermarkets in real time. This paper proposes a system implementation consisting of modules to capture the video of the vehicle, segmentation of video into frames, optical character recognition (OCR) to recognize the characters present on the number plate using Canny edge detection. After capturing the image, it is processed and the extracted characters are compared with the results in the database. A sample RTO database with all the required information about the vehicle would be created for the purpose of comparison. The obtained result after the validation of the vehicle number plate with different parameters has to be displayed from the master PC onto the monitor which lets the defaulter know of his/her violations. This is done using IOT. Once the violations have been displayed, the corresponding amount would then be deducted from the defaulter's bank account.

Keywords* : *Automatic Number Plate Recognition (ANPR), Canny Edge Detection, Optical character Recognition.

I. INTRODUCTION

The growing population in India has made the ownership of vehicle a necessity, resulting in problems such as monitoring theft, law enforcement, accessing parking facilities and automated tolls. The proposed Smart Transport System plays a major role in addressing the above problems.

The System works in 3 steps, firstly it detects and captures the vehicle image, second it locates the position of the number plate, and later individual characters are recognized using optical character recognition. The recognized characters are extracted using image segmentation technique. Each extracted character is compared with the alphanumeric character present in the database. The proposed design consists of two parts, first the most important portion the software model and second is the hardware model. The software model is implemented in MATLAB and it uses several image processing techniques. The hardware model consists of PC for executing the algorithm, camera to capture the image and devices to detect the presence of a vehicle.

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II. LITERATURE SURVEY

According to Indian Central Motor Vehicle Act, it is observed that vehicles following strict number plate standards are remarkably less in number [1]. Image acquisition, Plate localization, Character Segmentation and Character recognition techniques are used in ANPR systems [2] [3]. Several systems use neural network based OCR algorithms to locate the number plates [4] [5]. Few of them are implemented using 'Feature-based number plate localization' and characters are recognized by 'Image Scissoring [6]. Many Edge Detection Algorithms are available which can be used for extracting the characters. But Canny Edge Algorithm is widely used because of its adaptive parameters [7]. When Mean squared Error value and Peak Signal to Noise Ratio of various edge detection algorithms were compared, it was proved that Canny algorithm was best compared to other methods [8]. Misclassification Ratio (MR) is used to differentiate between various edge detection operators and it was proved that Canny edge operator gives the best result [9]. The captured image of vehicle license plate undergoes operations like erosion and dilation to obtain a smooth contour [10]. The disturbance in the captured image can be eliminated by using Gaussian Filter [11]. The edges of the captured image can be detected using gradient directions [12]. Based on gradient histograms threshold values can be set [13]. The distribution of gradients in each block and thresholds for the detected edges is found [14]. The contours of the vehicle can be found using Canny Algorithm [15]. Each character on the number plate can be extracted by considering two consecutives point in an image and finding out the difference in their intensity values. The intensity level of a point in the background is different from that of a character [16].

III. PROPOSED SYSTEM

The proposed system initially detects the vehicle. The license plate of the vehicle is located and the characters on it are extracted. The output of image processing is then cross-verified with the records on the database as shown in Fig. 1. The performance of the implemented system is analyzed in real time. It is observed that the proposed system successfully locates and recognizes the characters on the license plate. The complete working of the proposed algorithm is described as flow chart as shown in Fig. 3.

The proposed system consists of different image processing techniques at different level. First video capturing is done. Then video is processed using video segmentation to get frames.

Then color image is converted to gray scale image. Finally Canny edge detection algorithm is applied to recognize the characters present on the number plate. Recognized number is compared against the database to check the details of the vehicle.

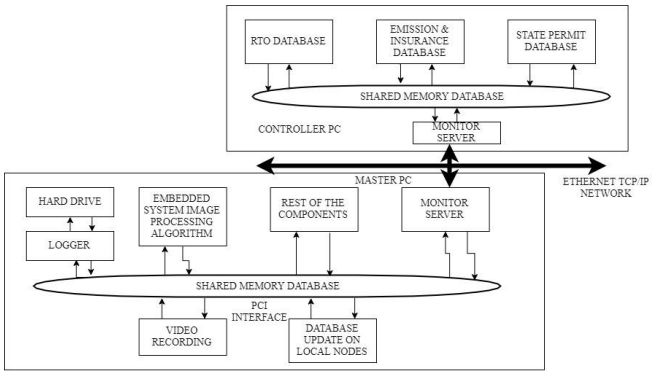


Fig. 1.Block Diagram of Proposed System

A. Segmentation

The captured video is split into number of frames and they are stored in the desired destination as jpg file. Since the time duration of the captured videos vary "n" frames are considered as a set. Each character in the video is extracted considering few attributes of the text in the video. Some attributes of text are:

- The intensity levels of text and the background vary. The intensity value of the background is high.
- Even if the image is affected by Noise. We will be able to recognize the character easily.

Characters are extracted by differentiating the intensity levels between two consecutive pixels. The intensity difference between successive pixels is found and the root mean squared deviation of it is computed. The difference of the root mean squared deviation is set to a threshold value of less than 1. If the standard deviation is less than the threshold value then it is considered as a frame.

B. Optical Character Recognition

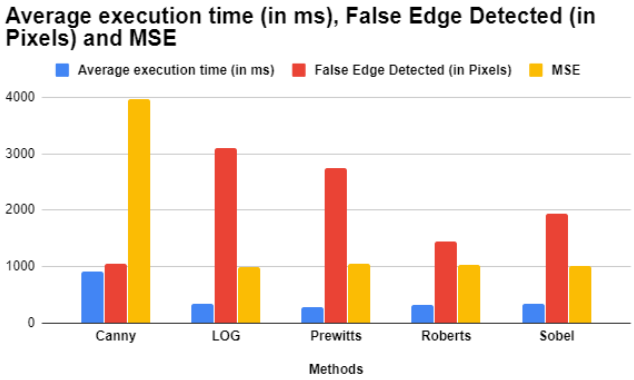
OCR is the technique that identifies printed or handwritten characters. Firstly the colored images are converted to gray for easier processing. Noise in the image is removed by performing operations like erosion and dilation. The license plate is localized and it is divided into blocks for character recognition. Character Recognition is done through Canny Edge Detector which is developed by John F Canny. It is widely used over other methods because of its adjustable parameters, which alters its effectiveness and computation time. Effectiveness of the algorithm can be determined based on the number of false edges detected, Mean Squared Error value(MSR), Average Execution time and Peak Signal to Noise ratio(PSNR) as shown in Fig. 2. If the number of false edges detected is less, we can say that the algorithm is more efficient. If the output of an edge detection algorithm has low PSNR values and high MSE values, then it can be said that it has high edge detection capability.

Gaussian Filter

All the Image Processing techniques are easily affected by noise. In presence of noise false edges are detected. The equation for a (2k+1)*(2k+1) size Gaussian filter is given by:

$$H_{ij} = \frac{1}{2\pi\sigma^2} exp\left(-\frac{(i-(k+1))^2 + (j-(k+1))^2}{2\sigma^2}\right) \quad (1)$$

$$where\ 1 \le i, \quad j \le (2k+1)$$



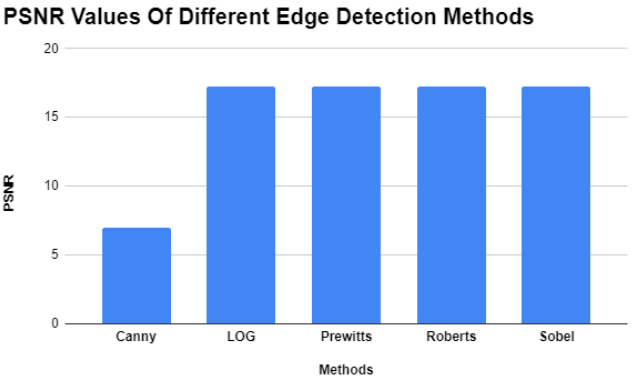


Fig. 2.Comparison of Different Edge detection Algorithms

Finding the Intensity Gradient of the Image

The edges of an image may point in various directions. Canny edge operator can detect the edges in four directions by using four filters, one for each direction. The direction of the edges and the gradient can be determined by finding the 1st derivative of edges in parallel and perpendicular directions. The 1st derivative of edges in parallel direction is given by (G_x) and (G_y) in perpendicular direction and it is given by:

$$G = \sqrt{G_x^2 + G_y^2} \quad (2)$$

$$\theta = atan2\ (G_y, G_x) \quad (3)$$

Where, atan2 is a two argument arctangent function and G is computed using the hypothetic function. There are 4 edge detection angles, parallel (0°), perpendicular (90°,) and two diagonal angles (45° and 135°).

Non-Maximum Suppression

The largest edge in an image is found out by Non-maximum suppression. Even after the calculation of directional change in intensity of the image, the extracted edge will be quite blur. The gradient values can be suppressed by using non maximum suppression, and it is done by fixing them to zero except the brightest pixels. Sharpest change in the intensity value can be found using Non Maximum Suppression. The algorithm used for each pixel in the image is:

- Comparing the intensity of the current edge with the intensity of edges in the positive and negative gradient directions.
- If intensity of the selected edge in the mask is smaller than the current pixel in the same direction, then its intensity value will be saved. A pixel pointing in the x direction is compared with the pixel beside it in left and right direction.

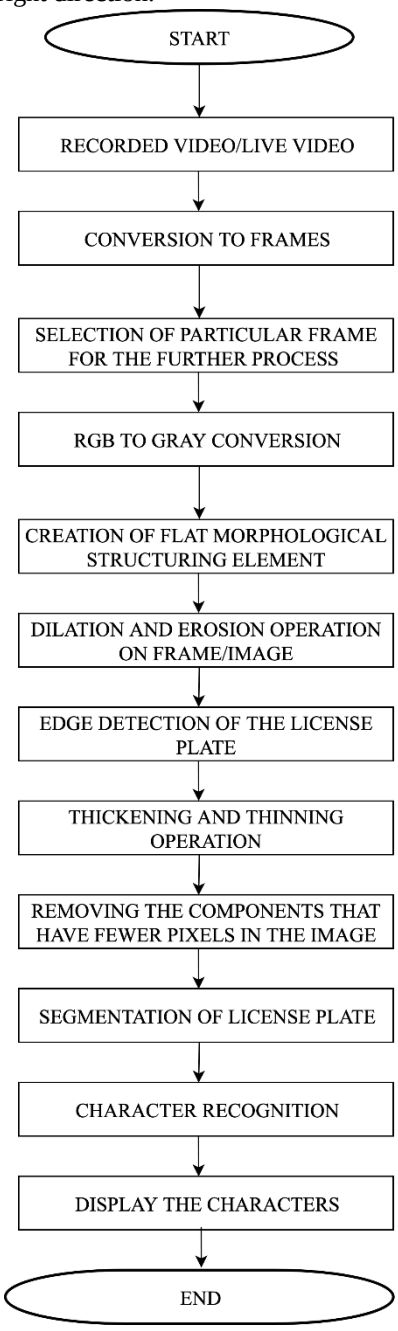


Fig. 3.Flowchart of the proposed algorithm

Double Threshold

After performing the non-maximum suppression, the final edges present will provide an accurate information about the actual edges of the image. Still due to color variation and noise some of the false edge pixels still remain. In order to overcome all these problems, edge pixels with low gradient value should be removed. And low and high threshold values are used to save the edges with high directional change in intensity. The two threshold values depends on content of the given image. An edge is marked as weak if gradient value of an edge lies between the low and high threshold value and is suppressed.

Edge Tracking By Hysteresis

Now the final image contains most of the strong edge pixels, as they are extracted from the true image. But, the edges with low intensities cannot be extracted from the true image.

To achieve a precise result with a high efficiency, the edges with low intensities caused due to various reasons should be eliminated. The connection of all the edges present in an image can be traced by blob Analysis. This is done by focusing on an edge with low intensity value and checking the neighborhood pixel to which it is connected. While noise responses are unconnected, an edge with low intensity is connected to another edge of strong pixel value.

C. Data Transmission

For the obtained result after the validation of the vehicle number plate with different parameters has to be displayed from the master PC onto the monitor. This is done using IOT. Fig. 4 shows the block diagram for interfacing with a controller. Transmission is done through a server. In this method we use controller, here the Controller acts as a client to transfer the data after validation from host 1 to the server, the information is recollected at the host 2 for displaying the information on the screen of the handheld device.

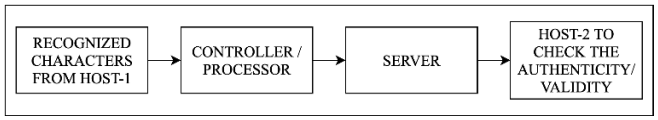


Fig. 4.Segmentation of video into frames and OCR

D. Database

After processing the captured image to extract the number from the plate, next step would be to run this number through a database in order to compare and find a match. In the real world scenario, the database would be maintained by the respective Regional Transport Offices. For the sake of our project, we have used an instance of Microsoft Access in order to create a sample RTO Database.

Once a match is found after through a comparative analysis for the extracted number in the RTO database, a query would automatically be run in the backend of the database. This query is used to extract all the vehicle related information corresponding to that number. The obtained details (License Validity, Emission Validity, Insurance Validity and Traffic Violations) would then be examined to check if they are valid and that there are no fines due (in case of traffic violations).

After examining these details, an alert message containing the violations would be sent to a secondary display, preferably an LCD screen (or a remote host). This alert message can then be used to deduct the required amount automatically from the defaulter's bank account, thus making this system completely automated.

IV. RESULTS

A. Segmentation and OCR

The captured video is segmented into n number of frames as desired shown in Fig. 5.

Fig. 5.Video split into frames

The best frame is selected from the ensemble of frames is as shown in Fig. 6. Then selected frame is converted to Gray image as shown in Fig. 7. Boundaries are detected using segmentation and number region of a vehicle is detected as shown in Fig. 8 and Fig. 9. The character from the template file that gives the highest correlation to the character in the image is the extracted character and it is written into a text file shown in Fig. 10.

Fig. 6.Chosen Frame

Fig. 7.RGB to Gray converted frame

Fig. 8.Boundary Detection

Fig. 9.Removing Horizontal Component & Detection of number

B. Database Validation

After processing the image, the characters are extracted, and the next step would be to run this result through a database in order to compare and find a match. The text file containing the set of extracted numbers is imported into the database as shown in Fig. 11, where it would be compared with an existing database.

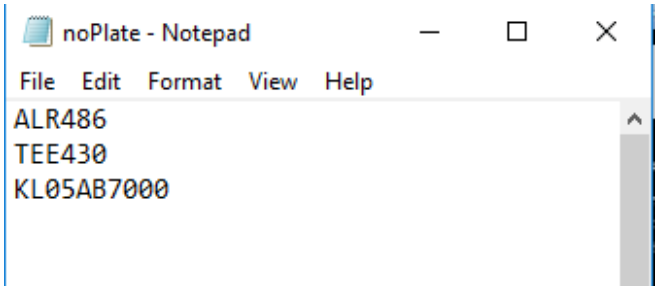


Fig. 10. Display of characters as a text file

Initially, a sample RTO database would be created for the purpose of comparison with the imported text file. This database would be procured from the RTO prior to the initiation of the recognition process to facilitate the comparison. A sample RTO database created using MS Access is as shown in Fig. 12.

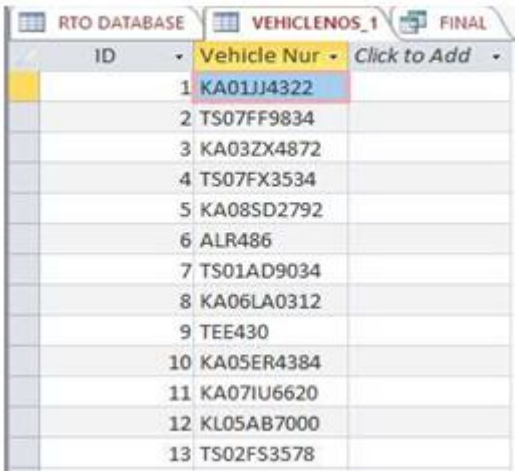
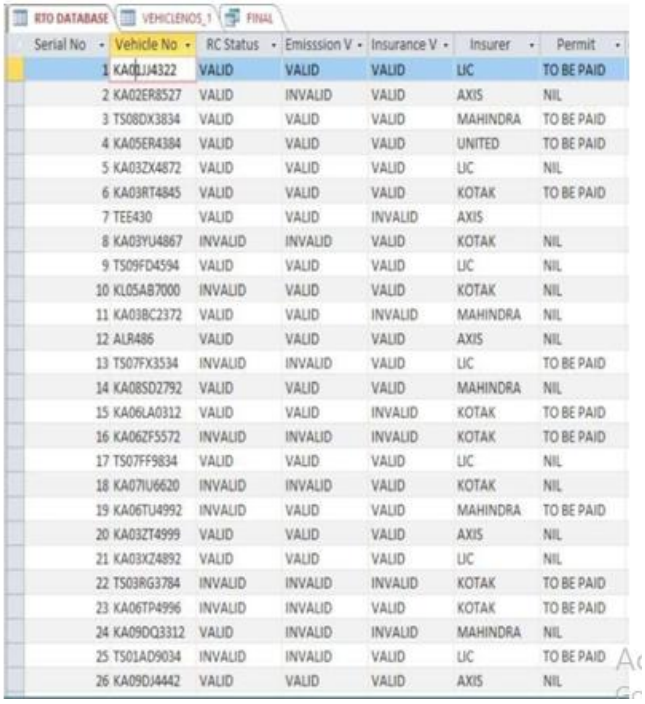


Fig. 11. Vehicle numbers imported from text file to database

A query would then automatically run in the background to find the corresponding details of the input license plate numbers. The design view of the query is as shown in Fig. 13.

This query is used to extract all the vehicle related information corresponding to that number. The obtained details (License Validity, Emission Validity, Insurance Validity and Traffic Violations) shown in Fig. 14.



Serial No	Vehicle No	RC Status	Emisssion V	Insurance V	Insurer	Permit
1	KA01JJ4322	VALID	VALID	VALID	LIC	TO BE PAID
2	KA02ER8527	VALID	INVALID	VALID	AXIS	NIL
3	TS08DX3834	VALID	VALID	VALID	MAHINDRA	TO BE PAID
4	KA05ER4384	VALID	VALID	VALID	UNITED	TO BE PAID
5	KA03ZX4872	VALID	VALID	VALID	LIC	NIL
6	KA03RT4845	VALID	VALID	VALID	KOTAK	TO BE PAID
7	TEE430	VALID	VALID	INVALID	AXIS	
8	KA03YU4867	INVALID	INVALID	VALID	KOTAK	NIL
9	TS09FD4594	VALID	VALID	VALID	LIC	NIL
10	KL05AB7000	INVALID	VALID	VALID	KOTAK	NIL
11	KA03BC2372	VALID	VALID	INVALID	MAHINDRA	NIL
12	ALR486	VALID	VALID	VALID	AXIS	NIL
13	TS07FX3534	INVALID	INVALID	VALID	LIC	TO BE PAID
14	KA08SD2792	VALID	VALID	VALID	MAHINDRA	NIL
15	KA06LA0312	VALID	VALID	INVALID	KOTAK	TO BE PAID
16	KA06ZF5572	INVALID	INVALID	INVALID	KOTAK	TO BE PAID
17	TS07FF9834	VALID	VALID	VALID	LIC	NIL
18	KA07IU6620	INVALID	INVALID	VALID	KOTAK	NIL
19	KA06TU4992	INVALID	VALID	VALID	MAHINDRA	TO BE PAID
20	KA03ZT4999	VALID	VALID	VALID	AXIS	NIL
21	KA03XZ4892	VALID	VALID	VALID	LIC	NIL
22	TS03RG3784	INVALID	INVALID	INVALID	KOTAK	TO BE PAID
23	KA06TP4996	INVALID	INVALID	VALID	KOTAK	TO BE PAID
24	KA09DQ3312	VALID	INVALID	INVALID	MAHINDRA	NIL
25	TS01AD9034	INVALID	INVALID	VALID	LIC	TO BE PAID
26	KA09DJ4442	VALID	VALID	VALID	AXIS	NIL

Fig. 12. Sample of RTO Database

The obtained information would then be displayed on an LCD screen in order to let the defaulter know of his/her violations in the recent past. Once the violations have been displayed, the corresponding amount would then be deducted from the defaulter's bank account. This would serve as an effective mechanism in encouraging people to strictly follow traffic rules, eventually resulting in a safer environment.

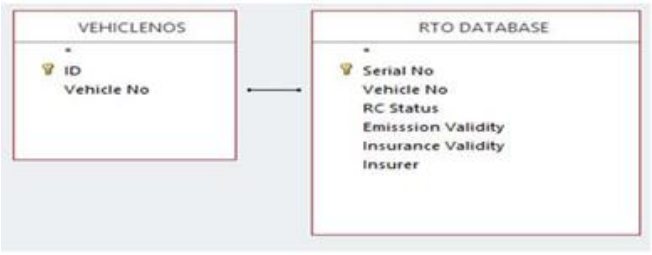


Fig. 13. Query for comparison

Vehicle Nur	RC Status	Emisssion V	Insurance V	Insurer	Permit
KA01JJ4322	VALID	VALID	VALID	LIC	TO BE PAID
KA05ER4384	VALID	VALID	VALID	UNITED	TO BE PAID
KA03ZX4872	VALID	VALID	VALID	LIC	NIL
TEE430	VALID	VALID	INVALID	AXIS	
KL05AB7000	INVALID	VALID	VALID	KOTAK	NIL
ALR486	VALID	VALID	VALID	AXIS	NIL
TS07FX3534	INVALID	INVALID	VALID	LIC	TO BE PAID
KA08SD2792	VALID	VALID	VALID	MAHINDRA	NIL
KA06LA0312	VALID	VALID	INVALID	KOTAK	TO BE PAID
TS07FF9834	VALID	VALID	VALID	LIC	NIL
KA07IU6620	INVALID	INVALID	VALID	KOTAK	NIL
TS01AD9034	INVALID	INVALID	VALID	LIC	TO BE PAID
TS02FS3578	INVALID	INVALID	INVALID	KOTAK	TO BE PAID

Fig. 14. Final Validated Output

C. Interfacing Results

After receiving the validated information from the database, it is being displayed on handheld device, explained with respect to host 1 and host 2 being interfaced, the Fig. 15 shows the results obtained at Host 2.

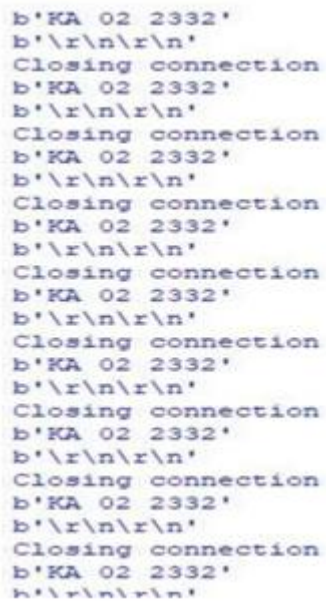


Fig. 15. Display of car number in Host 2

V. CONCLUSION

An automatic vehicle number identification system is presented. The system implemented using multiple image processing techniques for recognizing the characters present in the number plate starting from video capturing, segmentation and canny edge detection to recognize characters. The system is implemented using MATLAB. A sample RTO database is created to validate the proposed system. The results prove that the proposed smart transport system locates the number plate, recognizes the number under various lighting conditions. The System can be upgraded to use Unified Payment Interface (UPI) to link vehicle numbers with unique bank account to deduct the required amount automatically from the defaulter's bank account, thus making this system completely automated.

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Mr. Vinay B K has Bachelor Degree in Electronics and communication Engineering and Masters in Signal processing & VLSI Design. He has more than 6 years of teaching and 1 year of industry experience. Currently he is pursuing his PhD in the field of VLSI Design. His research interest includes Low power VLSI Design; Analog and Mixed signal VLSI Design, Circuit design and simulations, DSP, and Embedded Systems Design.

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