Volume 6, Issue 2, February 2016 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Automatic License Plate Recoganization System Using LabVIEW: Review

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Abstract— Intensive research has been done on Automatic License Plate Recoganization System (ALPR) and a large number of articles have been published on this topic during the last few decades. Many commercial ALPR systems are now available in the market. The quality of the acquired images is a major factor in the success of the ALPR. This system is based on regular PC with camera to acquire live images of vehicle which include a vehicle car license plate. This Processes acquired images to find out license plate and convert those characters into string by using OCR algorithm. The Proposed system has been implemented using Vision Assistant & LabVIEW. In this Paper, the current status of ALPR Systems and directions for future research are suggested.

Index Terms— Image Acquisition; License Plate Extraction; Digitization; Preprocessing; Segmentation; optical character recognition (OCR) or neural networks and LabVIEW.

I. INTRODUCTION

License plate recognition (LPR) is an image-processing technology used to identify vehicles by their license plates for missing value. This technology is gaining popularity in security and traffic installations. This paper presents a license plate recognition system overview as an application of computer vision. Computer vision is a process of using a computer to extract high level information from a digital image. A license plate reader works by extracting the characters from an image. This technology is used for many applications such as toll booths, parking decks, border control, and law enforcement. Much research has already been done for the recognition of Korean, Chinese, European, American and other license plates. From a social point of view the need for the intelligent transportation management without human being intervention in different countries throughout the world automatically influenced this field for being long active in literature. Large magnitude of papers within three last decades for ANPR have been demonstrated which shows the importance and the worth of this subject in literature [1]. Our system will provide a way to detect and identify license plates without constant human intervention.

This paper gives an overview of the research carried out so far in this area and the techniques employed in developing an LPR system in lieu of the following four stages: image acquisition, license plate extraction, and license plate segmentation and license plate recognition phases [3].

Image Acquisition: This phase deals with acquiring an image by an acquisition method. In our proposed system, we used a high resolution digital camera and adequate light source to acquire the input image.

License Plate Extraction: This phase extracts the region of interest, i.e., the license plate, from the acquired image. The proposed approach involves "Masking of a region with high probability of license plate and then scanning the whole masked region for license plate".

License Plate Character Segmentation : License Plate Segmentation, which is sometimes referred to as Character Isolation takes the region of interest and attempts to divideit into individual characters. In the proposed system segmentation is done in the OCR section.

Optical Character Recoganization: There are many methods used to recognize isolated characters. In the proposed system we are using Optical Character Recognition which is an inbuilt feature in Vision Assistant.

II. RELATED WORK

A variety of research work has been done on license plate recognition system. Most can be classified as differing on the plate detection methods, extraction methods, character segmentation methods and the character recognition methods.

Image Acquisition: Acquisition is the first step in an LPR system and there are a number of ways to acquire images, the current literature discusses different image acquisition methods used by various authors. *Yan, Dai., Hongqing, Ma., Jilin, Liu., and Langang, Li,* [5] used an image acquisition card that converts video signals to digital images based on some hardware-based image pre-processing. *Naito, T., Tsukada, T., Yamada, K.s Kozuka, K., and Yamamoto, S.,* [3,6,7] developed a sensing system, which uses two CCDs (Charge Coupled Devices) and a prism to split an incident ray into two lights with different intensities. The main feature of this sensing system is that it covers wide illumination conditions from twilight to noon under sunshine, and this system is capable of capturing images of fast moving vehicles without

blurring. *Salagado, L., Menendez, J. M., Rendon, E., and Garcia, N.,* [4] used a Sensor subsystem having a high resolution CCD camera supplemented with a number of new digital operation capabilities. *Kim, K. K., Kim, K. I., Kim, J.B., and Kim, H. J.,* [8] uses a video camera to acquire the image *Comelli, P., Ferragina, P., Granieri. M. N., and Stabile, F.,* [9] used a TV camera and a frame grabber card to acquire the image for the developed vehicle LPR system.

License Plate Extraction: This phase extracts the region of interest, i.e., the license plate, from the acquired image. *Hontani, H., and Koga, T.,* [10] proposed a method for extracting characters without prior knowledge of their position and size in the image. The technique is based on scale shape analysis, which in turn is based on the assumption that, characters have line-type shapes locally and blob-type shapes globally. In the scale shape analysis, Gaussian filters at various scales blur the given image and larger size shapes appear at larger scales. To detect these scales the idea of principal curvature plane is introduced. By means of normalized principal curvatures, characteristic points are extracted from the scale space x-y-t. The position (x, y) indicates the position of the figure and the scale t indicates the inherent characteristic size of corresponding figures. All these characteristic points enable the extraction of the figure from the given image that has line-type shapes locally and blob-type shapes globally. *Kim, K. K., Kim, K. I., Kim, J.B., and Kim, H. J.,* [8] used two Neural Network-based filters and a post processor to combine two filtered images in order to locate the license plates. The two Neural Networks used are vertical and horizontal filters, which examine small windows of vertical and horizontal cross sections of an image and decide whether each window contains a license plate. Cross-sections have sufficient information for distinguishing a plate from the background. *Lee, E. R., Earn, P. K., and Kim, H. J.,* [11] and *Park, S. FL, Kim, K. I., Jung, K., and Kim, H. J.,* [12] devised a method to extract Korean license plate depending on the color of the plate. A Korean license plate is composed of two different colors, one for characters and other for background and depending on this they are divided into three categories. In this method a neural network is used for extracting color of a pixel by HLS (Hue, Lightness and Saturation) values of eight neighboring pixels and a node of maximum value is chosen as a representative color. After every pixel of input image is converted into one of the four groups, horizontal and vertical histogram of white, red and green (i.e. Korean plates contains white, red and green colors) are calculated to extract a plate region. To select a probable plate region horizontal to vertical ratio of plate is used. *Cho, D. U., and Cho, Y. Ft.,* [13] presented histogram based approach for the extraction phase. *Kim G. M* [14] used Hough transform for the extraction of the license plate. The disadvantage is that, this method requires huge memory and is computationally expensive.

Segmentation: License Plate Segmentation, which is sometimes referred to as Character Isolation takes the region of interest and attempts to divide it into individual characters. Many different approaches have been proposed in the literature and some of them are as follows, *Nieuwoudt, C, and van Heerden, R.,* [15] used region growing for segmentation of characters. The basic idea behind region growing is to identify one or more criteria that are characteristic for the desired region. After establishing the criteria, the image is searched for any pixels that fulfill the requirements. Whenever such a pixel is encountered, its neighbors are checked, and if any of the neighbors also match the criteria, both the pixels are considered as belonging to the same region. *Morel, J., and Solemini, S.,* [16] used partial differential equations (PDE) based technique; Neural network and fuzzy logic were adopted in for segmentation into individual characters.*M.K. Sharma and V.S. Dhaka* [26] have proposed a segmentation technique for words and characters. The proposed Pixel Plot and Trace and Re-plot and Retrace (PPTRPRT) technique extracts text region from text scripts and lead iterative processes for segmentation of text lines along with skew and de-skew operations. The outcomes of iterations are used in pixel-space-based word segmentation, and the segmented words are used in segmentation of characters. Investigational outcome shows that the proposed techniqueis competent to segment characters from text scripts, and accuracy of outcomes is up to 99.578 %.

M.K. Sharma and V.S. Dhaka [28] have proposed a segmentation technique for words and characters. The PPTRPRT is a new technique for reconstructing the bilingual offline handwritten cursive scripts and will give a concrete base to design an OCR with optimum correctness and bottommost cost. The proposed PPTRPRT framework gives best segmentation outcomes up to 99.78 % using FFNN as a classifier, and the size of dataset was 68,000.

M.K. Sharma and V.S. Dhaka [29] have proposed a segmentation technique for cursive script. That research work presents a realistic technique for character segmentation of English offline handwritten cursive scripts using a FFNN. The PPTRPRT technique is a new technique for reconstructing English offline handwritten cursive and is driving the results by keeping an approach between under-segmentation and over-segmentation. The technique will provide a concrete basis by which design of an optical character reader with fine accuracy and low cost will be achieved.

Recognition : Some of the previous work in the classification and recognition of characters is as follows, *Hansen, H., Kristensen, A. W., Kohler, M. P., Mikkelsen, A. W. , Pedersen J. M., and Trangeled, M.,* [17] discusses a statistical pattern recognition approach for recognition but their technique found to be inefficient. This approach is based on the probabilistic model and uses statistical pattern recognition approach. *Cowell, J., and Hussain, F.,* [18] discussed the recognition of individual Arabic and Latin characters. Their approach identifies the characters based on the number of black pixel rows and columns of the character and comparison of those values to a set of templates or signatures in the database. *Cowell, J., and Hussain, F.,* [19] discusses the thinning of Arabic characters to extract essential structural information of each character which may be later used for the classification stage. *Yu, M., and Kim, Y. D.,* [20] and *Naito, T. Tsukada, T. Yamada, K. Kozuka, K. and Yamamoto, S.,* [6] used template matching. Template matching involves the use of a database of characters or templates. There is a separate template for each possible input character. Recognition is achieved by comparing the current input character to each of template in order to find the one which matches the best. If I(x,y) is the input character, T,,(x,y) is template n, then the matching function s (l, Tn) will return a value indicating how well template n matches the input. *Hamami, L., and, Berkani, D.,* [21] adopted a structural or syntactic approach to

recognize characters in a text document; this technique can yield a better result when applied on the recognition of individual characters. This approach is based on the detection of holes and concavities in the four directions (up, down, left and right), which permits the classification of characters into different classes. In addition, secondary characteristics are used in order to differentiate between the characters of each class. The approaches discussed in this paragraph are based on the structural information of the characters and uses syntactic pattern recognition approach. Hu, M. K.,[22] proposed seven moment that can be used as features to classify the characters. These moments are invariant to scaling, rotation and translation. The obtained moments acts as the features, which are passed to the neural network for the classification or recognition of characters. Zemike moments have also been used by several authors [25, 23, and 24] for recognition of characters. Using zernike moments both the rotation variant and rotation invariant features can be extracted. These features then uses neural network for the recognition phase. Neural network accepts any set of distinguishable features of a pattern as input. It then trains the network using the input data and the training algorithms to recognize the input pattern.

M.K. Sharma and V.S. Dhaka [27] have proposed a recognition technique for words and characters. In this three classifiers namely GADNT, GANNT and GNDT, with the storage constraints are proposed for image classification. The proposed GADNT is able to design the proper number of child nodes of each decision node in the GDT according to the classification error rate and computing complexity of GDT. In GNT, the GANNT is proposed to search for the proper number of hidden and output nodes in the neural network according to the classification error rate and computing complexity of GNT.

III. PROPERTIES OF ALPR

Indian License Plate: In India the number plate containing white background with black foreground colour for private cars and for the commercial vehicle used yellow as background and black as foreground colour. The number plate start with two digit letter "state code" followed by two digit numeral followed by single letter after those four consecutive digits as the below figure1.1.

Fig. 1. a

From the figure 1.a, 1 indicates the Country code, 2 indicate the state code, and 3 indicate the district code, 4 indicate the type of vehicle and 5 indicates the actual registration number.

Working Concept: When the vehicle approaches the secured area, the LPR unit senses the car and activates the illumination (invisible infra-red in most cases) as shown in Figure below. The LPR unit takes the pictures from either the front or rear plates from the LPR camera. The image of the vehicle contains the license plate. The LPR unit feeds the input image to the system. The system then enhances the image, detects the plate position, extracts the plate, segments the characters on the plate and recognizes the segmented characters, Checks if the vehicle appears on a predefined list of authorized vehicles, If found, it signals to open the gate by activating its relay.

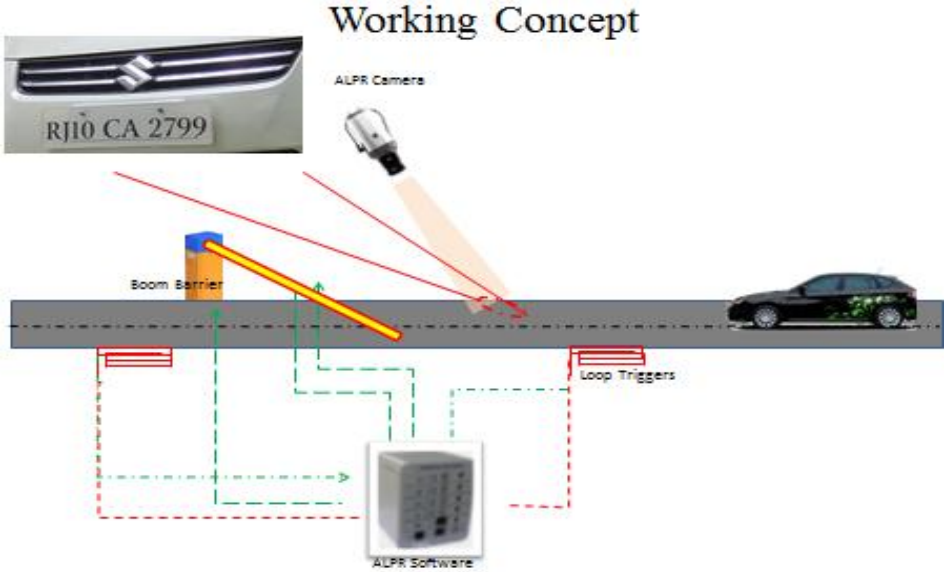

Fig. 2 ALPR Working Concept

ALPR Element: Important aspects of ALPR are

Camera: - Takes image of a vehicle from either front or rear end.

Illumination: - A controlled light that can bright up the plate, and allows day and night operation. In most cases the illumination is Infra-Red (IR) which is invisible to the driver.
Frame Grabber: - An interface board between the camera and the PC that allows the software to read the image information.
Computer: - Normally a PC runs Windows or Linux. It runs the LPR application that controls the system, reads the images, analyses and identifies the plate, and interfaces with other applications and systems.
Software: - The application and the recognition package.
Hardware: - Various input/output boards used to interface the external world (such as control boards and networking boards).
Database: - The events are recorded on a local database or transmitted over the network. The data includes the recognition results and (optionally) the vehicle or driver-face image file.
ALPR Application Area: The main advantage is that the system can store the image record for future references. Some of the applications are as follows:-
Law Enforcement: - The plate number is used to produce a violation fine on speeding vehicles, illegal use of bus lanes, and detection of stolen or wanted vehicles.
Parking: - The LPR system is used to automatically enter pre-paid members and calculate parking fee for non-members (by comparing the exit and entry times).
Automatic Toll Gates: - Manual toll gates require the vehicle to stop and the driver to pay an appropriate tariff. In an automatic system the vehicle would no longer need to stop.
*Border Crossing***:** - This application assists the registry of entry or exits to a country, and can be used to monitor the border crossings.
*Homeland Security***:** - The LPR system's ability to read strings of alpha-numeric characters and compare them instantaneously to Hot Lists allows a Command Center to organize and strategize efforts in reaction to the information captured.

ALPR Image Acquisition:

1. Click File » Acquire Image.
2. Click Acquire Image in the Acquisition function list.
3. Select the appropriate device and channel.
4. Click the Acquire Single Image button to acquire a single image with the IMAQ device and display it.
5. Click the Store Acquired Image in Browser button to send the image to the Image Browser.
6. Click Close to exit the Parameter window.
7. Process the image in Vision Assistant.

ALPR Image Processing: Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it.
The purpose of image processing is divided into 5 groups. They are

1. Visualization - Observe the objects that are not visible.
2. Image sharpening and restoration - To create a better image.
3. Image retrieval - Seek for the image of interest.
4. Measurement of pattern – Measures various objects in an image.
5. Image Recognition – Distinguish the objects in an image

ALPR Steps for Output:

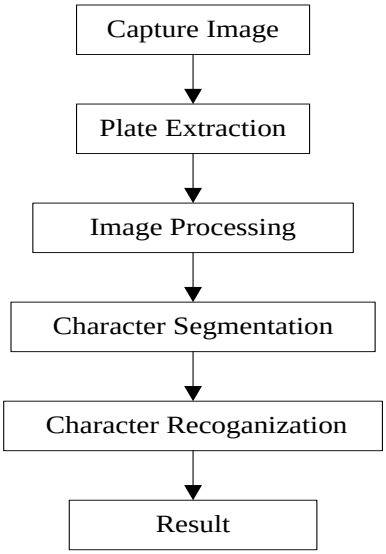

Fig.3 Steps for Output

ALPR OCR: Optical Character Recognition (OCR) is a type of document image analysis where a scanned digital image that contains either machine printed or handwritten script is input into an OCR software engine and translating it into an editable machine readable digital text format.

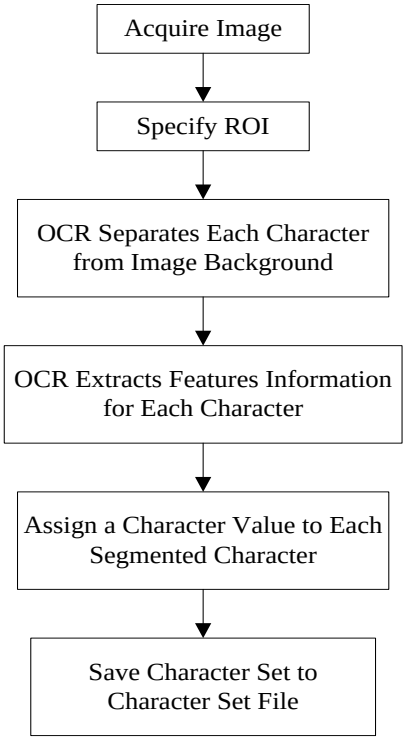

Fig.4 Steps of OCR

IV. ALPR TECHNIQUES

Fajas, F. Yousuf, P. R. Remya, S. Ambadiyil, & S. A. Varsha[30] Inthis License Plates are localized by firstly pre-processing which includes rgb to gray,edge detection and noise reduction following which possibly license plates are identified by changes in contrast, width by height factor. Character segmentation is done by looking for similarities in characteristics of characters. Character recognition is done with the help of ANNs.

M.H. Dashtban, Z. Dashtban and H. Bevrani [31] which gave a general algorithmic model proposed for vehicle plate identification. The proposed algorithm generally consist of three main parts, first the license plate detection model which has several steps. For enhancing overall results it converts 8-connectivity of background and finds desired connected components of input image with 8- connectivity. In the first step they had some special preprocessing which decay such issues as shadow or shadiness which are the result of various illumination conditions. That issue is done by using Gaussian low pass filter and histogram equalization for sharpening and increasing image intensity dynamic range. After extracting the appropriate object among the four biggest 8- connected objects, the character segmentation system utilized the Hough transform to find the longest line within the extracted boundary. This line was then used for its angle as the angle of the plate and rotation problem in skewed car plates using the obtained angle would be solved. Local binarization is used and then some basic morphological operations for enhancing the extracted plate are utilized. Then, a vertical projected histogram based technique in regard with the valleys is used to find space between characters.

D. Sagar, & M. Dutta [32] give a new method of block based ANPR system is presented for recognition of Indian License plates. The methodology consists of image pre-processing which consists of gray processing, image enhancement, filterization, binerization, thresholding and morphological operations – image erosion, removing small objects, image filling. Further character segmentation is performed which consists of Connected Component Analysis, Center Line Rule and Blob Extraction. Finally block based character recognition is performed using subphases of block based feature extraction and recognition. The authors claim to achieve a very high recognition rate of 98.2 % and a speedup of processing time to 3.3 ms. The system is also very robust.

G. T Sutar, A.V Shah[33] presents a method which uses improved segmentation along with OCR to recognize vehicle license plates. In this work LP extraction is done using either an estimate of plate location or image segmentation methods like image binarization, otsu's method or color segmentation. Improvement of segmentation of characters is done by calculating components, extracting each character and cropping individual characters. Finally OCR is used to recognize characters.

B. Bhushan, S. Singh, & R. Singla [34] give a novel technique of multi-thresholding combined with neural networks has been adopted for LPR which helps in achieving a higher recognition rate.Multi thresholding is a powerful technique for image segmentation. This is based on the assumption that an object and background pixels in an image can be distinguished by their gray-levels or colour values. According to the authors previous techniques using otsu method achieved 96.64 % recognition rate while multi thresholding technique has achieved a much improved recognition rate of 98.4 %.

A. Chaturvedi [35] proposed a method for implementing ALPR using Speed up Robust Feature matching (SURF) technique for plate detection and Advanced Radial Basis Function (RBF) for matching characters.

V. Mai, D. Miao, & R. Wang [36] implemented ALPR for all types of Vietnam license plates using edge detection and neural networks. The proposed methodology consists of 1. License Plate location (LPL) – combination of edge detection, image subtraction, mathematical morphology, radon transform, interpolation and specific characteristics of Vietnam license plate. 2. Character Segmentation – Peak to valley method and statistical parameters of Vietnam LP to segment characters & numbers in one-row and two-row types of Vietnam LP. 3. Character Recognition – Multilayer perceptron and back propogation algorithm. Overall the algorithm seems to outperform previous work in terms of recognition rate and computation time. It achieves the following rates

1. LP Location 97.13 %
2. LP Segmentation 98.21 %
3. LP Recognition 97.25 %
4. Overall ALPR System 97.43 %

The computation time is 0.25 s for a total of 700 Images

D. Ahuja, Kuldeepak [37] use different wavelets for license plate detection and feature extraction of license plate characters. Using different wavelets shape features of license plate characters are extracted and analysis of wavelets is done on the basis of recognition rate and time. It is found out that bior 3.9 has the highest recognition rate of 91.5 %. Haar wavelet requires the least time.

Mr. G. T. Sutar and Prof. Mr. A.V. Shah [38] that give a system which first captures the vehicle image then vehicle number plate region is extracted using the image segmentation in an image. Optical character recognition technique is used for the character recognition. The resulting data is then used to compare with the records on a database. The system is implemented and simulated in Matlab, and it performance is tested on real image.

D. Ventzas [39] present an approach distinguished by digit recognition performed by feed forward back propogation neural network, trained with four angle Radon transform of sample letters and numbers. The proposed algorithm is able to recognize correctly characters on license plate with probability of 94.1 %. The system was tested on 51 plate images including old type license plates; the recognition rate of 357 character strings was 99.15%. For the 51 images the outcomes were as follows

1. License plate isolation 51/51: 100 %
2. License plate recognition 48/51: 94.1 %
3. Character recognition 354/357: 99.1 %

M. Vashishath [40] an LPR system is developed which recognizes characters using OCR inside the framework of LAB View software. The system has been tested for vehicles containing different number plates for different states. In the process of final evaluation after optimizing the final parameters like brightness, contrast, and gamma, adjustments, optimum values for light and angle from which the image is taken, the system achieves an overall efficiency of 98%.

A. P. Nagare [41] presented character recognition using two neural networks, one is Back Propogation Neural Network and the other one is Learning Vector Quantization Neural Network (LVQNN). It is observed that character recognition results obtained using Learning Vector Quantization Neural Network is better than those obtained by using Back Propogation Neural Network. The efficiency of the system can be further improved by increasing the number of fonts for training the neural network.

M.A. Saeed, M. Waqas, Z. Akbar, N. Ali [42] give a recognition scheme which is independent of the Language Alphabets written on number plate, extraction is done with the help of edge detection and connected components labeling. That show the number plates are detected and extracted precisely based on connected components and sobel edge detection algorithm with a success rate of 81%.

V. Koval, V. Turchenko, V. Kochan, A. Sachenko, G. Markowsky, & P. Square[43] the authors discuss a method to recognize license plates through image fusion, neural networks, and threshold techniques. In the proposed methodology license plate extraction is done using thresholding technique while recognition is done using neural networks. The LPR system was designed using MATLAB 6.5. The structure of neural networks includes input layers with 366 inputs, one hidden layer with 50 neurons and output layer with 46 neurons. Some noise is added to the input images. A recognition rate of 95 % is achieved in the presence of noise with 50% density.

Table: 1 Comparison of various ALPR Technique

	Technique Used			
References	**Plate Detection**	**Character Segmentation**	**Character Recognition**	Results
Fajas, F. Yousuf, P.R. Remya, S. Ambadiyil, & S.A. Varsha [30]	Changes in contrast, width by height factor	Character characteristics similarities	ANN	93.7%
D. Sagar, & M. Dutta [32]	Edge detection, morphological operations	Connected Component Analysis	Block based ANN	98.2%
G. T Sutar, A.V Shah [33]	Estimate of plate location or image segmentation	Component analysis	Optical Character Recognition	93%

B. Bhushan, S. Singh, & R. Singla [34]	Multi-thresholding	Blob-extraction	ANN	98.4%
A. Chaturvedi [35]	SURF	Morphological operations and Connected Component Analysis	Radial Basis Function ANN	95%
V. Mai, D. Miao, & R. Wang [36]	Edge Detection, Morphological operation, radon transform	Peak to valley method and statistical parameters of license plate	ANN	97.43%
D. Ahuja, Kuldeepak [37]	Edge detection, Wavelets	Connected Component Analysis	Wavelets, ANN	91.5%
D. Ventzas [39]	Edge detection, Morphological operations, Connected Component Analysis &otsu	Connected Component Analysis	ANN with four angle Radon Transform	94.1%
M. Vashishath [40]	Thresholding	ROI Based character segmentation	Optical Character Recognition	98%
A. P. Nagare [41]	Morphological operations	Lines and Clips functions	Learning Vector Quanitzation Neural Network	94.4%
V. Koval, V. Turchenko, V. Kochan, A. Sachenko, G. Markowsky, & P. Square [43]	Thresholding	Cutting regions and thresholding	ANN	95%
M.A. Saeed, M. Waqas, Z. Akbar, N. Ali [42]	edge detection and connected components labeling	Sobel Edge detector and 8connectivity	Optical Character Recognition	81%
Mr. G. T. Sutar and Prof. Mr. A.V. Shah [38]	Edge Detection and RADON transform	Component analysis	Optical character recognition	93%
M.H. Dashtban, Z. Dashtban and H. Bevrani [31]	Gaussian low pass filter ,histogram equalization and Canny's method	Hough transform and 8-connectivity	multi-layerperceptron (MLP) neural network.	91%

V. OBJECTIVE

This work presented here aims at the following aspects.

- Study the existing license plate recognition systems,
- Develop a new technique or enhance existing techniques for each phase in a license plate recognition system,
- Compare the various techniques at hand with the proposed system, and
- Build a system that delivers optimal performance both in terms of speed and accuracy.

VI. CONCLUSION

The process of vehicle number plate recognition requires a very high degree of accuracy when we are working on a very busy road or parking which may not be possible manually as a human being tends to get fatigued due to monotonous nature of the job and they cannot keep track of the vehicles when there are multiple vehicles are passing in a very short time .To overcome this problem, many efforts have been made by the researchers across the globe for last many years. A similar effort has been made in this work to develop an accurate and automatic number plate recognition system.

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