I J C T A, 9(7), 2016, pp. 3341-3351 ISSN: 0974-5572

An Evaluation of Automatic Vehicle License Plate Recognition Algorithms and Techniques

Reji P.I.* and Dharun V.S.**

ABSTRACT

Automated License Plate Recognition (ALPR) system is a demanding field of research because of the implication with an extensive series of marketable appositeness. It discovers and distinguishes the characters straightforwardly from the vehicle's License Plate and can endow with a precious information basis for transport scheduling and engineering. Due to the quick growth of technology and escalating exploit of vehicles, in the previous decades License Plate Recognition has turn out to be the vital element in several transport administration and security systems such as automated speed control system, traffic supervising, detection of robbed vehicles, toll management systems on highways, parking lots access control systems etc. Various modules occupied in ALPR systems are Picture Attainment, Number Plate Localization, Number Extraction and Number Identification. Numerous authors established a variety of techniques for ALPR and this analysis paper depicts the distinctiveness of every ALPR systems along with their benefits and drawbacks and estimates distinctive Number Plate Recognition approaches and compares them based on exactness, efficiency, rapidity, intricacy, the helpfulness at dissimilar ecological situations etc; which guide the researchers to prefer the best relevant approaches for the particular employment, which is vigorous, at the same time intelligible solution to clear up the ordinary issues in Number Plate Recognition. Eventually, this paper furnishes to researchers an association to a public image database to mark out a conventional reference point for LPR algorithmic estimation and evaluation.

Keywords: Automated License Plate Recognition (ALPR); Picture attainment; Number Plate Localization; Number Extraction; Number Identification; Number Plate Recognition.

1. INTRODUCTION

ALPR is a real life appliance, which was organized as a mass surveillance image processing technology that utilizes Character Recognition on pictures to understand conveyance Registration Plates and haul out the automobile information. All international conveyances should have its license number transcribed on a License Plate mounted onto its motor vehicle's frame. Since the license number is the principal, most extensively acquired, individual readable, obligatory matchless identifier of automobiles, ALPR is intended to locate and distinguish the License Plate of a moving automobile without human intervention. There are lots of number plates utilized in the nation. License Plate employed in India typically composed of eight to ten characters.

Throughout the most recent two decades, several procedures for License Plate discovery have been advanced. LPR takes part a foremost responsibility because the quantity of automobiles multiplying daily, robbery, breaking of passage regulations, limited regions infringement etc raise continuously, in order to obstruct these violations LPR structure is considered, for a range of applications namely, automatic toll tax collection, supervising and trailing vehicles, vehicle parking management systems, boundary crossings, limited-access highway and arterial administration systems for traffic observation etc. Thus LPR is applied

* Research Scholar, Noorul Islam University, *Kumaracoil, Tamilnadu.*

** Principal, Archana College of Engneering, *Palamel, Kerala*

in real-time systems and can resolve a variety of troubles in Intelligent Transportation Systems (ITS); which tender precision and satisfactory swiftness.

This ALPR system work is reasonably not easy because of the multiplicity in number plate layouts and the uneven lighting circumstances at some stages of image acquirement, compound background which effects on speed of catching the actual section of plates, broken or polluted number plates that causes to achieve mistakes in recognizing numbers etc are a few of the central troubles, which any suggested LPR system has to rise above. On the other hand, loads of advances have been invented for LPR to reduce such restrictions. Mostly, so many efforts have been put forward for signifying practicable approaches that are not sensitive to ecological changes, sturdiness, and complexity and time expenditure tribulations. Abundant techniques have been created for LPR in motionless pictures or video sequences, and the most important target of our paper is that, classify and judge them and the problems such as processing time, computational power and identification and detection rates are also prescribed in this paper.

The remaining portion of our paper is structured as follows. The division II explores a concise introduction of a typical ALPR system. The Section III represents a literature review of LPR systems. The comparison results and performance evaluation of the review are given in Section IV and lastly, conclusions as well as future directions are condensed in Section V.

2. A TYPICAL ALPR SYSTEM

The typical ALPR structure contains the following five stages:

1. Picture Attainment
2. Picture Pre-processing
3. Number Plate Localization
4. Number Extraction and
5. Number Identification

In Image Acquisition, automobile input picture is captured by digital camera, which can be color or black and white, linked to the computer. In view of the fact that, the vehicle figures are taken in diverse background, lighting situations, and at a range of separation between camera and automobile, RGB picture is transformed to gray picture and all the further phases process on gray pictures.

Image Pre-processing steps are carried out on the captured gray scale pictures to the acquired figures so that the central processing on the motor image changes in to uncomplicated. The captured automobile pictures are influenced by so many deterioration components. So it is crucial to pre-process automobile

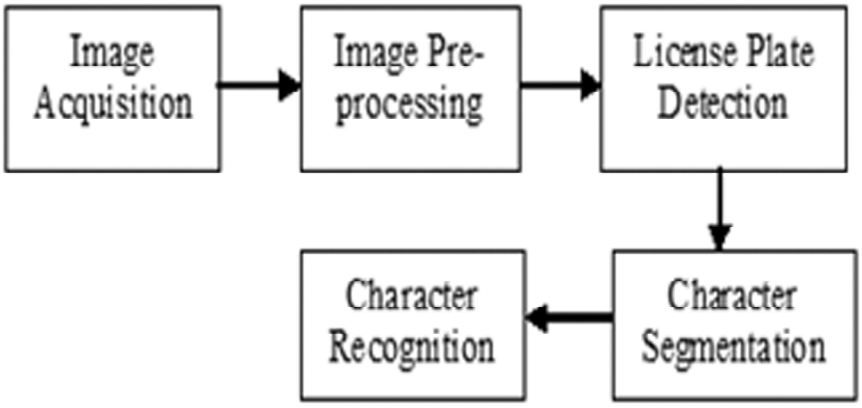

Figure 1: A typical ALPR structure

pictures and prepares them for the subsequent stages, to lessen difficulty of low quality and low contrast within the automobile pictures. There are a quite a lot of pre-processing algorithms for ALPR systems.

In Number Plate Localization, the Number Plate position is recognized, subsequently it is separated out from the motor image and the surroundings are removed. The result of this phase will be a sub picture that holds only the Number Plate. This is completed in two key phases:

a. Positioning a surrounding four-sided shape above Number Plate.

b. Deciding precise position of the Number Plate.

In Number Extraction, we search out individual character and numeral picture. It is an essential and exigent task in ALPR System because correctness of the Number Identification anticipates precision of Number Extraction phase. Therefore we should reinforce the Number Extraction phase with additional dominant algorithms.

Number Identification is the most significant and decisive phase of the ALPR system, in which characters are recognized, which turns the focal element of the identification procedure and determines the system exactness and identification speed. It encompasses to recognize the numerals and literals of Number Plates.

Some instances of the Picture Attainment, Number Plate Localization, Number Extraction and Number Identification are exposed in the second, third, fourth and fifth figures correspondingly.

3. LITERATURE REVIEW

This section incorporates the efforts already done on this ALPR system by different researchers by means of various approaches and algorithms. Some of them have an excellent exactness with extra complexity than others. Some of those procedures are computationally rigorous. Nevertheless, choosing one of them depending on certain criteria such as implementation time, usage of memory, complexity of the procedure

Figure 2: Picture Attainment

Figure 3: Number Plate Localization

Figure 4: Segmented Number Plates and Number Extraction [2]

Figure 5: Number Identification [2]

used and its correctness in various circumstances; is a challenging dilemma. Depending on that the intention of this paper is to learn, to scrutinize and to evaluate some imperative License Plate recognition procedures and compared them with reference to complexity, execution time, and their accurateness in dissimilar situations. Succeeding segment of this paper is the concise explanation of some of them:

In [1] the authors conducted a research on the algorithms for ALPR system, which makes use of low pass filter and gray transformation in the motor vehicle pictures. After making the segmented color image grayed, Wiener filtering is used to take away noise and finally, License Plates are made clear through histogram equalization. License Plate Localization is based on RS-BP neural network training and testing procedures. Depending on that, rough fuzzy neural network identification is projected, which makes use of contour of the Number Plate area, which accomplishes the accurate Number Plate Localization. Investigational outcomes exhibits anticipated scheme gives 91.9% positioning accurateness in general circumstances and moreover makes simpler the organization, enhances information potential, and correctness of Number Identification.

Meenakshi, R. B. Dubey proposed a vehicle LPR system in [2], which includes the following pre-processing steps such as, binary picture transformation; picture enrichment by means of histogram equalization and histogram matching to emphasize the given picture gray level scope; picture complement in which, black will becomes white and zeros will become ones and vice versa and gray-level simplest thresholding. In Image Segmentation process, after receiving the global knowledge the characteristic of the picture should be signified with histograms. A boundary based and edge-based segmentation processes are then used to attain the section outlines which creates objects out of acquired outlines. Segmented numbers rescale in order to suit them into a pane using normalization method. FFBN procedure performs identification of numbers and similar templates. Efficiency of this algorithm is evaluated on automobile number plates and shows the outstanding enrichment while using two hidden layers and gives extremely adequate results and can also be used for improving the safety measures and scalability of appliances.

A novel approach to an ALPR system is presented by Vaishali Singh, Sushmita Tiwari, Rajiv Kumar in [3]. This paper offers an experimental composition with PCA (Principle Component Analysis), which is a is a very significant statistical method that makes clear the covariance structure of data by means of a less number of components, for extracting the features of input License Plate image, horizontal & vertical segmentation for Character Segmentation, OCR (Optical Character Recognition), through which identification of numbers and letters are performed and SVM (Support Vector Machine) which is based on initial binary pictures of the characters, which are identified using Template matching. The training through SVM has given the perfect end results for the identification of assorted input motor pictures taken in the algorithm and is proficient enough over a calculated dataset of Licensed Plates. The procedures used in this paper are a lesser amount of restricted and can be of huge application for the ALPR systems, which can still be enhanced with the mode of number plates in dissimilar countries.

Mr. G. T. Sutar, Prof. Mr. A.V. Shah developed a number plate recognition system using an improved segmentation algorithm in [4]. The pre-processing steps performed here are gray processing and median filtering to remove the occurrence of noise within the motor vehicle images. The localization methods are edge detection, a few morphological operations and skew correction and discovery of License Plates. Character segmentation of separated number plate is completed via labeling components and then the character recognition by OCR which compares the each numbers and letters in opposition to entire alphanumeric repository. This particular algorithm fruitfully detects the Plate section of automobile representation and the mechanization of detection system for safety reason that could substitute the existing system of manual entry. The simulation end results presents that the system vigorously detect (96%) and recognize (93%) the automobile using license plate against dissimilar lightening environment circumstances and can be executed on the doorway of a highly restricted regions.

In [5] Lajish V. L, Sunil Kumar Kopparapu described a solution architecture and a sequel of algorithms for mobile phone based vehicle LPR for road policing. The various pre-processing steps carried out here are gray processing and Otsus global thresholding for picture binarization. Sobel edge detection and vertical cropping are transacted for attaining candidate License Plate regions. The character segmentation process encompasses the exploitation of Connected Component Analysis (CCA) to make sectors of the characters. The isolated characters are then dimension normalized by using affine transformation and bilinear interpolation procedures. The segmented characters are identified via template matching algorithm and the separated characters are compared with every reference character set and the resemblance is estimated by using correlation coefficient. This system has been checked over a huge amount of real truck pictures with incredibly inspiring outcomes and is speedy and provides robust detection and recognition end results.

Sneha G. Patel introduced a new vehicle LPR in [6]. Initially the RGB automobile figures are modified into grey pictures and median filtering is also performed. Then it measures variation between neighborhood pixel values to assemble the edges of images and number plate is projected. Subsequently, Sobel edge detection is performed. The appeared procedure practices morphological operations such as dilation and erosion, to obtain the smooth contour of the binary picture. The segmentation outcome is frontward to Number Plate Identification phase, which progresses auxiliary system effectiveness. BP neural network distinguishes the characters. Since it shows the exactness of the number plate area separation, the character can be segmented accurately from the number plate area. If the accurateness of the outcomes is a crucial part for ALPR systems, then multiple hidden layers network is utilized; while at the same time, if learning speed is a crucial part, then single hidden layer network is utilized.

A novel ALPR system is evaluated by R.Radha and C.P.Sumathi in [7]. Preprocessing steps comprise gray scale image conversion, binarization, median filtering, and LOG edge detection algorithm. Character localization and segmentation is performed by the morphological dilation operation and every part of connected components is then segmented. In text and non-text categorization of the number plates with yellow color background surroundings and black color foreground surroundings; as well as number plates with white color background surroundings and foreground surroundings with black color pictures were collected with almost 100% precision and the major prominence is in eliminating wrong positives with an accurateness of 93% for all number plates. The future work for this particular system will encompass in identifying the unique characters from the separated number plates.

Reference [8] gives a real time LPR system by Lekhana G.C and R. Srikantaswamy. License Plate extraction and character segmentation is implemented via fusion of spectral analysis, which depends on the Fourier transform to discover the inherent spatial frequency of the characters in a vehicle number plate and CCA, which makes use of picture labelling depending on the pixel connectivity to come across the margins or boundaries of the items in the figure and gives a healthier performance. Character recognition is accomplished using SVM binary classification, provides superior recognition precision.

Reference [9] gives a research on LPR algorithm based on SVM, proposed by Dong ZhengHao and FengXin. License Plate pre-processing technologies used here are image gray processing, picture enrichment using stretching and equalization of histograms denoising using mean filter, wavelet transform; for altering the pane outline, time-frequency scrutiny scheme and image edge detection. License Plate Location phase encompasses coarse location and fine location and skew correction using Hough transform. License Plate output image is eventually attained through projecting it vertically and is sectioned as dissimilar patches for getting the numbers and this particular LPR system demonstrates the efficiency of making use of SVM theory here.

Some authors presented an ALPR in [10]. As a pre-processing step the automobile picture is transformed into gray picture; after that binarization is prepared for enhancing vehicle picture contrast

for taking apart the background from highlights, accompanied by CCA operations, are implemented. License Plate Localization is conducted with the help of detecting edges followed by some morphological thinning processes. Number segmentation is obtained by making use of some pre-processing operations and horizontal and vertical segmentation. Eventually, character recognition makes use of FFNN (Feed Forward Neural Network). The projected method assists in spectacularly tumbling both the computational expenditure and algorithm convolution, resulting in easier design of algorithm and momentary computation times.

J. Layolin sobiya and P.Angelin priya introduced a fuzzy logic classifier in [11], which contains various preprocessing algorithms such as gray scale conversion, histogram equalization enhancement; Gaussian filter based Canny edge detection method and noise suppression, ROI thresholding. The number plate detection is resolved by making use of four-sided figure recognition with model pattern association. Number separation is obtained with the help of using adaptive thresholding, horizontal and vertical projections followed by normalizing the magnitude of a character. Number Plate Identification is premeditated by a fuzzy classifier. License Plate exposure and character recognition rates are turned to be 80% and 87.22% in the projected work with improved precision and processing rapidity, even when the pictures were taken on uninhibited environment. The main limitation is the problem of character similarity.

Reference [12] evaluated a License Plate detection and character recognition using contour analysis by Kumary R Soumya, Angel Babu, Laya Therattil. Some of the approaches used are gray scale translation and binary conversion techniques for pre-processing. The number plate detection is determined with the help of the edge based text detection method. In the recognition phase, the contour analysis is used to make out the characters obtained from thinning/contour withdrawal by determining the vector fundamentals of items. Character matching is performed using the character contours attained from contour analysis, which doesn't require any training and the system performs well at a quicker rate, which is resulted in 98% correctness in the discovery and identification of number plates. The projected system shows deprived presentation, when the obtained picture is low contrast or distorted.

An automatic License Plate based smart vehicle validation and security by gate control and e-mail send is described by Rinky Sharma in [13]. After the image acquisition and preprocessing, the proposed technique uses the techniques such as mathematical morphology for positioning Number Plates; intensity protrusions based Number Extraction and OCR based template matching. Because of the alignment of a variety of number plates, it turns out to be somewhat a wearisome mission to automatically make out vehicle number plate also backgrounds and surroundings enlarge the challenge.

Automatic vehicle number plate recognition using morphological edge detection and segmentation are tested in [14] by Teena Singh Rajput, which encompasses five main testimonial approaches; first is pre-processing of the gray scale transformed truck image, then extracting the pre-processed picture that followed by the edge withdrawal using morphological operations on the cropped motor picture, after this the character segmentation process by Otsu's algorithm and then eventually to the character recognition performed by the correlation matching algorithm implementation which gives the better grades that shows the middling exactness for general applications. The reason to concern this five testimonial approach is to get rid of the unnecessary section from the vehicle number plate and distinguish the prominent edges which are mandatory for the identification of the characters from the vehicle number plates. Hence, the recognition precision is very high and this particular system is relatively effortless and has a fine appliance viewpoint.

In [15] another approach for ALPR is projected by the researchers. The Number Plate positioning makes use of picture denoising and twofold edging exposure methods. For Number Extraction, an integrative scheme of positioning initial stage with enhanced perpendicular protrusion subdivision technique. The Number Identification procedure consists of categorization and template similarity for number features.

This algorithm centres appropriateness of Number Plate exposure and minor computations mostly decrease time period, huge correctness and meticulousness percentage.

In [16] Number Plate Identification using wavelets and neural networks are described by Dhiraj ahuja and Kuldeepak. This particular LPR system contains image acquisition, pre-processing steps such as gray processing, median filtering, binarization, sharpening filter masking, Sobel vertical edge extraction and CCA. Followed by, different wavelets are used for vehicle number plate detection, and feature extraction for License Plate characters. By making use of diverse wavelets shape characteristics of number plate characters are collected and investigation of wavelets is conducted on the basis of detection rate and instant. In neural networks, Back Propagation algorithm is used for License Plate detection. As number of truck images in training database is amplified, identification rate increases, in parallel the training time also increases. The highest recognition rate is found to be 91.5%.

Number plate recognition using OCR technique is presented in [17] by Er. Kavneet Kaur, Vijay Kumar Banga. After capturing the image, License Plate is cropped from the grey vehicle picture, which is the input for the character identification phase. After the removal of noises with the help of thresholding, the OCR technique is conducted to distinguish the optically processed characters within the number plates by pattern similarity method. The proposed procedure is evaluated over various enlightenment motor pictures and demonstrates superior outcomes.

Harshita Singh, Deepak Pandey, Surabhi Verma, Preeti Dhiman experimented an ALPR system in [18]. After grey scale renovation of the truck image, Sobel filter is used to detect vertical edges, which is uncomplicated and speedy and requires the permanence of the edges. Then the morphological steps that eradicate unnecessary edges are performed and the extraction rate is comparatively high. Tagging of associated pixels within binarized vehicle picture produces the separation of Number Plates. The labelled pixels are analysed, in which the identical dimension and the ratio of width to height of numbers are measured. The approach does not make the grade to extort every number plate characters when there are connected or wrecked number plate characters. The superlative resemblances of the characters are acknowledged by comparing the characters with the database stored previously in a template. A single pixel appearance gives information with reference to precise match of a template picture, with segmented input picture. Followed by the template matching process, particular plate number can be unerringly recognized**.** The projected framework has some restrictions on working with real time appliances and multiline License Plates.

Reference [19] is a LPR system using neural network, which was proposed by Anuja P. Nagare. Followed by the preprocessing steps, by widening picture diversity values enhancement of gray picture is improved; after that Tophat-Bothat conversion is done. Subsequently edging by Sobel mechanism and finally positioning of Number Plates by doing multiple opening and closing steps. Number Extraction is made by row scanning method and withdrawal of number characteristics by Fan-Beam Transform and Character Geometry; in which first one gives more exactness. The Number Identification is done by BPNN and LVQNN, in which second method (94.44%) shows better Number Identification consequences than that of obtained by using first method (66.67%). The effectiveness of this particular method is supplementary enhanced by raising quantity in the learning database.

Shreeja Chakraborty, Ranjan Parekh reviewed an improved template matching algorithm for car License Plate Recognition in [20]. In the pre-processing phase, greyscale image is transformed in to binary by means of suitable thresholding method. Character segmentation is performed using CCA and for recognition of number plate, an improved template matching algorithm is proposed, which uses dynamically produced License Plate characters as database template and recognition is done using correlation technique. The algorithm was experimented with 100 images of Indian vehicles taken under different surroundings of circumstances. The investigational outcome shows that 100% accuracy acquired is comparable to the best

figures reported in literature and is speedy in execution, proficient in recognition and easy in implementation. The system cannot handle two row plates that can be addressed in future.

In [21] an algorithm for ALPR applied to parking section is constructed by the authors. The essential steps are image acquisition, gray scale alteration; erect edging with the help of Sobel edge detector, filtering and matching; vertical and horizontal scanning for Number Extraction and Number Identification by utilizing template matching technique. The benefits of the proposed technique are high level of protection, automatic recognition of License Plate; with no need for human being observation and elevated swiftness. The restrictions are that the language of the number plate can be dissimilar and it cannot be identified if it is dirty or unclean. Comparing with the general preceding work that in some means controlled their working environment; hence the approaches projected in this paper are greatly less restricted.

Reference [22] is an ALPR system which contains various procedures. Pre-processing is performed by gray scale image transformation, filtering, adaptive Otsu's method for image binarization, Canny's edge detection; which has an accuracy of 98% which is extremely better than the other edge detection methods, feature extraction to localize the number plate from the automobile figure, horizontal and vertical projections for character segmentation, BPNN Number Identification. Proposed procedures perform powerfully, consequently on the whole system effectiveness increases.

S. Sudhanidhi and G.Sreenivasulu presented a novel ALPR system in [23], which comprises wiener technique for eliminating movement blurriness, pre-processing using Sobel vertical edge detection, median filtering, adaptive thresholding; License Plate detection using Sliding Window techniques containing coarse and fine window recognition, Number Plate confirmation using geometrical and textural properties, character segmentation based on thresholding and CCA and character recognition by comparing with the database.

Gaikwad Dhiraj Yeshwant, Samhita Maiti and Prof. P. B. Borole developed an ALPR system in [24] and the techniques used in this paper are image gray conversion, morphological dilation, horizontal and vertical edge processing using histogram approach, passing histograms through a low pass digital filter, filtering out unwanted regions in an image segmentation, region of interest extraction, character recognition using OCR. This procedure has a benefit of being uncomplicated and speedy while balancing with any other procedures and performs acceptably for broad distinction of circumstances and different types of number plates; however, proposed method still needs development, in terms of rapidity of truck, lettering and skew in the representation.

In [25], authors presented an ALPR, which contains new algorithm for License Plate Recognition using gray scale conversion, morphological and thresholding operations, vertical edge detection, some morphological opening and closing operations, positioning with the aid of bounding box evaluation, number region enhancement for Number Extraction using, CCA, vertical projection analysis and pattern technique and characteristic mining for Number Identification. The outcomes illustrate the rate of positioning as 90%, Number Extraction as 85% and Number Identification as 84%. Main shortcoming is that, it fails in identifying double line Number Plate.

4. COMPARISON OF REVIEWED RESULTS

This segment explores the performance assessment of a variety of recognition algorithms for an ALPR. Various techniques that are used for character recognition have a few benefits and drawbacks and the performance and effectiveness of the recognition system are based on these techniques. TABLE 1 is a comparison of various LPR algorithms being reviewed.

A graphical demonstration of the above reviewed results is also shown in Fig.6, which gives the effectiveness (%) of specified ALPR structures.

Table 1
% Efficiency of The Reviewed Algorithms

Reference Number	*Methods/Techniques*	*% Efficiency*
[1]	RS-BP Neural Network	91.9%
[4]	Improved Segmentation method	93%
[7]	LOG edge detection and Morphological operations	93%
[11]	Fuzzy logic classifier	87.22%
[12]	Contour Analysis	98%
[16]	Wavelets and Neural Networks	91.5%
[19]	BP and LV Neural Networks	94.44%
[20]	Improved Template Matching Algorithm	100%
[22]	BP Neural Network	98%
[25]	Automatic Licenses Plate Recognition	85%

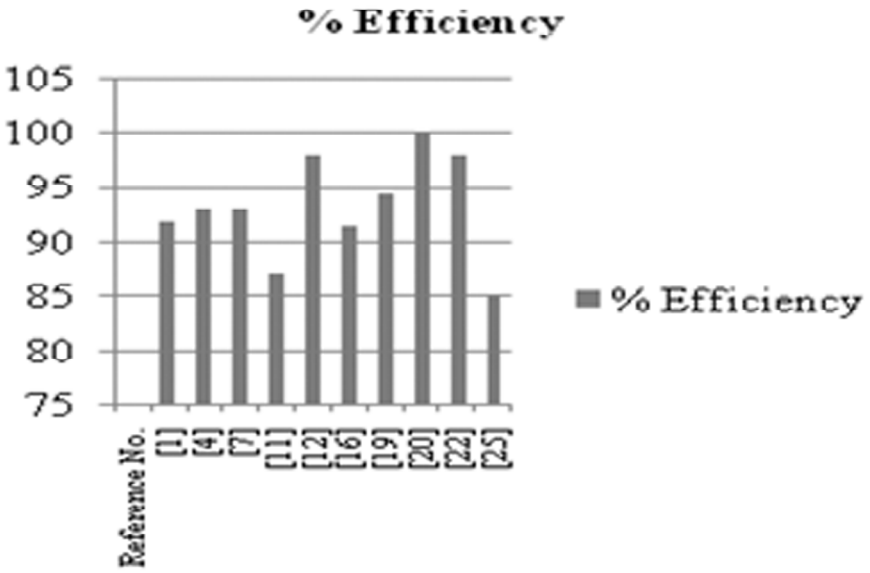

Figure 6: The % Efficiency of the Reviewed Algorithms

5. CONCLUSION AND FUTURE DIRECTIONS

This paper explores a widespread investigation of research on 25 various algorithms for License Plate character Recognition, which have been considered and compared to each other based on certain criteria. ALPR system acts a central character in Intelligent Transportation System (ITS) and has turned out to be a main solution of numerous traffic associated applications. Perfectly detecting the number plate from a motor vehicle image, extracting the numbers and characters from number plate and rapidly recognizing the number are treated to be the chief phases of ALPR system. They appreciably influence the identification accuracy and processing swiftness of the whole system.

Since LPR system comes across with a mixture of tribulations like illumination circumstances, rivet, different sizes, and rupture within truck pictures; the identification efficiency should be excellent to turn out a competent successful outcome. Thus to engender a valuable result, we reviewed different techniques for this system to know from which one we can get a improved accuracy and successful outcome and performance is experimented on actual pictures. Algorithms obtainable in this paper have both optimistic and pessimistic sides and so these procedures are compared by evidently citing their pros and cons. Some algorithms work fine for some cases; but not for other conditions, so depending on our obligation we should pick the algorithm

for our ALPR structures. Foremost involvement of our paper has been to make available a concise foundation of indication for researchers involved in License Plate detection and recognition. In our upcoming work, we focus on the evaluation of the hardware implementation of these particular algorithms.

REFERENCES

[1] Zou Yingyong, Zhai Jian, Zhang Yongde, Cao Xinyan, Yu Guangbin and Chen Juhui, "Research on Algorithm for Automatic License Plate Recognition System", International Journal of Multimedia and Ubiquitous Engineering, Vol. 10, No. 1 (2015), pp. 101-108.

[2] Meenakshi and R. B. Dubey, "Vehicle License Plate Recognition System", International Journal of Advanced Computer Research, Vol. 2 No. 4, Issue 7, December-2012.

[3] Vaishali Singh, Sushmita Tiwari and Rajiv Kumar, "A Novel Approach to an Automatic License Plate Recognition (ALPR) System", The International Journal Of Science & Technoledge, Vol. 3, Issue 3, March, 2015.

[4] G. T. Sutar and Prof. A.V. Shah, "Number Plate Recognition Using an Improved Segmentation", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 3, Issue 5, May 2014.

[5] Lajish V. L and Sunil Kumar Kopparapu, "Mobile Phone Based Vehicle License Plate Recognition for Road Policing", Apr 2015.

[6] Sneha G. Patel, "Vehicle license plate recognition using morphology and neural network", International Journal on Cybernetics & Informatics, Vol. 2, No.1, February 2013.

[7] R. Radha and C.P.Sumathi, "A novel approach to extract text from license plate of vehicles", Signal & Image Processing: An International Journal, Vol. 3, No. 4, August 2012.

[8] Lekhana G.C. and R. Srikantaswamy, "Real time license plate recognition system"**,** International Journal of Advanced Technology & Engineering Research,Vol. 2, Issue 4, July 2012.

[9] Dong Zheng Hao and FengXin, "Research on License Plate Recognition Algorithm based on Support Vector Machine", Journal of multimedia, Vol. 9, No. 2, February 2014.

[10] Shilpa Pawar, Prabhakar Singh, Shailender Singh and Roshan Kumar, "Automatic Number Plate Recognition", International Conference on Inter Disciplinary Research in Engineering and Technology, 2015.

[11] J. Layolin sobiya and P. Angelin Priya, "Automatic multistyle licensed plate detection by using fuzzy logic classifier", International Journal of Advanced Research in Computer Engineering & Technology, Vol. 3 Issue 4, April 2014.

[12] Kumary R. Soumya, Angel Babu and Laya Therattil, "License Plate Detection and Character Recognition Using Contour Analysis", International Journal of Advanced Trends in Computer Science and Engineering, Vol. 3, No.1, Feb 2014.

[13] Rinky Sharma, "Automatic License Plate Based Smart Vehicle Validation & Security by Gate Control &Email Send", International Journal of Computer Science and Information Technologies, Vol. 6 (2), 2015.

[14] Teena Singh Rajput, "Automatic Vehicle Number Plate Recognition Using Morphological Edge Detection and Segmentation", International Journal of Emerging Technology and Advanced Engineering, Vol.5, Issue 1, Jan 2015.

[15] Jin Chong. Chen Tianhua and Ji Linhao, "License Plate Recognition Based on Edge Detection Algorithm", Intelligent Information Hiding and Multimedia Signal Processing, IEEE 2013.

[16] Dhiraj ahuja and Kuldeepak, "License plate recognition using wavelets and neural networks", Journal of Research in Electrical and Electronics Engineering, Vol. 2, Issue 1, Jan 2013.

[17] Er. Kavneet Kaur and Vijay Kumar Banga, "Number plate recognition using ocr technique", International Journal of Research in Engineering and Technology, Vol. 2 Issue 9, Sep. 2013.

[18] Harshita Singh, Deepak Pandey, Surabhi Verma and Preeti Dhiman, "Automatic License Plate Recognition System", Journal of Emerging Technologies and Innovative Research, Vol. 2, Issue 3, March 2015.

[19] Anuja P. Nagare, "License Plate Character Recognition System using Neural Network", International Journal of Computer Applications, Vol. 25, No. 10, July 2011.

[20] Shreeja Chakraborty and Ranjan Parekh, "An Improved Template Matching Algorithm for Car License Plate Recognition", International Journal of Computer Applications, Vol. 118, No. 25, May 2015.

[21] Karishma. K .Jage, Gauri . D. Joshi, Shradhadevi . S. Nair and Shweta . A. Patil, "An Algorithm For Automatic License Plate Recognition Applied To Parking Section", International Journal of Engineering Research & Technology, Vol. 2, Issue 3, March–2013.

[22] Rishabh Agrawal, Saurabh Sharma and Shayani Gupta, "Number Plate Recognition System For Indian Vehicles", International Journal of Engineering Research & Technology, Vol. 2, Issue 3, March-2013.

[23] S. Sudhanidhi and G.Sreenivasulu, “License Plate Extraction and Recognition of Characters of a vehicle Using Sliding Window Technique”, International Journal of Engineering Research & Technology, Vol. 2, Issue 9, Sep 2013.

[24] Gaikwad Dhiraj Yeshwant, Samhita Maiti and Prof. P. B. Borole, “Automatic Number Plate Recognition System (ANPR System)”, International Journal of Engineering Research & Technology, Vol. 3 Issue 7, Jul 2014.

[25] Ronak P Patel, Narendra M Patel and Keyur Brahmbhatt, “Automatic Licenses Plate Recognition”, International Journal of Computer Science and Mobile Computing, Vol. 2, Issue 4, April 2013.