

Advanced License Number Plate Recognition System

Prof.Pallavi khare^{1,(a)}, Rupesh Dudhe^{2,(b)}, Amolsing Chungade^{2,(c)}, Ajit Naykinde^{2,(d)}

^{1,(a)} Prof, ^{2,(b)(c)(d)} Students Dept of Electronics & Telecommunication Engineering,
Dr. D Y Patil Institute of Engineering and Technology
Pimpri , Pune – 18, India

Abstract—This paper aims with character recognition of character of vehicle number plate .Advanced vehicle license number plate recognition system is the real time embedded system in which it automatically recognize the number of the vehicle. In this we considered the implementation of recognizing number plate. The recognized number are then transferred through network channel by using encryption & decryption technique. First recognized characters are embedded into image and that data is encrypted by using private key at sender's end.

At the receiving end, the data is extracted from the image by using decryption technique.

Keywords—License plate localization, binarization, edge detection, localization, deskewing, segmentation, normalization, feature extraction, license plate character recognition.

I. INTRODUCTION

Automatic Number Plate Recognition (ANPR) was invented in 1976 in the UK. The Automatic number plate recognition (ANPR) is the method that uses optical character recognition on images to read the license plate on vehicle. For this method can use specially designed camera i.e. closed circuit or road rule enforcement cameras. These kind of camera may used by various places by police or any other who want it, specially it is found at the electronic toll plazas. The ANPR can used to stored the images captured by cameras as well as text from the number plate, some cameras may able to store the picture of the driver. The ANPR work is generally framed into the steps: Number plate extraction, character segmentation, character recognition.

From the full image, only the number plate is detected and processed to the next step of character segmentation. In character segmentation phase each and every character is isolated and segmented. Based on the selection of features of characters, each character is recognized, in the character recognition phase. Extraction of number plate is difficult task, due to: Number plates generally have a small portion of whole image; difference in number plate formats, this step affects the accuracy of character segmentation and recognition work.

Basically, the Number Plate Recognition operation consists in capturing, recognizing and storing information such as images, plate numbers and location on a database for online verification or posterior analysis. The approach presented in this paper is to extract the region of the number plate from images taken from indoor parking lots, which suffer from various real world problems like lighting condition, luminance, weather conditions etc.

II. EXISTING SYSTEM

ANPR System using OCR

At the hub of the system is the OCR (Optical Character Recognition

system) which is used to extract the alphanumeric characters present on the number plate. To do this it first uses a series of image manipulation techniques to detect, normalize and enhance the image of the number plate. There are two components in the system, the cameras at the front-end and the remote computers at the back-end. Usually two cameras are used at a time to increase efficiency. The cameras as shown in the Fig. 1 just perform the task of capturing the images of number plates and sending it to the remote computers. The remote computers then perform further operations like OCR on the stored images sent by the cameras at the lane-level. In order to process the high amount of images stored, a “server farm” is used which comprises of many computers working together. An example of a server farm can be the London Congestion Charge project. The remote computers can be linked with the database which stores the details of the car owners and thus the required information can be obtained. Using this information the culprit can be caught.

The ANPR system using OCR was found to have the following shortcomings /disadvantages:

1. Misidentification:

In case the number is read partially, the remote computer might identify the number plate incorrectly or would not be able to decrypt at all.

2. Hazy images:

Hazy images can also make the detection process erroneous or there is a possibility of no detection at all.

3. Flaws in angular detection:

Angular detection is not possible in case of ANPR as the rectangulation algorithm, implemented in OCR is not possible thus characters may be misread/ overlapped.

III. PROPOSED METHOD

We first introduce how to locate license plates and extract their corresponding regions, then segment these characters on

located license plate, and finally use K-nearest neighbor (KNN) classifiers to recognize these segmented characters.

The K-nearest-neighbor (KNN) algorithm measures the distance between a query scenario and a set of scenarios in the data set. KNN is more appropriate than PNN (Probabilistic Neural Network) and its recognition rate is up to 98.51 % on average.

The recognition rate on average is about 95.87 % for the PNN classifier and about 98.51 % for the KNN classifier. The highest recognition rate for all arguments and block types for PNN are 97.14 %, the highest recognition rate for all ks and block types for KNN are 100 %. The highest recognition rate for block type is block 5x5, and the second is 10x5, no matter which classifier. Their recognition rates are 96.97 % (PNN) and 99.77 % (KNN), respectively. The KNN classifier uses features of testing image returns recognized character

IV. LITERATURE REVIEW

1. Paper: License Plate Character Recognition system using KNN

Source: 2006 IEEE

Author: Yen-Ching Chang, Huai-Chun Hsu, Jen-Jieh Lee, Chin-Chen Chueh

Abstract - Since license plate character recognition plays a very important role in vehicle control, such as electronic toll collection (ETC) for highways and management for parking lots, the cost of management can be reduced and the implementing efficiency can be promoted by automatizing license plate character recognition. As the technology of image processing, classifiers, and computational speed on computer advances, we adopt Sobel operators to detect the boundaries of objects in order to extract license plate regions. After extracting license plate regions, we segment corresponding characters and then standardize these characters in order to find out the features of characters, and finally use the classifiers of support vector machine (SVM) and K-nearest neighbor (KNN) to train and then recognize characters. Experimental results show that classifiers and features are closely linked, and KNN is more appropriate than SVM, and its recognition rate is up to 98.51 % on average.

2. Paper : An Approach for Automatic Detection of Vehicle License Plate and Character Recognition Using Classification Algorithm

Source : 2013 IJETAE

Author : Pawan Wawage, Shraddha Oza (Dept of Computer Engineering, MIT, Pune, India)

Abstract : Automatic Identification of Vehicle License Plate is a real time embedded system which identifies the characters directly from the image of the vehicle license plate. Since number plate guidelines are not strictly practiced everywhere, it often becomes difficult to correctly identify the non-standard number plate characters. This paper proposes a vehicle number plate identification system, which extracts the characters features of a plate from a captured image by a digital camera. This paper deals with computing techniques from the field of Artificial Intelligence, machine vision, and neural networks in construction of an Automatic System for Identification of Vehicle License Plate and Character Recognition.

3. Paper : An Approach for Automatic Vehicle License Plate Recognition Using Classification Algorithm

Source : 2011 IJARET

Author : M. M. Kodabagi, Mr. Vijayamahantesh S. Kanavi (Department of Computer Science and Engineering, Basaveshwar Engineering College, Bagalkot, Karnataka, India)

Abstract : License Plate Recognition (LPR) has been intensively studied in many countries. Due to the different types of number plates being used, the requirements of an automatic number plate recognition system are different for each country. In general, objective of any LPR system is to localize and recognize potential license plate region(s) of the vehicle images captured from handheld device/digital camera/mobile phone camera. The proposed method for License Plate Recognition (LPR) system works in three modules: localization of license plate, segmentation of the characters and recognition of the characters from the license plate.

Localization of the license plate is done using morphological operations, horizontal & vertical edge processing. Character segmentation is carried out using connected component labeling. Character recognition is done by using Neural Network classifier. The method is tested on 100 samples of Indian vehicle images. The system achieves 86% accuracy in localization, 81% accuracy in segmentation and 80% accuracy in character recognition.

PROBLEM STATEMENT:

Problem Definition –We considered the vehicle number plate as input image, system should extract that number from the image and should search the database for that recognized number plate. It should recognize the number plates even in the low light or shadow like conditions.

Problem Output - The main moto of ANPR system is to recognize the number plates gently and with higher efficiency without any human interference. The functionality of the system provides the ability to track a vehicle in any area.

Input image are taken from the front camera. The images are processed and the number plate will be detected. These detected number plate is then be used to find in the database to see if it present or not.

V. MATHEMATICAL STRUCTURE

1. Let us consider **S** as a system for Number Plate Recognition System for Indian Vehicles including the set of inputs, set of outputs, set of function, set of limitation, set of condition.

2. $S = \{ \dots \}$

3. Identify the inputs

$$S = \{ I, \dots \}$$

Input set:

$$I = \{ R \}$$

Where,

R is the set of image.

$$R = \{ i \mid 'i' \text{ images retrieved from database} \} \\ = \{ i \mid i=1 \}$$

4. Identify the outputs

$$S = \{ I, O, \dots \}$$

Output set:

$$O = \{ RN, RS, PI \}$$

Where,

RN is the set of recognized number.

$$RN = \{ i \mid i \text{ is the recognized number} \} \\ \text{Where,}$$

RS is the set of records associated with the number plate

$$RS = \{ i \mid i \text{ is the number of records} \} = \{ i \mid i=1 \}$$

Where,

PI is the set of image after preprocessing of the number

plate.

$PI = \{ i \mid i \text{ is the preprocessed image} \}$

5. Identify the functions

$$S = \{ I, O, F, \dots \}$$

Function set:

$$F = \{ M1, M2, M3 \}$$

Where,

$M1$ is the set of Functions used for preprocessing of the input image.

$$M1 = \{ E, B, L, S, SG \}$$

Where,

$E()$ enhances the features of the captured image. $B()$ is a function used to binarise the image

$L()$ is a function used to locate the number plate in the image.

$S()$ is a function that is used to sharpen the image.

$SG()$ is a function that is used to segmentation of the character.

$$M1(Ri) = PIi$$

$$M1i = \{ i \mid 'i' \text{ the preprocessed image} \}$$

Where, $M1$ preprocesses on the image Ri and gives the output as preprocessed image PIi .



$M2$ is the set of functions used for recognition of characters from preprocessed image of

$$M2 = \{ Rec \}$$

Where,

Rec recognizes the characters of the number plate.

$$M2(PIi) = RNi$$

$$M2i = \{ i \mid 'i' \text{ are the recognized characters} \}$$

Where,

$M2$ recognizes characters from the image PIi and gives the output as RNi



M3 is the set of functions used for searching and displaying records from the database.

M3= {SE,
D} Where,

SE searches the recognized number plate in the database.

D displays the details corresponding to the recognized number plate

M3 (RNi) =RSi

M3i= {i | 'i' are the recognized characters}

Where,

M3 searches and displays the details of the recognized number plate the image Ri and gives the output as Rs .



6. Identify the Limitations

$$S = \{I, O, F, P' \dots\}$$

Limitation Set:

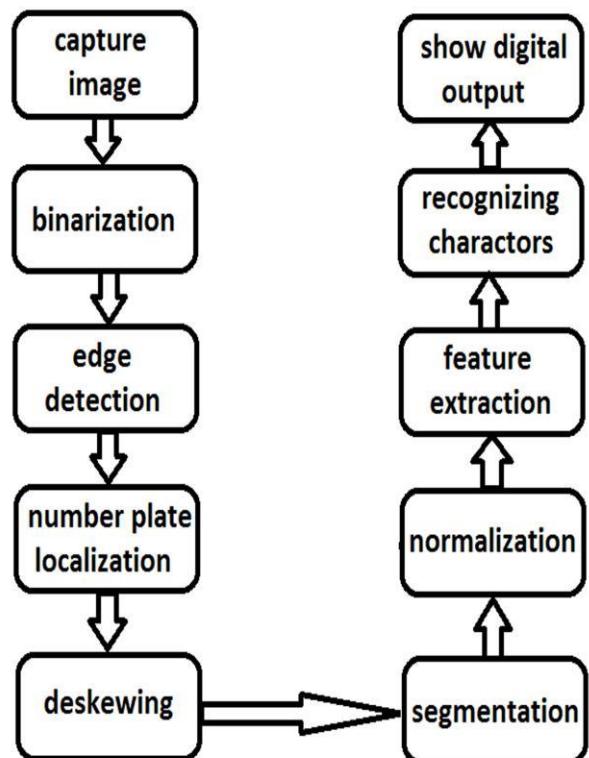
$$P' = \{Fz, Br\}$$

Where,

Fz states that the number plate to be recognized should not be fancy.

Br states that the number plate to be recognized should not be broken.

VI. BLOCK DIAGRAM



A. CAPTURE IMAGE

In image acquisition where vehicle images are acquire using the camera, Image can be input to the system by different methods by analog camera or by digital camera, nowadays digital technology has their advantages so better input method is by digital cameras or by direct digital photos. The camera sense the vehicle moving on the road and immediately capture either front or rare view of vehicle depending on the position of the vehicle.



Fig A. Capture image by using Camera

B. BINARIZATION

The captured image is then binarized, binarization is a widely used technique, its process is to first determine a gray threshold(GT) according to some objective criteria and then assigns each pixel (I_{xy}) to one class, windowing on the grey threshold image is then taken place, different methods are used for binarization, binarization process is broadly classified as global or local [9],[10], [11], [12] depending on how the threshold is calculated. In [8], the authors describe and evaluate the performance of about 40 different GT determining algorithms. This 40 thresholding methods are categorized into the six classes:(1)histogram shape-based methods,(2) clustering- based methods, (3)entropy-based methods, (4)object attribute-based methods, (5)the spatial methods and (6)local methods based on the local characteristics of each pixel.

Among these classes, many thresholding algorithms are based on independently defined criteria to acquire the optimal segmenting threshold, In this paper we propose a new edge based adaptive thresholding method which is capable of preserving the text region of an image robustly in real life conditions. This method uses local edge properties in a window to compute threshold which can be effectively used for text region extraction from the vehicle license plate images.



Sample no plate image



Windowing on Gray image

Fig B. Plate Binarization

C. EDGE DETECTION

After binarizing the image next step is to detect the edge of the license plate from the body of the vehicle. Let an image foreground be represented by G_1 and background by G_2 gray levels and let $G_1 > G_2$. Typically the gray levels between background and foreground change gradually. For binarizing such an image we should have a threshold GT such that $G_1 \geq GT \geq G_2$. A typical edge detection algorithm would mark edges at all or some of the locations marked by arrows in Figure 2. We exploit the edge image and use the edge pixels to identify the threshold (GT) for binarization. A computationally simple way to compute GT is to take the average gray value of the all the pixels on the edges.

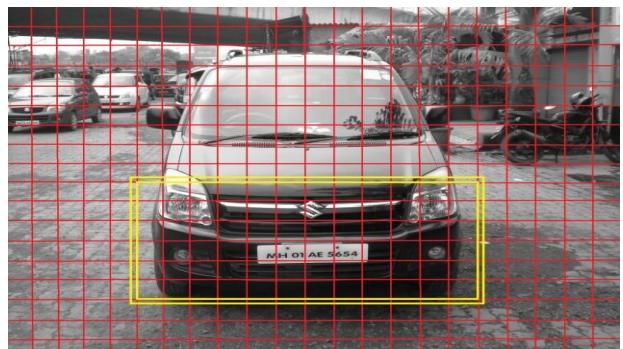


Fig C.1. Edge detection

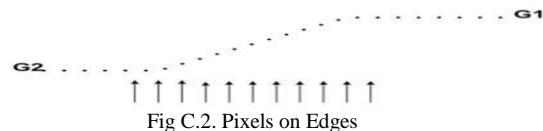


Fig C.2. Pixels on Edges

D. NUMBER PLATE LOCALIZATION

After detecting the edges of the vehicle next step is to find out where the number plate is located on the body of the vehicle, due to different size and shape of vehicles it is important to detect the location of the license plate area among the body of the vehicle,

Let us consider the number plate as a “rectangular area with increased occurrence of horizontal and vertical edges”. This process can sometimes detect a wrong area that does not correspond to a number plate. Because of this, we often detect several candidates for the plate by different algorithms.

There are several heuristics, which are used to determine the cost of selected candidates according to their properties. These heuristics have been chosen on ad-hoc basis during the practical experimentations. This recognition logic sorts candidates according to their cost from the most suitable to the least suitable. Then, the most suitable candidate is examined by a deeper heuristic analysis. The deeper analysis definitely accepts, or rejects the candidate. As there is a need to analyze individual characters, this type of analysis consumes big amount of processor time.



Fig D. Number plate localization

E. DESKEWING

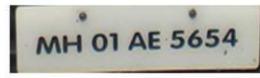
The captured rectangle plate can be rotated and skewed in many ways due to the positioning of vehicle towards the camera. Since the skew significantly degrades the recognition abilities, it is important to implement additional mechanisms, which are able to detect and correct skewed plates. The number plate is an object in three-dimensional space, which is projected into the two dimensional snapshot during the capture. The positioning of the object can sometimes cause the skew of angles and proportions. Hough transform is special operation, which is used to extract features of specific shape within a picture. The classical Hough transform is used for the detection of lines. The Hough transform is widely used for miscellaneous purpose in the problematic of machine vision, but here it is used to detect the skew of capture plate, and also to compute an angle of skew localization.

After capturing the front or rear view of the vehicle, the first step is to detect the exact area of the number plate from the captured image. Let us define the number plate as a “rectangular area with increased occurrence of horizontal and vertical edges”. The high density of horizontal and vertical edges on a small area is in many cases caused by contrast characters of a number plate, but not in every case. This process can sometimes detect a wrong area that does not correspond to a number plate. Because of this, we often detect several candidates for the plate by different algorithms.

There are several heuristics, which are used to determine the cost of selected candidates according to their properties. These heuristics have been chosen on ad-hoc basis during the practical experimentations. The recognition logic sorts candidates according to their cost from the most suitable to the least suitable. Then, the most suitable candidate is examined by a deeper heuristic analysis. The deeper analysis definitely accepts, or rejects the candidate. As there is a need to analyze individual characters, this type of analysis consumes big amount of processor time.



Before Deskewing



After Deskewing

Fig E. Deskewing

F. SEGMENTATION

By this step characters on license plate are segmented and identify. This step is the most important step in license plate recognition because all further steps rely on it. There are many factors that cause the character segmentation task difficult, such as image noise, plate frame, rivet, space mark, plate rotation and illumination variance. We here propose the algorithm that is quite robust and gives significantly good results on images having the above mentioned problems. for the segmentation pre-processing is required by conversion to gray scale and binarization. We use the method of horizontal projection for segmentation, If we assume only one row plate, the segmentation is the process of finding horizontal boundaries between characters. The segmented area of the plate can contain redundant space and other undesirable elements besides the characters. Since the “segment” has been processed by an adaptive thresholding filter, it contains only black and white pixels. The neighboring pixels are grouped together into larger pieces, and one of them is a character. Our goal is to divide the segment into several pieces, and identify only one piece representing the regular character.

The second phase of the segmentation is an enhancement of segments. The piece chosen by the heuristic is then converted to a monochrome bitmap image. Each such image corresponds to one horizontal segment. These images are considered as an output of the segmentation phase.

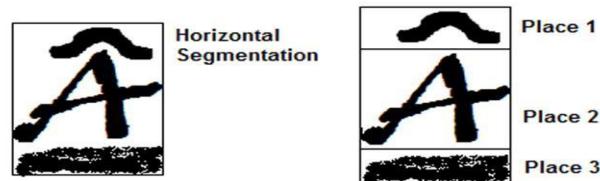


Fig F. Horizontal segment of the number plate

G. Normalization of Character

The first step in character normalization is to adjust the brightness and contrast of the segmented image, after adjusting brightness and contrast the second step is resize the characters in uniform dimension, the third step is feature extraction, the feature extraction algorithm extracts appropriate descriptors from the normalized characters, the normalization of the character is important step because brightness and contrast characteristics of segmented characters are varying due to different light conditions during the image is captured, techniques of global and adaptive thresholding are used to obtain monochrome representations of processed character segments. The monochrome (black & white) representation of image is more appropriate for analysis, because it defines clear boundaries of contained character.

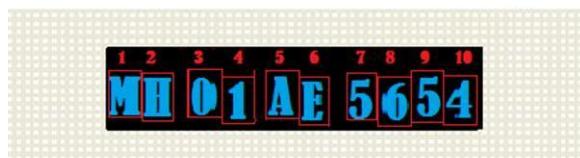


Fig G. Plate Normalization

H. FEATURE EXTRACTION

Before extracting feature descriptors from a bitmap representation of a character, it is necessary to normalize it into unified dimensions. We define the term “re-sampling” as the process of changing dimensions of the character. As original dimensions of un-normalized characters are usually higher than the normalized ones, the characters are in most cases down sampled. When we say down sample, we reduce information contained in the processed image.

There are several methods of re-sampling, such as the pixel re-size, bilinear interpolation, or the weighted-average re-sampling. We cannot determine which method is the best in general, because the successfullness of a particular method depends on many factors. To recognize a character from a bitmap representation, there is a need to extract feature descriptor of such bitmap. As the extraction method significantly affects the quality of whole OCR process, it is very important to extract features which will be invariant towards the various light conditions, used font type and deformation of characters caused by a skew of the image.

The description of normalized character is based on its external characteristics because we deal only with properties such as character shape. Then, the vector of descriptors includes characteristics such as number of lines, bays, lakes, the amount of horizontal, vertical, or diagonal edges etc. The feature extraction is a process of transformation of data from a bitmap representation into a form of descriptors, which are more suitable for computers. If we associate similar instances of the same character into the classes, then the descriptors of characters from the same class should be geometrically closed to each other in the vector space. This is the basic assumption for successfullness of the pattern recognition process.



Fig H.1. Extracted plate



Fig H.2. Histogram of extraction plate

I. CHARACTER RECOGNITION

By number plate extraction step final result is founded. Consider following figure as an final extracted license plates. The variations of the plate types or environments cause challenges in the detection and recognition of license plates. They are summarized as follows:

- 1) Location: Plates exist in different locations of an image.
- 2) Quantity: An image may contain no or many plates.
- 3) Size: Plates may have different sizes due to the camera distance and the zoom factor.
- 4) Colour: Plates may have various characters and background colours due to different plate types or capturing devices.
- 5) Font: Plates of different nations may be written in different fonts and language.

In this paper, the feature is referred to as block-binary-pixel-sum, which was applied in the paper. They provided an automatic license plate.

J. Digital Output

After Character Recognition process the recognized no apply to MATLAB software for further processor using KNN algorithm, the MATLAB Software provide number of license plate at the output.

MH 01 AE 5654

Fig J. Digital Output

VII. SOFTWARE DESIGN

Introduction to JAVA

Java is a high-level, third generation programming language, like C, FORTRAN, Smalltalk, Perl, and many others. You can use Java to write computer applications that play games, store data or do any of the thousands of other things computer software can do. Compared to other programming languages, Java is most similar to C. However

although Java shares much of C's syntax, it is not C. Knowing how to program in C or, better yet, C++, will certainly help you to learn Java more quickly, but you don't need to know C to learn Java. A Java compiler won't compile C code, and most large C programs need to be changed substantially before they can become Java programs. What's most special about Java in relation to other programming languages is that it lets you write special programs called applets that can be downloaded from the Internet and played safely within a web browser. Java language is called as an Object-Oriented Programming language and before beginning for Java, we have to learn the concept of OOPs (Object-Oriented Programming).

Features of Java are as follows:

1. Compiled and Interpreted
2. Platform Independent and portable
3. Object- oriented
4. Robust and secure
5. Distributed
6. Familiar, simple and small
7. Multithreaded and Interactive
8. High performance
9. Dynamic and Extensible

KNN (K-nearest-neighbor) Algorithm:

The K-nearest-neighbor (KNN) algorithm measures the distance between a query scenario and a set of scenarios in the data set.

- KNN is more appropriate its recognition rate is up to 98.51 % on average.
- The highest recognition rate for all ks and block types for KNN are 100 %.
- The highest recognition rate for block type is block 5x5, and the second is 10x5, no matter which classifier. Their recognition rates are 99.77 % (KNN).
- The KNN classifier uses features of testing image returns recognized character.

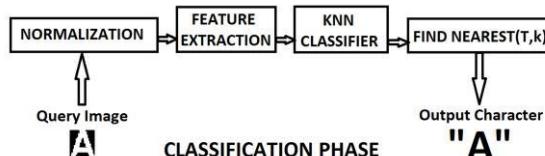


Fig b. KNN-based Character Classifier

Used Software

Net Beans IDE 7.4 software

NetBeans IDE is an open source integrated development environment. NetBeans IDE supports development of all JAVA application types out of the box.

- Developer : Oracle Corporation

- Stable Release: 8.0.1/September 9 2012
- Written in : JAVA
- Operating System: Windows, Mac OSX, Linux.
- Platform : JAVA SE.
- Available in : 24 Language.
- Type : JAVA IDE.
- License : CDDL or GPL2.

CONCLUSION

The aim of the paper is to raise the recognition rate of license plate characters through a combination of three main procedures. All trained and tested characters came from the following two main procedures: extracting license plate, segmenting characters. As a rule, the effectiveness of character processing will affect the effect of selected features, and then further affects the efficacy of chosen classifiers. As expected, experimental results show that our proposed combination of three main procedures does give a very high recognition rate, which can be up to 100 % for KNN

The system has been tested on static snapshots of vehicles, which has divided into several sets according to difficulties. Sets of blurry and skewed snapshots give worse recognition rates than a set of snapshots, which has been captured clearly.

The objective of the tests was not to find 100% recognizable set of snapshots, but to test the invariance of the algorithms on random snapshots systematically classified to the sets according to their properties.

Currently there are certain restrictions on parameters like speed of the vehicle, script on the number plate, cleanliness of number plate, quality of captured image, skew in the image which can be aptly removed by enhancing the algorithm further.

REFERENCES

- [1] Su-Hyun Lee, Young- Soo Seok and Eung-Joo Lee Department of information/Communication Eng., TongMyong Univ. of Information Technology: Multi-National Integrated Car-License Plate Recognition System Using Geometrical Feature and Hybrid Pattern Vector.
- [2] V. Franc and V. Hlaváč, Statistical Pattern Recognition Toolbox for MATLAB: User's Guide, Center for Machine Perception, Czech Technical University, 2004.
- [3] V. Wu, R. Manmatha, and E.M. Riseman, Automatic text detection and recognition. Proceedings of Image Understanding Workshop, pages 707-712, 1997.
- [4] V.L Lajish and Sunil Kopparapu. Mobile phone based vehicle licenseplate recognition for road policing. Experience Workshop, New Delhi, December 18, 2009 Co-located and Concurrently with Third International Conference on Pattern Recognition and Machine Intelligence(PReMI'09), 2009.
- [5] W. Zhou, H. Li, Y. Lu, and Q. Tian, "Principal visual word discovery for automatic license plate detection," IEEE Trans. Image Process., vol. 21, no. 9, pp. 4269-4279, 2012.
- [6] Y. Hasan and L. Karam, "Morphological Text Extraction from Images," IEEE Trans. Image Process., vol. 9, no. 11, pp. 1978-1983, 2000.
- [7] Z.-X. Chen, C.-Y. Liu, and F.-L. Chang, "Automatic license-plate location and recognition based on feature salience," IEEE Trans. Veh. Technol., vol. 58, no. 7, pp. 3781-3785, 2009.

[8] L. Angeline, M. Y. Choong, F. Wong, and K. T. K. Teo, "Tracking and localisation of moving vehicle license plate via signature analysis," *Int. Conf. Mechatronics: Integr. Eng. Ind. Soc. Dev.*, 2011.

[9] Luis Salgado, Jose M. Mene'ndex, Enrique Rendnn and Narciso Garcia (1999): Automatic Car Plate Detection and Recognition through Intelligent Vision Engineering, IEEE.

[10] Muhammad Tahir Qadri, Muhammad Asif : Automatic Number Plate Recognition System for Vehicle Identification Using Optical Character Recognition, International Conference on Education Technology and Computer, IEEE 2009.

[11] Osslan Osiris Vergara Villegas, Daniel Gonzál ez Balderrama, Humberto de Jesús Ochoa Domínguez and Vianey Guadalupe Cruz Sánchez, "License Plate Recognition Using a Novel Fuzzy Multilayer Neural Network", International Journal of Computers, Issue 1, Volume 3, 2009, pp.31-40.

[12] P.Anishiya, Prof. S. Mary Joans, "Number PlateRecognition for Indian Cars using Morphological Dilation andErosion with the Aid of Ocros" , 2011 International Conference on Information and Network Technology IACSIT Press, Singapore, IPCSIT vol.4 2011, pp.116-119.

[13] Prof. Thomas B. Fomby – "K-Nearest Neighbors Algorithm: Prediction and Classification" Department of Economics Southern Methodist University Dallas, TX 75275 February 2008

[14] R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, third ed., New Jersey: Prentice Hall, 2008.

[15] Rainer Lienhart and Axel Wernicke. Localizing and segmenting text in images and videos. *IEEE Transaction On Circuits and Systems for Video Technology*, 12(4), April 2002.

[16] Raveendran Pillai, Prof: (Dr). Sukeesh Kumar. A: A Real-time system for the automatic identification of motorcycle - using Artificial Neural Networks Recognition, World Academy of Science, Engineering and Technology 9, 2005.

[17] S. Du, M. Ibrahim, M. Shehata, and W. Badawy, "Automatic license plate recognition (ALPR): A state-of-the-art review," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 23, no. 2, pp. 311-325, 2013.

[18] Christos Nikolaos E. Anagnostopoulos, Ioannis E. Anagnostopoulos, Vassili Loumos, and Eleftherios Kayafas, "A License Plate-Recognition Algorithm for Intelligent Transportation System Applications", *IEEE, Transactions on Intelligent Transportation Systems*. Vol. 7, No.3, September 2006. pp. 377-392.

[19] Danian Zheng, Yannan Zhao, and Jiaxin Wang. An efficient method of license plate location. *Pattern Recogn.Lett.*, 26(15):2431–2438, 2005.

[20] F. Aghdasi and H. Ndungo, "Automatic licence plate recognition system," *IEEE AFRICON Conf.*, vol. 1, pp. 45–50, 2004.

[21] Hamid Mahini, Shohreh Kasaei, Faezeh Dorri, andFatemeh Dorri. Anefficient features - based license plate localization method. In *ICPR'06: Proceedings of the 18thInternational Conference on Pattern Recognition*, pages 841– 844, Washington, DC, USA, 2006. IEEE ComputerSociety.

[22] J. Sauvola and M. Pietikäinen, "Adaptive document image binarization," *Pattern Recognit.*, vol. 33, p. 225-236, 2000.

[23] J.-M. Guo and Y.-F. Liu, "License plate localization and character segmentation with feedback self-learning and hybrid binarization techniques," *IEEE Trans. Veh. Technol.*, vol. 57, no. 3, pp. 1417-1424, 2008.

[24] L. Angeline, W. Y. Kow, W. L. Khong, M. Y. Choong, and K. T. K. Teo, "License plate character recognition via signature analysis and features extraction," *Proc. Int. Conf. Comput. Intell., Model. Simulation*, pp. 1-6, 2012.

[25] Audibert, J.Y. & Tsybakov, A.B. (2007) "Fast learning rates for plug-in classifiers under the margin condition", *Ann. Statist.*, 35: 608–633.

[26] Bailey, T. & Jain, A. (1978) "A note on distance-weighted k-Nearest Neighbor rules", *IEEE Trans. Systems, Man, Cybernetics*, 8: 311-313.

[27] Baoli, L., Shiwen, Y. & Qin, L. (2003) "An Improved k-Nearest Neighbor Algorithm for Text Categorization, ArXiv Computer Science e-prints.

[28] Bauer, M.E., Burk, T.E., Ek, A.R., Coppin, P.R. Lime, S.D., Walsh, T.A., Walters, D.K., Befort, W. & Heinzen, D.F. (1994) "Satellite Inventory of Minnesota's Forest Resources", *Photogrammetric Engineering and Remote Sensing*, 60(3): 287–298.

[29] Bax, E. (2000) "Validation of nearest neighbor classifiers", *IEEE Trans. Inform. Theory*, 46: 2746–2752.

[30] Benetis, R., Jensen, C., Karciauskas, G. & Saltenis, S. (2006) "Nearest and Reverse Nearest Neighbor Queries for Moving Objects", *The International Journal on Very Large Data Bases*, 15(3): 229–250.

[31] Bermejo, T. & Cabestany, J. (2000) "Adaptive soft k-Nearest Neighbor classifiers", *Pattern Recognition*, 33: 1999-2005.

[32] Chitra, A. & Uma, S. (2010) "An Ensemble Model of Multiple Classifiers for Time Series Prediction", *International Journal of Computer Theory and Engineering*, 2(3): 1793-8201.

[33] Cover, T.M. (1968) "Rates of convergence for nearest neighbor procedures", In *Proceedings of the Hawaii International Conference on System Sciences*, Univ. Hawaii Press, Honolulu, 413–415.

[34] Cover, T.M. & Hart, P.E. (1967) "Nearest neighbor pattern classification", *IEEE Trans. Inf. Theory*, 13: 21–27.

[35] Devroye, L. (1981) "On the asymptotic probability of error in nonparametric discrimination", *Ann. Statist.*, 9: 1320–1327.

[36] Devroye, L. (1981) "On the equality of Cover and Hart in nearest neighbor discrimination", *IEEE Trans. Pattern Anal. Mach. Intell.* 3: 75–78.

[36] Devroye, L., Gyorfi, L., Krzyzak, A. & Lugosi, G. (1994) "On the strong universal consistency of nearest neighbor regression function estimates", *Ann. Statist.*, 22: 1371– 1385.

[37] Devroye, L. & Wagner, T.J. (1977) "The strong uniform consistency of nearest neighbor density estimates", *Ann. Statist.*, 5: 536–540.

[38] Devroye, L. & Wagner, T.J. (1982) "Nearest neighbor methods in discrimination, In *Classification, Pattern Recognition and Reduction of Dimensionality*", *Handbook of Statistics*, 2: 193–197. North-Holland, Amsterdam.

[39] Domeniconi, C., Peng, J. & Gunopoulos, D. (2002) "Locally adaptive metric nearestneighbor classification", *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 24(9): 1281–1285.

[40] Dudani, S.A. (1976) "The distance-weighted k-nearest neighbor rule", *IEEE Transactions on System, Man, and Cybernetics*, 6: 325-327.

[41] Eldestein, H.A. (1999) "Introduction to Data Mining and Knowledge Discovery", Two Crows Corporation, USA, ISBN: 1-892095- 02-5.