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# Comparative Study of Different Techniques for License Plate Recognition

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## ABSTRACT
License Plate detection and recognition is a key technique in most of the traffic related applications such as searching of stolen vehicles, road traffic monitoring, airport gate monitoring, speed monitoring and Automatic parking access control. It is simply the ability to automatically extract and recognition of the vehicle license number plate's character from a captured image. The License plate recognition systems have established a lot of interest from the research community because there is a certain limitation in particular territory, city or countries and lack of equivalence among different license plates. In This paper, we try to give an enhance and comprehensive view of the research work made in the area of LP detection and recognition and the techniques employed in developing a License Plate Recognition (LPR) system. In this analysis we not only study and also compare the License Plate Recognition Techniques based on different criteria like plate region extraction, character segmentation and character recognition rate using ANN, RBFNN and Template Matching along with its pros and cons.

## Keywords
LP detection, License Plate Recognition, Artificial Neural Network, Radial Basis Function Neural Network, Template Matching.

## 1. INTRODUCTION
License Plate Recognition (LPR) is an image technology used to identify plates for their vehicles. This technology is gaining popularity in security and traffic facilities. The purpose of LPR was to build a system capable of automatically recording of the license plate numbers of passing vehicles traveling down a roadway. [1] Nowadays, the license plate recognition is broadly employed in traffic management to recognize a vehicle whose owner has despoiled traffic laws or to find stolen vehicles. Vehicle License plate detection and recognition is a key technique in most of the traffic related applications such as searching of stolen vehicles, road traffic monitoring, airport gate monitoring, speed monitoring and Automatic parking lots access control. [4]

In order to solve such License plate remains the principle vehicle identifier despite the fact that it can be deliberated altered in fraud situation (with stolen plate). The License plate recognition system (LPRS) was introduced in 1976 at the police scientific development branch at the United Kingdom (UK). It is similar to the Automatic number plate recognition (ANPR). However, it has achieved must greater interest during the last few decades along with the upgrading of the digital cameras and increased in computational capacity [2]. The Purpose of this Automatic license plate recognition system is to impact illicit drug trafficking on the regional stability of the metro city in particular in combination with other present destabilizing factors. It is simply the ability to automatically extract and recognition of the vehicle license number plate's character from a captured image. It is essentially consist of frame grabber or camera that has the ability to grab an image, find the location of the number in the figure and take out the character of an instrument of character recognition to convert the pixel into easily readable character. It can also be used in highly sensitive areas like military zones or area above top government head offices. The detection of the stolen vehicle can be done in an efficient manner by using ANPR system installed on the highways [2] [3].

The LPRS operates in three steps, the first step is the detection and capturing a vehicle image, second step is the detection and extraction of number plate in an image and last step is use image segmentation technique to get the individual character and Optical Character Recognition (OCR) to identify the individual character with the help of database stored for each and every alphanumeric character [4].

The License Plate Recognition System (LPRS) is normally made up of four parts, where each of the process contains sub process.

### A. LP image Location

License Plate Location is an integral and inseparable part of the system, as it locates the plate that encloses the license plate numbers. The whole concept depends on the edges of the license plate only because there are a huge data in the image. The extraction of multiple license plates from an image with a complex background is the main factor. Different processes performed to extract the license plate. The extractor gives its output to the segmentation part. [4]

### B. Character Segmentation

License plate segmentation, process is also called as the Character Separation. After the license plate images are extracted from a picture, and then find individual character in the license plate to recognize it. In the segmentation of license

plate characters, license plate is first converted into binary image then characters divided into segments to essential parts obtaining the characters separately [4]. License plate Segmentation is useful to the license plate in arrange to outline the individual characters. License Plate Segmentation, which is referred to as Character Isolation takes the region of interest and attempts to split it into individual characters.

### C. Character Recognition.

License Plate Recognition is the last step of the LPR system. This step is the main part of the recognition process which decides the accuracy and recognition rate of the system. This Recognition involves about to recognize the characters of the license plate numbers and character [4] [5]. Before the recognition the license plate characters are normalized. Normalization is to improve the characters into a block containing no added white spaces (pixels) in all the four sides of the characters. In this Stage, the license plate character images that are taken out from the license plate image have to be recognized. It is actually the process of the character recognition of the license plate characters. The character recognition of the license plate can be find out through Neural Network, Template matching, Hough Transform, Radial Basic Function.

## 2. LITERATURE REVIEW

The literature review is divided into two sections. In first section we describe the License Plate Detection using RBF Neural Networks and in second section we describe some more techniques in detail for License Plate Detection using Template Matching.

### A. Review for license plate detection using RBFNN

#### 1. Vehicle License Plate Recognition Based on Text-line Construction and Multilevel RBF Neural Network

In this technique author gave a new approach for license plate recognition using the text-line construction and multilevel RBFNN. The location of the license plate will be determined according to the text-line construction result and the characteristics of the vehicle license plate character arrangement. And then the locally best adaptive binarization is utilized to make more accurate license plate localization. After the license plate localization, the method of vertical projection information with prior knowledge is proposed to segment character and extract the statistic feature. The multilevel classification RBF neural network is then used to recognize with feature vectors as input so that; the recognition result is reliable and satisfied by the accuracy requirement of the Intelligent Transportation Systems. [2]

Pros:
Use of Multilevel classification of RBFNN is improving the accuracy of the recognition of the characters.

Cons:
The system is unable to properly recognize some characters and numbers like 2, 0, 7 and more; due to this the recognition rate is lower compare to the other characters.

#### 2. Automatic License Plate Detection and Recognition Using Radial Basis Function Neural Network

In this work authors has used the Radial Basis Function Neural Network. The RBFNN used for the plate detection and recognition of the license plate. It also uses the different image pre-processing processes like edge detection, image dilation, filtering, filling and smoothing for improving the quality of the image. The pre-processing firstly performs gray scale conversion of the image. And then the gray scale image is converted into black and white image using sobel edge detector and morphological method. To fill the gaps, “flood fill algorithm is used. After completion of all this steps, the pre-processed images are used for LP detection. For this it uses threshold value, the objects those satisfy the maximum and minimum threshold value are then classified as “Plate” and “No Plate” categories. The RBFNN is used for LP detection. The objects those are classified as “Plate” are finally used for trained the RBFNN. For character detection the RBFNN is used with feature extraction process, the original features are extracted and feed into NN for classify the characters. [7]

Pros:
The character segmentation rate is 99%.

Cons:
The filtering process used for character recognition from other images, it may leads to erroneous License plate detection.

#### 3. An Algorithm for License Plate Recognition Using Radial Basis Function Neural Network

The authors proposed a new technique for the license plate recognition system. Sobel edge detector, vertical and horizontal projection and mathematical morphology (MM) operation used for LP region. The character segmentation with the help of different process like Binarization based on core region, Unifying the background color, connected component analysis, and Extract character size judgment. And RBFNN used for the character recognition process. This uses single hidden layer which provides maximal output according to the input. [8]

Pros:
Connected component analysis is used for the character segmentation. It eliminates the component whose height not match with the characters from the plate and provides the segmented characters. And with the help of this it finds the exact height of the characters.

Cons:
The system may fail if the texture of the plate is not clear and the License plate region is short of the threshold of projection operation.

#### 4. A Smart Hybrid License Plate Recognition System Based on Image Processing using Neural Network and Image Correlation

The authors involved in the field of the license plate recognition system as a variety of License Plates (LP). It uses the image processing for the character segmentation. Image correlation and Neural Network with LVQ (Learning Vector Quantization) used for recognition process. The hybrid

method is better for recognition, it uses image correlation and NN with LVQ with increases the probability of recognition of the right character. The character first passed to the image correlation if its value is greater or equal to the ½ then characters is recognized correctly. If it less than ½ then character is wrong. And finally it go it passes to the NN for recognition and accepted the character as the right one. [9]

Pros:

The character segmentation process segment the character 100%, which removes all unwanted areas.

Cons:

The main problem in the system is that if the correlation coefficient value is greater or equal than ½, it accepts the character as the correct whereas character may be wrong. And the correct character is getting by the neural network. But it accepts the character recognized by correlation not by the neural network.

## B. Review for license plate detection using Template matching

### 1. License Plate Recognition System for Indian vehicles

The authors involved in the field of the license plate recognition system as from field of image processing and machine vision in construction of a Automatic license plate recognition system for Indian vehicles term as (ALPRSIV). It includes algorithms, which make sure process plate normalization, process of suitable character segmentation, normalization and recognition. All these methods achieving invariance of systems towards image skew homographs and a variety of plate condition. The process of skew correction which uses the Gamma correction method, after that the image is converted to gray scale for intensity adjustment. Horizontal and vertical projection is done for separate the individual characters. Remove unwanted elements such as dots and scratches and then tries to enhancement in the segments.

Character recognition is done with OCR method. It tries to find out the nearest match. The pattern whose correlation value is nearest to the particular character is labeled as the respective character [10]

Pros:

The system gives information regarding the state and vehicle type according to the number plate after completion all processes.

Cons:

The system has some disadvantages that if the number plate contains extra designs or the font of the number plate alters regularly, it creates a problem. The vehicles that do not follow the standard rules of Indian Number plates pose a problem to the system. There are numerous number plates in the vehicle whose condition is so bad that even a human eye cannot recognize it. In those cases the system is obviously unable to obtain the expected results.

### 2. Vehicle-License-Plate Recognition Based on Neural Networks

The authors gave the innovative approach for License plate recognition based on Neural Network. To recognize the number plate the neural network chip is used. The chip composed of two modules video image processing module with neural network module using equalized image processing algorithm and network classification algorithm. The chip includes image sensor, CogniMem chip, interface circuit and PC monitoring module. The video from the image sensor is sent to video module of the CogniMem chip. The feature vector is automatically generated by the chip from the region of interest given by user. The recognition is shown on the PC. [11]

Pros:

High speed of recognition. The recognition time of CM1K system was 101μs, while most of the existing technologies need millisecond processing time.

High stability. The CM1K system performs better in stability than software system, because most of the circuit was integrated in the FPGA, and the bottom hardware finished much amount work of recognition. On the contrary, the software system is completely dependent on the PC, so any delay for the PC might make it loss some plates.

Cons:

Recognition rate is less.

### 3. A license plate recognition algorithm for Intelligent Transportation System applications

In this technique the author gave a new approach for image segmentation. The license plate recognition system as uses an algorithm novel adaptive image segmentation technique (Sliding Concentric Windows-SCW) and connected component analysis in conjunction with a character recognition Neural Network. The algorithm was tested with particular natural scene gray level vehicle images of different backgrounds and ambient illumination. The camera targeted within the plate, while the angle of sight and the distance from the vehicle varied according to the condition if needed. The character recognition process is done by PNN (Probabilistic Neural Network). The SCW is used for the describing the local irregularity in the image using image statistics. It creates two windows for the pixel of the image. If the ratio of statistical measurement in two windows more than threshold set by the user, then the central pixel of windows is considered as the Region of Interest. It gives optimal result, if the ratio of concentric window is near to the ratio of the object is defined.[12]

Pros:

The novel adaptive technique for segmentation i.e. Sliding Concentric windows used for the finding the region of Interest and for segmentation the connected component analysis is used.

The OCR system is a two layer Probabilistic Neural Network (PNN) with topology, whose performance for entire plate recognition reached has been improved easily.

Cons:

The major drawback in the proposed algorithmic sequence revolve around the varying light levels encountered during a 24 hour period and the effect those lighting changes have on the image being forwarded to the OCR program as well as due to the physical appearance of the plates.

### 4. Automatic License Plate Recognition

The authors describe automatic license plate recognition processes. The LPR system consists of four steps Plate Localization, Preprocessing, Segmentation and Normalization and Optical Character Recognition (OCR). Before applying the Morphological operator the RGB image is converted to the gray image and binary image. Otsu method applied to convert the gray image into Binary image. Then the morphological operator applied on the image to identify the plate location. Then the plate region is preprocessed by applying the histogram equalization technique. The smearing and morphological algorithms are used to segment the characters and segmented result is normalized and fed to the OCR part for recognition [13]

Pros:
Different methods are useful for providing better recognition rate.
Cons:
Some of the characters give the erroneous result for confusing characters like 2 and Z which decreases the recognition rate.

### 5. New Morphology-Based Method for Robust Iranian Car Plate Detection and Recognition

The author has presented a new real time and robust method of license plate detection and recognition based on the morphology and template matching. Isolation of the image is the main phase of the system, from digital image clicked by camera in different circumstances. Firstly the image is preprocessed for further recognition, after that morphological operator is applied for image location. The morphological operator is based on the shapes. Morphological process is used for character segmentation. It removes all small connected elements. Then dilation operator is applied to separate the character from each other. And partition scanning is done for character segmentation. Character recognition is done with the help of template matching process. For this image correlation method is used. [14]

Pros:
It gives better performance for license plate localization. It correctly finds the location of plate up to 97.3%.

Cons:
If the image quality is not good the system get failed to recognize the characters.

### 6. Automatic Vehicle Identification by Plate Recognition

The author presents a new smart and simple algorithm is presented for the license plate recognition. The LPR works in different parts: plate region extraction, character segmentation and recognition. The recognition process is done with the help of template matching. The plate is firstly converted into binarized image then the smearing algorithm is applied to find out the plate region. After this the morphological operator is applied to get the location. Then segmentation is done with the morphological function. The dilation operator is used for separate the characters. Before the recognition, the characters are normalized. Normaliztion is done for refine characters into a block containing no white spaces and then characters are fit into equal size for template matching. Cross correlation method is used for character recognition. [15]

Pros:
The detection of the plate is achieved with the higher accuracy.
It shows accuracy for plate extraction 97.6%, segmentation 96% and recognition of characters IS 98.8%.

Cons:
The similarity between some characters decreases the recognition rate.

## 3. CONCLUSION

The process of vehicle number plate recognition requires a very high degree of accuracy when the system is deal with different area of license plate detection like automatic parking, automated toll booth, border control, law enforcement and many more. In this paper we have presented a survey of License Plate Recognition Techniques. It also describes how these techniques are helpful for recognize number plate and how to improve recognition rate, character segmentation and plate region extraction rate. The performance, concepts along with pros and cons of License Plate Recognition techniques are summarized in this paper. Performance analysis of various License Plate Recognition techniques is discussed in the table below

| Sr. no | Techniques Employed | Recognition Rate (%) | Character Segmentation (%) | Plate Region Extraction (%) |
|---|---|---|---|---|
| 1 | LPR based on Text-line Construction and Multilevel RBFNN | 93 | - | - |
| 2 | Automatic LPR and Detection Using RBFNN | 91 | 99 | 95 |
| 3 | LPR using RBFNN | 94.3 | 97 | 99.3 |
| 4 | LPR with Image Correlation | 96.64 | 100 | 80 |

| | | | | |
|---|---|---|---|---|
| | and NN | | | |
| 5 | LPR for Indian Vehicles | 90 | - | - |
| 6 | Vehicle LPR in Neural Networks | 91.2 | - | - |
| 7 | A LPR Algorithm for ITS applications | 93 | 99.3 | - |
| 8 | Automatic LPR | - | - | - |
| 9 | New Morphology-Based Method for Robust Iranian Car Plate Detection and Recognition | 92 | 94 | 97.3 |
| 10 | Automatic Vehicle Identification by Plate Recognition | 98.8 | 96 | 97.6 |

Ref: LPR= License Plate recognition; RBFNN= Radial Basis Function Neural Network;

NN= Neural Network; ITS= Intelligent Transportation System

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