

## **ALPR for Ambiguous Character using Template Matching with Fuzzy Classifiers: a Survey**

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### **Abstract**

In this paper, we consider the difficulties in identifying the license plate number of a vehicle, due to the over brightness of the headlights in the vehicle, the muddy condition of the plate. Optical Character Recognition (OCR) technique is used to solve these problems and gives the solution. We would like to state that vehicle license plate information got from an image or a sequence of images can be extracted by using OCR. This extracted information can be applied in many applications with or without database, Ex. Traffic Surveillance. These images may be in color: black and white or infrared. The main success of the ALPR (Automatic License Plate Recognition) is the quality of the acquired images, and environmental independence, Ex. Indoors, outdoors, day or night time. ALPR supports the methodologies used in various nations, provinces and states. In this paper we present a survey result of various methodologies used in ALPR systems.

**Keywords:** Optical Character Recognition (OCR), Automatic License Plate Recognition (ALPR), Automatic Number Plate Recognition (ANPR), Car Plate Recognition (CPR), License Plate (LP).

### **1. INTRODUCTION**

OCR technique plays an important role in numerous real life applications such as automatic tool collection, traffic law enforcement, parking lot access control and road traffic monitoring. OCR technique gives the standard output for the vehicle's license plate (LP) number from an image or images. The input images can be taken by using infrared camera. OCR technique obtains standard output by using many techniques such as object detection, image processing and pattern recognition. OCR is known for automatic vehicle identification, car plate recognition and number plate recognition for cars. Detection and recognition of license plates method challenges the several plate types and environmental changes.

#### **1.1 Plate variations:**

- a) Location: Plates exist in various locations of an image.
- b) Quantity: More than one plate may occur in a single image.
- c) Size: The distance between the car, camera and the zoom factor.
- d) Color: Background of the plate color, font color and car color may be same or different based on nations.
- e) Font: Every nation has different font and languages.

- f) Standard Vs Vanity: Standard license plate and self interest license plate.
- g) Occlusion: Some plates may be obscured by dirt.
- h) Inclination: Some plates may be tilted.

## 1.2 Environmental variations:

- a) Illumination: Input image may have some different illumination such as Environmental lighting and vehicle headlights.
- b) Background: Background of image contains patterns similar to plates Ex. Number stamped, bumper with vertical patterns and textured floors.

The OCR system that extracts the LP number from a given image is composed of four stages [10]. First stage: Capture the car image by using camera. The parameters of the camera, such as shutter speed, orientation, camera resolution, type of camera and light has to be considered. Second stage: Input is considered as an image, than the LP is extracted output, based on some features, such as color, boundary or existence of the characters. Third stage: Input is considered as the LP, than characters of the LP are taken as segmented output, by projecting their Positions with templates. Final Stage: Input is segmented character, output is plate number as a standard form by using template matching or using classifiers (Neural network and Fuzzy classifiers). The OCR system performance relies on the robustness of individual stage. In this paper we present a survey of existing License Plate Recognition (LPR) and ALPR researches by categorizing existing method according to the feature they used, analyzing the pros and cons of these features, and comparing them in terms of recognition performance and speed of the process and to open some issues for the future research. The following figure represents the modules of the ALPR system.

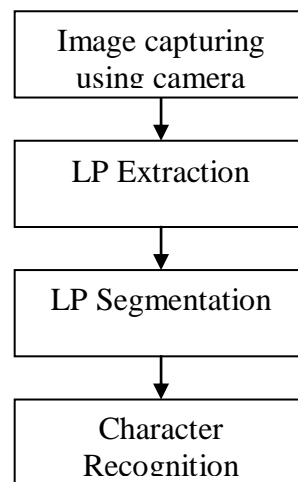


Fig 1. Four methods of ALPR system

The rest of the paper is organized as follows. In section II there is description about classification with detailed review of the LP extraction. In section III there is description about character segmentation method. In section IV there is description about character recognition method. In each section, we define the problem and its levels of difficulties then classify the existing algorithm. In section V present the analysis made and compression results.

## 2. LP EXTRACTION

In this section the input is considered as a car image and output is LP. The LP may exist anywhere in the image. Instead of processing every pixel in the image, which increases the processing time, the LP is based on some features. These features are derived from LP formats and characters. Ex features: color, boundary, texture, global image information and character feature. Color: LP contains different colors based on different country, state or province. Boundary: It mentions the rectangular shape of LP. Texture: Color changes between the characters and the background. Character: The existence of characters can be used as a feature to identify the region of the LP.



Fig 2. License plate in various illuminations

### 2.1 LP Extraction using Boundary:

Boundary method can be used to detect the edges of LP. The LP has a rectangular shape with aspect ratio. First, finding all the possible rectangles that can be extracted in the image by using edge detection method, [15,18,23,40]. Sobel filter is an important method of the edge detection [1,4,7,10,20,23]. Sometimes the car body and LP color are same. These problems can be overcome by using sobel filter. The edges are two horizontal lines used when performing the horizontal edge detection, two vertical lines when performing the vertical edge detection for a complete rectangle formation when performing both at the same time.

In [4] Hough Transform (HT) for boundary based extraction straight lines can be detected in the image to locate LP. The straight line detection can be up to 30° inclination [16]. HT is a time and memory consuming process.

In [9], generalized symmetry transformation (GST) is used to extract the LP. The image is scanned in the selective directions to detect corners, after getting edges. Similarly it is used to detect similarly these corners and LP regions.

In [10] the vertical edges are matched to obtain the same aspect ratio of the rectangle as the PL. In this method the result is 96.2% on images under various illumination conditions.

In [13], the unwanted edges are eliminated with morphological steps. It is simple and fast edge based method.

In [17] block-based method is not depend on the edge of the LP boundary, it can be applied to an image with an unclear plate boundary. The accuracy ratio for 180 pairs of images with 92.5%.

In [18] a hybrid method based on the morphology and edge statistics was proposed. Their accuracy of locating 9786 vehicle LP is 99.6%.

In [23] extracted vertical edges and the background edges to be removed are easily extracted from the edge image of the plate area. If the image was around 100% the detection rate is 1165. The processing time of a 384 x 288 image is 47.9ms.

In [24], the HT and contour algorithm are combined for boundary line- Based method. Their achieved extraction results are 98.8%.

In [42] geometric attribute is used to detect the LP rectangle for locating lines forming a rectangle. As the horizontal edges only can result in errors due to car bumper [10], the robustness extraction feature of the vertical edges for generate region [5, 9, 12, 16] can be used.

In [43] vertical Edge detection algorithm (VEDA) is a new and fast detection algorithm for LP extraction. It is faster than sobel operator by about seven to nine times.

In [44] inspection status of motorcycles for LP recognition is checked. Their recognition rate of 95.7% and 93.9% is based on inspection station and r ultra mobile PC and about 293ms on a PC to recognize an LP.

TABLE 1: Compression result of LP Extraction

METHODS	REFERENCES	PROS	CONS
Boundary features	[1,4,7,10,14,15,18,20,23]	Straightforward, fast and Simplest	Difficult to use complex images and sensitive.
Global image Features	[2,12,36,37]	Straightforward and independent of license plate position	Sometimes generate broken object.
Texture features	[3,8,30,38]	To detect even if the boundary is formed	Complex to use many edges
Color feature	[32]	To detect inclined and deformed license plates	RGB is limited to different environmental conditions and HLS is sensitive to unwanted image background
Character features	[5,31]	Robust to rotation	Time consuming

## 2.2 LP Extraction using Global Image Information:

The binary image processing [10, 25, 33, 39] is used as the important technique as a connected component analysis(CCA). CCA scans the labels and its pixels into components and binary images based on pixels connectivity. LP [36, 37] extraction is commonly used for the spatial measurements, Ex. Area and aspect ratio.

In [12], contour detection algorithm is applied on the binary image to detect connected object. But it requires same geometric features for the connected objects, and this algorithm can fail in the case of bad quality image.

In [37], CCA is applied on low resolution video. The false rate and correct extraction rate of a 240 minutes video is 96.62% and 1.77% respectively.

### 2.3 LP Extraction using Texture features

This method depends on the presence of characters in the LP, which results in gray-scale level between license plate background and character color and it results in a high edge density area due to color transition. Different techniques are used in [3, 30] for texture features.

In [3] and [30], the scan line technique is used. The results are based on changes of the gray-scale level. This numbers is equal to the number of characters.

### 3. LP SEGMENTATION

Here thin window scanning method is used for character segmentation. In this method extraction characters from plate is proposed, and it is conducted by checking the mean of each partition in image (the size of the partition will be 56 x 1 pixels).

By checking the mean of each partition, it can be decided that the partition is a part of character or background. In this process, background is defined as white (1) and character is defined as black (0).



Fig 3. Different types of numbers and characters in license plate

After some experiments, it is finalized that the threshold value is 0.8-0.85. Partition value which is larger than 0.8 - 0.85 is defined as background and another one is defined as character. Plate can be divided into three blocks. First block has letters which correspond to area domain of the car. Second block has numbers, and the final block contains letters.

In this segmentation procedure some features are followed. They are,

- a) Pixels connectivity:** It connects the pixels in the binary license plate image. Those pixels are analyzed and those which have the same size and aspect ratio of the characters are considered as license plate characters.
- b) Projection profiles:** LP background has different background colors, and has opposite binary values in the image.
- c) Prior Knowledge of character:** The binary image is scanned by a horizontal line to find the starting and ending positions of the characters.
- d) Character contours:** The shape is driven the active contour model is established, which utilizes a variation fast marching algorithm.

White objects are equally added on the right side of each window. Last the size of the window is 51 x 26 pixels.

TABLE 2 : Compression result of LP Segmentation

METHODS	REFERENCES	PROS	CONS
Pixel connectivity	[1,2]	Straightforward, robust and Simplest	Difficult to get character in joined and broken characters.
Projection profiles	[24,33]	Deal with some rotation and independent of character	Noises affect and require prior knowledge.
Prior knowledge of characters	[7,22]	Simple and more reliable	Result may change in error
Character contours	[11]	To get exact character	Slow and incomplete

#### 4. LP RECOGNITION

Fuzzy classifiers are designed to recognize 26 characters and 10 characters of the number. Here two separate Fuzzy classifiers topologies are designed.

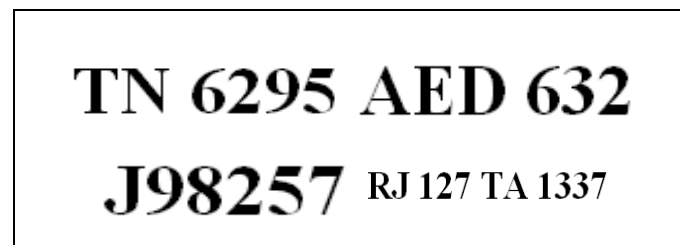


Fig 4. Standard output License plate Number

TABLE 3 : Compression result of LP Recognition

METHODS	REFERENCES	PROS	CONS
Pixels values	Template matching [10]	Straightforward and Simple.	Vulnerable to any font change, noise, rotation and thickness change, more processing time
Extracted features	[41]	Fast recognition	No robust takes degrade the recognition.

The following two recognition steps are performed in this Fuzzy classification.

1. Character Recognition
2. Number Recognition

In this recognition input is segmented character output is standard LP number. It considers the following features.

- a) Raw data: It uses the template matching method. It is a simple and straightforward method. It is performed after resizing the extracted character into the same size.
- b) Extracted features: Optical character recognition can be converted to the standard digitalized numbers from the original character.

## 5. COMPARISON STATUS

The following table gives information comparison status of some methodologies used in automatic license plate recognition. The table depicts the various methods used in ALPR. We also include the pros and cons of each method.

TABLE 4 : COMPARISON OF SOME TYPICAL ALPR SYSTEM

REF ERENCE S	PAPER TITLE	MAIN METHODS / RATES			DATABAS E SIZE	PROCESSIN G TIME	PLATE FORMAT
		LPE	LPS	OCR			
7	Feature based recognition of traffic video streams for online route tracing	-	Scan line and vertical projection / 99.2%	-	30000 + images	10-20 ms for LPS	Chinese plate
9	Automatic car license plate extraction using modified generalized symmetry transform and image warping	Edge detection and vertical and horizontal projection	Vertical and horizontal projections	Back propagation neural network	12 s video	100 ms	Taiwanese plates
10	Saudi Arabian license plate recognition system	Edge statistics and morphology / 99.6%	-	-	9825 images	100 ms	Chinese plates
16	Combining Hough transform and contour algorithm for detecting vehicles	Hough transform and contour algorithm / 98.8%	Vertical and horizontal projection / 97.6%	Hidden Markov model (HMM) / 97.5%	805 images	0.65 s for LPE and 0.1 s for OCR	Vietnamese plates
17	Extraction and recognition of license plates of	Block-based processing / 94.4%	-	Template matching	180 pairs of images	75 ms for LPE	Taiwanese plates

	motorcycles and vehicles on highways			g / 95.7%			
18	A hybrid license plate extraction method based on edge statistics and morphology	Vertical edges / ~100%	-	-	1165 images	47.9 ms	Chinese plates
24	Building an automatic vehicle license-plate recognition system	GST / 93.6%	-	-	330 images	1.3 s	Korean plates
39	Extracting characters from real vehicle license plates out-of-doors	CCA / 96.6%	-	-	4 hrs + video	30 ms	Taiwanese plates

## 5. CONCLUSION

In this paper we investigate the possibility of automatic recognition of a vehicle license plate. We use an OCR technique which is based upon Fuzzy classifiers for improving quality of an image and processing speed. Our survey result shows that OCR technique is efficient to use in illumination condition, distance images and images with background complexity. In future ALPR should concentrate on video-based ALPR, multi style plate recognition, ALPR using temporal information, multi plates processing, ambiguous-character recognition, high definition plate image processing, and so on.

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