



## Vehicle Licence Plate Recognition Using Gaussian Hermite Moments and Wavelets

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**Abstract**— License plate recognition in vehicles is a major problem due to the acquisition of images because vehicles are generally in motion, and weather conditions like sunlight, fog. The images of licence plate may also contain black borders or some stickers. License plate recognition not only involves recognition of characters but also pre-processing of licence plate. In this paper, the images of the vehicle's licence plate are collected from the car parking areas and from the web. First, the any noise, black border or any unwanted region other than character present on the image is removed. Then each individual character is segmented. The features of each character are calculated using Gaussian Hermite Moments and wavelets. These features are used as input to the neural networks for character recognition. The recognition rate of neural networks using wavelets and Gaussian Hermite Moments are also compared with the Moment Invariants and Principal Component Analysis. The recognition rate of neural network is 97.6%.

**Keywords**— Connected components, Dilation, Bounding box, Gaussian Hermite Moments, Wavelets, Artificial Neural Networks.

### I. INTRODUCTION

Licence plate recognition system recognizes the number of vehicle from still image of vehicle's licence plate. In this method an image of licence plate is taken from web and car parking. First, the image is converted into grayscale image and then preprocessed that includes removing noise, dilation and making the image suitable for further processing or analysis as per the requirements. Then each individual character is segmented and recognized by artificial neural networks. One of the applications of the image processing is vehicle licence plate recognition. License Plate Recognition (LPR) is a computer vision method in which vehicles are identified by their license plates. During past few years, LPR have been widely used as a core technology for security or traffic applications such as in traffic surveillance, parking lot access control, and information management.

### II. RELATED WORK

An J.R. Parker, Pavol Federl et al. [1] Locate the licence plate in raster images. First the rgb image is converted into grayscale image using formula

$$\text{Gray} = (\text{red} * 299 + \text{green} * 587 + \text{blue} * 114) / 1000$$

After that 5x5 median filter is used to remove the noise then the shen casten edge detector Shen, J. and Castan, S. et al. [2] is applied to detect the edges in image. The edge image helps us to find the rectangular shapes in the image. Then binary image is obtained by thresholding the image. Then 8-connected component region is determined and bounding boxes are determined for them. Then certain threshold is applied on the bounding boxes. The boxes that do not satisfy certain threshold are deleted. Then best candidate is selected as the characters in the licence plate. Then the licence plate in image is determined from the candidates using genetic algorithms. The inputs to genetic algorithms are bounding boxes and edge image. The licence plate is determined based upon the scoring function of bounding boxes. The problem is failure in locating licence plate due to character touch.

Muhammad H Dashtban, Zahra Dashtban et al. [3] proposed the algorithm that has three main parts, first is localization, second is segmentation and third is recognition. First the noise from the image is eliminated and then the rgb image is transformed to grayscale image. Then vertical sobel filter is used to detect the edges in image. Then 8-connectives are determined which contain the desired regions. The various geometric features of regions are calculated like aspect ratio, area, range of length and width, region intensity. After the plate localization 2-d median filter is applied to remove some unwanted noise then contrast enhancement is done using histogram equalization. Then canny line detection algorithm and hough transform are used to detect the longest line in image. Then each individual character is segmented. Then segmented block is prepared for neural networks using erosion, dilation, and skeletonization. Then multineuron perceptron are used to recognize the characters.

In P. Anishiya I, Prof. S. Mary Joans et al. [4] a combination of morphological operation is used for number plate localization. The application of edge detectors, labeling and fill hole approach is used to segment the characters. The character was recognised with the aid of optical characters by the process of Template matching. The system was experimented with Sobel, Canny, Prewitt, LOG edge detectors. First the image is converted into the grayscale image and noise removing techniques are applied to remove speckle noise, salt and pepper noise. Ocr and icr techniques are used to recognize characters. In this, the topological features of the image are calculated and compared with prestored character

template, the character template that best matches the input character are displayed. The experiment performed on images obtained from highways, parking under different lightning conditions. The success rate was 96%.

Zyad Shaaban et al. [5] proposed a method in which image is captured by digital camera using auto movie creator and divided into frames using mmread function. Then image filter using median and weiner filters A. Khireddine, K. Benmahammed, and W. Puech et al. [6] then edges are detected using perwitt edge detector. Then vertical and horizontal run length encodings are used to extract the pages. PCA is used to determine the skew angle. Vertical and horizontal projection histograms are used to segment English and Arabic part. In recognition phase principal component analysis Mia Hubert, Peter J Rousseeuw et al. [7], wavelet transformation [8] and moment invariants R. Gonzalez and R. Woods et al. [9] are used to extract the features to use in recognition stage. Back propagation neural network is used with supervised learning technique to recognized characters.

Anish Lazrus, Siddhartha Choubey, Sinha G.R. et al. [10] presents a robust method of license plate location, segmentation and recognition of the characters in licence plate. The images of vehicles are converted into gray-scale images. To remove noise present in the plates wiener2 filter is used and edges are found using Sobel. Then bwlabel is used to calculate the connected component. Finally, single character is extracted from the licence plate. The proposed method achieved accuracy of 98% by optimizing various parameters with higher recognition rate than the traditional methods.

Choudhury A. Rahman, Wael Badawy, Ahmad Radmanesh et al. [11] present a pattern matching for the recognition of number plates and it is developed for Alberta licence plate with prior knowledge of letters and numbers orientation. This system contains three distinct parts: outdoor part is the cameras installed in different intersections of interest for capturing images. The indoor part is the central control station that receives, stores and analyzes the captured images from all these installed cameras, communication link can be high speed cable or fiber optic connecting all these cameras to the central control station. There are seven general steps common to all number plate recognition algorithms D.G. Bailey, D. Irecki, B.K. Lim and L. Yang et al. [12]. Vertical concentration of colors is taken and the top and bottom positions of the characters are retrieved. Once the top and bottom positions of the characters in the image have been found, the area can be segmented from the image resulting now the image is used for character segmentation and recognition. Character segmentation is done by taking horizontal concentration of color. The pattern matching is used to find font closely matched with the one used in the number plate.

Christos Nikolaos E. Anagnostopoulos, Ioannis E. Anagnostopoulos, Vassili Loumos, Eleftherios Kayafas' et al. [13] proposed a novel adaptive image segmentation technique (sliding concentric windows) and connected component analysis with a character recognition neural network is used to for vehicle licence plate identification.[12][13] proposed the combination of edge based and morphological statistic to detect licence plate. T.-H. Wang, F.-C. Ni, K.-T. Li, and Y.-P. Chen et al. [14] and S. Draghici et al. [15] proposed methods for the color or gray scale based processing. It show better performance but face difficulties when different parts of car has similar color. Fuzzy logic N. Zimic, J. Ficzkó, M. Mraz, and J. Virant et al. [16] and gabor filter F. Kahraman, B. Kurt, and M. Gökmen, et al. [17] are also used to detect licence plate but has limitation of working only on the 2-d images. A Number of techniques are used to segment character after localizing licence plate. A number of techniques to segment each character after localizing the plate in the image have also been developed, such as feature vector extraction and mathematical morphology S. Nomura, K. Yamanaka, O. Katai, H. Kawakami, and T. Shiose et al. [18] and Markov random fields (MRFs) Y. Cui and Q. Huang et al. [19] are used to segment each character after localizing the plate in the image .After character segmentation character are recognized using various techniques. Using HMMs for the recognition begins with a preprocessing and a parameterization of the RoIs detected in the previous phase. The recognition result was reported to be 95.7% after a complex procedure of preprocessing and parameterization for the HMMs in Llorens, A. Marzal, V. Palazon, and J. M. Vilar et al. [20]. Multilayer perceptron neural networks were also used for character recognition A. Broumandnia and M. Fathy et al. [21], J. A. G. Nijhuis, M. H. ter Brugge, K. A. Helmholt et al. [22]. The error back propagation (BP) method is used for training. The network has to be trained for many training cycles in order to reach a good performance. S.-L. Chang, L.-S. Chen, Y.-C. Chung, and S.-W. Chen et al. [23], a self-organized neural network based on Kohonen's self-organized feature maps (SOFMs) was implemented to tolerate noisy, deformed, broken, or incomplete characters acquired from license plates, which were bent and/or tilted with respect to the camera. The major problems arise due to varying illumination condition in 24 h of day and due to the physical appearance of plates.

### **III. Image Processing**

Image processing is a method in which image is converted into digital form and perform some operations on it, to get an enhanced image or to get some useful information from it. It is a type of signal processing in which input is image, like photographs or video frame and output may be image or characteristics associated with that image.

#### *A. Dilaton*

Dilation is a process of improvising given image by filling holes in an image, sharpen the edges of objects in an image, and join the broken lines and increase the brightness of an image. Using dilation, the noise with-in an image can also be removed. By making the edges sharper, the difference of gray value between neighbouring pixels at the edge of an object can be increased.

#### *B Connected Components*

Suppose S represents a set of pixels in a binary image. Two pixels are said to be connected in S, if there exist a path

between them consisting entirely of pixels in S. The set of pixels that are connected to the pixel p in S, are called the connected component.

*C Gaussian Hermite Moments*

For an image I(x, y), Gaussian-Hermite moment is defined in equation 1 [24].

$$M_{pq} = \iint_{-\infty}^{\infty} I(u, v) H_p(u/\sigma) H_q(v/\sigma) du dv \tag{1}$$

The basis function of p+q degree is given in equation 2.

$$\Phi_{pq}(x, y) = H_p(x/\sigma) H_q(y/\sigma) = \frac{1}{\sqrt{2^{p+q-1} \pi \sigma^2}} G(x, y, \sigma) H_p(x/\sigma) H_q(y/\sigma) \tag{2}$$

Let I(x, y) be an digital, defined over a square K x K [0 ≤ i, j ≤ K - 1], then image coordinates normalized to be

$$-1 \leq x, y \leq 1 \text{ by } x = (2i - K + 1) / (K - 1), y = (2j - K + 1) / (K - 1)$$

The Gaussian-Hermite function in the discrete case (as image has number of rows and columns) is given in equation 3.

$$H_p(i) = \sqrt{\frac{2}{K}} H_p(x/\sigma) = \frac{1}{\sqrt{2^{p-1} p! \sqrt{\pi} \sigma K}} \exp\left(\frac{-x^2}{2\sigma^2}\right) H_p(x/\sigma) \tag{3}$$

$$H_p(j) = \sqrt{\frac{2}{K}} H_p(y/\sigma) = \frac{1}{\sqrt{2^{p-1} p! \sqrt{\pi} \sigma K}} \exp\left(\frac{-y^2}{2\sigma^2}\right) H_p(y/\sigma) \tag{4}$$

Where,

$$H_p = (-1)^p \exp(x^2) \frac{d^p}{dx^p} \exp(-x^2) \tag{5}$$

The image moments calculated are stored in a vector:

$$\alpha = [M_{00}, M_{01}, M_{02}, \dots, M_{pq}, \dots, M_{NN}]^T$$

*D Wavelets*

A wavelet is a wave-like oscillation whose amplitude begins at zero, then increases, and then again decreases back to zero. It is like a "brief oscillation" as one recorded by a seismograph or heart monitor. [25] Wavelets are purposefully used to create to specific properties that make them useful for image processing. The wavelet transform is computed separately for different time-domain signal segment at different frequencies. The wavelet transform mainly used for multi-resolution analysis means analyzing the signal at different frequencies giving different resolutions. The wavelet transform decomposes a signal into a set of basis functions and these basis functions are called wavelets. Wavelets are derived from a single prototype wavelet ψ(t) which is known as mother wavelet by dilations and shifting as given in equation 6:

$$\psi_{a,b}(t) = \frac{1}{\sqrt{a}} \psi\left(\frac{t-b}{a}\right) \tag{6}$$

where a and b are scaling and shifting parameter respectively. The oldest and simplest wavelet transform is based on Haar scaling and wavelet functions. The single scale wavelet transform of a signal with respect to Haar wavelets gives us a downsampled approximation and three directional (horizontal, vertical and diagonal) detail matrices.

**IV. Propose Method**

The proposed method, consists of three steps:

- A. Preprocessing
- B. Character segmentation
- C. Character Recognition

A. *Preprocessing:* In this step, the image is input to the system.the input image is shown in Figure 1.

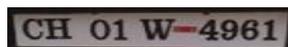


Fig. 1 Input Image

The image is converted into grayscale image. The grayscale image is shown in Figure 2.



Fig. 2 Grayscale Image of Licence Plate

For character segmentation the image of licence plate is converted into binary image. As the characters are of black color on white background, so the connected component analysis is used for character segmentation. The binary image of licence plate is shown in Figure 3.

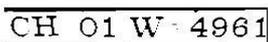


Fig 3. Binary image of Licence Plate

The connected components are found after complimenting the image. The complemented image is shown in Figure 4.



Fig 4. Complimented Image of Licence Plate

There are also other regions on the licence plate other than characters like stickers, black border, etc. First, these unwanted areas have to be removed from the licence plate. Each connected component is find on the licence plate. Then the area of each connected component is found. The border of the plate has the biggest area and removed from the licence plate. The plate without border is shown in Figure. 5



Fig. 5. Licence Plate Without Border

Some characters are not connected in the binary image like W in above image. This disconnected character is counted as two separate connected components. To connect these characters, the morphological operation dilation is performed. The Figure 6 shows the dilated image of Figure 5.



Fig 6 Dilated Image Of Licence Plate

There are also small connected components which are due to presence of some stickers or some text written on the licence plate. These stickers and text has small area than characters of licence plate and has to be removed. The binary image of licence plate containing only characters is shown in Figure 7.



Fig 7 Licence Plate Containing Only Characters

*B. Character Segmentation:* Now the individual character is segmented from the licence plate. For character segmentation, the number of characters is found on the licence plate. After finding the connected components the bounding box for each connected component is calculated. Now the each character is segmented using the coordinates of the bounding box. The segmented characters are shown in Figure 8.



Fig. 8 Segmented Characters

*C. Character Recognition:* For character recognition , first each segmented character is standardized to 20x20. Then the 49 features of each character is extracted using Gaussian Hermite Moments. These features are stored in vector. Then thinning operation is applied on each character. After that 5 features are extracted using wavelets. The characters after thinning are shown in Figure 9.

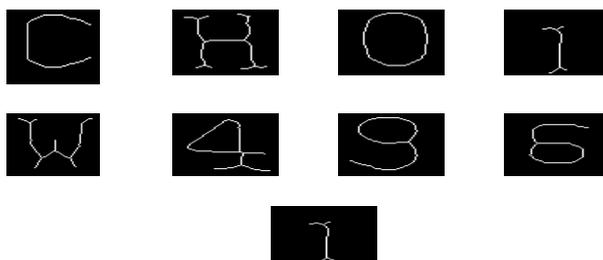


Fig 9. Characters After Thinning

1) *Neural Network for Licence Plate Recognition:* The licence plate contains any character from A to Z and number from 0 to 9. The licence plate contains the combination of characters and numerals. The first two letters on the licence plate indicates the state to which the vehicle is registered. The next two digit numbers indicates the

sequential number of a district. The third part is a 4 digit number unique to each plate. To recognize the licence plate the neural network has 54 inputs. These 54 inputs are the features of the characters. The 49 features are extracted using Gaussian Hermite moments and 5 features are extracted using wavelets. The neural network has 36 outputs, 26 for English alphabets and 10 for numerals. The network has one hidden layer with 100 neurons. Figure 10. shows the neural network for licence plate character recognition.

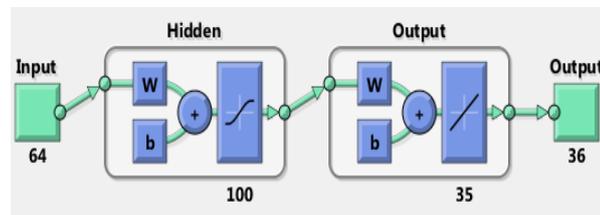
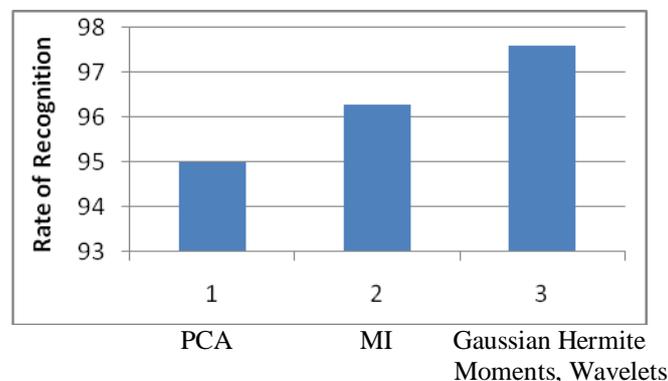


Fig. 10 Neural Network For Licence Plate Character Recognition

## V. Experimental Results

The proposed method is tested on images taken from parking areas and from the web. The recognition rate is 97.6%. For the recognition of the characters, the characters features are extracted using Gaussian Hermite Moments and wavelets. 7 features are extracted using MI (Moment Invariants), 3 features are extracted using PCA (Principal Component Analysis) and 54 features are extracted in our proposed approach. The rate of recognition for PCA, MI and proposed approach are shown in Figure 11.



## VI. Conclusion And Future Scope

The proposed approach recognizes the licence plate taken from the parking areas and web. The system successfully recognize the licence plate that conatins black border and some unwanted regions. Then the comparison with character recognition using PCA and MI is done. The results show that proposed system is far better than the PCA and MI. In future, the system may be developed to recognize characters of different font styles.

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