An Analysis of Vehicle Number Plate Recognition Through Extensive Literature Review

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Abstract- In this study, a license plate detection and recognition method has been analyzed. The license plate detection study shows that this method is relatively insensitive to variations in illumination, license plate patterns, camera perspective and background variations. They tested our method on the Caltech data set. We also studied how its performance is impacted by different levels of noise and motion blur. After license plate detection, we proceed to perform character segmentation and recognition using SVM classifiers with HOG features. In character segmentation, we need to deal with low contrast and tilted plates. The system performs window searching in different scales and analyzes the HOG feature using a SVM and locates their bounding boxes using Mean Shift method for extracting the characters without prior knowledge of their position and size in the image. The technique is based on scale shape analysis, which in turn is based on the assumption that, characters have line-type shapes locally and blob-type shapes globally.

Keywords:- License Plate Recognition, Plate Localization, Character Segmentation and Feature Extraction.

I. INTRODUCTION

License plate recognition (LPR) [2] is an image-processing technology used to identify vehicles by their license plates. This technology is gaining popularity in security and traffic installations. Much research has already been done for the recognition of Korean, Chinese, European, American and other license plates,

Applications of LPR Systems

Vehicle license plate recognition is one form of automatic vehicle identification system. LPR systems are of considerable interest, because of their potential applications to areas such as highway electronic toll collection, automatic parking attendant, petrol station forecourt surveillance, speed limit enforcement, security, customer identification enabling personalized services, etc. Real time LPR plays a major role in automatic monitoring of traffic rules and maintaining law enforcement on public roads. This area is challenging because it requires an integration of many computer vision problem solvers, which include Object Detection and Character Recognition. The automatic identification of vehicles by the contents of their license plates is important in private transport applications. There are many applications of such recognition systems, some of them are discussed below [12].

Law Enforcement :- The plate number is used to produce a violation fine on speeding vehicles, illegal use of bus lanes, and detection of stolen or wanted vehicles. License plate recognition technology has gained popularity in security and traffic applications as it is based on the fact that all vehicles have a license plate and there is no need to install any additional tracking apparatus. The main advantage is that the system can store the image record for future references. The rear part of the vehicle is extracted off the filmed image and is given to the system for processing. The processed result is fed into the database as input. The violators can pay the fine online and can be presented with the image of the car as a proof along with the speeding information [11].

Parking :- The LPR system is used to automatically enter pre-paid members and calculate parking fee for non-members (by comparing the exit and entry times). The car plate is recognized and stored and upon its exit the car plate is read again and the driver is charged for the duration of parking.

Automatic Toll Gates :- Manual toll gates require the vehicle to stop and the driver to pay an appropriate tariff. In an automatic system the vehicle would no longer need to stop. As it passes the toll gate, it would be automatically classified in order to calculate the correct tariff.

Border Crossing :- This application assists the registry of entry or exits to a country, and can be used to monitor the border crossings. Each vehicle information is registered into a central database and can be linked to additional information.

Homeland Security :- The LPR system's ability to read strings of alpha-numeric characters and compare them instantaneously to Hot Lists allows a Command Center to organize and strategize efforts in reaction to the information captured. Fixed LPR systems, which can be mounted to bridges, gates and other high traffic areas can help keep a tight watch on entire cities, ports, borders and other vulnerable areas. Every LPR camera is capturing critical data such as color photos, date and time stamps, as well as GPS coordinates on every vehicle that passes or is passed. This incredible database provides a wealth of clues and proof, which can greatly aid Law Enforcement with

- Pattern recognition
- Placing a suspect at a scene
- Watch list development
- Identifying witnesses

Working of Typical LPR System

When the vehicle approaches the secured area, the LPR unit senses the car and activates the illumination (invisible infra-red in most cases) as shown in Figure below. The LPR unit takes the pictures from either the front or rear plates from the LPR camera. The image of the vehicle contains the license plate. The LPR unit feeds the input image to the system. The system then enhances the image, detects the plate position, extracts the plate, segments the characters on the plate and recognizes the segmented characters, Checks if the vehicle appears on a predefined list of authorized vehicles, If found, it signals to open the gate by activating its relay. The unit can also switch on a green "go-ahead" light or red "stop" light. The unit can also display a welcome message or a message with personalized data. The authorized vehicle enters into the secured area. After passing the gate its detector closes the gate. Now the system waits for the next vehicle to approach the secured area [3].

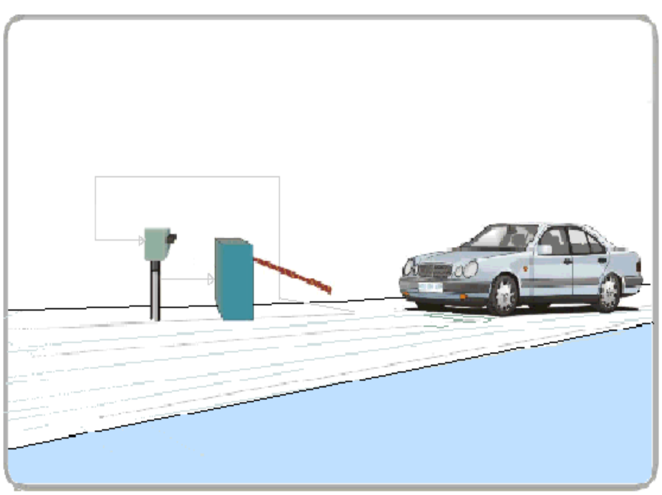

Fig. 1.1 A car approaching a license plate recognition system

Here introduce the original LBP operator as well as multi-scale LBP and the uniform LBP. The original LBP operator is a non-parametric 3×3 kernel as shown in Fig. 1. 2. At a given pixel position (x_c, y_c) in the image, LBP is defined as an ordered setof binary comparisons of pixel intensities between the center pixel and its eight surrounding pixels. For example, if the center pixel's value is greater than the neighbor, write "1", otherwise, write "0". This will generate an 8-digit binary number along a circle, i. e. clockwise or counter-clockwise. Normally, it will convert this binary number into decimal number for computational convenience.

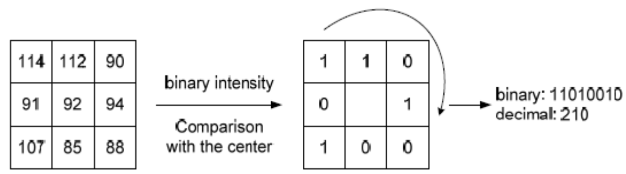

Fig. 1. 2 An illustration of the original LBP calculation.

Later, the Multi-Scale LBP, an extension of the original LBP. This Multi-Scale LBP operator will calculate the binary comparisons of pixel intensities to a circular neighborhood of different radius size. They used LBPP,R to denote the LBP with P equally spaced pixel on a circle of radius R. The LBP8,1 and LBP8,2 are illustrated in Fig. 1. 3.

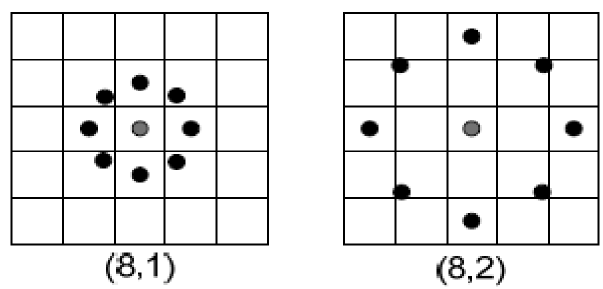

Fig. 1. 3 Examples of Multi-Scale LBP.

II. SYSTEM MODULE

To search the location of license plates in an image, a scanning window needs to be defined and slide over the image at different scales and locations as shown in Fig. 2. 1. In each location, the HOG feature will be extracted from the window and sent to the SVM classifier which will decide if the region is a license plate or not. The regions with large positive response from SVM classifier will be collected as potential detection, and fused with non-maximum suppression algorithms into one final detection result. The step size of the sliding window is related to the algorithm efficiency and detection precision. Different step sizes of the sliding window will be evaluated during our experiments [2].

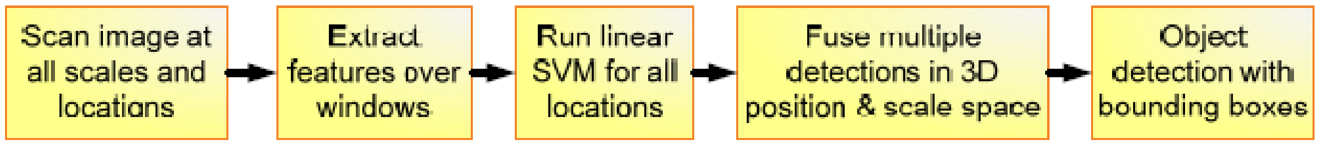

Fig. 2. 1 An overview of license plate detection procedure

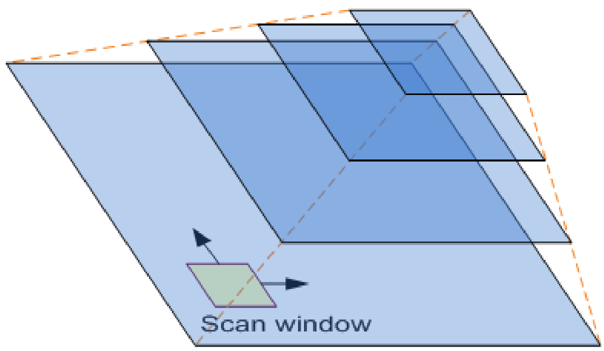

Fig. 2. 2 Scan-window and image pyramid

HOG Features

License plate detection is a challenging task It is a robust feature set should allow the license plates to be discriminated cleanly even in cluttered backgrounds with poor lighting conditions. It has been shown that the locally normalized Histogram of Oriented Gradient (HOG) descriptors provides excellent performance in object detection over other existing feature sets including Haar wavelets As mentioned in [13], HOG descriptors are reminiscent of edge orientation histograms, SIFT descriptors and shape contexts, but they are computed on a dense grid of uniformly spaced cells and they use overlapping local contrast normalizations for improved performance. The HOG descriptors have many advantages in license plate detection. It extracts the edge or gradient information which is very characteristic of local shapes, and performs with a controllable degree of invariance to local geometric and photometric transformations.

Feature Extraction Procedure (for R-HOG)

Fig. 2. 4 shows the major steps to extract R-HOG features. First, the window will be divided into small regions, called cells. And for each cell, then compute a local 1D histogram of gradient directions over the pixels of the cell. The combined histogram will form the descriptor. The contrast-normalization will also be performed in order to make the descriptor invariant to illumination and shadows. This can be done by accumulating the local histogram over larger spatial regions ("blocks")[7].

The image preprocessing of color normalization or gamma correction is often required for many other feature descriptors. However, Dalal and Triggs pointed out that this step can be omitted in HOG descriptors, Different block normalization schemes can be applied. Four normalization schemes were evaluated in [8].

- L2-norm: $\boldsymbol{v} \leftarrow \boldsymbol{v}/\sqrt{\|\boldsymbol{V}\|_2^2 + \epsilon^2}$:
- L2-Hys: L2-norm followed by clipping (limiting the maximum values of **v** to 0.2)

  and renormalizing;
- L1-norm $\boldsymbol{v} \leftarrow \boldsymbol{v}/(\|\boldsymbol{V}\|_1 + \epsilon)$;
- L1-sqrt $\boldsymbol{v} \leftarrow \boldsymbol{v}/\sqrt{\|\boldsymbol{V}\|_1 + \epsilon}$;

Where **v** is the normalized descriptor vector, $\|\boldsymbol{V}\|_k$ is its k-norm for k = 1,2, and -1 is a small normalization constant to avoid division by zero. It was shown in that L2-Hys, L2-norm and L1-sqrt normalization achieved equally good performance while L1-norm degrades the performance by 5% when compared with the other three.

Non-maximum Suppression

After applying the SVM classifier to the HOG features extracted from the sliding windows over all scales, a number of bounding boxes may be derived by a threshold to the prediction score. A non-maximum suppression algorithm is needed to fuse these potential detections into one final result. The uniform kernel Mean shift algorithms [1] to fuse the overlapped detection over all scales. All the detections can be presented in 3-D space as **y**i = [xi, yi, si], where xi and yi present the position for the *i*-th

$$s_i = \log(scale_i)$$

detection, and

$$f(y) = \frac{1}{n}\sum_{i=1}^{n} K_H(y - y_i)$$

$$K_H(y) = |H|^{-\frac{1}{2}} K(H^{-1/2} y)$$

$$K_U(y) = \begin{cases} 1 & 0 \leq y \leq \sigma \\ 0 & y \geq \sigma \end{cases}$$

$$K_U(y) = \begin{cases} C_d & \|y\| \leq \sigma \\ 0 & \|y\| \geq \sigma \end{cases}$$

III. LITERATURE REVIEW

In the year of 2014 Salahshoor, M.; Broumandnia, A.; Rastgarpour, M., [1] The study of Despite recent advances in Vehicle License Plate Recognition Systems (VLPRS), there are still several challenges in these systems such as incompatibility with different conditions. These incompatibilities are caused by some reasons including shadows, skews and dirt on license plate, changing illumination intensity, weather conditions, varying distance between camera and vehicle and rotation of license plates. This paper investigates the challenges related to shadows on license plate, changing illumination intensity and other similar cases. They will be solved by the Bernsen thresholding method along with other new techniques. Moreover, the proposed approach tries to provide a rotation and size invariant system. It consists of three stages: plate Localization by horizontal projection and Sobel filter, character segmentation stage through vertical projection, and character recognition by 4-directional distance profile features. This paper uses a database containing 400 images of vehicles under complicated and non-uniform conditions whereas 200 images for training and 200 images for system evaluation.

In the year of 2013 Jagannathan, J.; Sherajdheen, A.; Deepak, R.M.V.; Krishnan, N.,[2] Investigated on Intelligent Traffic Systems (ITS) is an integral component of modern day road transportation networks. Identification of vehicles is one of the most important challenges to be addressed in the design of any intelligent traffic system. License plate being a unique identity for any registered vehicle, License Plate Recognition (LPR) systems have been used as the means to resolve the issue of identification of vehicles. Intelligent systems involving LPR has been widely applied in several applications such as intelligent traffic rule enforcement, prevention of car theft, intelligent traffic emergency/accident handling, monitoring of vehicle traffic and flow control, intelligent parking, automated toll payment, intelligent surveillance and security enforcement etc. A typical LPR process consists of three stages viz; License Plate Extraction, Character Segmentation and Character Recognition. This paper address the Character Segmentation problem. The character segmentation method using horizontal and vertical projection and with dynaic thresholding is proposed in this paper. From the experimental studies made, it is learned that the proposed technique works reasonably well in real world scenarios.

In the year of 2013 Yi-Ling Chen; Tse-Shih Chen; Tsiao-Wen Huang; Liang-Chun Yin; Shiou-Yaw Wang; Tzi-cker Chiueh,[3] The study of digital surveillance systems are ubiquitously installed and continuously generate huge amount of video data. Very often, human inspection of the recorded videois still required for threat detection. Even though automated techniques exist to facilitate the detection of potential security problems, it remains a highly computation demanding task to process these data. The emergence of cloud environments has made feasible to deploy intelligent video surveillance technologies as services through Internet to enhance public security. In this paper, authors present a novel system aiming at bringing together automatic license plate recognition engines and cloud computing technology in order to realize massive data analysis and enable the detection and tracking of a target vehicle in a city with a given license plate number. It realizes a fully integrated system with a surveillance network of city scale, automatic large scale data retrieval and analysis, combination with pattern recognition technology to achieve contextual information analysis. Performance evaluation and some results of applying the proposed system to real-world data are demonstrated and the experiences authors gained when implementing it are also discussed.

In the year of 2013 Rashid, A.E.,[4] Investigated on License Plate Recognition (LPR) is one of the most important types of intelligent transport system and is of considerable interest because of its potential applications to many areas such as highway electronic toll collection, traffic monitoring systems and so on. It was developed to identify vehicles by the contents of their license plate. Research is in progress for the recognition of Korean, Chinese, European and other license plates. In this paper, authors will describe a fast algorithm for automatic license plate detection system for the Egyptian license plates that achieves a high detection rate without the need for a high quality images from expensive hardware. The system captures images of the vehicles with a digital camera. An algorithm for the extraction of the license plate has been explained and designed using Matlab. Authors achieved about 96% detection rate for small dataset.

In the year of 2013 Volna, E.; Kotyrba, M., [5] The study of an important example of using artificial neural networks in computer vision. Vehicle Number Plate Recognition is a special form of optical character recognition (OCR). Vehicle number plate recognition is a type of technology, mainly software, which enables computer systems to read automatically the registration number of vehicles from digital pictures. Authors proposed developed methods based on multilayer feed-forward back-propagation algorithm using one hidden layer that is able to recognize numbers and letters in a plate. Authors also proposed method that is able to find some area with a number plate, which is cut out from the input image and forwarded to neural network application. The performance of the proposed system has been tested on real images.

In the year of 2012 Zhuofeng Zhao; Qiang Ma,[6] Investigated on the continuous expansion of the scope of the transportation sensor networks, a new kind of data, namely traffic sensor data, becomes widely available. Traffic sensor data gathered by large amounts of transportation sensors shows the massive, continuous, streaming and probabilistic characteristics compared to traditional data. In order to satisfy the requirements of different traffic sensor data applications, the capability of real-time processing for massive traffic sensor data is emergently needed. In this paper, a Real-Time Processing System (shorted as RTPS), which adopts the decentralized distributed architecture to support the parallel processing of traffic sensor data, is presented with a case study of a real world application about vehicle license plate recognition data. And the parallel computing model behind RTPS and corresponding programing interface are proposed. The experiment based on application of vehicle license plate recognition data shows that our system has good scalability and the processing performance increases in linear progression as the number of processing nodes increases.

In the year of 2012 Arulmozhi, K.; Perumal, S.A.; Sanooj, P.; Nallaperumal, K.,[7] The study of Automatic License Plate Recognition (ALPR) is used in Intelligent Transportation systems wherein they are deployed for automatic ticketing of vehicles at car parking area, tracking vehicles during traffic signal violations and related applications. Out of the three major modules of ALPR systems, namely 1. localization of license plate from vehicle image, 2. segmentation of the characters images from the localized license plate and 3. Recognition of segmented characters images as license plate number, localization of potential license plate from the vehicle images is the most challenging task due to the huge variations in size, shape, color, texture and spatial orientations of license plate regions in such images. LP Localization fails often due to the presence of complex background and non-uniform illumination of license plate due to varying lighting conditions. In this paper, authors proposed a smart, simple and efficient algorithm for Indian license Plate Localization using Top Hat Transformation, which suppresses the background of image and remove the non uniform illumination. The algorithm is tested with live ALPR field images, confirming the robustness of the proposed method against adverse imaging condition.

In the year of 2011 Satish, M.; Lajish, V.L.; Kopparapu, S.K.,[8] Investigated on Identity of a motor vehicle is usually through its license plate. Automatic vehicle license plate recognition has several applications in intelligent traffic management systems. In this paper, authors propose and describe a fast edge assisted adaptive binarization technique for improved extraction of text from license plate images captured using mobile phone camera. Authors evaluate and compare the performance of the proposed binarization scheme with some well known algorithms on real vehicle images. Experiments on 400 real vehicle images captured using mobile phones shows that the edge based scheme is not only fast but also performs as well as the other binarization technique.

IV. PROBLEM FORMULATION

The first challenge concerns In LPR, authors need to deal with a large variety of license plates, especially in india. Each state in india has its own license plate color, pattern and formats of numbers and characters. Moreover, every few years, each state will issue new license plate patterns. the license plates from india. And in some states, thegovernment allows vehicle owners to have personalized license plates which will further increase the difficulty of license plate detection and recognition. Another challenge in LPR is that the image quality taking by camera in real time may be affected by severe weather conditions, poor lighting conditions, and low camera resolutions. The aperture time of the camera will cause the blurring effect of the moving vehicle. The third challenging issue authors need to address in LPR is the large variations in camera perspectives when the license plate image is captured.

V. CONCLUSIONS & FUTURE WORK

A license plate detection method using with HOG feature was developed in this work. The system performs window-based searching at different scales and analyzes the HOG feature using a SVM and locates their bounding boxes using Mean Shift. A car head and rear detection method was also May accelerate the time consuming scanning process. Performance comparison and analysis of the algorithm with different cell and block sizes of HOG feature was provided, and four rounds of bootstrapping was performed to ensure better detection results. License plate detection results show that this method is relatively insensitive to variations in illumination, license plate patterns, perspective of license plates and background complexity. Quantitative analysis was also performed on the Caltech data set.

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