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Vehicle License Plate Detection: A Survey

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Abstract – ***World has experienced an economical bloom in past few decades. This has led to urbanization on larger scale; as a result the number of privately owned vehicles has grown exponentially so have the license plates. This has given rise to problem such as identification of particular vehicle from a group of vehicles. This paper presents License plate recognition algorithms that consist of following processing steps: I) Extraction of LP region II) Segmentation of LP characters III) Detection of LP characters. The task to identify license plates is quite challenging as it depends on various external factors like Fonts, colors, size, non uniform outdoor lights, weather conditions etc. Thus, most approaches work only under specific conditions such as limited vehicle speed, good illuminations, and ideal weather conditions. Eventually techniques have been developed for License plate recognition using image processing in real time arrangement. Extraction of LP region is an important aspect of intelligent traffic system, as all countries in the world have adopted a uniform way to identify vehicle with help of License Plate system. The size of license plate varies from vehicle to vehicle or country to country. To identify the size of characters segmentation of the captured image is necessary in intelligent traffic system. Each country has its own method to provide License Number to Vehicles. Hence to identify them correctly every country will require a unique way to identify these license plates with the help of character recognition in intelligent traffic system. This will reduce the chaos of identification of vehicles.***

Key Words: *License Plate (LP), CCTV, Vehicles, Image Processing, License plate recognition (LPR).*

1. INTRODUCTION

1.1 License Plate Recognitions (LPR):

India has been experiencing economic bloom in past few decades this has led to urbanization on large scale resulting in large number of privately owned vehicles. In Today's world number of vehicles is increasing rapidly proving to be a serious problem. Mankind has fallen victim to its own invention in form of Traffic-jams, Accidents, Parking issues etc. Intelligent traffic system (I.T.S) consists of intelligent vehicle systems and intelligent infrastructure systems [16]. In LRP vehicles are identified by their license plate using image processing technologies [17]. LPR is used in various traffic applications, such as dynamic traffic control emergency vehicle clearance, security purposes etc.

Furthermore License plate recognition algorithms should work in real time as it is a curial to never miss any object in the scene. However with technological advances processing power has been developed for LPR system to work in real time

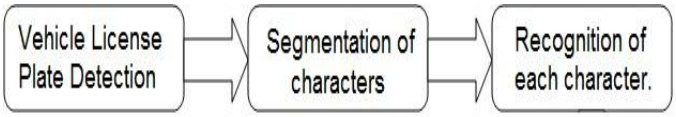


Fig -1: Vehicle License Plate Detection System

1.2 Scope of this Survey:

This paper presents a survey of papers consisting of image and video processing techniques that use similar methods for license plate recognition. Whenever available parameters such as platform used for each method, accuracy, performance, image size, and execution time are appraised. This paper highlights that there is a need of standardization in the way that methods are evaluated, and for that reason, it is not suitable to explicitly declare which methods truly demonstrate the peak performance. Aiming to put forward a widespread and important survey of latest license plate recognition methods, this paper is prearranged as follows: In Section II, we impart a wide ranging review of techniques to detect License Plate using image or video processing. Character segmentation methods and criteria are discussed in Section III, whereas Section IV demonstrates the character classification techniques. Lastly, this paper summarizes with a discussion on latest license plate recognition techniques.

2. LICENSE PLATE DETECTION

2.1 Binary Image Processing

2.1.1 Edge Detection

An Edge is a point at which the brightness in an image changes sharply. Mathematical methods that identify points where brightness changes sharply in an image are called as edge detection techniques. Edge detection is basic method for characteristic detection or extraction [1]. Different edge detection algorithm / operators such as Vertical Edge Detection [10] & Sobel operator [4] are used for edge detection.

In [4] and [10] vertical edges of vehicle images were enhanced using sobel operator with a high accuracy rate that gives binary image. This is followed by removing noise & most of background making it easy to Filter-Out the Long and Short Edges [4] these techniques yield an accuracy rate of over 97% which is good enough to be used in real time system. Figure below demonstrates a vertical edge image followed by sobel operator applied to remove unwanted edges

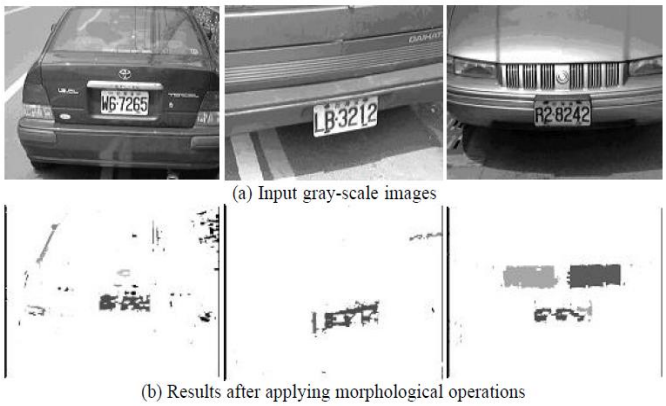
(a) (b)

(a) vertical edge image, (b) removing background and noise edges (filter-out the long and short edges).

Fig -2: Edge Detection.

2.1.2 Morphology

Morphological image processing is a set of non-linear operations that are related to the image characteristics [18]. These operations rely only on relative ordering of pixel values. Hence morphology is well suited for binary image processing. Morphological processing can be used to detect license plate by comparing the contrast between the background plate and letters [4] [6] [13], the license plate detection rate is high after applying morphological image processing. Following image demonstrates the use of morphological operations.



(a) Input gray-scale images

(b) Results after applying morphological operations

Fig -3: Morphology.

2.2 Gray-Level Processing

2.2.1 Region Segmentation

Sliding concentric window is a Segmentation technique used for Region Segmentation. A new method is being planned to examine roadside images which frequently contains vehicles and extort license plate from usual properties by finding vertical and horizontal boundaries from vehicle section. The SCWs are base on the arithmetical dimension of standard difference. While working with this technique, all pixels in the picture are inspect one by one in terms of gratifying a comparison rule about the standard difference values of nearest areas. The algorithm was urbanized and implemented as follows:

- Creation two concentric casement in which A of size (X1) x (Y 1) pixels and B of size (X2) x (Y 2) pixels; correspondingly.
- Computation of the standard difference of the pixels in Casement A(std_A) and B(std_B).

Description of segmentation rule: if the standard difference ratios of the two casements surpass a doorstep set by the user, then the central pixel of the Casement is considered to belong to a vertical and horizontal region.

Sliding concentric window is used for faster detection of regions in dissimilar usual backgrounds and algorithmic sequence managing plates of different size and positions. [7]

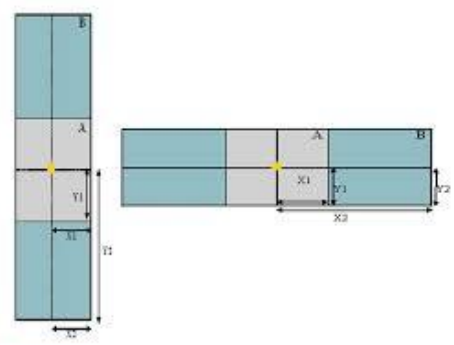


Fig -4: Concentric windows for detecting vertical and horizontal regions.

2.3 Color Processing

2.3.1 Color Model Transformation

Color is explained by its well-known RGB system, or by some of its linear revolution as XYZ. This Transformation is based on RGB color image. There are many edges, which are in close shared immediacy and are dispersed in a recurring way, contained in a license plate. The edge recognizer is so responsive to only three kinds of edges, black-white, red-white, and green-white. By disregarding other kinds of edges in an image, very few edges license plates are not detected due to background with very clutter. The RGB color of the input color image is converted into the HSI color image. [11]

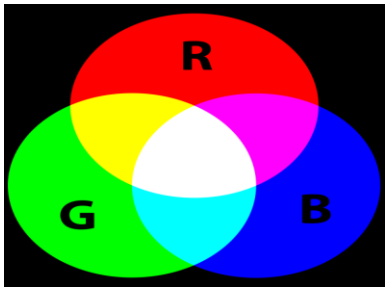


Fig -5: RGB Model

2.3.2 Histogram Processing

A histogram is a graph that represents the rate of anything. Histograms have bars that show the rate of occurring of data in the whole data set. Authors in [7] say Histogram Represent rate of pixels intensity values. In an image histogram, the x axis shows the gray level intensities and the y axis shows the frequency of these intensities.

Histograms take part in a fundamental role of image processing, in region such as development, segmentation and explanation. Histogram operations are performed on an image in the HSI color space.

In Horizontal position in the histogram were two substances are found where each substance corresponds with one row. Then the rows are inaccessible and processed independently. In the vertical position in the histogram we can find inaccessible alphanumeric characters.

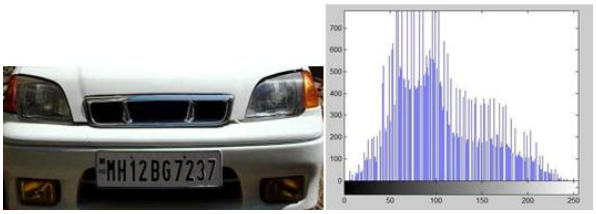


Fig -6: Histogram.

2.4 Classifiers

2.4.1 Computational Intelligence

License plate detection is a key role in intelligent transportation systems. It can be functional in vehicle management, such as security control, traffic monitoring, automatic vehicle ticketing.

In this some systems require complicated video capture hardware, perhaps mutual with infrared strobe lights (PVW), or require that the images be taken with little deformation from view-point changes. [3]

Computer visualization and character detection algorithms for LPR are used as center modules for intelligent transportation systems like electronic payment systems (toll payment and parking fee payment) and expressway and major managing systems for traffic observation.

Neural network (PCNN) schema was illustrated to produce candidate regions that may enclose an LP. [11] A number of adjustments and deviations were introduced to the original research in and to style its presentation to image processing algorithms.

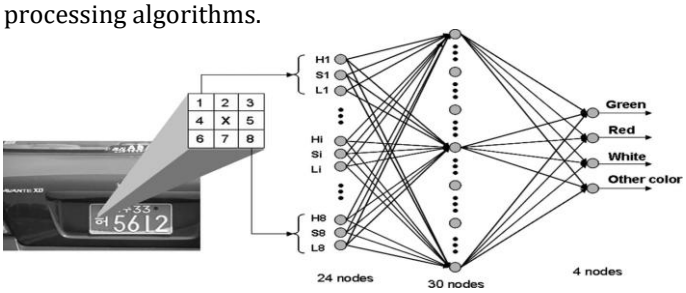


Fig -7: Neural network projected in license plate detection.

2.4.2 AdaBoost

Author of [9] say Adaptive boosting (AdaBoost) was used in conjunction with Haar-like features for preparation flow classifiers in, a total of 100 Haar-like features are applied to sub regions sized 45 × 15 pixels being scan as projected LP areas in the original image. AdaBoost is adaptive in the intelligence that consequent weak learners are twist in favor of those cases misclassified by preceding classifiers. [14] AdaBoost is responsive to raucous data and outliers. In some problems, conversely, it can be less vulnerable to the over fitting trouble than other knowledge algorithms. The individual learner can be weak, but as long as the presentation of each one is vaguely better than chance guessing.

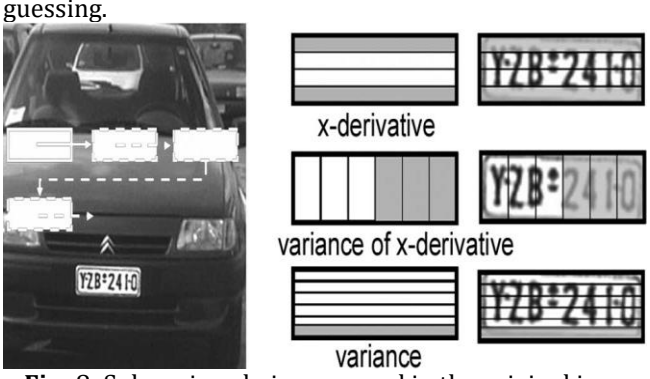


Fig -8: Sub regions being scanned in the original image. (Right) Example AdaBoost.

3. CHARACTER SEGMENTATION

3.1 Binary Image Processing

3.1.1 Projections and Binary Algorithms

A projection of the incidence group i.e. totaling power values at the same horizontal edge of the incidence band will produce a horizontal frequency total energy sharing graph with the same vertical direction. The Authors in [5] wish to discover block among higher values. The location of the blocks represents the upper and lower edges of the LP. A two-stage procedure is projected in the advance, the uneven location, and the correct. The uneven location in which candidate regions of license plate are found, and the correct location where the exact plate region is take out from candidate regions.

3.1.2 Mathematical Morphology

In this technique, ascent extent and their local variance in an image are calculated. They are based on the possessions that the brightness change in the license plate region is more extraordinary and more recurrent than otherwise. Block-based exemption is also sustained. Then, regions with a high edge level and high edge conflict are recognized as possible license plate regions. Since this technique does not depend on the edge of license plate periphery, it can be functional to an image with indistinct license plate border and can be implemented simply and fast. A disadvantage is that edge-based methods alone can hardly be functional to multifaceted images, since they are too responsive to not needed edges, which may also show high edge extent or variance. [4] In spitefulness of this, when mutual with morphological steps that reduce not needed edges in the processed images, the license plate removal rate is comparatively lofty and quick judge against to other technique.

3.2 Gray-Level Processing

3.2.2 Local/ Adaptive Thresholding and Transformations

Binary is the worldwide doorsill which cannot constantly generate practical results in such cases, adaptive local binary methods were also implemented. In much narrow binarization technique, an image is divided into $m \times n$ blocks, and a threshold is chosen for each block. [10] The study carried out in the follows the above block partition method that implements the vibrant binarization technique.

Using the configurations of the antenna and the detachment between the antenna and vehicles, the expected size of characters in the images was expected in advance. To professionally deal with all probable combinations of candidate regions of font, the authors in [12] employed several hypotheses that were represent using tree explanation, as in similarly, in and, Thresholding techniques are used for pixel separately.

3.3 Color Processing

3.3.2 Principal Visual Word

Visual words generated from unsubstantiated bunch are responsive to raucous features from image conditions; it is attractive to yield the principal visual words that communicate to each exclusive nature in the license plate. [3] Besides, these principal visual words are predictable to contain arithmetical circumstance, which can be used to presume the size of the equivalent character. The PVW technique yield an accuracy rate of over 93.2% while character segmentation. [3] Thus making it good enough for real time application of this system.

3.4 Classifiers

3.4.2 Gradient Density

Sections that enclose a license plate be inclined to have a high thickness of edge in order. For algorithm effortlessness purpose, the gradient in order is investigated rather than edge in order in [9] because a proficient universal purpose edge detector is usually complicated to obtain in practice. The gradient density in a block is used to illustrate the edge thickness of the block.

4. CHARACTER RECOGNITION

4.1 Binary Image Processing

4.1.1 Morphological skeletization

It is an outline (or medial axis) illustration of a shape or binary image, premeditated by means of morphological operators. [13] Morphological skeletons are of two kinds:

- Those defined by means of morphological notch, from which the original character can be modernized and,
- Those compute by means of the hit-or-miss transform, which preserve the shape's topology.

The cavities analysis is very effective as it allows you to relate a group that was initially composed of 26 letters and 10 numbers to 3 groups different: elements with two, one or no cavity. [6] To complete this task it is necessary to develop two algorithms responsible for the detection of cavities and the other responsible counting. We note that, with this analysis, we can easily recognize the characters "B" and "8" as the only ones present two cavities. As for characters that have a single cavity, we have a group of 6 letters and 4 numbers, leaving the group of all cavities 19 letters and five numbers. The analysis end is to identify the extreme points of a character.

4.2 Gray-Level Processing

4.2.1 Hidden Markov models

For the acknowledgment of segmented characters, frequent algorithms browbeaten mainly in ocular character-recognition application utilized hidden Markov models (HMMs), neural networks Hausdorff indifference, SVM-based character recognizer, and pattern identical. When HMMs are employed, the admiration begins with a preprocessing and a parameterization of the RoIs detected in the previous segment. The recognition result in [8] was reported to be 95.7% after a complex procedure of preprocessing and parameterization for the HMMs.

4.3 Color Processing

4.3.1 Principal Visual Word

Visual words generated from unsubstantiated bunch are responsive to raucous features from image conditions; it is attractive to yield the principal visual words that communicate to each exclusive nature in the license plate. [3] Besides, these principal visual words are predictable to contain arithmetical circumstance, which can be used to presume the size of the equivalent character. The PVW yields an accuracy rate of 84.8% for character recognition making it ideal to use in real time system.

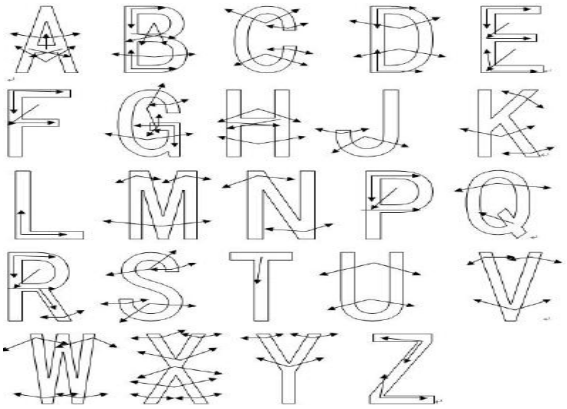


Fig -9: PVW of each letter from "A" to "Z, excluding "I" and "O." Each arrow denotes a PVW.

4.3.2 Histogram Processing

A histogram is a graph that represents the rate of anything. Histograms have bars that show the rate of occurring of data in the whole data set. Histogram Represent rate of pixels intensity values. In an image histogram, the x axis shows the gray level intensities and the y axis shows the frequency of these intensities.

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In Horizontal position in the histogram were two substances are found where each substance corresponds with one row. Then the rows are inaccessible and processed independently. In the vertical position in the histogram we can find inaccessible alphanumeric characters.

4.4 Classifiers

4.4.1 Template Matching & Neural Network

Teuvo Kohonen introduced a self organizing map (SOM) in the year 1980 known as the Kohonen Model. [19] It produces low-dimensional representation of input space of license plates

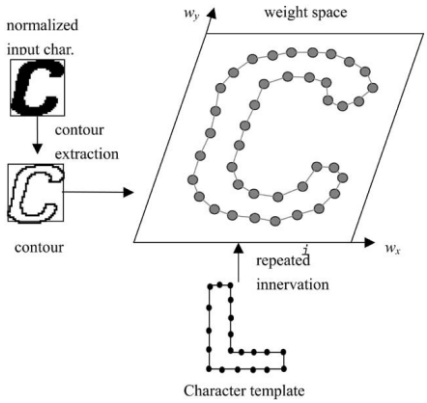

Fig -10: Example of SO character recognition

5. CONCLUSIONS

5.1Current Trends

License Plate Recognition is an umbrella application that caters to various applications such as intelligent traffic system, speed estimation, surveillance, vehicle identification etc. LPR has traffic management applications such as emergency vehicle clearance, dynamic traffic signal time system; stolen vehicle detection system etc. Moreover for highway transport management LPR is useful to avoid traffic at toll booths.

5.2 Outlook for the Future

Although LPR has seen significant progress in last decade, there is lot of work to be done to make LP detection robust. LPR system should work effectively under various environmental conditions, illumination conditions etc. With new technological advancements in the auto industry vehicles are getting faster and faster. So LPR has to also upgrade its technology to match the speed of vehicles in real time. Moreover traffic may consist of variety of vehicles and motorcycles it is important for LPR to recognize each vehicle in real time. As already described in this survey, many algorithms utilize fixed plate geometry, color, and character fonts for LP location, segmentation, and character recognition. [15]. There is a lot of scope for LPR in near future as new image processing techniques will evolve to solve the alarming problem of traffic & transportation management system.

5.3 Summary

This paper has been an effort to provide a complete survey of research on LPR. The foremost contribution of this paper has been to offer a brief source of reference for LP detection researchers. This paper would allow system developers to understand the methods involved in LPR.

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