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An Evaluation of Automatic License Plate Recognition

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ABSTRACT: In the last decades vehicle license plate recognition systems are as central part in many traffic management and security systems such as automatic speed control, tracking stolen cars, automatic toll management, and access control to limited areas. There are many techniques for license plate detection. The goal of this paper is study and evaluates some most important LPD algorithms and compared them in terms of accuracy, performance, complexity, and their usefulness in different environmental condition. This paper discussed on automatic parking system and electronic parking fee collection based on vehicle number plate recognition. The aim of this research is to develop and implement an automatic parking system that will increase convenience and security of the public parking lot as well as collecting parking fee without hassles of using magnetic card. This paper presents algorithm technology based method for license plate extraction from car images followed by the segmentation of characters and reorganization and also develop electronics parking fee collection system based on number plate information.

KEYWORDS: Automated Parking System, License Plate Recognition and Character Segmentation. autocorrelation, image processing, mean square error, plate number recognition structural similarity index.

I. INTRODUCTION

The car license plate recognition identification and Electronic toll collection (ETC) is an important application in the field of Intelligent Transport System (ITS). The objective is to extract and recognize vehicle registration numbers from car images, process the image data finally utilize for access record and prepare electronic bill. Electronic toll collection (ETC) or Electronic Car parking payment is one of the major research topics in intelligent transportation system (ITS) [1]. ETC is an implementation of a road pricing concept in order to create benefits such as increasing the capacity of toll stations, reducing a toll paying time, enhancing the convenience and safety of travellers, and minimizing air pollution and fuel consumption. There are many algorithms for LPR. Some of them have a good accuracy with more complexity than others. Some of those algorithms are computationally intensive. However, selecting one of them based on some criteria such as execution time, memory usage, complexity of the algorithm, and its accuracy in different situation is a challenging problem. Based on that the purpose of this paper is to study, to investigate and to evaluate some important LPD algorithms and compared them in terms of complexity, execution time, and their accuracy in different situations. In addition, some practical criteria are also considered. Some practical aspects of algorithm are as follows.

- The ability to use in embedded systems or SoC due to the minimum hardware requirements for running.
- Applicable in real-time systems due to high processing speed and accuracy.
- The ability to use in both indoor and outdoor Environments due to independency of lighting and weather conditions.

The LPR is used in real-time systems; it should provide both accuracy and acceptable response time. Most of the LPR systems are based on image processing techniques and character recognition systems. Each LPR system consists of three basic sections namely, image acquisition, License Plate Detection (LPD), and Optical Character Reader (OCR). The image acquisition section receives a signal from a motion sensor and captures an image using a camera. In order to reduce motion blur it should use a high speed shutter. A database is maintained with the in-time and out-time of the vehicle. With the help of the database the electronic bill is generated.

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II. PROPOSED SYSTEM

The block diagram of license plate recognition system implementation is shown in the Fig. 1. There are various steps in this approach and these are implementation using MATLAB R2013a software.

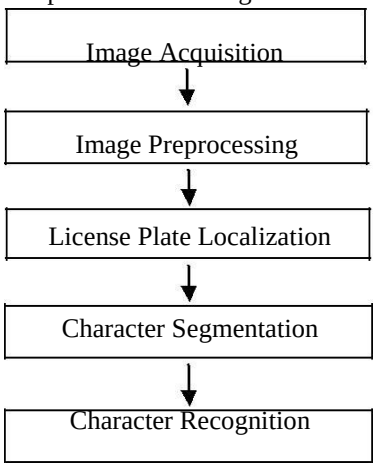

Figure: -1 Block diagram of proposed system

A. Image acquisition

The first stage of any vision system is the image acquisition. The input image is taken either from low resolution camera or from database as per the application. Figure.3. Shows the acquired image of car below which is consider as original or raw image of car.

Figure:- 2. Original image

B. Image pre-processing

When an image is acquired, there may be noises, low contrast, unwanted object etc present in an image. These noises affect the recognition rate greatly. So, these unwanted noises should be removed from the images. To get enhanced image the original image preprocessing with various operation and these are described below.

B.1 Gray scale conversion

It involves conversion of RGB image into a gray scale image. It is more convenient and easier to deal with one component (intensity) in gray scale images than three color components (red, green, blue) in color images

$$G(x,y) = 0.3R + 0.59G + 0.11B$$

Fig 4. Shows conversion of RGB image into gray scale image, noise reduction and contrast enhanced image. The method is based on different color transform. According to the RGB value, gray value is obtained.

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B.2 Noise reduction

We used median filtering technique to reduce the paper and salt noise. We have used 3 x 3 masks to get eight neighbors of a pixel and their corresponding gray value. If f(x, y) represents the dealt image and g(x,y) represents the result image, noise removal using median filtering is shown as:

$$g(x,y)= f(x,y)*h(x,y)$$

Where h(x, y) is filter transfer. Noise removal is necessary step for license plate recognition because it greatly affects the recognition rate of the system.

B.3 Contrast enhancement

Using histogram equalization technique the contrast of each image is being enhanced. The function used to enhancement that is I_Adst = imadjust(I_Gray,[0.3 0.7],[]). The pixel with value below 0.3 is 0 and value above 0.7 is 1 and in between is kept same.

Figure :- 3. Grayscale, noise reduced & contrast enhanced image

B.4 License plate localization

The plate localization is the most important phase of the license plate recognition system. License plate localization consists of number of step. We will see each step in detail. License plate region are localized based on the features of license plates.

B.5 Opening and closing of image

Opening is nothing but erosion followed by dilation and closing is inverse of opening. Opening of image is processes of adding pixel to boundary & closing is removing of pixel from boundary. Firstly, enhanced image is opened and then closed using imopen and imclose function respectively. Fig. 4.Shows (a) opening image & (b) closing image. Once we get this two image take different of them. We get difference result as show in fig.4 (c). In which we can see that license plate region as highlighting.

(a) (b) (c)

Figure 4 (a) Opening (b) Closing of gray scale image & (c) Difference of opening and closing image

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C. Image binarization

In image processing, Otsu's thresolding method (1979) is used for automatic binarization level decision, based on the shape of histogram [54]. The algorithms consider that image composed of two basic classes: foreground and background. It then computes an optimal threshold value that minimizes weighted within the class variance of two classes.

Fig.5 shows binary image. For a given gray scale image, examine the intensity value of each pixel. If it is above a threshold, we mark it as white; otherwise we mark it as black. The threshold chosen for the candidate selection process is 102 (given intensity values ranging from 0 to 255). This threshold is chosen based on examining. Having only black and white pixels makes the image much easier to work.

Figure 5. Binarized image

C.1 Elimination of unwanted region

The binary image show in fig.5 consists of many unwanted region. This unwanted is eliminated in following way and thus produce another binary image.

1. Determine the connected components.

```
[L num]=bwlabel(bw); Compute the area of each component.
STATS=regionprops(L,'area');
```

2. Remove small objects on the base of area idx = find([STATS.Area] > 500); bw2 = ismember(L, idx);

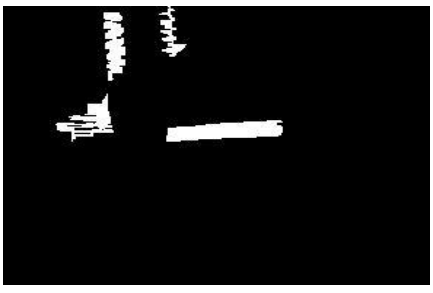

Figure 6. Binary image with unwanted region eliminated.

C.2 Mapping of candidate region

After unwanted region is eliminated a bounding box is obtained from the binary image and mapped on original image. In following way dimension for mapping we get:

```
Iprops = regionprops(Ilabel);    Ibox = [Iprops.BoundingBox];
```

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Bounding box is dimension of rectangle box created around the connected object within an image. Fig. 7 shows a bounding box mapped image.

Figure 7. Mapped candidate region

D. License Plate Extraction

The mapped candidate region are check for certain parameter if all the parameter are satisfied the candidate region is consider as license plate and is segmented from whole image . The parameter of license plate includes shape, symmetry, height-to width ratio, area and number of connected component. Fig.8 show license plate which extracted is from the whole image and binarized.

Figure 8. Extracted License Plate

D.1 Character Segmentation

Character segmentation is important step for recognition of character. Again the unwanted object like dots or some noise needs to be removed. After removing the unwanted object we get the license plate as shown in fig. 9.

Figure 9. License plate free of unwanted object

After removing unwanted objects dilation is performed. Dilation is adding of pixel to boundary of an object. The need for dilation is, in case of broken or disjoints character. As we will use connected component analysis for segmentation, a single character may be treated as two connected component due to broken. Once the character is dilated connected component analysis is done and bounding box is obtained from the dilated image. And this bounding box is mapped on the license plate free of unwanted object. Fig.10 show mapping of character in license plate. Mapped character are cropped and bordered by black pixel. Fig.11 show segmented character.

Figure 10. Mapped Character

Figure 11. Segmented Character

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D.2 Character Recognition

The final step of the license plate recognition system is character recognition. Two essential components in a character recognition algorithm are the feature extractor and the classifier. Feature analysis determines the descriptors, or feature set, used to describe all characters. Given a character image, the feature extractor derives the features that the character possesses. The derived features are then used as input to the character classifier.

Template matching, or matrix matching, is one of the most common classification methods. In template matching, individual image pixels are used as features. Classification is performed by comparing an input character image with a set of templates from each character class. Each comparison results in a similarity measure between the input character and the template. One measure increases the amount of similarity when a pixel in the observed character is identical to the same pixel in the template image. If the pixels differ the measure of similarity may be decreased. After all templates have been compared with the observed character image, the character's identity is assigned as the identity of the most similar template.

The character recognition method consists of the following steps:

1. Skeletonization of segmented character.
2. Inverted input image.
3. Normalization of Individual characters.
4. Recognition using Template Matching.
5. Convert the recognized character images to text.

GUI model constructed as show in fig.12. As seen in fig12. there are two radio button namely online and offline for acquiring car image. By selecting online radio button car image will be captured by laptop camera and by selecting offline button camera image will be selected from database.

Axes 1 (Input) shows the original image and candidate region mapping on original image. Axes 2 shows the mapping of character to be segmented. Axes3 shows the segmented character image and axes 4 show the skeleton of each segmented character. Two push button are provided namely refresh and exit. A graphical user interface provides the user with a familiar environment in which to work.

Figure 12. GUI model for license plate recognition system

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III . CONCLUSION & FUTURE WORK

The process of vehicle number plate recognition requires a very high degree of accuracy when we are working on a very busy road or parking which may not be possible manually as a human being tends to get fatigued due to monotonous nature of the job and they cannot keep track of the vehicles when there are multiple vehicles are passing in a very short time. To overcome this problem, many efforts have been made by the researchers across the globe for last many years. A similar effort has been made in this work to develop an accurate and automatic number plate recognition system.

In this paper, an efficient less time consuming license plate recognition method is proposed which has been tested on complex image. The system has been also tested on images of various lighting conditions, angle etc but still there are some restriction. This system improves different and simple algorithms among the neural network, support vector and the other systems.

In future scope the License Plate Recognition System is to be design for real time stand alone by using the DSP processors. Expand the system to work with real time video· Expand the system to work with Non- Standard License Plates.

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